Alternative Resource Adequacy Structures for New Jersey

STAFF REPORT ON THE INVESTIGATION OF RESOURCE ADEQUACY ALTERNATIVES, DOCKET #EO20030203

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NOTICE

This report was prepared by Staff of the New Jersey Board of Public Utilities (BPU) with research and analytical support from consultants at The Brattle Group. The report reflects the opinions of Staff members of the New Jersey BPU Staff the analytical findings of the individual consultants of the Brattle Group contributing to this study. This report does not necessarily reflect the opinions of New Jersey BPU Commissioners, nor other clients or consultants of The Brattle Group.

The information relied upon in this report included modeling assumptions finalized between December 2020 and April 2021; modeling assumptions have not been adjusted to reflect subsequent market events.

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Resource Adequacy Investigation Findings

In May 2020, the New Jersey Board of Public Utilities (BPU or Board) initiated an investigation into resource adequacy[1] alternatives, directing Staff to assess "whether New Jersey can achieve its long-term clean energy and environmental objectives under the current resource adequacy paradigm and, if not, recommend how best to meet New Jersey's resource adequacy needs in a manner consistent with the State's clean energy and environmental objectives, while considering costs to utility customers."[2]

Over the past year, the Board and Staff have collected extensive input and evidence from stakeholders through receipt of written comments, a series of work sessions, and engagement with regional stakeholders. The BPU has further engaged consultants at The Brattle Group to conduct a modeling assessment of several resource adequacy alternatives, examining the cost, financial risk, and likely environmental outcomes of each framework under consideration.

Based on this evidence, this investigation finds that:

- **Incorporating New Jersey's clean energy goals in the regional market is the most efficient way to provide New Jersey consumers with reliable, affordable, *and* carbon-free electricity.** A clean power grid is necessary to address the crisis of climate change. The transition to a clean energy future must happen, and will happen, with or without a working wholesale power market. But the transition to clean energy can be faster, better, more reliable, and more affordable if power markets are reformed to focus incentives toward achieving policy goals. Of the regional approaches evaluated by Staff, the Integrated Clean Capacity Market (ICCM) best incorporates New Jersey's clean energy targets into the regional energy and capacity markets, which would drive significant investment in zero-carbon generation at a modest increase to current system costs, resulting in a substantially cleaner New Jersey *and* PJM grid.
- **Existing regional market structures have fulfilled their design objectives to maintain reliability at competitive prices, but have lagged behind in addressing state clean energy policies.** To date, participation in competitive regional electricity markets has offered significant benefits to New Jersey ratepayers by offering access to a broad, competitive marketplace for reliability. New Jersey should continue to participate in these markets *if* doing so can be made to be consistent with the State's commitment to eliminating carbon emissions associated with electricity production. Reforming the problematic Minimum Offer Price Rule (MOPR) so that it no longer excludes state policy resources is a necessary, but not sufficient, step toward supporting state environmental policies. The current regional marketplace will not be a satisfactory system to serve New Jersey's reliability and public policy goals until our state's clean energy policies can be explicitly represented, such as through a clean energy market.
- **Regulatory developments at the regional and national level make it premature to consider leaving the regional market structure.** Staff carefully examined a number of resource adequacy alternatives that involved leaving the regional market and adopting a New Jersey-centric resource adequacy

1 "Resource Adequacy" is the process of ensuring that there is a sufficient supply of electricity generating capacity, in the right areas of the electric grid, to reliably meet customer's need for electricity, plus an adequate buffer or "reserve margin," to accommodate periods of high demand or stress on the electric grid, or allow the grid to continue functioning even when isolated generation or transmission resources fail. Since restructuring, New Jersey has relied on the centralized, regional capacity market, run by PJM Interconnection, to meet our resource adequacy needs and ensure a reliable grid.

2 "NJBPU Launches Investigation to Ensure State's Clean Energy Future Despite Federal Regulation that Favors Fossil Fuels," State of New Jersey Board of Public Utilities news release, March 27, 2020; *In the Matter of BPU Investigation of Resource Adequacy Alternatives*, Docket No. EO20030203 (March 27, 2020).

model under the Fixed Resource Requirement (FRR) alternative. Staff concluded that it would be premature to do so while important market reforms are being considered at the regional and federal level that could facilitate the rapid decarbonization of the electricity sector. New Jersey should continue to pursue the first-best outcome of a broad regional ICCM or other clean energy marketplace, as long as a regional clean energy market appears on track for timely implementation.

- **New Jersey should continue to explore the option to implement a New Jersey or multi-state ICCM under the FRR structure.** In case ongoing regional reforms fail to deliver the clean energy marketplace that New Jersey requires, the State should maintain the option to utilize the FRR alternative to implement the ICCM or a similar competitive auction design for meeting the state's reliability and policy requirements. Pursuing a New Jersey ICCM under the FRR structure would require a substantial effort to designate or create a qualified ICCM auction administrator, implement a successful auction, mitigate market power concerns, and enable future participation of other leading clean energy states.

Executive Summary

The State of New Jersey is committed to achieving a 100% clean energy economy by 2050, consistent with the mandates in the Global Warming Response Act, the Clean Energy Act, and Governor Murphy's Executive Order 28.[3] The New Jersey BPU and other state agencies are following through on these commitments with a range of policies and strategies described in the 2019 Energy Master Plan.[4] Policies, practices, and infrastructure across the energy landscape must adapt and advance in order to achieve these commitments at the most affordable cost. Among these critical reforms are advances to the PJM regional electricity marketplace.

Over the past two decades, PJM markets have for the most part performed well in their role to deliver power to New Jersey consumers reliably and at competitive prices. However, these markets include no path to reducing, and eventually eliminating, fossil fueled power plants, as mandated by New Jersey public policy and environmental goals. Instead, states with aggressive carbon reduction mandates, including New Jersey, are forced to develop increasingly elaborate workarounds to meet clean energy goals. For example, PJM wholesale market incentives, which are based on maintaining reliability at the least cost, have attracted large-scale investments in over 35,000 MW of new natural gas-fired plants into the PJM region since the 2015/16 delivery year.[5] The scale, speed, and competitive pricing at which these plants have been developed demonstrate the capability of a broad regional marketplace to mobilize private capital to achieve large-scale resource transformation without putting ratepayers at risk. However, the fact that these investments are made in new fossil plants rather than clean energy resources also demonstrates the fundamental disconnect between the current market design and New Jersey's clean energy future.

Another illustration of this growing disconnect was the December 2019 Federal Energy Regulatory Commission (FERC) order requiring PJM to expand the application of the MOPR to clean energy resources receiving environmental incentives from state policy makers.[6] The expanded MOPR has become a catalyst for states, environmental advocates, clean energy companies, and consumers to demand reforms to PJM's capacity market, the Reliability Pricing Model (RPM), that help, not hinder, state clean energy objectives.

Within its Resource Adequacy Investigation, the New Jersey BPU has been taking action to address this gap and identify a path forward for the state and the broader PJM region. Beyond the near-term issue of avoiding MOPR impacts, the Board sought input on the longer-term consistency between New Jersey's energy and environmental objectives and the current RPM capacity market design. The Board's consultants at The Brattle Group evaluated New Jersey ratepayer costs and clean energy outcomes across a range of resource adequacy alternatives identified within the Board's investigation. The high-level results of that assessment are summarized in Figure 1.

The charts demonstrate two main takeaways: *first*, that the lowest-cost resource adequacy market solution, the "No-MOPR" capacity market does not advance New Jersey's clean energy achievement as compared to the status quo; and *second*, that achieving 90%+ percent of clean energy can be achieved at modest costs through a PJM-wide or New Jersey-only ICCM approach to resource adequacy.

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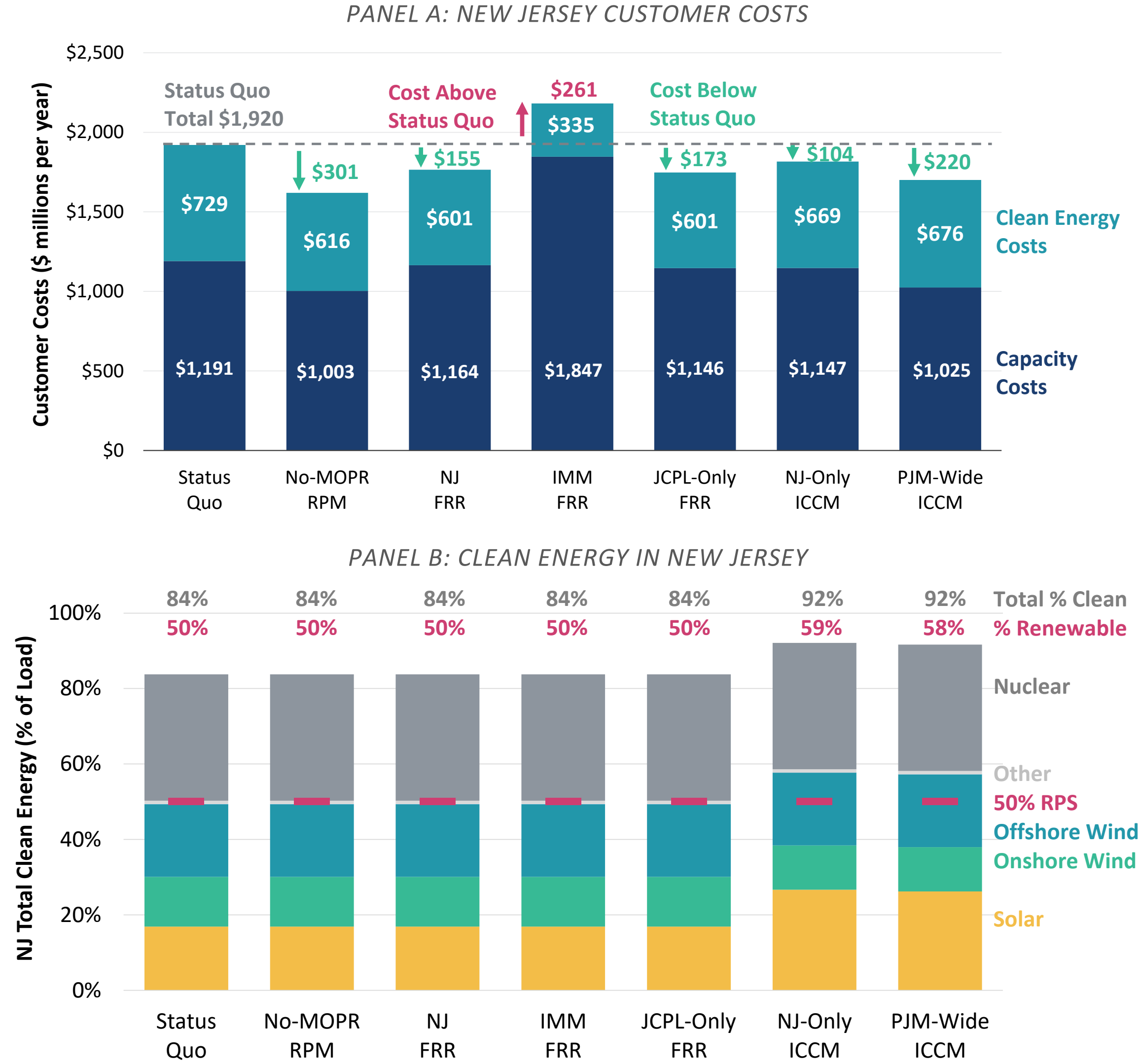
3 *See* State of New Jersey Department of Environmental Protection, "New Jersey's Clean Energy Picture" and New Jersey Government Executive Order No. 28.

4 *See* State of New Jersey Energy Master Plan.

5 PJM Interconnection, L.L.C., "2022/2023 RPM Base Residual Auction Results," Table 8.

6 *See* *Calpine Corporation et al. v. PJM Interconnection, L.L.C*, 169 FERC ¶ 61,239 (December 19, 2019). *See also* "FERC Directs PJM to Expand Minimum Office Price Rule," Federal Energy Regulatory Commission news release, December 19, 2019.

FIGURE 1: NEW JERSEY CUSTOMER COSTS AND SUPPLY MIX IN 2030 BY RESOURCE ADEQUACY DESIGN



The MOPR rules in effect as of June 2021, if left in place, will cost New Jersey customers approximately $300 million per year by 2030; PJM-wide customer costs will be approximately $1,700 million per year. The current MOPR is costly, directly opposes New Jersey's policy goals, and should be immediately repealed or significantly reformed. However, **Staff emphasizes that immediately eliminating the application of MOPR to policy resources is an essential, but by no means sufficient, step toward correcting the PJM markets.** Repealing or reforming the MOPR will do nothing to address the more fundamental disconnect between the PJM marketplace and New Jersey's clean energy transition. Accordingly, this investigation recommends that New Jersey Board and Staff should not only advocate for the elimination or reform of the MOPR, but also focus effort on the essential task of identifying a long-term sustainable market design that facilitates the efficient and cost-effective achievement of the State's clean energy goals.

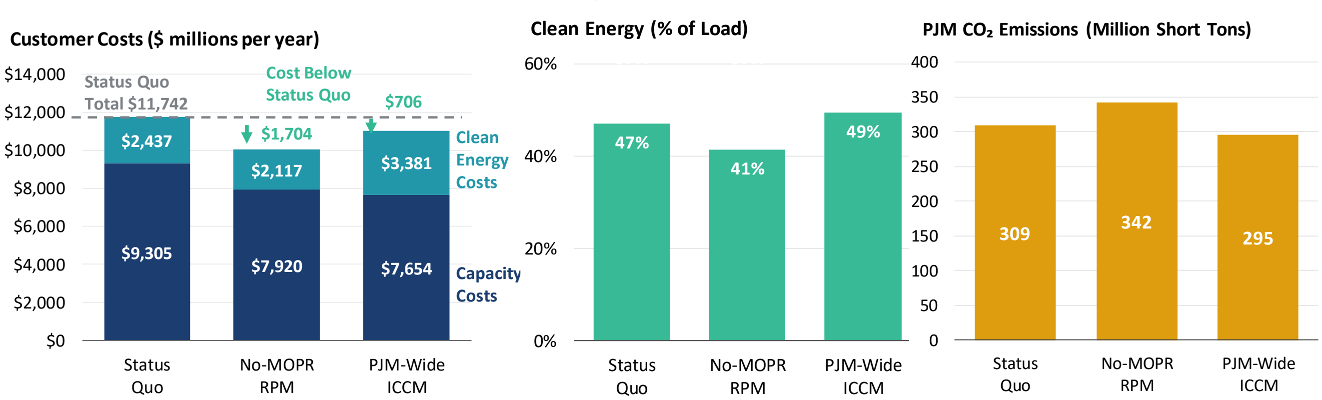
Throughout the investigation, commenters also proposed several avenues for New Jersey to manage its own resource adequacy responsibilities through use of PJM's FRR alternative. Some of the FRR alternatives are focused exclusively on limiting the customer cost impacts of the 2019 MOPR, but would pose a number of implementation risks. Under near-best-case assumptions, pursuing a MOPR-focused FRR could save approximately half the costs of a full MOPR repeal; under near-worst-case assumptions, an FRR could impose costs significantly in excess of the costs imposed under MOPR. Staff is currently monitoring PJM's MOPR reform efforts, and PJM states that it intends to implement a revised MOPR prior to the December 2021 auction (for delivery year 2023/24), which would eliminate the need to consider the FRR alternatives that are primarily oriented toward mitigating cost impacts from MOPR. Assuming the 2019 MOPR is repealed in a timely fashion, New Jersey should only consider pursuing an FRR alternative as a means to implement a resource adequacy structure that advances the State's clean energy goals.

Staff also examined the benefits of adopting a new market design, the ICCM, focused on meeting New Jersey's reliability and clean energy requirements in a competitive fashion. The ICCM would secure commitments to produce clean energy attributes three years in the future from clean energy resources that, when taken together, results in the lowest cost, reliable, electric grid that delivers on states' clean energy objectives. Staff examined two pathways to implement the ICCM, either: (1) through PJM-wide adoption of the ICCM as a replacement to the RPM; or (2) through a New Jersey or multi-state FRR ICCM construct. Staff concluded that both approaches would address the identified limitations of the current RPM design, and fulfill New Jersey's requirement to support the reliable, affordable, and carbon-free resource mix needed for grid transition.

Staff concluded that both of these pathways could address the limitations of the current RPM construct and advance New Jersey's clean energy goals at affordable costs. Compared to the status quo (with the current MOPR) a PJM-wide implementation of the ICCM could save New Jersey customers approximately $220 million per year, while a New Jersey ICCM implemented under FRR could save approximately $100 million per year. Both ICCM approaches would advance renewable energy from 50% to approximately 59% of New Jersey customer demand by 2030 (increasing from 84% to 92% considering renewables plus nuclear).

The PJM-wide ICCM has several advantages over the New Jersey ICCM however, given that the economic and environmental benefits would be amplified across the broad regional marketplace, as illustrated in Figure 2. The entire PJM footprint would advance clean energy from 41% (under No MOPR RPM) to 49% (under PJM-wide ICCM). The carbon impact of adopting ICCM on a region-wide basis would be similarly amplified, reducing PJM-wide carbon emissions by approximately 50 million tons per year (or 14%) by 2030. Depending on how states across the PJM footprint would choose to express their policy goals, the ICCM could be utilized to reduce the costs of meeting existing clean energy goals; accelerate renewable deployment; retain existing nuclear plants at risk for retirement; accelerate development of clean capacity resources such as demand response and storage; and/or enable customers to meet their own clean energy objectives. Such a marketplace would offer the greatest economic and environmental benefits if implemented across the broadest possible footprint. Thus, New Jersey should seek to achieve the ICCM or a similar solution on a PJM-wide basis as a replacement to RPM.

FIGURE 2: PJM-WIDE CUSTOMER COSTS, CLEAN ENERGY AND CARBON DIOXIDE EMISSIONS



In parallel to and partly in response to the Board's resource adequacy investigation, the Organization of PJM States, Inc. (OPSI), PJM Interconnection, and the FERC have each initiated separate efforts to repeal the 2019 MOPR and pursue broader capacity market reforms.[7] These initiatives demonstrate a growing understanding that PJM's capacity market must be reformed to align with the clean electricity future reflected in state policy goals. PJM processes beginning in July 2021 may offer one avenue through which New Jersey and other leading states can express the requirements that the new PJM market design must meet in order to support our clean energy future.[8] However, New Jersey cannot guarantee that a satisfactory resource adequacy market will be achieved through these reform efforts, nor that it will be implemented in the timeframe dictated by State policy goals. Staff therefore recommends the State continue to examine the use of an FRR structure to implement a New Jersey or multi-state ICCM.

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[7] *See* Organization of PJM States, Inc. (OPSI), Letter of OPSI Principles to Guide PJM Market Design Evolution, January 8, 2021; Craig Glazer and Stu Bresler, "Capacity Market," PJM Interconnection, L.L.C, February 12, 2021; and Federal Energy Regulatory Commission "Technical Conference on Modernizing Electricity Market Design under AD21-10".

[8] *See* Adam Keech, Lisa Morelli, Dave Anders, "Capacity Market Workshop #4 –Next Steps," PJM Interconnection, L.L.C., March 26, 2021, p. 27.

I. Background

As a participant in the PJM wholesale power market since its inception, New Jersey has relied on the regional marketplace to provide low-cost and reliable electricity, which are the stated goals of RPM. While the regional competitive market has performed well in offering secure low-cost supply to New Jersey, the PJM wholesale power market was not designed to meet the State's growing demand for a cleaner electricity supply mix. At best, the current wholesale market is indifferent to carbon emissions; at worst, the wholesale market is acting at cross purposes to environmental goals (e.g., through the application of MOPR to clean energy projects incentivized through state programs and by attracting investments in new gas-fired power plants).

Because the PJM market does not yet account for the growing policy and consumer demand for clean energy, New Jersey meets these needs separately through its own programs. In recent years, New Jersey has implemented policies for a clean energy future including a 50% Renewable Portfolio Standard (RPS) by 2030 and planning a pathway toward 100% clean energy by 2050.[9] To meet its policy mandates, New Jersey incentivizes renewable energy resources to enter the market with competitive solicitations for offshore wind, a market for renewable energy credits (RECs), a zero emissions certificate (ZEC) program for retaining existing nuclear resources at risk for retirement, support for solar and storage resources, and various other policy incentives.

As a foundation for this investigation, Staff has reviewed the workings of the current PJM capacity market and its interactions with other aspects New Jersey policy to identify the components of RPM that misalign with New Jersey's stated clean energy future and identify the needed reforms.

A. New Jersey's Energy Policy Goals

New Jersey has ambitious goals to reduce greenhouse gas emissions and eliminate fossil fuel generation from its supply mix. The State's RPS, last updated in 2018, requires transitioning to a 35% renewable power supply by 2025 and 50% renewable by 2030.[10] The State has also set a goal of 7,500 MW of offshore wind energy by 2035.[11] Further, the 2019 Energy Master Plan outlined strategies to reach Governor Phil Murphy's administration's goal of 100% clean energy by 2050.[12] Finally, New Jersey also supports in-state nuclear resources through ZECs.[13] Figure 3 summarizes the mix of renewable and nuclear supply that will contribute to New Jersey's clean energy supply consistent with the 2019 Energy Master Plan, 50% by 2030 RPS, ZEC program, and other clean energy mandates.

9 *See* "2019 New Jersey Energy Master Plan: Pathway to 2050," New Jersey Board of Public Utilities, accessed May 7, 2019.

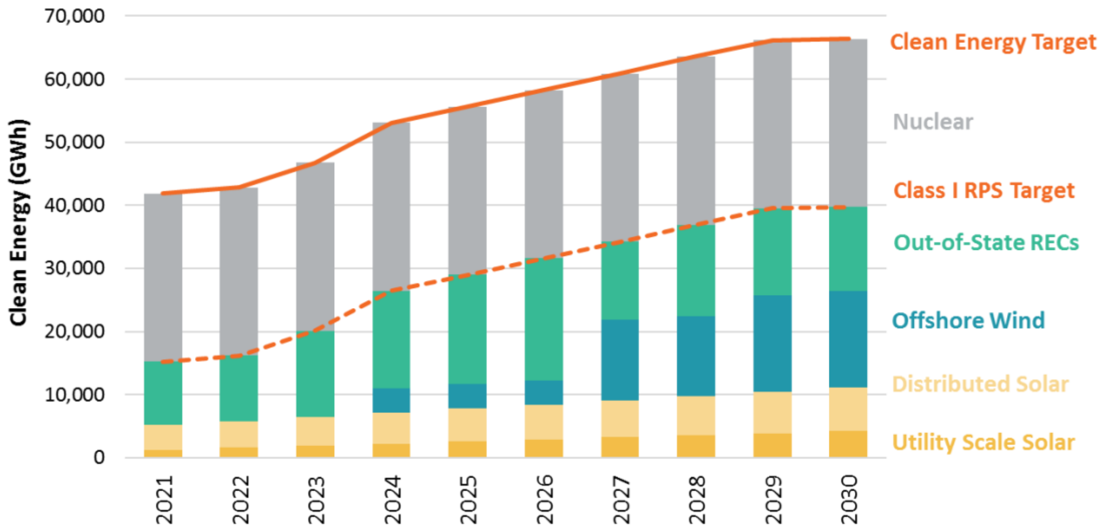
10 The renewable portfolio standard also requires a minimum amount of sales to be served from qualifying solar electric generation, decreasing from 5.1% in Energy Year 2021 to 1.1% by Energy Year 2033. These requirements are in addition to 2.5% of electricity which must come from qualified Class II renewable energy sources. *See also*, "New Jersey," PJM Environmental Information Services.

11 State of New Jersey, *Executive Order no. 92*, November 19, 2019, accessed May 7, 2021.

12 For order directing the completion of the 2019 Energy Master Plan, see State of New Jersey, *Executive Order no. 28*, May 23, 2018; For energy master plan, see State of New Jersey, "2019 New Jersey Energy Master Plan Pathway to 2050."

13 *See* N.J. Stat. § 48:3-87.8(d), approved May 23, 2018.

