STATE OF NEW JERSEY
BOARD OF PUBLIC UTILITIES
Request for Written Comments
Investigation of Resource Adequacy Alternatives
Docket No. EO20030203
Supplemental Comments of the PJM Power Providers Group

The PJM Power Providers Group ("P3") respectfully requests the opportunity to submit this additional information to further supplement its May 20, 2020 initial comments, June 24, 2020 reply comments, and to specifically respond to the Northbridge Group analysis of FRR potential FRR alternatives for New Jersey.[1]

To further enhance the record, P3 offers the attached paper from former PJM Chief Economist Dr. Paul Sotkiewicz explaining the inaccuracies of the Northbridge Group analysis submitted by PSEG and Exelon in its June 24, 2020 Joint Reply Comments. P3 respectfully requests the Board accept this additional information in order to enhance the record and facilitate the decision-making process.

[1] P3 is a non-profit organization that supports the development of properly designed and well-functioning markets in the PJM region. Combined, P3 members own approximately 67,000 megawatts of generation assets, produce enough power to supply over 50 million homes in the PJM region covering 13 states and the