FIGURE 3: CLEAN ELECTRICITY SUPPLY TO MEET NEW JERSEY CLEAN ENERGY MANDATES THROUGH 2030



Sources and Notes: Nuclear is eligible for support under the ZEC program. RPS target and solar carveout obtained from PJM Environmental Information Services, "Comparison of Renewable Portfolio Standards (RPS) Programs in PJM States," August 19, 2020. Percentage targets converted to MWh using BPU jurisdictional load subject to RPS in 2020 scaled by the PJM growth rate for New Jersey wholesale load from the 2021 PJM Load Forecast Report. Solar generation calculated based on existing capacity as reported in the BPU November 2020 Installation Report, assuming an additional 250 ICAP MW each per year for both behind-the-meter solar and grid supply solar, and a 15% capacity factor. Offshore wind generation based on New Jersey solicitation schedule assuming 1,800 MW procured for 2027 and 600 MW procured for 2029, and capacity factors of 40% for the first 1,100 MW procured and 50% thereafter. *See* "Governor Murphy Announces Offshore Wind Solicitation Schedule of 7,500 MW through 2035," Office of the Governor of the State of New Jersey press release, February 28, 2020. Out-of-state RECs calculated as balance in energy required to meet New Jersey's RPS goals. Nuclear generation estimated using 2019 historical generation from Form EIA 923.

B. The Role of PJM's Capacity Market in Supporting Reliability

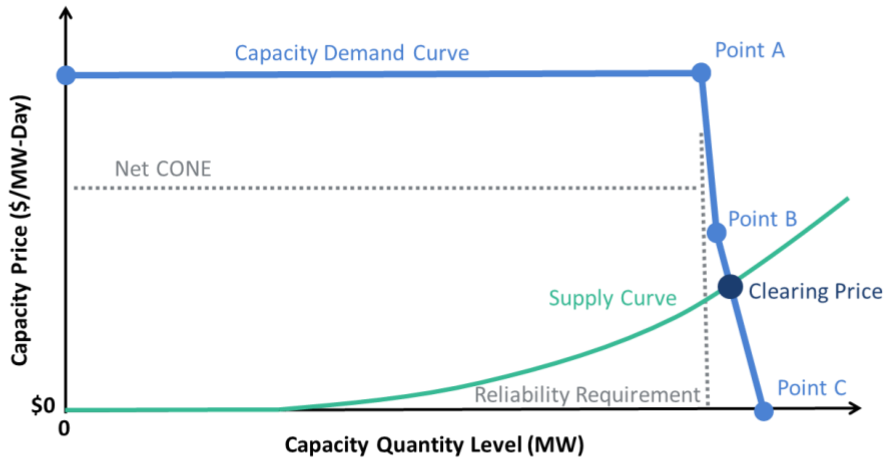
PJM's capacity market, the RPM, is a market-based system for procuring commitments from capacity resources that must be available to meet system and locational reliability needs. The quantity of capacity procured must be sufficient to meet a reliability standard of no more than *one expected loss-of-load event in ten years* (0.1 LOLE or 1-in-10). PJM establishes a reliability requirement based on forecasted peak load plus the installed reserve margin (IRM) needed to maintain 1-in-10 reliability. The capacity market aims to procure sufficient generation, storage, or demand response to meet reliability needs at the lowest possible cost through the three-year forward competitive Base Residual Auctions (BRAs). The RPM uses locational pricing that reflects transmission system limitations and uses a pay-for-performance incentive and penalty structure to incentivize resources to deliver on their capacity commitments during reliability events.

PJM uses an administratively-determined Variable Resource Requirement (VRR) curve to procure capacity under the RPM, as illustrated in Figure 4. The VRR is a downward-sloping demand curve that specifies the prices and demand relative to the IRM.[14] Prices in the VRR curve are tied to the administrative estimate of the Net Cost of New Entry (Net CONE), which is the price at which new generation resources would be

[14] PJM Interconnection Capacity Market & Demand Response Operations, "PJM Manual 18: PJM Capacity Market," Revision 47, January 27, 2021, Section 3.

willing to enter the market. System wide and locational VRR curves are designed to allow for the procurement of sufficient capacity to achieve resource adequacy, mitigate price volatility, and mitigate the ability for sellers to exercise market power.[15] Market participants with existing resources are required to offer available capacity into the RPM. New resources (not subject to MOPR provisions) may also offer into the market as price takers or at prices that reflect their individual net costs of entering.[16] The intersection of market participant supply offers and the VRR curve in each location sets the market price paid to all cleared capacity resources for the relevant one-year delivery period in that location. Supply resources unable to meet their capacity commitments are subject to deficiency and penalty charges. RPM prices are designed to be consistent with supply-demand conditions; the RPM produces low prices when there is more than enough supply to meet resource adequacy needs and high prices when capacity supply is scarce.

FIGURE 4: ILLUSTRATIVE PJM CAPACITY SUPPLY AND DEMAND CURVES



Historically, the PJM capacity market has been able to attract new investment and procure capacity that exceeds the reliability requirement, and at prices below the administrative estimate of Net CONE. Since the 2007/08 delivery year, 46,000 ICAP MW of new generation capacity has been attracted into the PJM capacity market, with an additional 11,000 ICAP MW from uprates to increase the output capability of existing resources. Beyond these additions of generation capacity, RPM has attracted other sources of capacity supply. Demand response and energy efficiency have increased by 15,000 ICAP MW, and net capacity imports have increased by 3,000 ICAP MW. These incremental capacity resources have been sufficient to meet increases in regional demand and replace large quantities of retirements from aging coal, nuclear, oil-fired, and high-heat rate natural gas plants.[17]

PJM uses the capacity market to procure capacity across the region to meet system-wide and local reliability needs at the lowest possible cost. Subregions of PJM with limited import capability due to transmission constraints are modeled as separate Locational Deliverability Areas (LDAs). Figure 5 shows a map of LDAs that are currently modeled in the RPM.

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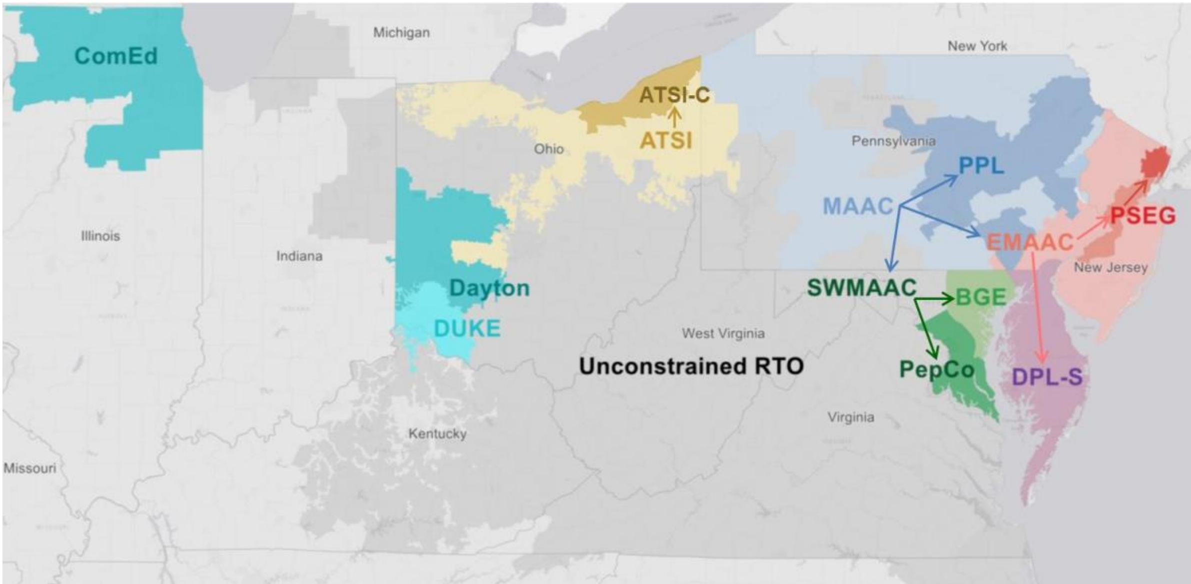
[15] Samuel Newell *et al*. "PJM Cost of New Entry: Combustion Turbines and Combined-Cycle Plants with June 1, 2022 Online Date," April 19, 2018.

[16] Seller offer prices are driven primarily by their going-forward investment and fixed costs minus any net revenues they anticipate to earn from selling other products such as energy, ancillary services, or RECs. Many capacity resources offer at a zero price if they have already come online and have few going-forward capital investments or can pre-sell most of their capacity or energy through bilateral contracts. Participants may also adjust their capacity offer price based on their long-term view of future energy and capacity prices.

[17] PJM Interconnection, L.L.C, "2022/23 RPM Base Residual Auction Results," May 23, 2018, pp. 20, 22, and 24.

FIGURE 5: MAP OF MODELED LOCATIONAL DELIVERABILITY AREAS IN PJM



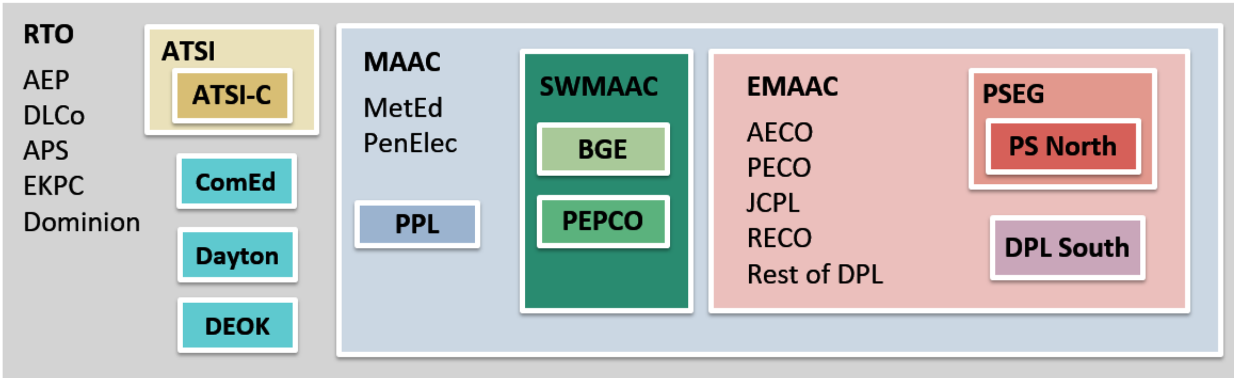
Sources and Notes: Samuel Newell *et al.,* "Fourth Review of PJM's Variable Resource Requirement Curve," April 19, 2018, Figure 1. The map represents modeled LDAs as of 2022/23.

Modeled LDAs each have a locational VRR curve, local Reliability Requirement, and locally estimated Net CONE. A "nested" LDA structure is used to reflect the transmission topology across the PJM system, in which successively smaller LDAs can procure capacity locally or from larger "parent" LDAs. Each LDA must have enough capacity procured to meet the local reliability requirements but can import a portion of that capacity from the parent LDA up to the maximum quantity that the transmission system can support or the Capacity Emergency Transfer Limit (CETL).[18]

This complex transmission topology is illustrated in Figure 6 below. Note that modeled LDAs in the capacity market do not necessarily align with utility service territories or state boundaries. The State of New Jersey comprises all or parts of three distinct modeled LDAs: EMAAC, Public Service Electric and Gas Company (PSEG), and PSEG North (PS-North). In addition, New Jersey can serve a portion of its capacity needs through imports from its parent LDA, the Mid-Atlantic Area Council (MAAC). Each modeled LDA has separate reliability parameters that must be achieved and each may produce distinct capacity clearing prices. The RPM reflects these transmission constraints within auction clearing by optimizing capacity imports to meet the reliability needs of all LDAs at the lowest cost. By participating in a broad regional marketplace, New Jersey can save costs by importing lower-cost capacity (to the extent possible) while ensuring that sufficient local capacity will be available for reliability needs.

[18] *See* "Special Planning Committee: CETO/CETL Education," PJM Interconnection LLC, accessed May 7, 2021.

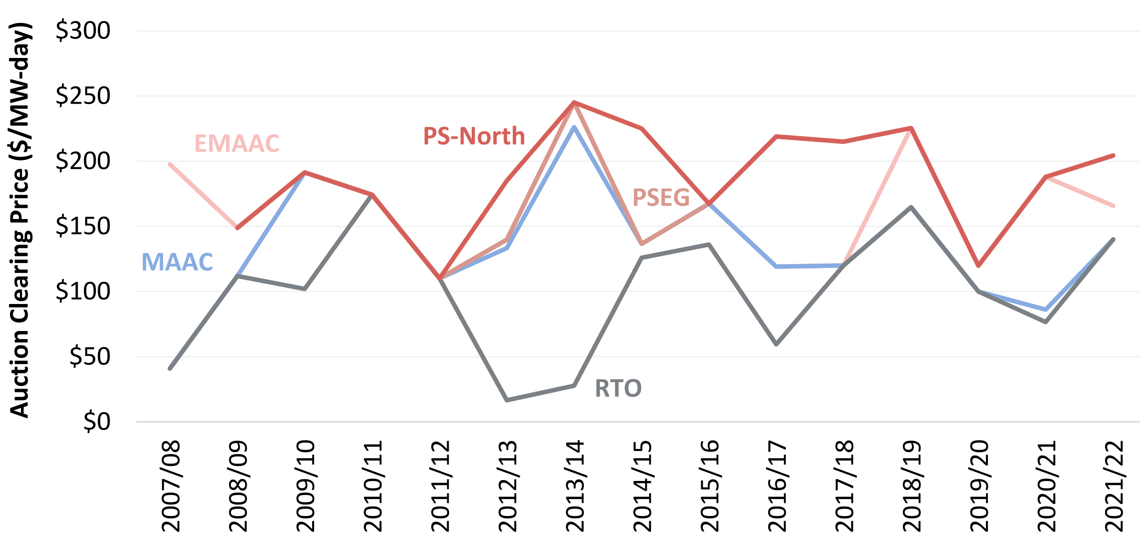
FIGURE 6: SCHEMATIC OF NESTED STRUCTURE OF LOCATIONAL DELIVERABILITY AREAS



Sources and Notes: The nested schematic is from Samuel A. Newell *et al*., "Fourth Review of PJM's Variable Resource Requirement Curve," April 19, 2018, Figure 10. Each rectangle and bold label represent an LDA modeled in the 2022/2023 RPM Base Residual Auction Planning Parameters; individual energy zones listed in non-bold without boxes are not currently modeled. See list of acronyms for full LDA names.

Under the RPM pricing structure, import-constrained LDAs can experience higher clearing prices relative to their parent LDAs due to transmission limits and tight local supply-demand balance. The smaller LDAs have equal or higher prices as compared to the parent zones and can produce occasional price spikes due to the relatively large price impact from small changes in supply, demand, and transmission parameters. Higher prices in constrained LDAs can serve as a signal to attract new investment in supply resources that are needed to support local reliability requirements, even though developing capacity resources may be more expensive in these locations.

FIGURE 7: CAPACITY CLEARING PRICES IN THE NEW JERSEY LDAS



Sources and Notes: Monitoring Analytics, "2019 State of the Market Report for PJM: Volume II, Section 5 – Capacity Market," March 12, 2020, Table 5-21. See list of acronyms for full LDA names.

C. Interactions between the Capacity Market and Clean Electricity Mandates

Currently, 11 out of 14 PJM states have established RPS programs to support clean energy goals.[19] While today's RPM was not designed to incorporate state clean energy policies, there are certain interactions between clean energy policy and capacity market outcomes in the interconnected regional market. There are some aspects of the wholesale power markets that beneficially complement and support clean energy policies, but other aspects that tend to work at cross purposes with these state policies.

In terms of beneficial interactions with clean energy policies, wholesale power markets offer a ready marketplace for clean energy resources to sell energy, capacity (subject to MOPR application), and (if relevant) ancillary services at a fair price. Depending on the resource type, a share or even the majority of the resources' investment costs can be paid for through participating in the wholesale markets, thus reducing the net cost of the state's clean energy policy programs. These transparent, open markets create opportunities for innovative players such as in the demand response and battery storage space to identify new technologies and business models for providing reliability services to the grid.

The wholesale markets further offer balancing services to complement the output profiles of intermittent resources and maintain reliability, such that the cost of integrating renewables in the PJM region has been modest to date. The "network access" approach to ensuring transmission sufficiency ensures that clean energy resources across the PJM system are simultaneously deliverable to load centers. Several jurisdictions including New Jersey, Pennsylvania, Maryland, Delaware, and Washington, DC allow RECs to be purchased across state lines to help meet their clean energy goals and access lower-cost clean energy.[20]

State policies to support clean energy resources also impact the wholesale markets, by displacing other resources that would have supplied the energy and capacity to the grid. When the clean energy resources displace fossil plants, this achieves state environmental goals by causing reduced emissions by reducing operation (in the energy market) or commitment (in the capacity market) of coal and gas power plants. However, the markets do not presently have any means for a state to select the clean energy resources desired to achieve state environmental policy goals, including those laid out in New Jersey's mandates.

Moreover, the type of REC-based clean electricity mandates most common in the PJM region have historically addressed only megawatt-hours of electricity, and do not address when the power is delivered, or whether the resources supplying the clean energy are capable of keeping the grid reliable. This concern only increases as RPS or clean energy standards (CES) programs start approaching 100% clean energy. For example, a 100% RPS standard would offset in-state fossil fuel generation with carbon-free electricity generated somewhere in the PJM footprint, but it would not directly address reliability concerns or the fact that the state is relying on fossil generation to keep the lights on. While shifting to a time-of-use RPS or other "advanced" REC product may lessen these concerns, the fact remains that the existing PJM market does not provide consumers or policy markets any levers to limit their reliance on fossil fuel generation, especially for resource adequacy purposes.

Overall, there is a substantial and growing disconnect between the design of the wholesale power markets and state clean energy mandates. Namely, the capacity market aims to meet reliability needs (but is indifferent to carbon emissions or other energy policy goals) and will attract investments in whatever type

19 PJM Environmental Information Services, "Comparison of Renewable Portfolio Standards (RPS) Programs in PJM States," August 19, Environmental Information Services, PJM Interconnection LLC, August 2020.

20 Skyler Marzewski, Devendra Canchi, and John Hyatt, "State RPS Fulfillment," Monitoring Analytics, October 24, 2019, p. 4.

of capacity resource is available at the lowest cost. Recently, the lowest-cost resources attracted into the PJM capacity market have been natural gas-fired power plants, with approximately 29,000 MW of new natural gas-fired plants into the PJM region over the past 6 years.[21] At the same time, the wholesale power market has not provided sufficient financial incentives to attract new renewables or retain certain existing nuclear resources that will be needed for a cost-effective transition to a decarbonized electricity grid. This disconnect illustrates the need to reform the wholesale power markets to incorporate states' and consumers' decarbonization requirements as a foundational market design goal (alongside maintaining reliability and minimizing cost).

The rules of PJM and other regions' power markets were developed at a time when the resource mix was dominated by large central power stations, fossil fuel resources, and when state clean energy goals were modest. The RPM capacity market is a product of the assumptions and resource mix relevant at that time; with rapidly evolving landscape of energy resources and increasing clean energy goals across PJM states, many of these assumptions are no longer valid. Staff conducting this investigation appreciate the PJM Board's recent recognition of this rapid evolution.[22]

Looking ahead, a new market design aligned with a decarbonized energy grid should assume that clean energy resources including renewables, nuclear, demand response, batteries, and distributed supply will increasingly dominate the resource mix. Consumers, states, and PJM must be able to rely on these emerging resources to fulfill increasing shares and eventually 100% of all reliability needs, at least within those subregions serving states that choose to adopt 100% clean electricity mandates. A resource adequacy structure designed in alignment with this future could have a number of features in common with the current RPM capacity market, including least-cost achievement of design parameters, reliance on a competitive, technology-neutral, market design, a three-year forward procurement cycle, minimization of barriers to entry, transparency in market parameters and pricing, and robust monitoring and mitigation.

The reforms needed to better align the capacity market and broader PJM markets with state clean energy goals are substantial and may take many years of effort and active engagement to implement. PJM's recent commitments to support state policy goals in alignment with the principles established by OPSI are a significant step in that direction, but the number and scope of essential reforms must be understood as a fundamental and foundational shift across all aspects of the power market design in order to match the scale and timeframe of the task at hand.

II. Impacts of the Minimum Offer Price Rule in New Jersey

Among the key stated goals of this investigation was an analysis of whether New Jersey can achieve its long-term clean energy and environmental objectives under the current resource adequacy paradigm, with specific reference to the 2019 MOPR.[23] This ruling expanded the application of the MOPR to apply a

[21] PJM Interconnection, L.L.C., "2021/2022 RPM Base Residual Auction Results," May 23, 2018, p. 22.

[22] *See* Letter from the PJM Board of Managers to PJM Stakeholders dated April 6, 2021. ("[T]he PJM Board acknowledges that our industry continues to evolve rapidly. The capacity market should be part of this evolution. While it has served its originally stated purpose and achieved sound results, it is now timely to consider whether certain elements of it need to change to continue to meet our collective future needs.")

[23] *In the Matter of BPU Investigation of Resource Adequacy Alternatives*, Docket No. EO20030203 (March 27, 2020).

floor price to resources that receive state subsidies,[24] and was adopted over the objections of the New Jersey BPU.[25] The expanded MOPR, if maintained in its present form, will limit the ability of new renewable energy resources to clear the PJM capacity market and impose excess costs on New Jersey's customers. Accordingly, this investigation finds that the 2019 MOPR actively interferes with achievement of New Jersey's long-term clean energy and environmental priorities. New Jersey should continue to advocate for repeal and/or significant reform of the 2019 MOPR as a threshold first step in any PJM capacity market reform to accommodate state clean energy policy.

A. The Minimum Offer Price Rule and its Application to Policy Resources

The original and appropriate economic purpose of the MOPR is to protect the market from the exercise of buyer-side market power. Specifically, schemes where large net buyers or their contractual counterparties offer a small amount of uneconomic supply into the market below cost in order to artificially suppress market-clearing prices.[26] By taking a loss on that small sell position, a large net buyer could then benefit from low prices on a much larger buy-side position in the market. The MOPR is designed to ensure that entities with the incentive and ability to engage in manipulative price suppression would be unable to do so by requiring their capacity market offers to reflect their full costs. Uneconomic new resources sponsored by large net buyers would fail to clear (or would set the prices at a higher level) and prevent the entity from achieving the benefits of manipulative price suppression. Symmetrical rules are imposed on large net sellers of capacity in order to prevent them from exercising economic or physical withholding.

In December 2019, FERC issued an order expanding the scope of MOPR to apply to new or existing resources that receive state subsides, such as RECs and ZECs.[27] Exemptions apply only to existing resources that have previously cleared an auction or new resources that had an interconnection agreement prior to the December 2019 order.

The rationale for the expanded MOPR was accepted by FERC as of the December 2019 order, but is no longer accepted or shared by the majority of FERC commissioners. At the time, the FERC's rationale for having expanded MOPR to policy-supported resources was to "protect" prices in the competitive market from being suppressed by state-sponsored resource planning decisions. State policy support will tend to attract incremental clean energy supply, displace fossil generation that would otherwise be built (or allow additional aging plants to retire), and reduce prevailing capacity market prices. Under FERC's theory as of the December 2019 order, these lower prices amount to an artificial "suppression" of market prices; applying an expanded MOPR "corrects" market prices to the higher level that would prevail absent states' policies.[28]

24 *Calpine Corporation et al. v. PJM Interconnection, L.L.C*, 169 FERC ¶ 61,239 (December 19, 2019).

25 *See* Request for Rehearing of the New Jersey Board of Public Utilities, EL16-49-000, July 30, 2018; Initial Argument of the New Jersey Board of Public Utilities, EL18-178-000, October 2, 2018; and Reply Argument of the New Jersey Board of Public Utilities, EL18-178-000, November 6, 2018.

26 A "net" buyer is one whose purchases are larger than their sales. If an entity has a large net buyer position, they may have the incentive to suppress capacity prices in order to secure power at lower total costs.

27 *Calpine Corporation et al. v. PJM Interconnection, L.L.C*, 169 FERC ¶ 61,239 (December 19, 2019).

28 *Calpine Corporation et al. v. PJM Interconnection, L.L.C*, 169 FERC ¶ 61,239 (December 19, 2019).

Instead, state policies such as New Jersey's aim to address the market's failure to recognize environmental externalities, such as carbon and other air pollutants emitted in the production of electricity. Renewable energy credits and other forms of support for carbon-free generation technologies is a rational attempt to recognize the value of the environmental externalities.[29] While the policy support these resources receive does reduce their net cost of providing capacity, the intent of clean energy incentives is not to affect wholesale market prices, but to incent the transition to cleaner sources of electricity. The "competitive" cost of providing capacity for these policy resources can be low, or even zero, as they are primarily developed for other reasons other than for earning capacity payments. Imposing a price floor on such resources and ignoring the capacity value they provide distorts the market, rather than correcting it. Excluding policy resources causes the market to procure more capacity than needed and improperly raises prices above the level corresponding to actual supply and demand conditions.

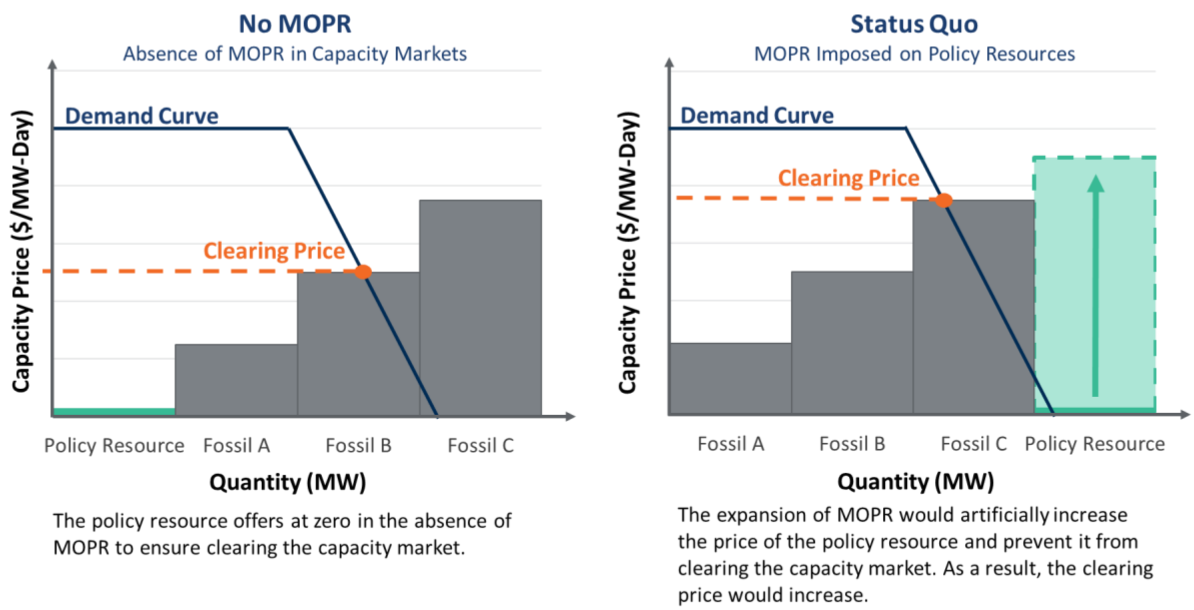
Figure 8 illustrates the impact of MOPR on the ability of policy resources to clear the capacity market. The "No MOPR" scenario on the left illustrates clearing outcomes if all capacity resources are allowed to offer at their preferred offer price.[30] Many policy resources would prefer offer at a near-zero price, especially if they would be developed regardless of the capacity revenues they receive. Fossil plants and other capacity resources' competitive offer prices would typically reflect the payments needed to cover their net avoidable going-forward costs (that is, economic costs they will incur as a result of providing capacity in the delivery year that they would not otherwise incur). Clearing prices are set at the intersection of supply and demand, as illustrated on the left panel of Figure 8.

The right-hand panel, however, illustrates the application of MOPR to a policy resource. The MOPR raises the offer price of the policy resource relative to the No MOPR scenario and reorders the capacity market offer supply curve. As the MOPR level exceeds the capacity clearing price, the policy resource does not clear, and the market's incremental capacity need is met by fossil resource C at a higher price.

[29] For a comprehensive discussion of the uneconomic basis of the MOPR, see New Jersey BPU, pp. 8-9 "Attribute Compensation Programs Correct for Long-Standing Deficiencies in FERC's Market, Are Economically Efficient, and Should Not Be Mitigated," November 6, 2018.

[30] For illustration, we show a policy resource offering into the capacity market at zero. In reality, policy resources may choose to offer at higher prices even without the MOPR depending on their individual circumstances. However, the restriction imposed by MOPR is to force policy resources offer at high prices above what would be required for them to supply capacity.

FIGURE 8: IMPACT OF MOPR TO EXCLUDE POLICY RESOURCES AND INCREASE CAPACITY MARKET PRICES



Overall, applying MOPR to policy-supported resources in New Jersey can be expected to lead to the following undesirable effects:

- Limiting the ability for clean energy resources to generate revenue and interfere with New Jersey's clean energy mandates.
- Retaining uneconomic high volumes of capacity supply that is unnecessary for reliability.
- Retaining aging fossil plants that will impede New Jersey's transition to clean electricity.
- Causing higher market clearing prices exceeding the level corresponding to actual supply conditions and causing a large wealth transfer from customers to incumbent suppliers.
- Driving an unsustainable market as these distortions become larger over time under New Jersey's statutory mandate to achieve 50% renewable electricity (84% total clean energy including nuclear) by 2030, and 100% clean energy by 2050.

All of these challenges are amplified by the fact that several other jurisdictions across the PJM region have made similarly strong commitments to clean energy including Washington DC at 100% renewables by 2032, Maryland at 50% renewable by 2040, Delaware at 40% renewable by 2035, Virginia at 100% renewable by 2045/2050, and Illinois considering 100% clean energy as early as 2030.[31]

The 2019 MOPR ruling initiated extensive rehearing requests and compliance filings. As a result, there have been significant delays to the PJM capacity auction schedule; the planning year 2022/23 auction that was originally scheduled for spring 2019 was rescheduled for mid-2021.[32] Auctions for the subsequent planning years will be conducted on a compressed schedule approximately every six months until the market resumes its normal schedule with a May 2024 auction for the delivery year 2027/28.

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31 *See* PJM-EIS "Comparison of Renewable Portfolio Standards (RPS) Programs in PJM States," and "What is the Clean Energy Jobs Act," Illinois Citizens Utility Board.

32 *See* the PJM capacity market schedule in Pete Langbein, "Update on Base Residual Auction Schedule," PJM Interconnection, L.L.C., November 19, 2020.

In parallel, there are continued efforts to eliminate the MOPR through other avenues. The composition and leadership of the FERC has recently changed significantly and now appears likely to require PJM to eliminate MOPR prior to the December 2021 auction (for delivery year 2023/24).[33] PJM itself has identified the current MOPR as an "unsustainable" rule that will need to be reformed (and largely eliminated) under an expedited process prior to the December 2021 auction.[34] Beyond FERC and PJM efforts, the U.S. Court of Appeals for the Seventh Circuit is set to begin hearings on appeals to the MOPR expansion early in 2021 with the possibility of ruling as soon as late 2021.[35] The elimination or reform of the MOPR is not guaranteed and will require continued focus from New Jersey policymakers and Board Staff. However, the outlook for a positive resolution, including repeal or substantial reduction of the MOPR, is far superior as compared to the outlook when the Board initiated the resource adequacy investigation in May 2020.

B. Scale of Policy Resources Affected

The 2019 MOPR amendments ordered by FERC expressly imposes an offer price floor on state policy-supported resources, which in some cases may impede their ability to sell capacity in the PJM capacity market. However, not all of New Jersey's clean energy resources would be excluded from clearing RPM by the 2019 MOPR. Most important, Staff does not see the 2019 MOPR as affecting the ability of nuclear units receiving ZECs to clear in the PJM capacity auction. While the nuclear units are technically subject to MOPR in the May 2021 Base Residual Auction, the 2019 MOPR allows the nuclear units to offer into the market at a MOPR floor price of $0/MW-day. Thus, MOPR has no effect on the nuclear units. Further, existing renewables resources that previously received public policy support under RPS and cleared the RPM or signed interconnection agreements prior to the December 2019 order are categorically exempt from MOPR. Likewise, resources that do not participate in the capacity market (*i.e.*, net-metered solar) do not receive capacity market revenues and are therefore not impacted by MOPR. Finally, resources have the opportunity to seek a unit-specific MOPR price that is lower than the PJM default MOPR floor price, which could enable some policy resources to clear the market even if they are subject to the expanded MOPR.[36]

Figure 9 summarizes the outlook for New Jersey policy resources that will be subject to MOPR if the current rule remains in place. All values in this figure are reported on an unforced capacity (UCAP) basis, which is a best understood as the number of megawatts of capacity consistently provided by a generating facility, after accounting for performance, reliability, and (in the case of renewable resources) variability in performance levels driven by weather. UCAP is thus an appropriate metric for determining a given resource's contribution to the resource adequacy of the electric grid and the one typically used in

[33] *See* Catherine Morehouse, "FERC open to revisiting MOPR, as grid operators, utilities mull future of wholesale markets," *Utility* Dive, March 24, 2021; and Catherine Morehouse, "Glick: FERC should tackle MOPR if PJM can't agree on update by December capacity auction," *Utility Dive,* April 13, 2021.

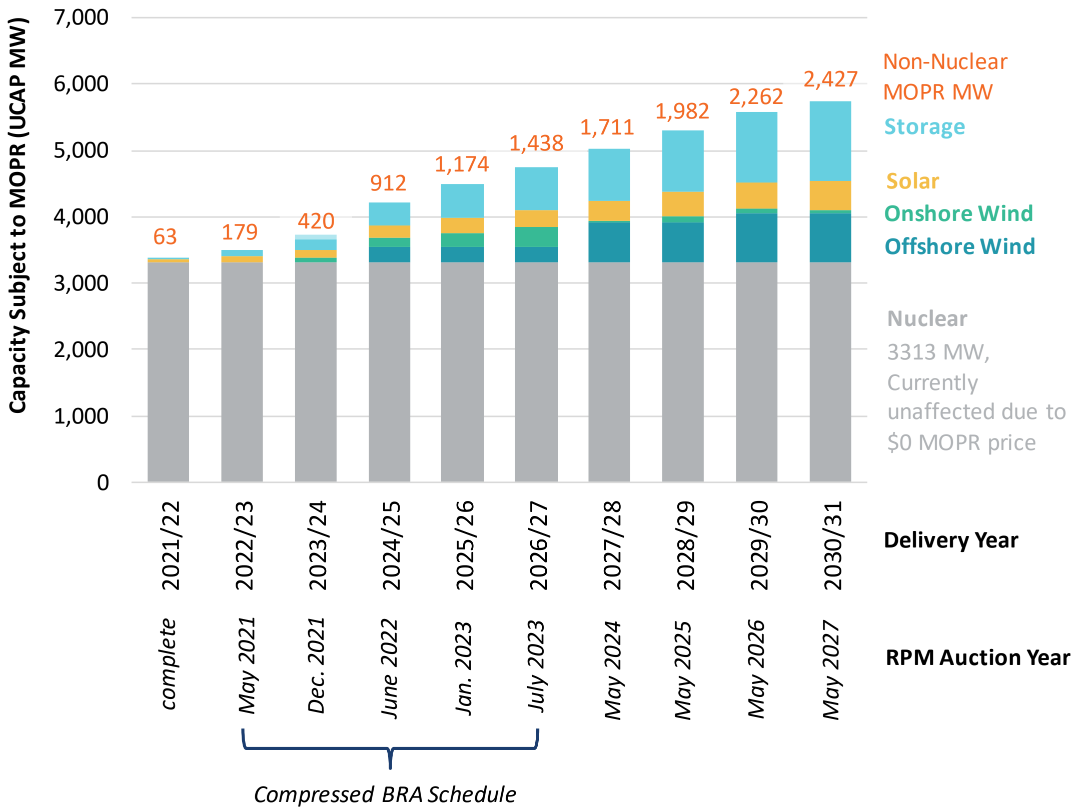
[34] PJM Interconnection, L.L.C., "Technical Conference on Resource Adequacy in the Evolving Electricity Sector: Statement of PJM Interconnection," March 21, 2021.

[35] *See* additional discussion of the status and outlook for the 2019 MOPR from Jeff Dennis, "MOPR and More: Where the Minimum Offer Price Rule and Related Measures Stand Going Into 2021," *Advanced Energy Economy*, December 16, 2020.

[36] The analysis of MOPR presented in this report assumes that resources will offer at the default MOPR price, as adjusted for realistic technology cost declines over the relevant timeframe. Cost impacts could be lower if some resources are enabled to clear the market through unit-specific exemptions, or higher if more resources would fail to clear due to higher MOPR prices in the future, particularly for nuclear resources.

electricity markets nationwide, including in PJM.[37] In general, the impact of MOPR is modest in the early years and grows with time. In particular, new resources procured to meet New Jersey's ambitious offshore wind goals, new solar program targets, storage targets and the growing RPS, among others, will generally be swept up into MOPR and forced to offer their capacity at artificially high prices. Unless FERC reverses course, the capacity subject to a MOPR price floor could grow to approximately 1,200 UCAP MW by 2025 and 2,400 UCAP MW by 2030. Those numbers could grow further to 4,500 UCAP MW by 2025 and approximately 5,700 UCAP MW by 2030 if nuclear resources are meaningfully affected by MOPR in future auctions.

FIGURE 9: NEW JERSEY POLICY RESOURCES AT RISK OF NOT CLEARING BECAUSE OF MOPR



Sources and Notes: Nuclear capacity based on UCAP rating in 2021/22 offers. Offshore wind capacity based on New Jersey solicitation schedule; assuming 1,800 MW procured for 2027 and 600 MW procured for 2029. *See* "Governor Murphy Announces Offshore Wind Solicitation Schedule of 7,500 MW through 2035," Office of the Governor of the State of New Jersey press release, February 28, 2020. Assuming an additional 250 ICAP MW of solar per year. Out-of-state wind calculated as balance in capacity required to meet New Jersey's RPS goals. Storage capacity based on N.J. Stat. § 48:3-87.8(d), approved May 23, 2018; assuming the 600 ICAP MW target is not met until 2022 and a linear increase to 2,000 ICAP MW in 2030. Revised BRA schedule obtained from Pete Langbein, "Update on Base Residual Auction schedule," November 19, 2020, p. 2.

The total quantity of resources subject to the expanded MOPR PJM-wide could be approximately 8,100 UCAP MW by 2025 and 11,500 UCAP MW by 2030. The majority of these resources are multi-unit nuclear plants earning ZECs and able to offer at zero MOPR price and thus unless the MOPR floor price changes, would be unaffected by the expanded MOPR. However, given current MOPR price levels (and after

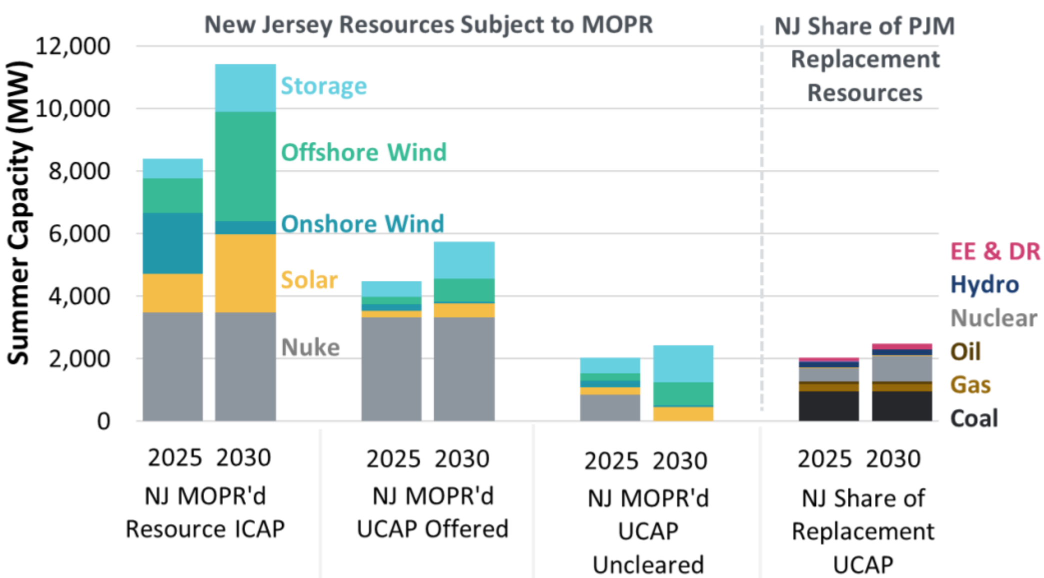
[37] The UCAP value of these facilities is small than the total "installed capacity" of the policy resources (i.e., their ICAP rating). So while New Jersey policies typically speak in terms of installed capacity, the PJM capacity market recognizes only a percentage of a facility's ICAP value. This is because the "unforced capacity" or UCAP value renewable or capacity resources for capacity market purposes is only a fraction of their ICAP ratings. The number of UCAP megawatts affected by the 2019 MOPR is further reduced because a significant share of anticipated clean energy resources are exempt from MOPR for other reasons.

adjusting for projected resource cost declines), new onshore wind, offshore wind, solar, and storage resources are unlikely to clear at default MOPR floor prices. Thus, on a PJM-wide basis we find that approximately 3,500 UCAP MW of policy resources are at risk of not clearing by 2025, and up to 6,800 UCAP MW by 2030.[38]

C. Impacts on Resource Mix and Customer Cost

In New Jersey, the expanded MOPR will likely prevent all renewable resources subject to the MOPR from clearing, while all nuclear resources' offer prices would be unaffected due to the $0/MW-day offer floor. Figure 10: New Jersey Contracted capacity Subject to MOPR and Replacement Capacity illustrates the contracted renewable resources subject to MOPR in New Jersey in 2025 and 2030 and the market response to replace the uncleared capacity. Our analysis indicates that fossil resources are likely to replace approximately 60% of the uncleared policy resources contracted to New Jersey in 2025, and 50% in 2030. Absent the expanded MOPR, these aging fossil resources would be likely to permanently retire.

FIGURE 10: NEW JERSEY CONTRACTED CAPACITY SUBJECT TO MOPR AND REPLACEMENT CAPACITY



Sources and Notes: "NJ Share of Replacement UCAP" summarizes the replacement capacity resources that are uncleared under a No MOPR scenario that do clear under MOPR. It reflects New Jersey's share of the incremental PJM-wide cleared capacity, calculated as the fraction of New Jersey uncleared MW divided by PJM-wide uncleared MW.

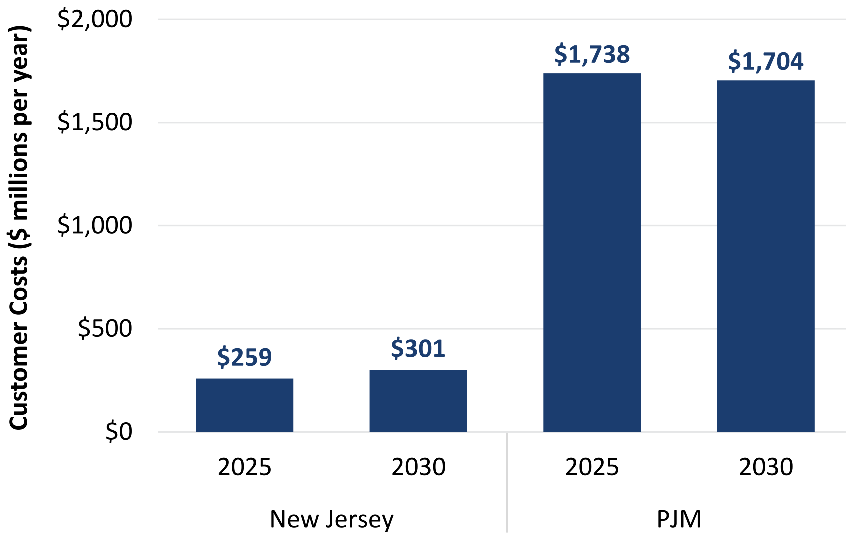
The application of MOPR to policy resources will subject New Jersey customers to approximately $260-300 million per year in excess costs as summarized in Figure 11.[39] On a PJM-wide basis, the expanded

[38] Outlook developed based on an analysis of individual states' policy goals, existing resource mix, resource ratings, current MOPR price levels, and the outlook for resource cost declines. "2022/2023 BRA Default MOPR Floor Offer Prices for New Entry Capacity Resources with State Subsidy," PJM Interconnection, L.L.C. and "2020 Annual Technology Baseline," National Renewable Energy Laboratory. The volume of resources subject to MOPR in New Jersey and PJM-wide differ from the estimates presented in the March 19, 2021 work session within the BPU resource adequacy investigation based on updates to remove the Ohio nuclear resources that will no longer earn ZEC support and updates to estimated ELCC values for battery storage and renewable resources.

[39] The Brattle model of the PJM RPM in 2025 reflects confidential supply offer data from the 2021/22 auction, adjusted for expected retirements and new entry. For 2030, we use a synthetic supply curve based on public data and estimate the long-run average avoidable net going forward costs of supplying capacity; this 2030 supply curve is more elastic, yielding relatively lower price impacts of MOPR for the same quantity of capacity excluded by MOPR.

MOPR would cost approximately $1,700 million per year in excess costs. As discussed above, the application of MOPR to policy resources leads to higher capacity prices because policy resources excluded by MOPR are replaced by more expensive resources, and fewer resources clear the capacity market overall (producing higher prices and lower quantities on the PJM demand curve). We estimate that average capacity prices paid by New Jersey consumers would include a MOPR-driven premium of $26/MW-day in 2025 and $25/MW-day in 2030. These estimates are consistent with or on the lower end of price impacts of expanded MOPR presented in other studies.[40] In addition, a double payment occurs because customers are paying for capacity through the capacity market and again for renewable capacity under the New Jersey RPS, further increasing the costs of the expanded MOPR.

FIGURE 11: CUSTOMER COSTS IMPOSED BY MOPR



III. Fixed Resource Requirement

One potential path available in the pursuit of ensuring state policy resources serve as New Jersey capacity, notwithstanding application of the MOPR, is for the State to elect the FRR alternative. Under the FRR alternative, New Jersey would be responsible for procuring its own capacity supply mix and utilize its own chosen approach to meeting the State's resource adequacy needs. This election is required for a minimum of five consecutive years. Procured resources would be submitted to PJM as the State's FRR plan for meeting total and locational capacity requirements. The FRR alternative is not a single design option, but instead an open-ended opportunity for New Jersey to determine any and all features of how capacity needs could be met, within the parameters of the PJM Governing Documents. The open-ended nature of the FRR alternative is an opportunity and a challenge in that the state would need to develop its own, new approach to meeting resource adequacy needs and mitigate the myriad attendant risks.

Numerous commenters have proposed options for how the FRR alternative could be designed and implemented in New Jersey and Staff particularly wishes to thank those commenters for their deeply thoughtful and well-researched positions. These options were described in a series of commenter filings

40 For example, in MOPR/FRR Sensitivity Analyses of the 2021/22 RPM Base Residual Auction, the IMM estimated a $25-$234/MW-day cost reduction from FRR application to various quantities of supply subject to MOPR and other design structures. In a dissent to the December 19, 2019 FERC Order which expanded the scope of MOPR to renewable sources, Commissioner Richard Glick stated a $40/MW-day price impact due to MOPR. In a webinar, ICF estimated $25-35/MW-day short term, $30-50/MW-day mid-term, and $50-70/MW-day long-term price effects due to implementation of MOPR with no additional FRR.

and presented in a Technical Session held on September 18, 2020, and a dedicated Work Session held on November 9, 2020.[41] The FRR alternatives investigated most fully included:

- *Contracting-based FRR approaches* in which a state agency or utility would engage in long-term contracting with clean energy resources that serve the dual purposes of meeting state policy goals and securing capacity that would be utilized under the FRR plan;
- *New Jersey state-wide FRR auctions* in which a state agency or utility would begin the state FRR plan by utilizing the UCAP capacity value of any MOPR'd resources that the state already holds title to, and meet any remaining capacity needs through a competitive single-state capacity auction to meet the FRR plan requirements;
- *Partial state FRR auctions covering only one utility area,* in which a portion of the state would be selected to utilize an FRR plan that would be large enough to utilize all of New Jersey contracted MOPR resources, requiring a smaller residual share of the FRR plan capacity requirements to be procured via competitive auction; and
- *Utilizing the FRR construct to implement the ICCM or similar clean capacity market,* which is more fully addressed in Section IV below.

This report does not opine on whether these FRR reforms would be consistent with current law and statutory authorities, but has instead focuses on conducting a review of the economic merits and practical considerations involved in implementing each approach with the understanding that implementation of any one of these options would involve a number of complicated legal questions. All three approaches share some of the same substantial implementation challenges such as the need to designate an FRR entity, authorize and fund the FRR entity, develop procurement mechanisms, and each approach introduces various implementation risks. Staff identified the contracting-based approach as generally less attractive given the greater complexity, reliance on administrative judgement, increased risks to consumers, and conflict with New Jersey's policy to rely on market-based approaches. The two capacity auction-based approaches offer the advantage of being the most straightforward means of implementing FRR and maintaining a competitive format, but still pose serious implementation risks, including the potential for generator owners to exercise market power, thus driving up prices to non-competitive levels. These simplest auction-based approaches could help to mitigate MOPR-related costs, but do nothing to address the more fundamental disconnects between the capacity market and New Jersey's clean energy mandates, or make progress toward a sustainable regional market design.

Overall, if MOPR is not eliminated from the broader RPM capacity market in a timely fashion, then an auction-based, single-zone FRR could be pursued further to determine whether it is a viable option to reduce the impacts from the expanded MOPR. Serious implementation risks have been raised by commenters, and any future evaluation or implementation of the FRR alternative must carefully consider all risks to New Jersey customers. However, if the expanded MOPR is eliminated from the broader PJM market, these capacity-only, MOPR-focused FRR options would retain these same risks with substantially less benefit. These options may become more attractive if regional or federal regulators stand in opposition to New Jersey's clean energy objectives. Under a no-MOPR RPM scenario, the primary rationale for pursuing an FRR would be as a vehicle for New Jersey, and possibly other states, to pursue a state-driven clean capacity market as discussed further in Section IV below.

41 *See* State of New Jersey Board of Public Utilities Technical Conference Agenda for September 18, 2020 and First Work Session Notice for November 9, 2020.

A. The FRR Alternative

Since its inception, the RPM has included provisions for the FRR alternative that can be utilized by any qualified entities that wish to procure capacity outside the PJM capacity market on behalf of their customers. The FRR was originally designed to fit the needs of vertically integrated utilities that conduct resource planning and that do not wish to have uncertainty in the quantity of capacity requirements that can be produced by the sloped demand curve.[42]

Though not originally intended for this purpose, New Jersey could elect to exercise the FRR alternative to limit the impact of the expanded MOPR on New Jersey policy resources. The FRR construct requires that sufficient capacity resources be procured to meet total and location-specific capacity requirements to meet local peak load plus a required capacity reserve margin. The PJM requirements under FRR remain agnostic as to how the resources are procured or at what price. This mechanism would allow New Jersey to select its own mix of capacity resources without regard to the application of MOPR.

Eligible FRR entities interested in electing the FRR alternative for the first time must notify PJM at least four months before the BRA for the first delivery year the FRR alternative will be in effect.[43] Given the currently compressed PJM auction schedule, the deadlines for FRR election are similarly compressed and accelerated. To initiate FRR beginning with the 2024/25, 2025/26, or 2026/27 delivery year would require formal election of the FRR alternative by February 2022, September 2022, or March 2023 respectively.[44] The election for the FRR alternative requires a commitment of a minimum of five consecutive delivery years. However, FRR elections can be terminated early based on the following conditions:

- PJM establishes a separate VRR curve for an LDA encompassing the FRR service area.
- A state regulatory "structural change," such as the transition to a competitive retail market.

If choosing an FRR alternative, an "FRR entity" must take responsibility for securing capacity commitments on behalf of the designated customers. Table 1 summarizes the FRR obligations for the LDAs that would be relevant for a New Jersey FRR plan in the 2022/23 delivery year. A New Jersey-wide FRR would need to procure approximately 20,000 UCAP MW of capacity (second to last row), of which a minimum share must be located within each of the relevant LDAs (last row). Note that the nested LDA structure means that the locational requirements are not additive. For example, any capacity within the PS North LDA would contribute toward meeting the PS North, PSEG, EMAAC, MAAC, and New-Jersey-wide capacity obligations.

The FRR entity must submit an FRR plan to PJM three years in advance of delivery (and at least four months in advance of the RPM auction) to identify the specific resources committed to serving customers. If any of the identified resources would fail to fulfill its delivery obligation or incur performance penalties, the associated penalties would be assessed to the FRR entity.[45] If insufficient resources are committed under the FRR plan for a particular day (e.g. because the resource fails to come online), the FRR entity would be subject to a deficiency change equal to 1.2 times the locational capacity market price that would have applied in the auctions. In addition, the FRR entity would need to select whether to utilize a physical or financial non-performance approach to addressing obligations under capacity performance rules, under

[42] *See* Section 11, PJM Manual 18: PJM Capacity Market and Comments of PJM within the New Jersey BPU Staff Investigation of Resource Adequacy Alternatives.

[43] For additional discussion of FRR rules and procedures, *see* Schedule 8.1 in "Reliability Assurance Agreement among Load Serving Entities in the PJM Region," PJM Interconnection, accessed May 7, 2021.

[44] *See* PJM Capacity Market Auction Schedule.

[45] Sections 11.8 and 11.9 of PJM Manual 18: PJM Capacity Market, January 27, 2021.

which the FRR entity would take responsibility for the performance of all individual resources committed under the FRR plan. Any FRR approach pursued would need to clearly define and distribute risk of underperformance, to avoid negative reliability outcomes and downside performance risk remaining with New Jersey ratepayers.

In addition, a recent dispute has been raised as to whether an initial FRR plan requires only a one-year resource commitment, or a commitment for the full five-year minimum FRR term.[46] The outcome of this dispute will bear on any future evaluation of the FRR Alternative, as a requirement for a minimum five-term commitment of capacity resources would require substantial additional considerations related to risk mitigation and procurement strategies in any of the FRR Design Options listed below.

TABLE 1: NEW JERSEY LDA FRR OBLIGATIONS AND RESOURCE REQUIREMENTS (2022/23 DELIVERY YEAR)

			RTO	MAAC	EMAAC	PSEG	PS-North
Total LDA							
Coincident Peak Load	*(MW)*	[1]	152,505	55,042	29,914	9,392	4,874
Forecast Pool Requirement	*(%)*	[2]	108.9%	n/a	n/a	n/a	n/a
CETL	*(UCAP MW)*	[3]	n/a	2,252	9,752	7,445	3,777
Reliability Requirement	*(UCAP MW)*	[4]	166,032	65,149	36,302	11,557	6,131
Price Responsive Demand	*(UCAP MW)*	[5]	425	425	65	0	0
EE Addback	*(UCAP MW)*	[6]	3,913	1,345	937	379	89
FRR Obligations							
Min Internal Resource Requirement	*(%)*	[7]	n/a	100.0%	81.5%	40.2%	44.4%
Reliability Req Adjusted for FRR	*(UCAP MW)*	[8]	152,993	65,149	36,302	11,557	6,131
New Jersey Portion of LDA							
Coincident Peak Load	*(MW)*	[9]	17,714	17,714	17,714	9,392	4,874
New Jersey % of Coincident Peak Load	*(%)*	[10]	11.6%	32.2%	59.2%	100.0%	100.0%
Price Responsive Demand	*(UCAP MW)*	[11]	0	0	0	0	0
EE Addback	*(UCAP MW)*	[12]	605	605	605	379	89
FRR Obligations							
FRR Entity UCAP Obligations	*(UCAP MW)*	[13]	**19,890**	19,890	19,890	10,604	5,396
Min Internal Resource Requirement	*(UCAP MW)*	[14]	n/a	**19,890**	**16,210**	**4,263**	**2,396**

Sources and Notes:
[1] - [5], [8], [9] – [10]: 2022/2023 RPM Base Residual Auction Planning Parameters
[6]: Not available for 2022/23 at the time of publication, adopted PJM 2021/2022 RPM Base Residual Auction Planning Parameters, adjusted for forecasted growth in peak load.
[7]: Minimum of 100% and ([4] – [3]) / ([1] x [2]).
[9] = [1] for PSEG and PS-North; EMAAC obtained as sum of PSEG, JCPL, AECO, and RECO peak load from 2022/2023 RPM Base Residual Auction Planning Parameters; MAAC = EMAAC; RTO = MAAC.
[10] = [9] / [1].
[11]: No price responsive demand in New Jersey. *See* James McAnany, "2020 Demand Response Operations – Markets Activity Report: December 2020," PJM Interconnection, L.L.C, December 7, 2020, Figure 1.
[12] = [10] x [6] for PSEG and PS-North; EMAAC = PSEG + New Jersey share of non-PSEG EE Addback in EMAAC; MAAC = EMAAC; RTO = MAAC.
[13] = ([9] – [11]) x [2] + [12].
[14] = [13] x [7].

46 See complaint filed by LS Power before the FERC on May 7, 2021, Docket No. EL21-72.

B. Structural Competitiveness of New Jersey Capacity Supply

Several commenters and the PJM Independent Market Monitor (IMM)[47] have expressed concern that adopting an FRR would present or exacerbate risks associated with the potential exercise of market power. The findings of this investigation confirm these concerns.

Small sub-regions of capacity markets tend to face challenges with a lack of structural competitiveness. Capacity markets tend to be structurally non-competitive when one or a small number of firms control market share sufficient that they have the incentive and ability to exercise market power. Large LDAs with an excess of capacity will tend to be competitive because more supply is available to meet local needs than the minimum required and so local sellers must compete with imports. An LDA with a more fragmented ownership structure will also be more competitive. However, an LDA with a small quantity of excess supply and a single entity owning most of that supply is structurally uncompetitive. In that circumstance, a single seller could engage in economic or physical withholding, drive up local prices, and earn greater revenues on its entire portfolio of local resources.

The smallest LDAs of PS-North and PSEG are both structurally non-competitive and have relatively tight supply-demand balance.[48] The remainder of New Jersey is within the EMAAC LDA which is structurally more competitive, but not sufficiently competitive to ensure that one or more firms would be unable to privately benefit from economic or physical withholding. The lack of structural competitiveness within various RPM sub-regions is a challenge that already exists today in the PJM capacity market, a concern that the IMM regularly comments on and suggests should be addressed.[49]

Given the lack of structural competitiveness of resource adequacy markets generally and the particular situation of the New Jersey region it would be essential for any resource adequacy structure (whether RPM, FRR, or otherwise) to be overseen with a robust monitoring and mitigation framework. The FRR presents new challenges in mitigating this endemic market power, as New Jersey has not previously imposed must-offer, offer cap, or other market monitoring and mitigation measures similar to PJM's approaches under RPM. Any resource adequacy structure considered should also aim to avoid further segmenting the market if doing so would increase market concentration in any submarkets unless there are offsetting benefits that would outweigh the greater exposure to exercise of market power. This structural non-competitiveness requires further review and development of appropriate and robust mitigation measures before any FRR option can be recommended or implemented.

47 Monitoring Analytics is the long-standing IMM for PJM and describes itself as a "fully independent external market monitor for PJM Interconnection … [and is] responsible for promoting a robust, competitive and nondiscriminatory electric power market in PJM by implementing the PJM Market Monitoring Plan."

48 Based on analysis of resource supply, RPM demand parameters, and ownership data obtained from the ABB Energy Velocity suite.

49 For example, *see* Monitoring Analytics, "State of the Market Report for PJM: Volume II, Section 5 – Capacity Market," March 11, 2021, p. 261.

C. FRR Design Options

CONTRACTING-BASED FRR APPROACHES

Early on in the BPU investigation, FRR concepts were offered that would transition New Jersey away from a market-oriented approach to meeting supply needs and toward a system of long-term contracts.[50] The details of these options varied across commenters and offered varying levels of specificity, but shared the general concept that the State would increase its reliance on state-sponsored, multi-year contracts to meet its environmental goals. The capacity value of the contracted resources would then be utilized within an FRR plan submitted to PJM. Residual capacity needs beyond what was fulfilled through clean energy contracts could be procured through one-year capacity-only contracts with other existing supply resources, or could use some means to prioritize clean resources in any residual capacity procurement.

Implementing a contracting-based FRR approach in New Jersey would be a complex task and require the State to designate an FRR entity and authorize it to conduct capacity procurement, with associated costs recovered from customers. The designated FRR entity could be a state agency, the distribution utility, an independent procurement administrator, or some combination. The FRR entity would be selected either state-wide or individually for each distribution utility's service territory and would take responsibility for meeting the capacity needs of customers within that service territory. There are many examples of how such a contracting-based approach could evolve and function. New Jersey already engages in competitive solicitations and long-term contracting with offshore wind developers, and could expand its contracting activities to more resource types. If these administrative contracts were expanded to cover the entire supply mix, the sector may operate similar to Ontario's single-buyer model in which a state agency determines the types of supply needed and contracts with power producers to develop or retain that supply.

Many variations of a contracting-based FRR could be developed, but the general outlines of how a contracting-based FRR could be implemented (given adequate authorities) are as follows:

- A state agency would determine how each existing and anticipated future clean energy contract could be translated into a capacity resource under the FRR plan. Mechanisms would need to be developed to appropriately incorporate existing State-approved contracts for offshore wind, and existing contracts with customers or competitive retailers. The goal would be to ensure that these existing resource arrangements can be translated into capacity commitments under an FRR plan.
- Future needs for clean energy would be met through a new system of multi-year contracts (proposals ranged from five-year commitments consistent with the minimum FRR period to long-term contracts as consistent with resource life). Commenters offered a range of ideas for how the long-term contracts would be selected, prioritized, and priced. The common element of these proposals was that the State could oversee an approach that would be designed to achieve environmental policy mandates, capacity requirements, and other policy goals. All resources contracted under the FRR would be required to submit their environmental attributes to the state agency or FRR entity, and the capacity commitment would be offered to the FRR entity. These capacity commitments would be submitted as part of the FRR plan to PJM (and would not be subject to MOPR).

50 *See*, for example, "Joint Reply Comments of PSEG and Exelon Generating Company LLC," Public Service Enterprise Group and Exelon Generation, May 20, 2020 and "Initial Comments of Public Interest Organizations Regarding Resource Adequacy Alternatives," Natural Resources Defense Council and Sierra Club, May 20, 2020 submitted in *In the Matter of BPU Investigation of Resource Adequacy Alternatives*, State of New Jersey Board of Public Utilities Docket No. EO20030203.

- The contracted resources may fulfill only a portion of the total capacity requirements needed, in which case the FRR entity would engage in competitive solicitations to procure any residual capacity needs. This residual procurement could include procurement from the lowest-cost capacity resources (whether fossil or clean) or could prioritize procurement of clean capacity resources.
- Contracted supply resources (whether under long-term contract or one-year commitments) would make a capacity commitment to the FRR entity up to the quantity that they are qualified to contribute under PJM's capacity accounting mechanisms. The FRR entity would be obligated to pay the seller for these capacity commitments at the agreed-upon price; the resource would be obligated to perform under PJM's capacity obligations.
- The FRR entity would take responsibility for all settlements with PJM under the FERC Tariff. Any non-delivery or performance penalties caused by resources under an FRR commitment would be charged to the FRR entity (and likely should then be passed back as an assessment to the individual resource creating the penalty liability).[51]
- The FRR entity would likely need to be compensated for conducting the resource planning, procurement, settlement functions, and managing penalty risks, including compensation for the risks and costs associated with any bilateral contracts and would seek to earn an approved rate of return on any required resource investments.
- Costs associated with capacity procurements and FRR entity compensation would be passed on to all end-use customers as non-bypassable charges.

The contracting-based FRR approaches discussed by commenters in this investigation offer a wide range of alternative approaches that would need to be further developed, vetted, and approved before recommendation. Namely, future evaluation would need to include: how to determine the contract term; procurement mechanisms; unbundled or all-in bundled nature of contracts for each resource type; if using bundled contracts, how to fairly value the contributions of resources with very different energy, capacity, and attribute volumes; whether and how to express preferences for clean over fossil resources, how to set payment levels; and how much discretion would be afforded to the FRR entity versus submitted for regulatory approval.

If pursued widely or for many more resources, the contracting-based FRR approach would mark a significant and substantially risky departure from current state policies that are designed to rely on competitive forces within the wholesale market to drive efficient supply-side resource investments and enable competitive retail providers to serve end use customers. Instead, the FRR entity would take on many of the responsibilities that are currently left to individual market participants reacting to price incentives. Compared to current approaches, the contracting-based FRR would create greater ability to reflect a wide range of non-price policy objectives within the resource plan, but would risk reliance on the technical ability of the FRR entity to engage in efficient planning and contracting. The FRR entity would need to be identified (or created), authorized, and funded, and would be vested with a more complex task with greater financial consequences than under other FRR options considered. This approach would place greater reliance on state agencies to develop effective oversight, and offer fewer opportunities to utilize regional competition and market mitigation to achieve competitive prices for New Jersey ratepayers. To the extent that the resource plan is implemented through longer-term contracts or bundled contracts, this would shift risks away from electricity producers and toward customers. Both sellers and customers would enjoy more pricing stability and access to lower-cost financing under such an approach, but the costs of any uneconomic planning or contracting decisions would be borne solely by customers. Overall,

[51] Penalties could arise, for example, if resources retire early, have a delayed online date, fail to output their committed capacity during a routine test, face a capacity de-rate under PJM accounting, or perform poorly during emergency events.

a contracting-based FRR would be a shift away from markets and toward a regulated planning model, in contravention of the Board's long-held positions in support of regional market competition.

NEW JERSEY STATE-WIDE FRR AUCTIONS

Other commenters developed auction-based options for implementing a New Jersey FRR plan that could be developed on a state-wide basis (or within an individual utility zone, as described below).[52] An auction-based approach to implementing an FRR would have some similarities with the contracting-based approach described above but would utilize a competitive auction format to procure the quantity of capacity needed. The approaches considered here assume that the five-year FRR term could be fulfilled via individual one-year commitments procured via auctions.[53] The auction-based FRR would be implemented as follows:

- Each year the FRR entity would publish the parameters of a capacity procurement auction, clarifying the quantity of capacity that it would seek to procure on behalf of New Jersey customers including the minimum share of total capacity that would need to be procured within each applicable LDA.
- As under the contracting-based FRR, a portion of the FRR plan would be met by resources otherwise subject to the MOPR that are contracted on behalf of New Jersey customers; contracted offshore wind resources would be an example of resources that might be automatically incorporated into the state FRR plan. The investigation did not evaluate the terms of existing contracts to evaluate which policy resources can be required to make such commitments under the FRR plan, but generally assumes that future contracts could be structured to require participation.
- The FRR entity would conduct a competitive auction to procure the remaining needed capacity from any PJM-qualified capacity resource in the relevant LDAs. The FRR auction could include maximum limits on the amount of fossil capacity purchased, or alternatively, require that a certain minimum share of capacity be procured from clean resources. Policy resources excluded by expanded MOPR would likely offer into the FRR auction at a low price given that they would be unlikely to earn capacity payments by selling into PJM's RPM auction. Other capacity resources without market power should rationally offer at prices near the expected price in the upcoming RPM auction (reflecting the opportunity cost of not selling into the PJM market).[54] If any entities would have structural market power, it may be possible to exercise through physical or economic withholding within the FRR auction unless sufficient monitoring and mitigation measures are in place.
- The FRR procurement auction could take a variety of forms, the simplest of which would be a single round, uniform price auction. However, Staff would suggest that any FRR auction would procure at least two prices, one for generic fossil capacity and another for clean capacity. The State could determine a price at which it would select the clean resource over a less expensive fossil resource.

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52 *See*, for example, "Post-Technical Conference Comments of PSEG," October 2, 2020, submitted in *In the Matter of BPU Investigation of Resource Adequacy Alternatives*, State of New Jersey Board of Public Utilities Docket No. EO20030203; "BPU Resource Adequacy Investigation: FRR Discussion," November 9, 2020; and "Jersey Central Power & Light Company Post-Work Session Comments," November 23, 2020, submitted in *In the Matter of BPU Investigation of Resource Adequacy Alternatives*, State of New Jersey Board of Public Utilities Docket No. EO20030203.

53 A pending complaint before FERC submitted by LS Power suggests that FRR plans should instead include multi-year commitments from resources; the Staff investigation assumes the previously-existing status quo that no multi-year commitments will be required under any FRR. A multi-year commitment requirement would be a substantial change that may pose significant additional challenges to implementing an FRR plan.

54 *See* additional discussion of how RPM opportunity costs would affect FRR participation in "Jersey Central Power & Light Company Post-Work Session Comments," November 23, 2020, submitted in *In the Matter of Investigation of Resource Adequacy Alternatives*, State of New Jersey Board of Public Utilities Docket No. EO20030203.

- To ensure adequate procurement within the import-constrained subregions, the auction would need to be structured so as to enable higher prices in the import-constrained subregions. Considering the FRR parameters prevailing in recent years (see above), the majority of New Jersey capacity supply under FRR would be priced consistent with the EMAAC LDA; very modest volumes from the broader MAAC LDA would be possible to utilize at potentially lower prices; and no volumes would be possible to utilize at lowest RTO prices.[55] The most import-constrained areas of PSEG and PS-North would potentially clear at higher prices. These import-constrained areas have a relatively tight supply-demand balance and have highly concentrated supply ownership.
- The FRR entity would make a payment commitment consistent with the procurement auction to the cleared capacity resources and submit these cleared resources to PJM within the FRR plan (which must be submitted approximately one month prior to the broader PJM auction). Any capacity resources that fail to clear the New Jersey FRR auction would be able to offer their capacity into the subsequent BRA.
- Any shortfalls in procured volumes through the FRR or resource non-delivery of the FRR would result in FRR shortfall penalties at a rate of 1.2 times the relevant RPM price; poor resource performance could incur additional performance penalties. The FRR entity would interact directly with PJM for the purposes of any penalty settlements, passing any associated costs on to the individual resources (or to customers, e.g. if the FRR plan had insufficient resource commitments).

Similar to the contracting-based FRR, the auction-based approach would create an opportunity to enable resources contracted for policy purposes, and subject to the expanded MOPR, to provide capacity within the PJM footprint. This applies whether the policy resource is contracted on behalf of New Jersey's customers or those of other states. The auction-based approach would not offer the same level of competitive benefits as participation in the broad RPM market, but would retain some of these benefits due to the reliance on a competitive auction format with transparent demand parameters, auction format, unbundled one-year capacity contracts, and transparent pricing. Oversight and compensation of the FRR entity would be far less challenging than under a contracting-based FRR given that the auction procedures would be strictly delineated and approved by state authorities (minimizing the role of administrative judgement or misaligned incentives in resource selection).

However, the New Jersey-wide FRR auction poses implementation challenges that could make it less attractive as a permanent resource adequacy structure. New Jersey is a relatively small share of the PJM market, with demand requirements that must be met for each successively more import-constrained LDA (MAAC, EMAAC, PSEG, and PS-North). The most import-constrained areas, PSEG and PS-North, are highly concentrated. The broader EMAAC area serving the majority of the state is more structurally competitive, but not so competitive that market forces alone can be relied upon to mitigate the potential for the exercise of market power. These challenges raise the concern that there could be a lack of competition or the exercise of market power within a New Jersey FRR auction. Competition issues would be even more pronounced if the State were to implement a clean capacity constraint in the FRR auction and limit supply participation to in-state resources, given the even more concentrated market for carbon-free capacity, which is dominated by nuclear resources in New Jersey. Market monitoring and mitigation would be more feasible in an auction format than in a contracting-based approach, but would pose particular complexities due to the need to allow offers reflective of the opportunity cost of not participating in the RPM auction and a lack of any pre-existing mitigation mechanisms overseen by New Jersey.

[55] In the RPM auction, New Jersey is able to utilize a small portion of supply from the RTO region consistent with its pro-rata share of import capability, or CETL, into the MAAC LDA. Within the FRR construct, New Jersey is not able to utilize any supply from the unconstrained RTO region due to a nuance of how regional FRR obligations are calculated (namely, the CETL into MAAC is small enough that it becomes zeroed-out relative to the internal MAAC resource requirements).

The state-wide FRR would also require New Jersey to determine whether to maintain a sloping demand curve for capacity within the various LDAs. The elimination of the sloping capacity demand curve could save some costs in the short term by reducing capacity over-supply, but would expose New Jersey to the challenges of a vertical demand curve if maintained over a longer time period. Particularly in the smallest LDAs, the vertical demand curve in New Jersey could produce higher price volatility, greater exposure to locational reliability shortfalls (or associated FRR penalties), and greater exposure to exercise of market power. Overall over the long term, the higher price volatility would produce a less attractive investment climate and so may produce less favorable outcomes over the long term as new resources are needed or existing resources need reinvestment to continue operating; PSEG and PS North are most likely to face these small-market challenges in the near term (though other areas of New Jersey could face these issues as well in the future, particularly if new LDAs are identified and must be modeled within the RPM).

PARTIAL STATE FRR AUCTIONS

To circumvent the most significant challenges of an auction-based FRR approach in the small LDAs of PSEG and PS-North, some commenters have recommended focusing on a partial state FRR auction. The mechanics of a partial-state FRR would be identical to those described above for a full-state FRR, but the geographic scope would be limited to one utility area. Under a partial state FRR:

- A state agency would project the volume of resources anticipated to be excluded from clearing by the expanded MOPR and that would not otherwise serve as PJM capacity to be procured within the FRR construct. A single utility zone would be designated to select the FRR alternative. Commenters recommended that the JCPL utility zone is a sensible choice given that it is large enough to utilize all New Jersey policy resources that might be excluded by MOPR over the coming five years.[56] Further, JCPL is not within the most import-constrained subregions and so would have access to greater volumes of supply across the EMAAC region (including from outside of New Jersey).
- The competitive FRR auction would proceed as described above, procuring sufficient resources to satisfy the FRR requirement of the individual utility zone selected.
- If capacity prices realized under the FRR auction are materially different from those borne by customers in other regions of the state, the State would need to adopt appropriate mechanisms to address any resulting cost-shifts (requiring the development of an appropriate regulatory mechanism that does not presently exist). The purpose of the partial-state FRR would be to mitigate expanded MOPR costs for all customers across New Jersey, and so the resulting costs (or benefits) of the FRR auction would be borne by all customers not just those within the designated FRR utility area.[57]

The partial state FRR auction achieves most or all of the benefits of a state-wide FRR auction by ensuring resources subject to the expanded MOPR serve New Jersey as capacity resources, but would require development of a new construct to create reliance on competitive auction-based pricing. This investigation does not fully evaluate that necessary new construct or evaluate the existing Board authority to implement it. The partial state FRR avoids some of the most problematic aspects of the state-wide FRR auction because it does not include the smallest and most highly concentrated capacity LDAs of PSEG and

[56] As illustrated above, we estimate that approximately 5,700 UCAP MW of New Jersey policy resources would be subject to MOPR by 2030 (including ZEC resources). As of the 2022/23 planning year, the JCPL peak load plus forecast pool requirement that would determine total capacity requirements is approximately 6,100 MW. For example, see comments of PSEG and Exelon witness Northbridge Group, pp. 2-3, filed June 24, 2020.

[57] For additional discussion of single-zone FRR options, *see* "Jersey Central Power & Light Company Post-Work Session Comments," November 23, 2020, submitted in *In the Matter of BPU Investigation of Resource Adequacy Alternatives*, State of New Jersey Board of Public Utilities Docket No. EO20030203.

PS North. Other implementation challenges and risks would still remain, such as implementation costs, market monitoring and mitigation, and risks of design flaws, but the scale of downside risks to New Jersey customers from any uneconomic pricing outcomes would be somewhat mitigated due to the smaller volumes procured in the auction.

D. FRR Implementation Choices

Any pursuit of an FRR approach would require the State to make a number of choices regarding how the FRR would be implemented in light of the relevant implementation challenges and assess which approaches will require additional regulatory authorities to implement. Among the choices that need to be further evaluated before the FRR can be implemented may include:

- **How to Best Manage Costs and Achieve Policy Goals (As Relevant Under Contracting-Based Approaches).** Pursuing a contracting-based FRR raises the opportunity as well as the challenges associated with a significant shift away from market-oriented approaches toward expanded regulator-approved contracting. To transition toward a workable system of expanded contracts would require the State to establish enhanced approaches to selecting resources; setting prices; prioritizing amongst clean and fossil capacity; establishing contract structures and terms; and achieving competition in solicitations. New Jersey already has developed such approaches within its OSW contract solicitations, but would need to develop appropriate mechanisms for all other resource types and for any residual capacity procurements. The risks of high costs that could be borne by New Jersey customers are higher under a contracting-based approach than under other alternatives investigated in this docket, raising the necessity of identifying regulatory oversight mechanisms to maintain cost discipline and limit exposure to uneconomic contracting choices.
- **Selection or Creation of the FRR Entity.** The PJM FRR rules align with distribution utility service territories, meaning that the utilities will likely need to have some role in assisting with data requirements and settlements. However, the utilities are not a natural party to make most resource contracting decisions in New Jersey given their affiliate relationships with capacity suppliers and potential contractual counterparties. Another option would be to task a state agency or a third party independent evaluator to select capacity commitments, then possibly transferring the obligations to each separate utility to manage settlements and penalties.
- **Geographic Scope of the FRR Election.** If the primary purpose of the FRR is to ensure that resources subject to the expanded MOPR serve as capacity (and therefore avoid double-payment), then the selection of a single utility area (rather than the entire state) is likely a preferred design choice in order to mitigate implementation risks. To effectuate a partial-state FRR, a specific utility area, such as JCPL, would need to be selected that is large enough to serve this purpose and that has the greatest access to supply. If the FRR aims to achieve broader environmental goals however, the limited geographic scope would make it less attractive.
- **How to Manage Penalty and Under-procurement Risks.** The FRR entity responsible for settlements with PJM will face penalties if the FRR plan has insufficient supply, if any of the FRR resources fail to deliver the promised capacity, or if resources under-perform relative to their capacity obligations. Under full RPM participation, PJM itself uses a system of credit requirements and imposes any penalties directly to individual resources' owners. In a New Jersey FRR, the FRR entity would become responsible for the aggregate performance of all resources submitted under the FRR plan. Specifically related to penalties and bonus payments relevant to performance during system

shortfall events, the FRR plan can be managed under either a financial or quantity-based approach.[58] Under the financial non-performance approach, PJM would assess to the FRR entity any penalties that arise from under-performance of the individual resources in the FRR plan; under the quantity-based non-performance approach the FRR entity could address any performance shortfall by submitting greater capacity volumes in a subsequent capacity year. The contractual means to pass these penalty risks back to the individual resources and to manage the risk of counterparty defaults would need to be developed (as any default on penalty payments would otherwise be passed to New Jersey customers).

- **How to Remunerate the FRR Entity.** The FRR entity or entities would need to be compensated for their administrative activities and for the risks they bear, and the State may be well served by creating a new entity if it were to select the FRR option. These costs including the administration of auctions, implementing settlements, managing penalties and counterparty risks, and the costs of engaging in large volumes of long-term contracts (under the contracting-based approach). The State would need to determine whether a fee-for-service approach is appropriate and whether any incentive-based remuneration would be pursued as a means of achieving cost efficiency on behalf of customers.
- **Monitoring and Mitigation.** At a minimum, any FRR plan should include some means of reviewing market structure, auction competitiveness, and the potential for exercise of market power. An auction-based approach offers greater opportunities to implement effective controls on the exercise of market power, to the extent that a state agency has the authority to implement them. If New Jersey has the authority, it would be beneficial to impose a capacity must-offer requirement and appropriate capacity offer caps on suppliers that may have the incentive and ability to exercise market power, especially the smallest import-constrained LDAs (PSEG and PS North). The offer caps would need to be high enough to reflect all resource net going forward costs (including the expected opportunity cost of not selling capacity into the subsequent RPM auction), introducing additional challenges to robust mitigation.
- **LDA Sloping Demand Curves.** To the extent that the FRR auction would be utilized to support resource adequacy over an investment or reinvestment cycle, a sloping demand curve may benefit the sustainability of the design. Adopting a well-designed curve for the smallest LDAs could provide a more sustainable basis for investments and maintaining locational reliability. For the portions of New Jersey that can be served from resources in EMAAC and MAAC, the interaction with the broader market will provide this price-stabilizing benefit even if New Jersey maintains a vertical demand curve under the FRR auction.[59]
- **RPM-Derivative Pricing.** Most sellers in the FRR auction would likely offer at their opportunity cost of not selling capacity in the subsequent RPM auction. However, sellers will not know the upcoming RPM clearing price and so would have some uncertainty as to the best offer price in the New Jersey FRR. If sellers guess systematically low, New Jersey customers could benefit from a one-off discount to their capacity payments. If sellers guess systematically high (particularly in any constrained sub-LDAs), New Jersey customers may have to pay an uneconomically high price for that one year. Generally, suppliers would wish to avoid this type of risk, and therefore there may be reduced liquidity in a New Jersey-only FRR auction. Alternatively, suppliers may systematically offer only prices significantly above the clearing price anticipated in the relevant BRA. To address these challenges, variations of an "RPM-derivative pricing" approach have been proposed by

58 *See* PJM Interconnection, L.L.C., "FRR Entity Physical Option for Non-Performance Assessment," May 4, 2016.

59 This price stabilizing effect would materialize indirectly through supplier expectations of RPM prices. RPM prices (which are somewhat more stable due to the regional and RTO-wide capacity demand curves) would inform supplier pricing expectations, and would result in FRR auction offer prices that are distributed around that expectation.

commenters.[60] The RPM-derivative pricing approaches would seek to reduce this problem by accepting offer prices expressed either: (a) as a percentage of the subsequent RPM price; or (b) a pre-specified adder above the subsequent RPM price. These options protect customers from uneconomic high prices (but also forgo the possible benefits of low-price FRR outcomes). We note that this concept poses other complexities and challenges that increase implementation and mitigation complexity, particularly as associated with locational price differences and resources that have a minimum absolute payment needed to take a capacity commitment.

E. Advantages and Disadvantages

The alternative approaches for implementing a New Jersey FRR would ensure that New Jersey policy resources can be applied to serve capacity needs, but would offer a range of other advantages and disadvantages as summarized in Table 2 below.

Of these three FRR options, the contracting-based approach is relatively unattractive given the high implementation complexity, the potential for high costs, shifting risks to consumers, and inconsistency with New Jersey's policy to rely on competitive markets. The auction-based FRR approaches, particularly an option that would select a minimum amount of clean capacity resources or a maximum quantity of fossil resources, are preferred over contracting-based approaches. The auction-based FRR options would allow New Jersey to avoid application of the expanded MOPR to policy resources, and (under some design options) offer opportunities to advance New Jersey's preference to rely on clean capacity resources. Auction-based FRR designs also pose implementation challenges and risks including the need to address the potential for exercise of market power. In general, Staff finds that a preferred approach to addressing policy priorities would be to reflect them through the regional RPM marketplace rather than utilizing the FRR construct. However, should promised reforms to the PJM market not materialize, Staff would suggest revisiting an auction-based FRR in the future.

60 *See* "Jersey Central Power & Light Company Post-Work Session Comments," November 23, 2020, and Public Service Enterprise Group "Post-Technical Conference Comments of PSEG," October 2, 2020, submitted in *In the Matter of BPU Investigation of Resource Adequacy Alternatives*, State of New Jersey Board of Public Utilities Docket No. EO20030203.

TABLE 2: RELATIVE ADVANTAGES OF FRR IMPLEMENTATION ALTERNATIVES

DESIGN	ADVANTAGES	DISADVANTAGES
Long-Term Contracting-Based FRR	• Eliminate MOPR on policy resources & mitigate MOPR cost impacts • Ability to advance environmental and other policy objectives	• Lose competitive market benefits, substantial associated risk of less efficient planning decisions • Reliance on administrative judgement, shift of risk from producers to consumers, misalignment with retail choice, and reduced transparency • Exposure to exercise of market power, and less ability to monitor and mitigate as compared to auction-based approaches • High implementation complexity & risks • Further evaluation required to determine statutory and regulatory authority • 5-year FRR lock-in period
New Jersey State-Wide FRR Auctions	• Eliminate MOPR on policy resources & mitigate MOPR cost impacts • Maintain some partial benefits of competition for procuring unbundled capacity • Ability to advance environmental and other policy objectives (e.g. through minimum clean capacity requirements)	• Lose efficiency benefits of participating in the broad regional PJM capacity market • Small sub-market challenges including exposure to price volatility, exercise of market power, and periodic reliability (especially in PSEG and PS North) • Medium implementation complexity & risks, including market mitigation • Further evaluation required to determine statutory and regulatory authority • 5-year FRR lock-in period
Partial State FRR Auctions	• Eliminate MOPR on policy resources & mitigate MOPR cost impacts • Maintain some partial benefits of competition for procuring unbundled capacity • Maintain RPM participation for the majority of New Jersey capacity needs • Ability to advance environmental and other policy objectives (e.g. through minimum clean capacity requirements)	• Lose some regional market efficiency benefits (but less than under full state FRR) • Face some market power concerns (but less than under a full state FRR) • Medium implementation complexity, including potential in-state capacity cost sharing • Medium downside economic risks • Further evaluation required to determine statutory and regulatory authority • 5-year FRR lock-in period

IV. Integrated Clean Capacity Market

Beyond the near-term issue of avoiding MOPR impacts, the BPU's investigation has focused on the long-term question of how to align the resource adequacy paradigm with New Jersey's clean energy objectives. Eliminating or substantially reforming the expanded MOPR is a necessary first step, but does nothing to more fundamentally align market incentives to attract and retain the *clean* supply mix that will be needed to reliably serve New Jersey customers in a fully decarbonized grid as envisioned in the Energy Master Plan. The Board and commenters alike have discussed in this docket the importance of a more fundamental realignment of the resource adequacy construct to use a market-based approach to meeting reliability and decarbonization objectives.

Toward that end, BPU Staff and consultants developed a new ICCM design concept that could be utilized as the foundation and framework for driving the reliable, clean, and affordable resource mix demanded by New Jersey, other PJM states, and customers across PJM. At the same time, the ICCM was designed to accommodate the diversity of state goals within the broad regional footprint including states that are decarbonizing at different rates, states' preference to use a range of contracting and policy practices, and acknowledging that some states do not wish to pay any premium for carbon-free resources. The ICCM or a similar Forward Clean Energy Market[61] design could be pursued under a New Jersey FRR, a multi-state FRR, or as a PJM-wide replacement to the current capacity market, with risks decreasing and benefits increasing with geographically broader implementation scope.

A preliminary ICCM straw proposal was discussed in the BPU work session on February 19, 2021 and within a PJM workshop on March 12, 2021, and has been updated in the body of this report and within Appendix B based on feedback received from commenters.[62] Other states are considering variations of the ICCM design or similar proposals including Maryland, New England (all states), and New York.[63] The ICCM is not necessarily the only option that could or should be considered by the state of New Jersey and the broader PJM footprint, but is an example of a fundamentally reformed wholesale market that will be needed to drive a reliable, least-cost decarbonization pathway.

This investigation concludes that a competitive, technology-agnostic, forward clean energy market such as the ICCM can help New Jersey affordably achieve its resource adequacy and clean energy objectives at the lowest combined cost. Staff examined both New Jersey-centric and regional options, and concluded that both options can drive affordable investment in clean energy infrastructure. Depending on how states across the PJM footprint would choose to express their policy goals, a regional solution has the greatest ability to reduce the costs of meeting existing clean energy goals; accelerate renewable deployment; retain existing nuclear plants at risk for retirement; accelerate development of clean capacity resources such as demand response and storage; and/or enable customers to meet their own clean energy objectives. Such a marketplace would offer the greatest economic and environmental benefits if implemented across the broadest possible footprint.

Accordingly, New Jersey should seek to achieve the ICCM or a similar solution on a PJM-wide basis as a replacement to RPM. This report recommends that the Board and Board Staff continue to maintain an active leadership role in the development of any capacity market alternative, and advocate for competitive market structures that sufficiently support and efficiently achieve New Jersey's energy policy goals such as the ICCM.

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61 A Forward Clean Energy Market, or FCEM, also involves forward contracting for clean energy resources by a state or group of states and has clean energy and economic outcomes that are almost as positive as an ICCM structure. The main difference is that ICCM allows the market to automatically optimize the ratio of clean energy resources to conventional resources, while an FCEM relies on market participants to self-manage these risks. For ease of discussion, this report largely uses the ICCM terminology, although almost all the same benefits accrue in both market designs.

62 *See* State of New Jersey Board of Public Utilities, "Notice of Work Session: Investigation of Resource Adequacy Alternative (Docket No. EO20030203)," January 21, 2021 and Kathleen Spees, Walter Graf, and Samuel Newell, "Integrated Clean Capacity Market: A Design Option For Aligning Investment Incentives To Achieve Regional Reliability And Clean Energy Mandates," March 12, 2021.

63 *See* Kathleen Spees *et al.*, "Alternative Resource Adequacy Structures for Maryland: Review of the PJM Capacity Market and Options for Enhancing Alignment With Maryland's Clean Electricity Future," March 2021; Kathleen Spees, "The Integrated Clean Capacity Market: A Design Option for New England's Grid Transition," October 1, 2020; and Kathleen Spees, Samuel Newell, and John Imon Pedtke, "Qualitative Analysis of Resource Adequacy Structures for New York," May 19, 2020.

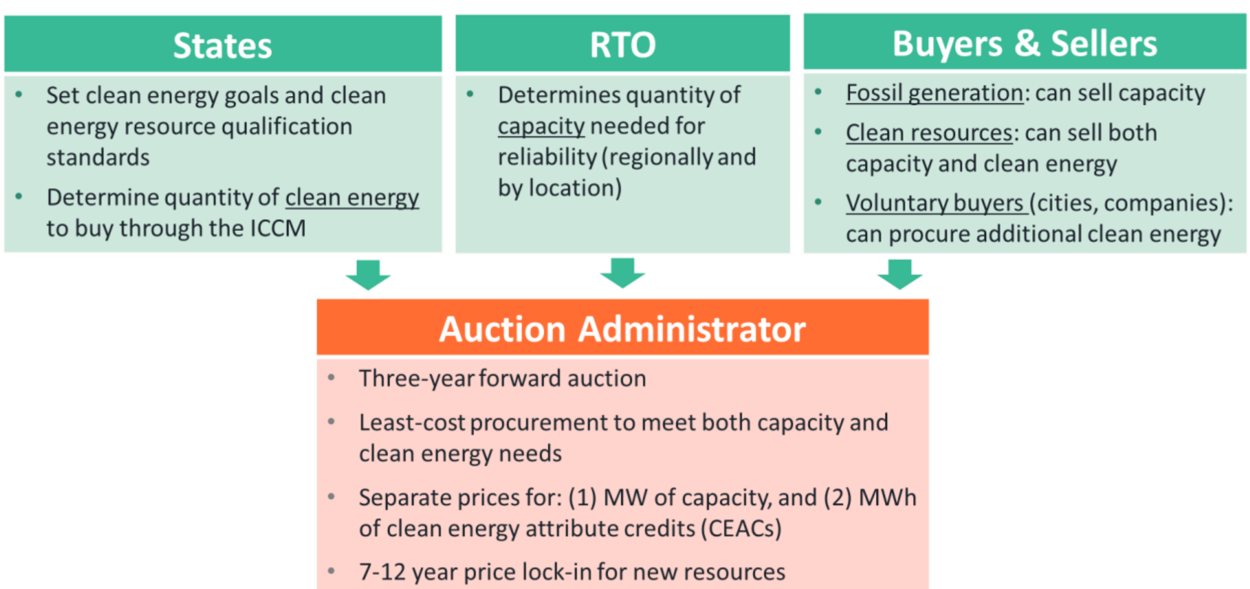
A. Description of the ICCM

The ICCM design could replace the current RPM with a new concept for resource adequacy that aims to achieve not only reliability requirements (as under the current capacity market) but also serve the clean energy demand expressed by states and customers. The ICCM would achieve both of these objectives at the lowest combined cost in a broad regional market place. At a high level, these primary objectives will need to be incorporated into any regional design that is to form the foundation of a sustainable PJM-wide market design that can meet the region's decarbonization requirements.

The ICCM would build on the successful elements of the current PJM capacity market as summarized in Figure 12. The ICCM would be a three-year forward auction to procure two products: (1) capacity in units of UCAP MW as under the current RPM; plus (2) clean energy in MWh of unbundled clean energy attributes. Participating states and voluntary buyers would determine the volume of attributes they wish to procure, their willingness to pay for clean energy, and the specific clean energy attribute product they seek to purchase. The ICCM could accommodate procurement of state-defined RECs, state-defined ZECs, or PJM regionally-defined clean energy attribute credits (CEACs). States could adopt downward-sloping demand curves for clean energy that accelerate decarbonization if the costs of doing so are low, as regulatory structures allow. The costs of procuring the clean energy attributes would be allocated to the individual states or consumers consistent with their submitted demand bids.

The three-year forward ICCM auction would procure capacity and clean energy requirements sufficient to meet all system and local reliability needs and serve all demand for clean energy attributes at the lowest combined cost. The resulting market prices would incentivize private investors to identify low-cost solutions to meet reliability and decarbonization needs, drawing on the broad regional marketplace to drive efficiencies and competitive prices.

FIGURE 12: THREE-YEAR FORWARD ICCM AUCTION FOR CAPACITY AND CLEAN ENERGY NEEDS



Regional Scope, Governance, and Implementation: A PJM-wide ICCM could be pursued as a regional solution to MOPR-related conflicts that could ultimately be implemented by PJM and replace the current RPM structure. Downside risks are minimized under this implementation paradigm, due to strong regional existing mitigation structures as well as relying on PJM's existing infrastructure and capabilities to implement the ICCM design. This preferred implementation structure would offer the greatest economic and environmental benefits with the lowest downside risk to New Jersey.

Potential Sub-Regional Scope, Governance, and Implementation: Alternatively, a New Jersey-alone or multi-state ICCM could be implemented under the current PJM Tariff rules for an FRR. As with other FRR structures, this would necessitate establishing an independent auction administrator and FRR entities to engage in settlements with PJM. States' joint effort to develop and implement the Regional Greenhouse Gas Initiative (RGGI) is a potentially helpful example of how a collective of like-minded states could create an entity that would be empowered run an environmentally-focused market driven by participating members' requirements. The New Jersey-alone approach to ICCM would offer the state the greatest control over the design and implementation schedule.

State Participation as Clean Energy Buyers: A central tenet of the ICCM is that states would set their own policy goals. Each state would determine whether to adopt clean energy mandates, the scale of these mandates, which resources are eligible, applicable budget caps, and whether to procure clean energy via the ICCM or via other mechanisms. The ICCM would be tailored to each state's unique policies, while enabling participating states to tap into the competitive benefits of a broad regional marketplace for clean energy.

Voluntary Buyers of Clean Energy: In addition to state demand for clean energy, there are many other entities that may wish to participate within the ICCM as voluntary buyers of clean energy. Such entities could include cities, competitive retailers, corporate sustainability buyers, public power entities, or integrated utilities. Such voluntary buyers may operate within states with no clean energy mandates, or may wish to exceed any applicable state mandates. Through the ICCM, these buyers would be able to submit voluntary demand bids for clean energy attributes (and specify a maximum price they are willing to pay).

Role of the RTO: As the RTO, PJM would continue to establish the quantity of capacity needed regionally and by location to maintain system reliability consistent with the 1-event-in-10-years ("1-in-10") reliability standard.

Seller Participation: Qualified resources, both clean and emitting, identify a total annual payment that they would require to provide capacity and/or clean energy in the relevant delivery year.

- *Clean resources* would be eligible to sell both capacity and clean energy.[64] These resources would offer their resources' capability into the auction at one price and two quantities (*i.e.*, they will specify one total payment needed in order to deliver their total qualified volumes of each capacity and clean energy). Clean resources would also be eligible to lock in their clean energy payment prices for up to seven years, as a means to provide investment certainty.
- *Emitting resources* would only be eligible to sell capacity.

Role of the Auction Administrator: The auction administrator would conduct a three-year forward auction to determine the lowest-cost mix of clean and emitting resources necessary to meet: (i) the clean energy requirements expressed by each state and customer; and (ii) the capacity needed to meet regional and locational reliability needs.

- The auction administrator would utilize a co-optimized single auction to meet all capacity and clean energy needs at the lowest combined procurement cost. The auction would continuously adjust the selection of cleared resources until the most advantageous portfolio of resources in the system is identified (see Appendix B for more detail). The auction would produce two simultaneous "clearing

64 Rules governing emitting resources using carbon capture and sequestration will have to be developed if the technology becomes commercially available in the PJM regions. Further discussion would be required to establish eligibility rules that might award clean energy credits in proportion to the emissions sequestered.

prices," one for clean energy (priced in $/CEAC, $/REC, or $/ZEC as applicable for a given state) and one for traditional capacity service (priced in $/MW-day as applicable for each location).

- By co-optimizing the two products within a single auction, consumers would benefit from identifying the lowest-cost, fully reliable system that meets the share of clean energy required by state policies while having the necessary resources to contribute to capacity needs.
- Because sellers identify the amount of capacity and clean energy they have to sell separately, clean resources benefit from having two sources of revenue that adjust to the efficient level as part of the simultaneous clearing process.
- The price signals that result from the single auction would demonstrate the need for reliable, clean energy, by location, depending on the appetite of a state or buyer for clean energy.

B. State Participation within the ICCM

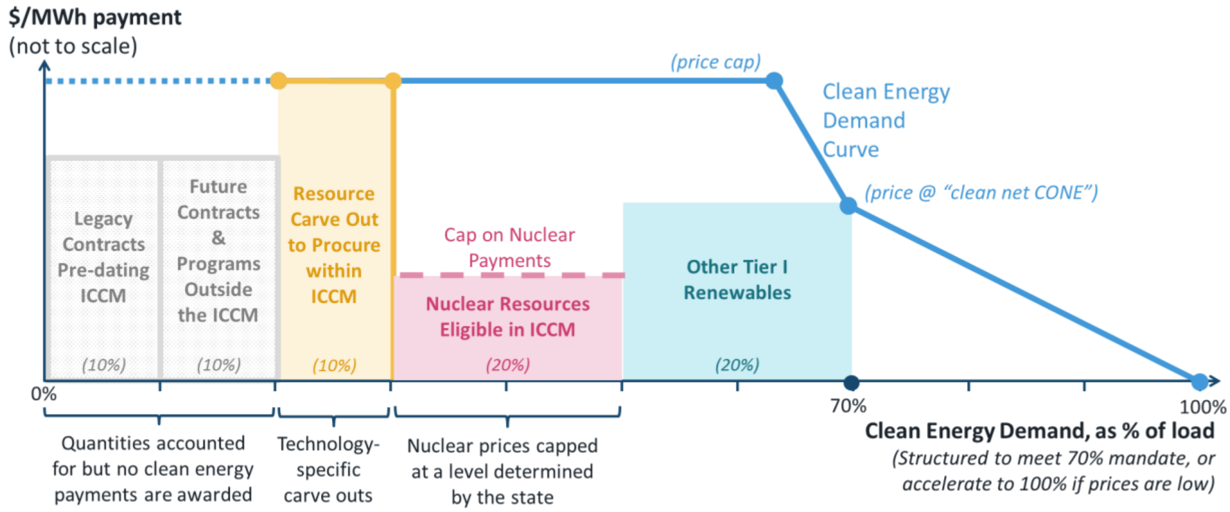
State participation as clean energy attribute buyers in the ICCM would be voluntary.[65] Meeting capacity requirements would continue to be mandatory for all customers, but could be met bilaterally or via the ICCM. States wishing to procure clean energy through the ICCM could determine the volume of clean energy they wish to procure and the prices they are willing to pay. In the alternative, a state may direct the auction administrator to translate existing state policy goals that the state wishes to procure competitively through the ICCM, into these price and quantity values consistent with state law, for review and approval by the state. Each state would retain the flexibility to tailor the structure of their demand bids consistent with state policy objectives.

States would have the option to use a downward-sloping demand curve to express their willingness to pay for clean energy. There are a number of benefits to using a sloped demand curve. A sloping curve mitigates year-to-year price volatility as market conditions fluctuate and mitigates potential exercise of market power. These beneficial price formation properties can stabilize pricing in a way that helps to support the financing of new resources when needed. A sloping curve can also help balance program costs against the pace of decarbonization to achieve faster carbon abatement if this can be done at reasonable costs to the consumer.

Within the total clean energy procurement target, many states will also have a variety of state programs or procurements that need to be accommodated. Some of these state programs would be reflected as a part of a state's total demand for clean energy within ICCM, while others would be procured outside the ICCM. As an example, Figure 13 illustrates the demand of a "typical" state with multiple policies including ZEC payments for existing nuclear resources and a renewable portfolio standard with technology-specific carve outs. The ICCM can be used to meet the overall state policy goals while accounting for existing contracts and future clean energy procurements that may occur outside the ICCM.

65 Corporate buyers seeking to acquire clean energy could also develop a demand curve to express their increased willingness to pay for clean energy, including selecting new resources or purchasing only from their preferred state-specified REC products. Other ways of enabling and supporting private demand for clean energy would be evaluated on an ongoing basis.

FIGURE 13: CLEAN ENERGY DEMAND IN ICCM FOR A STATE WITH MULTIPLE CLEAN ENERGY POLICIES



To meet these particular goals, the state demand could be reflected within the ICCM as:

- **Overall Clean Energy Demand Curve** (blue line): The state would translate (or ask the ICCM auction administrator to translate) its total appetite for clean energy into a state-specific demand curve. In this example, the total state demand for clean energy is 50% renewables, plus 20% under the ZEC program (70% total clean energy mandate). This total demand for clean energy is expressed by the total state demand curve (blue line). The specific price and quantity parameters of the curve would be developed or approved by each state's policymakers consistent with state policy and adjusted over time. Resources cleared within the blue area would receive prices set by the intersection of supply with the blue demand curve, and would be obligated to produce and deliver Tier 1 RECs as defined by that particular state. Additional discussion of how states might wish to implement their demand curve is included in Appendix B.
- **Legacy Contracts and Procurements Outside of ICCM** (gray boxes): States would maintain total flexibility to continue using existing or future programs other than the ICCM at their own discretion. In this example, the state anticipates meeting 10% of its clean energy mandate through legacy contracts. It further anticipates meeting an additional 10% of its clean energy needs through future programs or procurements outside the ICCM construct (for example, through a specific state-sponsored resource investment). The volumes of clean energy from any contracts signed outside of ICCM would be accounted for in auction clearing (but the resources would not earn any attribute payments). These clean energy resources would be fully enabled to sell capacity into the ICCM capacity product with no MOPR. After legacy contract expiration, these resources would become eligible to participate in ICCM as existing resources eligible to earn both capacity and clean energy attribute payments.
- **Technology-Specific Carve Outs within ICCM** (yellow box): Some states may have technology-specific mandates such as for in-state solar or offshore wind within their clean energy standards. The states may elect to achieve these minimum procurements within the ICCM by specifying a minimum share of the total demand that must be met by resources qualified under the particular technology type to produce the relevant class of attributes such as solar RECs (Solar Renewable Energy Certificate or SRECs) or offshore wind RECs (ORECs). States could choose to apply a different price cap and different new resource lock-in period for these carve-out resources than the generalized clean energy demand curve. The carve outs might produce higher (but not lower)

clearing prices for the SREC, OREC, or other attributes created by these preferred technology types.[66]

- **Nuclear Resources** (pink box): Each state would determine the extent to which nuclear resources would be eligible to contribute to their clean energy goals, including whether only in-state nuclear resources could qualify or whether out-of-state nuclear resources could also qualify. States can impose a $/ZEC cap on payments awarded to nuclear supply and/or on volumes of nuclear supply eligible to serve their total clean energy demand. This structure introduces downside price competition for nuclear resources from other sources of clean energy supply, but can prevent payments in excess of nuclear program budgets.
- **Other Tier 1 Renewables** (blue box): All other qualified resources could compete to serve the state's demand for clean energy, up to the maximum price and quantity defined in the total state demand curve for clean energy.

Together, these structures offer each participating state total flexibility to meet none, some, or all of their clean energy needs within the ICCM.[67] While procuring all of the state's clean energy objectives through the ICCM would result in the lowest-cost path to decarbonization, each state still maintains the ability to procure clean capacity outside the market or voluntarily pay a premium for resources that they see as necessary to achieve their public policy goals. To maximize the competitive benefits of the ICCM over time, participating states can collaborate on opportunities to increase the quantities procured, reduce the volume of resource carve outs, increase alignment of resource qualification across states, and shift their demand toward procuring greater volumes from the PJM regionally-defined CEAC product that would qualify all clean resources across the PJM footprint.

C. ICCM Implementation Choices

Staff have developed the ICCM design concept as one viable and fully-specified approach to address the broad problems identified within the current RPM market structure. (This is unlike the FRR alternative variations considered above that were primarily tailored to address only one problem: the application of MOPR to policy resources.) An ICCM structure would offer the flexibility to implement a number of additional design elements within the same basic ICCM framework, and also offers a number of beneficial features that should be considered to enhance the performance of the RPM even if the ICCM were never implemented. Some of these design elements and implementation choices include:

- **Features to Be Considered within the PJM Capacity Market (with or without ICCM):** Several aspects of the current RPM design could be enhanced to better align with state and consumer decarbonization goals. Amongst the design options that should be considered regardless of the ICCM implementation include:
  - More accurate ELCC-based capacity accounting for all resources, including thermal power plants;

66 *See* Appendix H.3 here for additional discussion of auction clearing with technology-specific carve outs.

67 As an additional element of flexibility to states concerned about the deliverability of clean energy within their subregion of the grid, the ICCM could be utilized to impose a maximum constraint on the quantity of capacity that could be procured from fossil resources. This constraint would ensure that the remainder of state system and local capacity needs will be supplied by clean energy resources, including non-CEAC-eligible resources such as demand response and storage.

- Enhanced seasonal resource adequacy accounting and price formation that better reflects resources' capability, summer and winter reliability needs, and the differentiated value of capacity delivered across summer and winter seasons;[68] and
- Evaluation and consideration of whether flexible capacity requirements are needed and should be reflected within the capacity market construct.

- **Geographic Scope and Governance Structure of the ICCM:** The ICCM could be implemented regionally across PJM, sub-regionally for a group of states, or specifically for New Jersey. Even if the ICCM design remains identical, the governance, implementation, and impacts could differ substantially across these pathways:
  - *PJM-wide implementation* of ICCM would replace the current RPM with a new structure that provides states and consumers greater opportunities to express their resource requirements in the wholesale marketplace. PJM as an organization would be well-positioned to implement and operate this market drawing on its staff expertise and operational capabilities. Existing mitigation capabilities mitigate the exposure to the exercise of market power. This implementation pathway would offer the greatest economic and environmental benefits and place the lowest implementation burden on New Jersey or other participating states; however it may face barriers to implementation absent strong leadership from PJM, FERC, or both.
  - *Multi-state implementation* of an Forward Clean Energy Market, which is a simplified version of ICCM involving the forward procurement of clean energy without a capacity component, might take on a governance format and implementation pathway modeled on the RGGI. Under this implementation approach, two or more states would work together to refine the parameters of the FCEM to tailor it to their policy requirements. An auction administrator would be selected to implement the auction, which could be PJM, another third-party entity, or a newly created organization similar to RGGI. The auction administrator would procure clean energy to meet policy requirements on behalf of each participating state. Also similar to RGGI, the framework would be set up to invite and enable additional states and customers to participate over time and further the underlying aim of delivering a reliable and decarbonized resource mix.
  - *New Jersey or regional implementation* of an ICCM could also be pursued under an FRR plan by a selected auction administrator. Whether developed by New Jersey or a group of clean energy states, the ICCM would be designed to invite additional states to participate in the market over time. This approach would offer New Jersey the greatest opportunity to implement its chosen ICCM design. Further, many of the implementation, liquidity and market power challenges become less significant as the market expands. However, the complexity associated with an FRR option would still apply.
- **State-Defined ICCM Participation Choices:** Each state participating within the ICCM would have the ability to determine the parameters of its participation including: (a) selecting the products it wishes to buy such as state-defined RECs, SRECs, ORECs, or ZECs or PJM-defined CEACs; (b) determining the volume to be procured; (c) selecting the parameters of the state demand curve for attributes (or approving a formula by which the auction administrator would calculate these demand curves).
- **ICCM Design Enhancements that Could Be Implemented at Later Dates**: Some design elements within the ICCM may be desirable but take more time to implement. The evolution of the ICCM

[68] *See* additional discussion of such a two-season capacity market for the PJM region that could achieve approximately $100-$600 million per year in societal costs as compared to the current seasonal resource matching approach. Samuel Newell *et al.*, "Opportunities to More Efficiently Meet Seasonal Capacity Needs in PJM," April 12, 2018, pp. 13-16.

design could envision staged implementation that incorporates some design elements over time, such as:

- The development of enhanced PJM-defined CEAC products, such as an attribute credit that is tied to the marginal carbon abatement value of resources (and thus provides greater incentives for resources that displace more carbon, and that provides a basis for valuing storage resources that are operated to charge on clean energy and discharge to displace fossil plant production);[69]
- The adoption of a minimum clean capacity requirement that would allow states to stipulate not only the share of clean energy attributes they demand but also the share of their capacity needs that must be met by clean capacity resources that must be deliverable to serve reliability needs. This approach offers an opportunity to attract and retain clean resources such as nuclear, existing hydro, storage, and demand response that are needed for reliability in a clean energy future and that are not always eligible for state policy support.

These and other features of the ICCM are discussed in more detail in Appendices B-C. Many of these design features could be considered as part of a different long-term sustainable market design for meeting reliability and decarbonization requirements, even if the ICCM itself is not ultimately adopted.

D. Advantages and Disadvantages

This investigation specifically designed ICCM in response to the Board's charge to recommend alternative resource adequacy structures targeted towards efficiently achieving New Jersey's environmental and clean-energy policy goals. Compared to the other resource adequacy alternatives investigated, the ICCM is best aligned to sustainably achieve these policy objectives using market-based approaches to maintain reliability and drive clean energy achievement along the least cost pathway. The ICCM would maintain and expand reliance on competitive approaches, reduce the costs of achieving New Jersey's clean energy goals, and offer the opportunity to accelerate clean energy achievement through a downward-sloping demand curve.

If the MOPR is maintained in its current form, New Jersey would have the unilateral authority to implement a single-state ICCM to achieve these benefits while avoiding the application of the expanded MOPR to its policy resources, though such an approach introduces additional risks. Even if MOPR is eliminated, the single-state ICCM could offer New Jersey the benefits of a competitive mechanism for meeting its various clean energy objectives in alignment with reliability needs. A single state ICCM would come at the cost of exiting the regional capacity market, losing the associated efficiency benefits, introducing implementation risks associated with the FRR, and risks of exercise of market power. A multi-state FRR approach would expand the environmental and economic benefits of the ICCM across a broader regional footprint, but would face some of the same implementation challenges of an FRR, introduce a larger coordination challenge, and reduce the ability for New Jersey to implement its chosen design. The greatest economic and environmental benefits would be achieved under a PJM-wide ICCM, though at that scale New Jersey has the least ability to select its preferred design.

The primary disadvantages of an ICCM are the complexity and barriers to implementation, both of which are amplified if a regional solution is to be pursued. The relative advantages of different ICCM approaches are summarized in Table 3.

[69] For additional discussion of a marginal carbon abatement REC, see Spees, Oates "Locational Carbon Emissions", May 2021; and Appendix H.1, of Spees, *et al.* paper on a forward market for clean energy attributes.

TABLE 3: RELATIVE ADVANTAGES OF ICCM IMPLEMENTATION ALTERNATIVES

DESIGN	ADVANTAGES	DISADVANTAGES
New Jersey ICCM Implemented under FRR	• Eliminate MOPR on policy resources & mitigate/eliminate MOPR costs • Enhance competition among clean energy resources and reduce costs of achieving policy goals • Efficiency benefits of co-optimizing capacity and clean energy procurements • Option to accelerate clean energy achievement if prices are low • New Jersey has unilateral authority to implement its chosen design	• Lose competitive benefits of participation in PJM's broad regional capacity market • Market monitoring and implementation risks of a state-wide FRR, particularly in small capacity areas • Further evaluation required to determine statutory and regulatory authority • High implementation complexity
Multi-State ICCM Implemented under FRR	• Eliminate MOPR on policy resources & mitigate/eliminate MOPR costs • Maintain a share of the benefits from participation in broad regional capacity market, scaled to the size of multi-state region • Enhance competition among clean energy resources and reduce costs of achieving policy goals, scaled to the size of the multi-state region • Efficiency benefits of co-optimizing capacity and clean energy procurements • Option to accelerate clean energy achievement if prices are low • Multi-state approach can reduce costs of transition to clean electricity grid	• Greater coordination challenges to achieve multi-state coalition and alignment for implementation • Further evaluation required to determine statutory and regulatory authority • High implementation complexity
Regional ICCM Implemented by PJM	• Eliminate MOPR on policy resources & eliminate MOPR costs • Maintain full benefits of participation in broad regional capacity market • Maximum competition among clean energy resources and reduced costs of achieving policy goals • Efficiency benefits of regionally co-optimizing capacity and clean energy procurements • Option to accelerate clean energy achievement if prices are low • Broad regional approach can achieve least-cost efficient transition to clean electricity grid • Leverage PJM existing expertise and capability to design and operate the ICCM	• New Jersey's authority to implement its chosen design is reduced under a broader regional approach • Medium implementation complexity, aided by PJM and Stakeholder expertise
Regional Forward Clean Energy Market	• Creates an effective market for financing low cost clean energy resources • Maximize competition among clean energy resources • Ability to be implemented without involvement from federal or regional regulators and may involve fewer jurisdictional issues • (Slightly) less technical complexity than a full ICCM	• Less overall savings compared to a full ICCM implementation • Longer timeframe to stand up a new market structure outside the existing PJM structure • Medium complexity (if implemented by PJM)

V. Economic Assessment of Resource Adequacy Alternatives

To assess the economic implications of alternative resource adequacy structures for New Jersey, Staff engaged with consultants at The Brattle Group. This assessment utilized a model that replicates the outcomes of the PJM capacity auction under the status quo design and after any assumed design changes. Brattle estimated the potential impacts of the various design scenarios on capacity costs, payments for clean energy, patterns of retirement and new entry, and resource supply mix in the years 2025 and 2030. Brattle evaluated the following alternative resource adequacy scenarios:

- **Status Quo:** New Jersey stays in PJM capacity market and pays the cost of the 2019 MOPR.
- **No-MOPR RPM:** New Jersey stays in PJM capacity market, but the 2019 MOPR is repealed.
- **Best-Case Auction-Based FRR (State-Wide or Partial State JCPL-Only):** New Jersey leaves the PJM capacity market and conducts its own FRR capacity auction for one-year capacity commitments with optimistic, near-best-case competitive pricing outcomes achieved in each respective capacity zone. This scenario assumes suppliers of capacity not subject to MOPR are willing to sell capacity in the New Jersey FRR auction at prices only five percent higher than what they would expect to receive in the PJM market, *and* that they are perfectly able to predict their opportunity costs of not participating in the PJM market with no uncertainty, *and* that there would be no excess market power in the FRR auction relative to RPM.[70]
- **IMM-Assumed Pricing for FRR:** New Jersey leaves the PJM capacity market, but implements the FRR under an FRR design that results in higher pricing outcomes in line with the assumptions developed by the Independent Market Monitor (IMM) in a prior analysis of a New Jersey FRR.[71] These realized higher FRR prices could be driven by some combination of sequential-auction pricing uncertainty, lack of supply participation, exercise of market power, and/or implementation flaws. Following the IMM, this scenario assumes prices reach the level of Net CONE times the balancing ratio (equal to 78% based on the PJM 2022/23 parameters).
- **New Jersey-Only ICCM:** New Jersey elects the FRR option and conducts its own ICCM to procure both capacity and clean energy attributes on behalf of customers under a competitive procurement approach, under the same assumptions utilized under the near-best-case auction-based FRR including capacity prices at 5% above subsequent BRA prices. Other states remain in the PJM capacity market and face the costs of the 2019 MOPR; MOPR-influenced pricing also affects capacity prices available to New Jersey under the ICCM.
- **PJM-Wide ICCM:** The entire PJM region adopts an ICCM as an evolution of the current capacity market, achieving the competitive benefits of a no-MOPR full RPM plus a regional clean energy marketplace. Appendix C describes a variation of the PJM-wide ICCM that also imposes clean capacity requirements within the ICCM (that would require the capacity requirement to be served by clean resources).

As inputs to its model, Brattle utilized offer data from the PJM 2021/22 BRA, as updated to reflect future conditions anticipated by 2025 and 2030. Additional modeling detail is included in Appendix A.

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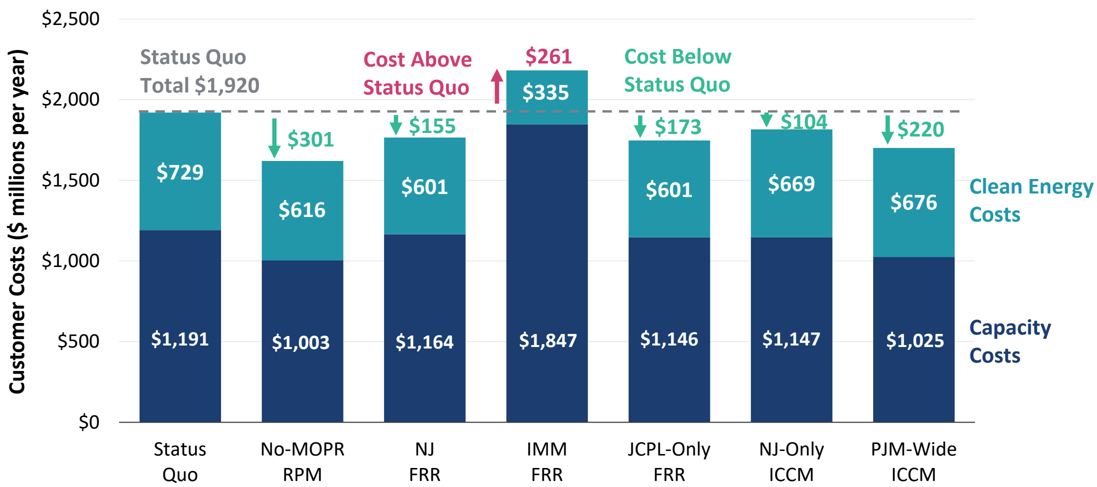
70 Note that certain FRR auction structures could make it more likely to achieve this outcome, such as the RPM-derivative pricing options in which resources were able to express their offer prices as a percentage of subsequent RPM clearing prices.

71 Monitoring Analytics, "Potential Impacts of the Creation of New Jersey FRRs," May 13, 2020.

A. New Jersey Customer Costs

Figure 14 compares the results of the New Jersey customer cost analysis across the seven scenarios examined in 2030 (2025 results can be found in Appendix A). The near-best-case outcome under a competitive FRR leads New Jersey customers to save approximately half of the cost of the current MOPR, regardless of whether the FRR is implemented state wide or for one utility zone. There are two primary drivers of these savings: (1) electing FRR allows thousands of MW of resources that cannot clear due to the expanded 2019 MOPR to provide capacity to New Jersey, thus eliminating the capacity double-payment effect for policy resources; and (2) applying policy resources to serve New Jersey capacity needs increases the supply of capacity in aggregate to the PJM footprint, thus lowering capacity prices for New Jersey customers and other PJM customers alike. These estimates also account for a smaller cost savings from the 3% reduction in procured quantities under an FRR due to the elimination of the sloping capacity market demand curve. The costs of the expanded MOPR are not eliminated by selecting an FRR however, because the broader PJM market prices would still be inflated by MOPR application to resources in other states. A New Jersey FRR auction would need to produce prices at least as high as the prevailing capacity market price in the relevant capacity LDAs order to attract sufficient supply offers.

FIGURE 14: NEW JERSEY CUSTOMER COSTS BY RESOURCE ADEQUACY DESIGN (2030)



Notes: Clean energy resource costs include payments to new onshore wind, offshore wind, and utility-scale solar resources in excess of their energy and capacity revenues. Capacity costs include New Jersey's share of PJM capacity costs (when participating in the PJM auction) or the New Jersey FRR cost (when not).

The substantial cost savings under a "Best Case FRR" depends on the willingness of non-MOPR capacity suppliers to sell into the New Jersey FRR auction at competitive prices. Competitive non-MOPR capacity sellers should rationally offer at the anticipated price in the upcoming BRA (as they would not be willing to accept a lower price to serve New Jersey than to sell into the full PJM market); they would only offer higher if their true underlying net going forward costs of providing capacity were higher. In a competitive market with appropriate measures to prevent the exercise of market power, if sellers could predict RPM prices perfectly or the auction could be constructed to exactly reflect sellers' true opportunity costs, then prices would converge between the FRR auction and subsequent BRA; this scenario assumes FRR prices will have a 5% premium over RPM outcomes.

There are also a number of plausible scenarios under which higher prices than the idealized Best Case FRR could materialize under a New Jersey FRR. Higher prices could arise from suppliers offering at prices above later-realized RPM prices due to uncertainties, lack of supply participation, localized market power, or FRR implementation flaws. If these outcomes were to produce higher prices near the levels previously assumed by the IMM, customer costs could increase (rather than decrease) under an FRR. Under this scenario, the cost savings achieved by avoiding the expanded MOPR on policy resources are more than offset by the higher capacity payments that exceed the pricing that would be available in the broader PJM market. If left unaddressed or locked in under long-term contracts, then a poorly-design or poorly-implemented FRR could cost the same or significantly more than staying within the RPM and accepting the costs of the expanded MOPR. These pricing risks highlight the importance of thoughtful design of an auction-based FRR and avoiding any lock-in of potentially unfavorable prices. The partial-state FRR would substantially limit the exposure to these potentially uneconomic outcomes.

If New Jersey elected the FRR and designed a single-state ICCM to procure both capacity and RECs, New Jersey consumers could save approximately one-third of the costs of expanded MOPR (even if MOPR would remain in place across the broader PJM footprint). The customers savings from the New Jersey ICCM are not as great as under New Jersey FRR, because the state procures additional clean energy through the ICCM (as discussed further below). This design is subject to some of the same challenges of other New Jersey-alone FRR cases as relates to pricing of the capacity product, such as the need to address the potential for exercise of market power. Careful implementation of the New Jersey-only ICCM would be necessary to mitigate such potential outcomes.

A PJM-wide ICCM would save approximately two-thirds of the cost of the expanded MOPR. These costs savings from ICCM would be realized even though New Jersey would substantially increase its clean energy achievement as discussed in the following section, accelerating renewable deployment 50% to 58% by 2030 (from 84% to 92% total clean energy including nuclear).

B. Implications for New Jersey Clean Energy Goals

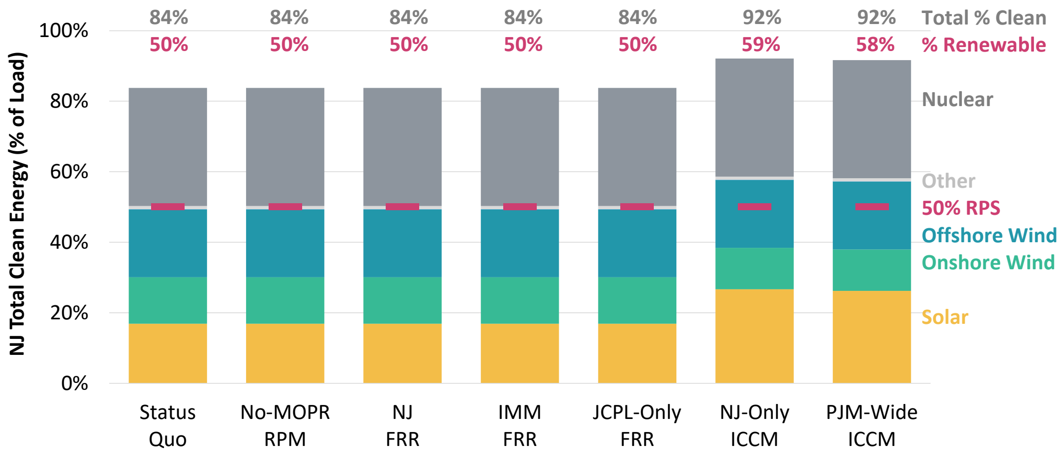
New Jersey's clean energy mix also changes across a subset of the alternative resource adequacy structures. The volume of clean energy resources procured toward New Jersey's clean energy goals does not vary across the Status Quo, No-MOPR RPM, Best Case FRR, or IMM FRR as summarized in Figure 15 for the year 2030. In these scenarios, clean energy additions are chosen to exactly meet the total RPS target and offshore wind procurements levels; total (Class I) renewable supply is equal to 50% of New Jersey load (84% if including nuclear generation).

Both the New Jersey-Only ICCM and PJM-Wide ICCM design scenarios procure substantially more clean energy due to the introduction of a downward-sloping demand curve that can accelerate clean energy procurement.[72] By 2030 a New Jersey-alone ICCM could attract sufficient incremental new clean resources to increase New Jersey's share of load served by renewables from 50% to 59% by 2030 (or from 84% to 92% including both renewables and nuclear supply).

[72] The demand curve utilized for New Jersey and all other states within the ICCM construct is described more fully in Appendix B, however the specifics of how New Jersey would choose to implement its demand curve would need to be further developed as consistent with State law.

FIGURE 15: NEW JERSEY ENERGY AND CAPACITY MIX BY RESOURCE ADEQUACY DESIGN (2030)

NEW AND EXISTING CLEAN ENERGY RESOURCES SERVING NEW JERSEY



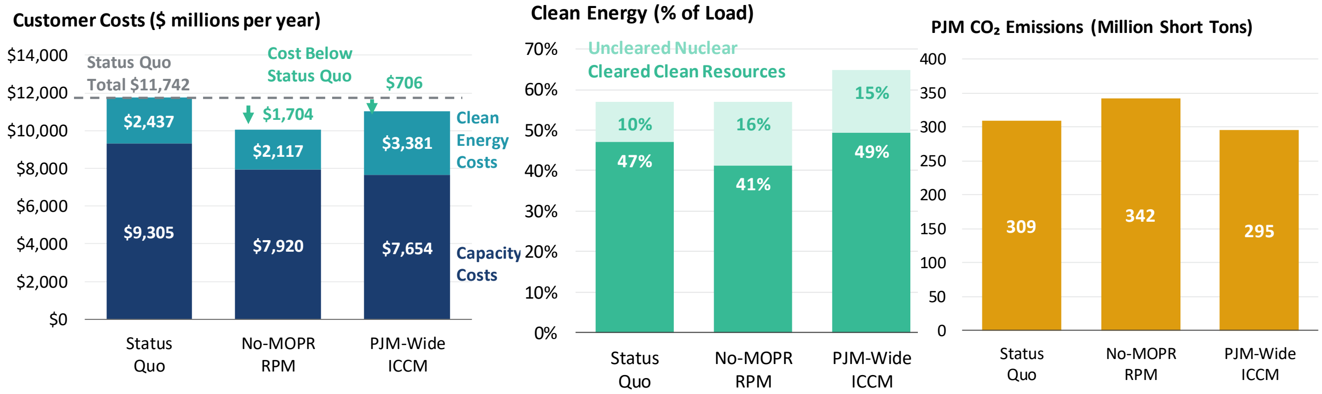
Notes: "Other" clean energy includes landfill gas, other biomass gas, municipal solid waste, geothermal, and in-state hydroelectric facilities less than 3 MW in service after July 23, 2012 currently providing RECs to meet New Jersey's RPS targets.

C. PJM-Wide Impacts on Cost and Resource Mix

A PJM-wide resolution to the expanded MOPR conflicts and better alignment with state policies could offer benefits not only to New Jersey but customers across the entire PJM region. Figure 16 illustrates the differences in customer costs, clean energy penetration, and regional carbon emissions across the cases relevant for regional solution including the status quo, no-MOPR, and regional ICCM design alternatives considered. The simplest option to eliminate MOPR applicability to policy resources would lower PJM-wide customer costs by $1,700 million per year by 2030. However, the share of nuclear resources that may fail to clear the capacity market under a no-MOPR RPM would increase (from roughly 10% to 16% of PJM customer demand) due to lower capacity market prices. This outcome illustrates why the RPM structure, even after the elimination of MOPR, is insufficient to support the most cost effective clean energy transition. Without a means to express their preference to rely on clean energy and clean capacity resources through the market, the RPM may continue to clear fossil resources rather than retaining nuclear (even if states and customers would prefer to pay the incremental cost required to rely on a cleaner supply mix).

Introducing a regional, PJM-wide ICCM would reduce costs by $700 million per year compared to the status quo, while at the same time increasing the share of PJM customer demand served by clean energy from 41% to 49%; cutting regional carbon emissions by 14% across the entire PJM footprint. This outcome is achieved by eliminating the costs of MOPR and redirecting incentives away from fossil resources, benefitting all customers including those with no clean energy policies and those with substantial clean energy goals. At the same time, New Jersey and other clean energy states are assumed to adopt downward-sloping demand curves for clean energy attributes that accelerate renewable development, the associated costs borne by the consumers within that state. Overall, the effect of the ICCM is to shift resource incentives away from the development and retention of fossil plants and toward the development of incremental renewable energy.

FIGURE 16: PJM-WIDE CUSTOMER COSTS, CLEAN ENERGY AND CARBON EMISSIONS



VI. List of Acronyms

AECO	Atlantic City Electric Company
AEP	American Electric Power Company
APS	Allegheny Power Systems
ATSI	American Transmission Systems, Inc.
ATSI-C	American Transmission Systems, Inc. – Cleveland
BGE	Baltimore Gas and Electric Company
BRA	Base Residual Auction
CETL	Capacity Emergency Transfer Limits
CEAC	Clean Energy Attribute Credit
ComEd	Commonwealth Edison
Dayton	Dayton Power and Light Company
DEOK	Duke Energy Ohio and Kentucky
DLCo	Duquesne Lighting Company
DPL	Delmarva Power and Light Company
EKPC	East Kentucky Power Cooperative
ELCC	Effective Load Carrying Capability
EMAAC	Eastern Mid-Atlantic Area Council
FERC	Federal Energy Regulatory Commission
FRR	Fixed Resource Requirement
FCEM	Forward Clean Energy Market
ICAP	Installed Capacity
ICCM	Integrated Clean Capacity Market
IMM	Independent Market Monitor
IRM	Installed Reserve Margin
JCPL	Jersey Central Power and Light Company
LDA	Locational Deliverability Area
LSE	Load-Serving Entity
MAAC	Mid-Atlantic Area Council
MetEd	Metropolitan Edison Company
MOPR	Minimum Offer Price Rule
MW	Megawatt
Net CONE	Net Cost of New Entry
OPSI	Organization of PJM States, Inc.
PJM	PJM Interconnection
PSEG	Public Service Electric & Gas Company
PS-North	PSEG North
RGGI	Regional Greenhouse Gas Initiative
RTO	Regional Transmission Organization
RPM	Reliability Pricing Model
REC	Renewable Energy Credit

RPS	Renewable Energy Portfolio Standard
SREC	Solar Renewable Energy Certificate
SWMAAC	Southwest Mid-Atlantic Area Council
UCAP	Unforced Capacity
VRR	Variable Resource Requirement
ZEC	Zero-Emissions Certificate

VII. Appendices

A. Modeling Details

This appendix provides additional detail on modeling input assumptions and results as developed by Brattle and summarized in Section V above. Though price and other outcomes are subject to a number of uncertainties, the analysis has applied consistent assumptions across all studied resource adequacy design alternatives.

Supply Offers. The model of the PJM region in 2025 reflects confidential supply offer data from the 2021/22 auction received from PJM, adjusted for announced retirements and new entry. For 2030, this supply curve is updated based on public data and estimate the long-run average avoidable net going forward costs of supplying capacity, which yields a more elastic 2030 supply curve.[73] Consistent with recent market experience, the modeling assumes that new entry of gas combined cycle and renewable resources can be attracted at prices 20% below the administrative estimate of the net cost of new entry (Net CONE), with new resource costs projected to decline consistent with National Renewable Energy Laboratory (NREL) projections.[74] The approach produces outcomes with greater price differences in 2025 than in 2030 caused by the same quantity of supply or demand changes. This accounts for the fact that in the short-term capacity prices can be quite sensitive, with large price changes driven by relatively small changes in supply or demand. However, over the longer term, extreme pricing impacts will tend to be moderated by supply exit (in the case of persistent low prices) and new entry (in the case of persistent high prices).

Demand and Transmission Parameters. This modeling assumes that policy-supported resources must offer at least the default MOPR price when subject to MOPR. The capacity demand curve reflects the 2022/23 PJM RPM demand curve, updated to 2025/26 and 2030/31 conditions to account for changes in peak demand by LDA and anticipated changes in Net CONE. CETL into each LDA are assumed to stay constant throughout the study period.

Auction-Based FRR Options. The various FRR options are modeled as sequential auctions, with PJM resources offering into the FRR auction at their economic costs, including opportunity costs of not clearing the subsequent PJM BRA. The near-best-case FRR and New Jersey ICCM cases assume that suppliers project RPM revenues with near perfect foresight (leading to a 5% price premium in FRR clearing prices relative to the RPM prices in most LDAs). The IMM-Assumed Pricing FRR case assumes that FRR prices are set at the balancing ratio times Net CONE.[75] Capacity demand curves in the FRR are vertical at the New Jersey reliability requirement.[76]

New Jersey ICCM. In the New Jersey ICCM, the present offshore wind carve-outs to the RPS remain in place as today. In addition, a new demand curve for the clean energy attribute is implemented as discussed in Section IV that reflects demand for the incremental (non-carveout) clean energy needed to meet the RPS at a $/MWh reference price given by the expected cost of new clean entry, net of energy

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73 Monitoring Analytics, "CONE and ACR Values – Preliminary," January 28, 2020.

74 "2020 Annual Technology Baseline," National Renewable Energy Laboratory.

75 Assumption derived from the IMM study of FRR implementation in New Jersey. Monitoring Analytics, "Potential Impacts of the Creation of New Jersey FRRs," May 13, 2020.

76 We adjust the reliability requirement for energy efficiency and price-responsive demand in accordance with PJM's accounting for these factors in the determination of RPM demand curves.

and capacity revenues. Solar and onshore wind are assumed to be able to provide clean energy and capacity, though the capacity value of both is assumed to decline as penetration increases. The demand curve slopes down to a point reflecting 100% clean energy at $0/MWh price. As in the simple FRR cases, capacity subject to MOPR in the rest of the PJM footprint can also offer capacity at non-MOPR prices, subject to limits by LDA of the amount of local capacity needed to meet the FRR requirement.

PJM-Wide ICCM. In the PJM-Wide ICCM, the capacity and clean energy attribute markets are co-optimized across the PJM footprint. States' offshore wind carve-outs are maintained, with additional generic clean energy available from either solar or onshore wind, whichever is most economic (considering both their clean energy value and capacity value at the prevailing clean and capacity prices). The PJM-wide demand curve for clean energy is implemented similarly to the one developed for New Jersey and applies only to states that have already adopted renewable portfolio standards.

PJM-Wide ICCM with Clean Capacity Requirements (results in Appendix C). In addition to the assumptions described above in the PJM-Wide ICCM, this scenario enforces a minimum constraint on clean *capacity* that is available and deliverable to consumers in clean energy. Separate clean capacity constraints are imposed system-wide, as well as in MAAC, SWMAAC, and EMAAC capacity areas.

Table 4 provides a summary of prices, costs, and quantities procured across study years and alternative market design scenarios.

TABLE 4: SUMMARY OF ECONOMIC RESULTS BY RESOURCE ADEQUACY DESIGN

PANEL A: 2025

		Status Quo	No-MOPR RPM	NJ FRR	IMM FRR	JCPL-Only FRR
New Jersey Customer Costs						
Capacity						
Cleared UCAP MW	*(UCAP MW)*	20,641	20,772	20,413	20,413	20,582
Uncleared NJ MOPR Resources	*(UCAP MW)*	2,028	1,567	854	854	854
Average NJ Capacity Price	*($/MW-day)*	$197	$171	$194	$222	$190
Capacity Costs	*($ Millions/yr)*	$1,483	$1,297	$1,442	$1,655	$1,426
Contracts and Clean Energy			26			
Renewable Energy Supply	*(% of Load)*	38%	38%	38%	38%	38%
Clean Energy Supply	*(% of Load)*	73%	73%	73%	73%	73%
CEAC Price	*($/MWh)*	n/a	n/a	n/a	n/a	n/a
Contracts and Clean Energy Costs	*($ Millions/yr)*	$453	$381	$374	$301	$373
Total New Jersey Customer Costs	***($ Millions/yr)***	**$1,936**	**$1,678**	**$1,817**	**$1,956**	**$1,799**
Change vs. Status Quo	*($ Millions/yr)*	*n/a*	*($259)*	*($120)*	*$19*	*($137)*

PANEL B: 2030

		Status Quo	No-MOPR RPM	NJ FRR	IMM FRR	JCPL-Only FRR	NJ-Only ICCM	PJM-Wide ICCM	Low Clean Capacity	Mid Clean Capacity	High Clean Capacity
New Jersey Customer Costs											
Capacity											
Cleared UCAP MW	*(UCAP MW)*	21,523	21,626	20,988	20,988	21,366	20,988	21,660	21,761	21,931	22,023
Uncleared NJ MOPR Resources	*(UCAP MW)*	2,427	0	0	0	0	0	0	0	0	0
Average NJ Capacity Price	*($/MW-day)*	$152	$127	$152	$241	$147	$150	$130	$117	$158	$210
Capacity Costs	*($ Millions/yr)*	$1,191	$1,003	$1,164	$1,847	$1,146	$1,147	$1,025	$931	$1,264	$1,687
Contracts and Clean Energy			25								
Renewable Energy Supply	*(% of Load)*	50%	50%	50%	50%	50%	59%	58%	58%	58%	59%
Clean Energy Supply	*(% of Load)*	84%	84%	84%	84%	84%	92%	92%	92%	92%	92%
CEAC Price	*($/MWh)*	n/a	n/a	n/a	n/a	n/a	$17	$18	$18	$18	$17
Contracts and Clean Energy Costs	*($ Millions/yr)*	$729	$616	$601	$335	$601	$669	$676	$671	$650	$640
Total New Jersey Customer Costs	***($ Millions/yr)***	**$1,920**	**$1,620**	**$1,765**	**$2,182**	**$1,747**	**$1,816**	**$1,700**	**$1,602**	**$1,915**	**$2,327**
Change vs. Status Quo	*($ Millions/yr)*	*n/a*	*($301)*	*($155)*	*$261*	*($173)*	*($104)*	*($220)*	*($318)*	*($6)*	*$407*

Note: Monetary values reported in nominal dollars.

B. Design Details of the Integrated Clean Capacity Market

The ICCM is a state or regional market design for attracting and retaining the least-cost set of resources for maintaining grid reliability, achieving state electricity goals, accelerating clean energy adoption, empowering customers, and unlocking innovative new technologies. The ICCM builds on best practice by using a centralized competitive auction to meet capacity and clean energy needs through competitive merchant investments.[77] Supply resources continue to participate in the energy markets and earn energy

[77] Many design details of the resource adequacy market will be derived from the current practice of PJM RPM capacity market; many design details of the clean energy product procurement will be derived from the Forward Clean Energy Market (FCEM) design proposal described in the appendix of: Kathleen Spees, *et al.*, "How States, Cities, and Customers Can Harness Competitive Markets to Meet Ambitious Carbon Goals: Through a Forward Market for Clean Energy Attributes," September 2019.

market revenues as they do today. This ensures that the resource adequacy market achieves a resource mix that is both reliable and consistent with participating states' decarbonization goals and public policies.

The ICCM clearing engine starts with the assumption that the market will procure enough clean energy (denominated as regionally-defined CEACs, state-defined RECs, or state-defined ZECs) to meet each participating state's clean energy requirements. The total clean energy accounted for will include resources selected through the ICCM as well as those procured outside the ICCM and offsetting each state's clean energy requirements.[78] Because the ICCM procures the specified percentage of clean energy in a competitive fashion, there is no longer any need for a MOPR; all clean energy resources are eligible to clear the ICCM auction without mitigation. The ICCM auction clearing engine determines the lowest-cost suite of clean and emitting generation resources to procure the specified volume of clean energy, account for state policy procurements outside of ICCM, *and* commit enough capacity to satisfy all regional and local reliability constraints. The ICCM thus simultaneously procures two distinct products (capacity and clean energy) at the lowest combined cost, while accommodating state policy.

Resources will offer qualified quantities of both capacity MW and clean energy MWhs, up to a maximum determined under eligibility rules. Capacity and clean energy will clear at two different prices (denominated in $/MW-day of unforced capacity (UCAP) for capacity and in $/CEAC, $/REC, or $/ZEC for each MWh of clean energy). Cleared capacity and clean energy products will be committed for delivery in the specified ICCM delivery year, which is three years after the auction is conducted. ***Because the ICCM integrates clean energy and locational capacity requirements into a single auction, it could entirely replace the existing RPM structure, while also advancing decarbonization at a regional scale.***

[78] Resources procured outside of ICCM could include (but is not limited to): resources procured under state solicitations, resources approved under state planning, or resources developed under incentives programs that the state wishes to maintain outside the ICCM construct. States could choose to maintain any and all such existing programs (which would reduce the volumes procured via ICCM), or could utilize the ICCM to meet their entire clean energy demand.

DETAILED DESIGN STRAW PROPOSAL SUMMARY

The ICCM would procure two products: (1) capacity and (2) clean energy. Table 5 provides design details describing how capacity and clean energy needs would be defined and procured.

TABLE 5: ICCM DESIGN PROPOSAL DETAILS FOR CAPACITY AND CLEAN ENERGY NEEDS

	Capacity *Denominated in $/MW-day UCAP*	**Clean Energy** *Denominated in $/ CEAC, $/REC, or $/ZEC*
Who Sets Demand?	• PJM	• State policymakers (who may delegate demand curve development to the auction administrator) • Voluntary buyers (retailers, companies)
Product Definition	• Unforced capacity (UCAP MW) • Keep locational specificity (as today) • Accurate accounting of capacity needs and values of resource types	• Unbundled clean energy attributes • States can buy regionally-defined CEACs, or state-defined REC or ZEC products • *Consider*: CEAC accreditation tied to carbon abatement value
Supply Eligibility	• All clean and fossil resources are eligible • Effective load carrying capability (ELCC) accounting used to develop resource-neutral capacity values (by location, season, and flexibility)	• CEACs: clean energy resources across PJM • RECs: state-defined eligibility, including for technology-specific classes of RECs to fulfill carve-out requirements • ZECs: each state determines whether in-state and out-of-state nuclear qualifies • Each state can specify eligible technologies (but aim to limit cross-state differences to maximize competition)
Quantity to Procure	• Quantity needed to support 1-in-10 reliability standards • Based on advanced reliability modeling that considers resource characteristics and flexibility needs in the clean grid • *Consider*: State option to impose a maximum on the share of capacity procured from fossil plants	• States and customers set demand quantity • Pre-existing contracts are fully accounted for as self-supply • In vertically integrated or other Fixed Resource Requirement states, the resource mix is approved by the state and not subject to ICCM
Willingness to Pay for each Product	• Sloping demand curves for each system-wide and locational capacity requirement • *Consider*: Separate demand curves for summer/winter needs and "flexible" capacity needs	• States submit or approve an auction-administrator-developed sloping demand curves for total clean energy demand, and carve out requirements (if any) • Voluntary buyers can submit price-quantity pairs to exceed state mandates, for regional CEACs or state-defined RECs/ZECs

AUCTION FORMAT, RESOURCE CLEARING, AND PRICE SETTING

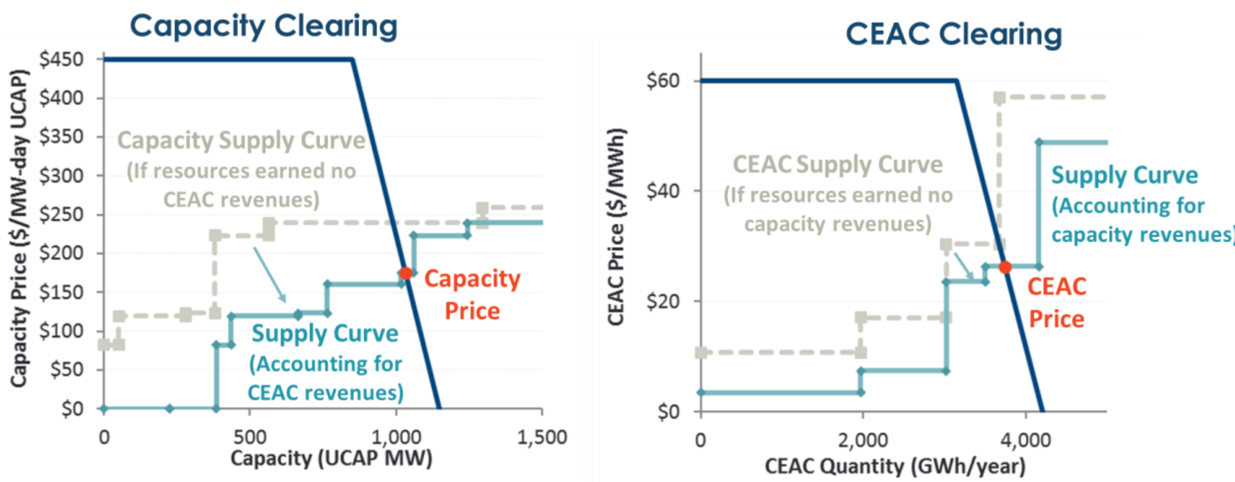
The ICCM auction format and clearing procedures derive from best practices in resource adequacy market design while incorporating certain new design concepts to ensure that clean energy needs are procured alongside capacity. The approach used to procure this least-cost, clean resource mix includes:

- **Three-Year Forward Auction:** The auction administrator would conduct an auction for each year to procure enough capacity and clean energy to meet system needs three years later. For example, the auction conducted in 2025 would procure capacity and clean energy for delivery in 2028.
- **Single-Round, Uniform Price:** The auction format would be a single-round auction that would produce a separate, uniform clearing price for each clean energy and capacity products (*i.e.*, single clearing price for each distinct product).
- **Optimized Clearing:** The auction would clear using a surplus-maximizing optimization formulation. This would maximize the value of cleared capacity and clean energy to states and customers, minus the cost of procured resources. This optimal resource mix is identified by continuously adjusting the set of cleared resources; determining the relevant clearing price for each product as consistent with the total volume cleared on the capacity and clean energy demand curves; assessing which resources would wish to clear (or not to clear) consistent with those prices; and then readjusting the selection of cleared resources. This is comparable to today's capacity market design.
- **Price-Setting Based on Marginal Value:** Prices for each product would be set based on marginal value (*i.e.*, at the intersection of supply and demand). To the extent that locational transmission constraints apply, capacity prices may differ by LDA, just as in today's capacity market. If a state wishes to meet a technology-specific carve out, such as for in-state solar, the ICCM will also support this through a separate class of RECs for the targeted resource type. The auction will include a constraint requiring the minimum share of RECs be procured from resources eligible to meet the technology-specific carve out. Any such state carve-out REC product may clear at higher prices than the more broadly-defined CEAC product. If states impose a separate (smaller) cap on ZEC volumes or program costs, this could produce a lower clearing price for ZECs delivered to their state.

Viewed from the customer's perspective, this auction format seeks to identify the lowest-cost portfolio of resources to meet capacity and clean energy needs by continuously adjusting resource selection until the lowest possible total procurement cost is achieved. Viewed from the seller's perspective, the same auction format seeks to clear any resource that can earn its total revenue requirement from some combination of clean energy and capacity payments; the auction would exclude any resource that cannot earn sufficient revenue to cover its offer price. Overall, the outcome from the auction maximizes social value by identifying the least-cost solution for customers and ensuring that sellers' private incentives align with auction outcomes (*i.e.*, profitable projects clear while unprofitable projects do not).

Figure 17 illustrates auction clearing and price setting in a simplified example. The curves illustrate the capacity demand curve developed by the auction administrator (on the left) and the clean energy demand curve developed by each state or voluntary commercial buyer, as described further below (on the right). Sellers offer their resources at the minimum payments they would accept to take on the obligation to sell both capacity and clean energy attributes. The gray dashed supply curves are drawn as if the seller would need to earn its entire offer price from just one product. The lower aqua supply curves account for clean energy revenues driving a lower capacity supply curve (and vice versa, with capacity revenues driving a lower clean energy supply curve).

FIGURE 17: CO-OPTIMIZED PRICE FORMATION REFLECTING THE MARGINAL COST OF EACH PRODUCT



Notes: Simplified simulation illustrating ICCM procurement outcomes in a simplified example, contact authors for the underlying model used to create this numerical example.

This simplified example illustrates that by optimizing the procurement across both products, prices and customer costs can be reduced. If the auction were designed to narrowly focus on capacity procurement (as the RPM market does today), it would likely procure capacity primarily from fossil plants and attract investments in new gas combined-cycle resources. This outcome runs counter to policy goals in many states by expanding the reliance on fossil resources even for states that wish to decarbonize. States would then need to conduct separate solicitations for clean energy resources, inducing an excess of total capacity in the market and leaving customers to pay for duplicate resources. This double-payment problem is amplified by the expanded MOPR construct that will increasingly exclude clean energy resources from the capacity market, however some of the inefficiencies and customer costs associated with a sub-optimal resource mix would persist in the RPM even without MOPR.

A joint auction resolves these inconsistencies in ways that will drive the resource mix toward an efficient balance of firm capacity needed for reliability and bulk clean energy resources needed to decarbonize the grid. As illustrated in Figure 17 above, the price paid for capacity will go down as clean resources earn a portion of their revenue requirements from the CEAC product. CEAC payment prices will also go down as clean resources earn a portion of their revenues from selling capacity. These customer savings do not occur by accident, but rather by utilizing competitive forces to drive the right quantity and the right mix of supply to meet all system needs.

HOW RELIABILITY IS MAINTAINED WITHIN THE ICCM

PJM Interconnection will continue to set reliability standards both system-wide and by LDA. However, the auction administrator (whether PJM or another entity) would take on responsibility for ensuring that sufficient capacity is procured to meet these standards. PJM will have the following responsibilities associated with its mandate of maintaining the 1-in-10 reliability standard:

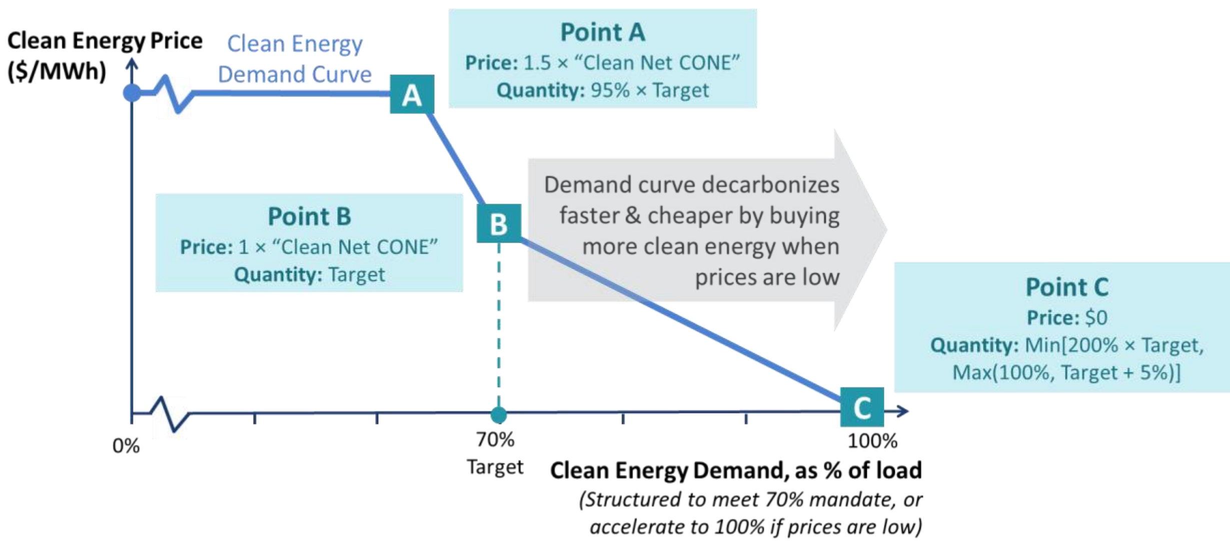
- Determining the Reliability Requirement or UCAP MW quantity of supply needed system-wide and within each LDA in order to maintain reliability;
- Determining the UCAP MW ratings of each eligible supply resource including both fossil and clean energy resources, developed in a technology-neutral fashion such that 1 UCAP MW of capacity has the same reliability value regardless of the underlying technology type;

- Determining which LDAs must be separately considered for reliability purposes and calculating the CETL of supply that could be imported into each LDA; and
- Enhancing current reliability accounting practices to align with the region's clean energy transition, including considering: (a) more accurate accounting of resources' reliability value and ensuring full participation of emerging clean energy technologies; (b) separate summer and winter reliability requirements; and (c) flexible capacity requirements.

The auction administrator will take these reliability parameters as inputs into the ICCM. The auction administrator will translate capacity needs into system-wide and locational demand curves for capacity, and will ensure that CETL and other reliability constraints are appropriately reflected within ICCM auction clearing. Based on this foundation of accurate supply and demand accounting, the ICCM will be able to ensure reliability by procuring sufficient UCAP MW to meet all system and locational reliability needs.

THE SHAPE OF STATE-DEFINED DEMAND CURVES

FIGURE 18: ILLUSTRATIVE DEMAND CURVE FOR A STATE WITH A 70% CLEAN ENERGY TARGET



For the purposes of this proposal, a draft state design curve could be defined by three price and quantity points that would be updated each year using a formula that reflects each state's willingness to pay to achieve carbon abatement, as illustrated in Figure 18:

- **Point B:** The curve is anchored at "Point B," which is the procurement target at a price equal to the Clean Resource Net Cost of New Entry ("Clean Net CONE"), calculated as the estimated CEAC price that would be needed to attract new clean energy resources into the PJM region (*i.e.*, the net of anticipated energy, ancillary service, and capacity payments).[79]
- **Point C:** To the right of the anchor point, the demand curve slopes downward and reaches "Point C" at a price of zero at either (i) double the procurement target if clean energy targets are below 50% of electricity load; (ii) at 100% of forecasted electricity demand if the clean energy target is between 50 and 95%; or (iii) at the target plus 5% for clean energy targets exceeding 95%. This low-priced portion of the demand curve enables the state to pursue an accelerated pace of decarbonization if it is possible to do so at low cost.

[79] This proposal envisions Clean Net CONE being determined through a periodic expert review in accordance with the ICCM governance structure.

- **Point A:** To the left of the anchor point, the curve slopes up to the price cap at "Point A". The price is capped at 1.5 times Clean Net CONE, at a quantity 5% less than the target. States would have the flexibility to adjust the price and quantity at Point A in order to only procure CEACs below a threshold price cap or program budget cap. This higher-priced portion of the demand curve allows the pace of decarbonization to moderate slightly if CEACs are only available at high prices (e.g., in case there is a period with high commodity prices or tight financial market conditions). During such a time, a state may wish to take a somewhat moderated pace as a cost mitigation decision.

These price and quantity points are a reasonable starting point for states that wish to use a demand curve approach, though the specific formula for each point should be adjusted to match the state's policy priorities. If a state prioritizes to never fall short of the target, "Point A" should be right-shifted so that the sloping part of the demand curve can start at the target. If total cost is the main concern, the price at the cap can be lower than in the figure. If the state wishes to maximize the pace of decarbonization, the foot of the curve can extend to 105% of load even if the target begins at a low level. As long as the curve passes through the target quantity at a price near or above Clean Net CONE, the curve will help meet the clean energy objectives while appropriately balancing costs, mitigating price volatility, and supporting a sustainable marketplace.

HOW SUPPLY RESOURCES PARTICIPATE IN THE ICCM

Participating resources, both clean and emitting, participate in the ICCM by identifying their annual net going forward costs for delivering capacity and clean energy in the targeted delivery year (three years in the future). Offer prices for new resources will likely reflect annualized investment costs minus net energy and ancillary service market revenues, as all such resource costs could be 'avoided' if their resource were not selected through ICCM. For traditional resources, the offer price is the total payment needed to deliver their qualified quantity of unforced capacity (in UCAP MW, comparable to today's capacity market). In the case of clean resources, the sell offer will also include the number of clean energy MWh (denominated as CEACs, RECs, or ZECs) the clean resource is expected to produce during the delivery year. New clean suppliers would have the option of selecting a 7-12 year price lock-in on clean energy payments to promote efficient financing.[80]

A clean energy supply resource would be eligible to sell capacity, CEACs, or both products into the ICCM. Examples of bids would include:[81]

- **A new 100 MW (nameplate) onshore windfarm**, with a $76/kW-year installed capacity (ICAP) revenue requirement and a 30% annual capacity factor would expect to produce 262,800 MWh of clean electricity and 13 MW of unforced capacity. It would be eligible to sell 262,800 CEACs and 13 MW UCAP of capacity.
- **A new 100 MW (nameplate) solar facility,** with a $61/kW-year ICAP revenue requirement and a 15% annual capacity factor would expect to produce 131,400 MWh of clean electricity and 42 MW of unforced capacity. It would be eligible to sell 131,400 CEACs and 42 UCAP MW of capacity.
- **A new 100 MW (nameplate) gas-fired peaking resource**, with an $82/kW-year ICAP revenue requirement, would expect to produce 0 MWh of clean electricity and 95 MW of unforced capacity. It would be eligible to sell 0 CEACs and 95 UCAP MW of capacity.

80 Resources that acquire a price lock would have their clean energy contributions automatically credited for the duration of the price lock (*i.e.*, have their supply offered at zero in subsequent auctions during the price lock period).

81 The majority of the numbers in these examples are derived from PJM's August 2020 filing before the Federal Energy Regulatory Commission regarding MOPR levels for new resources. *See* *Re: PJM Interconnection, L.L.C, Docket Nos. EL19-58-003, Informational Filing with Indicative Values for Energy and Ancillary Services Offset*, August 19, 2020.

Each supply resource would select one of three different offer types, representing their offer of committed production in the delivery year, three years in the future:

- **Capacity-Only Offers** (in units of $/MW-day UCAP) would be submitted by fossil plants or demand response that can sell capacity but that cannot sell CEACs;
- **Bundled Capacity + Clean Energy Offers** (in units of total $/year revenue requirement to deliver the independently-specified volumes of capacity and clean energy), which would be offered by clean energy resources that seek to earn this total revenue requirement but that are indifferent as to whether the revenues are earned from capacity or clean energy payments; or
- **Clean-Energy-Only Offers** (in units of $/MWh of CEACs, RECs, or ZECs) would be offered by sellers that wish to market their clean energy sales independent of any capacity obligation. This offer type might be primarily relevant for clean energy resources that have failed to qualify for capacity sales, or market participants that hold excess volumes of unbundled CEACs that were procured bilaterally.

Each resource would compete to sell capacity and clean energy up to their maximum offered quantity. The auction clearing would account for each resource's eligibility to serve each LDA demand curve and fulfill each state's demand curve (as well as to meet any state resource carve outs that it is eligible to serve). Resources would clear to sell the highest-value products for which they are eligible and would be guaranteed to earn payments equal to or exceeding their offer price.

Once cleared in the forward auction, each supply resource would take on an obligation to deliver the cleared volume in the specified delivery year. Resources that produce excess volumes of clean energy attributes within the delivery year would be able to sell these excess volumes bilaterally, in a spot auction, or possibly bank the excess credits. Resources that produce an insufficient volume of clean energy relative to their commitment would be required to fulfill the obligation either through a bilateral purchase or a procurement within the final spot auction.[82]

C. ICCM with Clean Capacity Requirements

One of the design options of ICCM is to adopt consideration of "clean capacity requirements" that would advance not only the share of clean *energy* on the system, but also the share of *capacity* that would be served by clean energy resources. These requirements may be relevant, for example, if states want their reliability services provided by clean resources (such as storage, demand response, nuclear, and some existing hydro) that may not be eligible under REC or ZEC programs. Under a clean capacity requirement, the state would specify a share of the *capacity* product that must be met from clean capacity resources. The clean capacity requirement would likely be lower than the clean energy goal. For example, New Jersey's Energy Master Plan found that the least-cost decarbonization pathway included 84% clean energy by 2030, but only approximately 42% clean capacity over the same timeframe.[83] The remainder of capacity and other reliability needs would continue to be served by infrequently-operated fossil fuel plants that are maintained for the primary purpose of serving reliability and balancing needs.

The Brattle Group estimated the potential market outcomes within an ICCM design with three levels of clean capacity requirements, as summarized in Table 6. The three cases examined are: (i) a *High Clean Capacity Requirement* scenario, in which state mandates for clean energy are also applied as a mandate for clean capacity, the New Jersey 2030 clean capacity requirement is 84% (equal to the state renewable

[82] See additional discussion of arrangements for discussion of delivery obligations in Appendix D here.

[83] *See* State of New Jersey Energy Master Plan.

plus nuclear policy); (ii) a *Low Clean Capacity Requirement* scenario, in which the clean capacity requirement is half the size of the clean energy policy, or 42% in new Jersey by 2030, this scenario is approximately consistent with the Energy Master Plan; and (iii) a *Mid Clean Capacity Requirement,* which is half way between the other two.

TABLE 6: MINIMUM CLEAN CAPACITY REQUIREMENTS

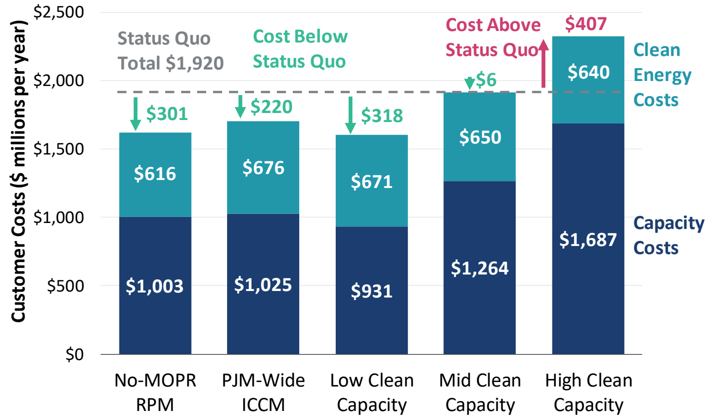
	Clean Energy (RPS + Nuke)	Total Clean Capacity Needed (Local + Imports)			Local Clean Capacity Needed		
		Low Clean Capacity	Mid Clean Capacity	High Clean Capacity	Low Clean Capacity	Mid Clean Capacity	High Clean Capacity
RTO	54%	27%	41%	54%	n/a	n/a	n/a
MAAC	68%	34%	51%	68%	32%	48%	65%
EMAAC	74%	37%	55%	74%	24%	35%	47%
NJ	84%	42%	63%	84%	n/a	n/a	n/a

Figure 19 summarizes the New Jersey customer cost and resource mix outcomes by 2030 under an ICCM with clean capacity requirements. As illustrated in the top panel, the ICCM with clean capacity requirements can produce customer costs ranging from $320 million per year in customer savings relative to the status quo, up to $400 million per year in additional costs above status quo. The figure further illustrates that an increasing share of New Jersey customers' capacity costs are directed toward clean capacity resources at higher clean capacity requirement levels.

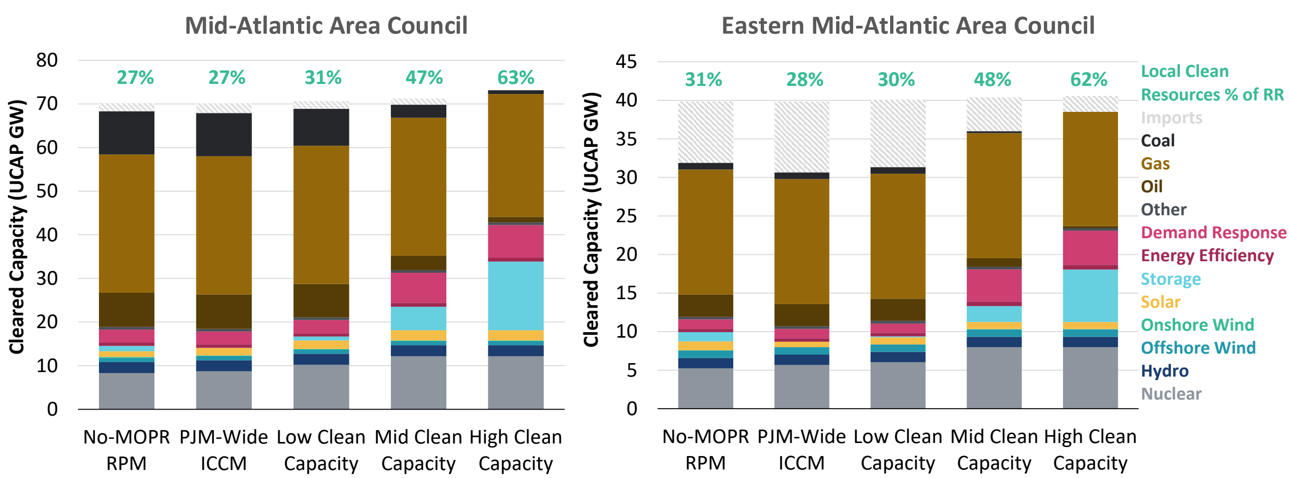
The bottom panel illustrates the resource mix under each of these alternatives, focusing on the MAAC and EMAAC regions serving New Jersey. In EMAAC, the share of clean capacity could increase from 28% (under a PJM-wide ICCM) up to 30-60% (under the range of clean capacity requirements modeled). The additional clean capacity comes primarily from at-risk nuclear that might otherwise retire, demand response, and storage. The additional clean capacity supply displaces fossil plants (primarily aging oil and coal plants) in EMAAC as well as the broader PJM footprint.

FIGURE 19: NEW JERSEY CUSTOMER COSTS AND SUPPLY MIX IN 2030 BY RESOURCE ADEQUACY DESIGN

PANEL A: NEW JERSEY CUSTOMER COSTS



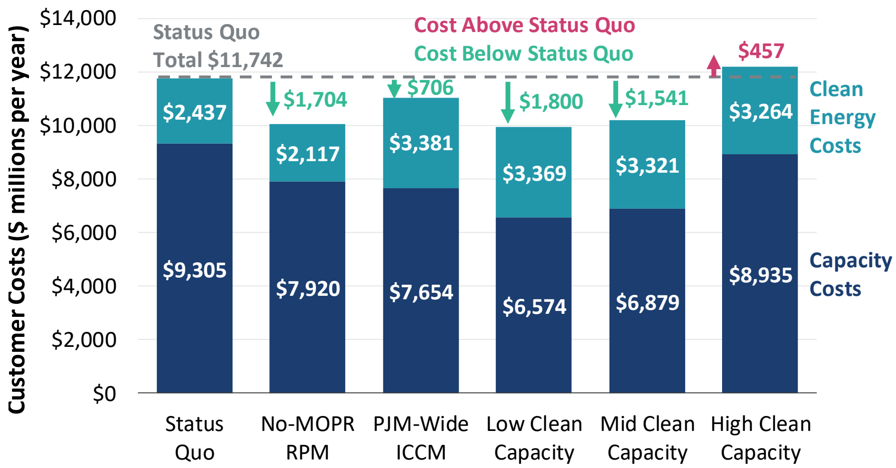
PANEL B: CAPACITY MIX IN THE EASTERN CAPACITY AREAS SERVING NEW JERSEY



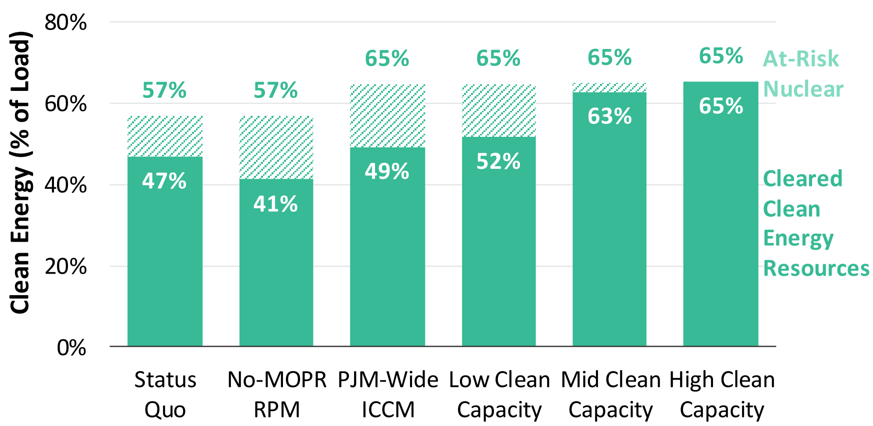
On a PJM-wide basis, imposing clean capacity requirements would similarly shift investment incentives and the resource mix. At lower clean capacity requirements, total customer costs would drop by approximately $1,800 million per year compared to the status quo; the midpoint case would reduce costs by $1,550 million per year; while the highest level of clean capacity requirements could increase total customer costs by $450 million per year. On a PJM-wide basis, the total share of capacity needs met from clean energy resources would increase from 27% under ICCM, and up to 29-56% of the total PJM capacity mix depending on the size of the clean capacity requirement. The incremental clean capacity needs are fulfilled by at-risk nuclear that might otherwise retire (Figure 20B), demand response, and storage. The clean capacity requirements offer an opportunity to retain existing nuclear plants, even if they are not eligible to sell clean energy attributes to all states under the ICCM. Considering both increases in renewables and increases in retained nuclear, the ICCM with clean capacity constraints could advance PJM-wide clean energy from 41% (in the No-MOPR RPM) up to 52-65% of total PJM-wide demand. For demand response and storage, clean capacity requirements would maintain and advance their position as likely the most cost-effective means of providing reliability services in states that wish to achieve complete decarbonization of the supply mix. The incremental clean capacity resources encourage the retirement of aging fossil plants, primarily coal and oil (Figure 20C).

FIGURE 20: PJM-WIDE CUSTOMER COSTS AND SUPPLY MIX IN 2030 BY RESOURCE ADEQUACY DESIGN

PANEL A: CUSTOMER COSTS IN PJM



PANEL B: CLEAN ENERGY GENERATION



PANEL C: PJM CAPACITY MIX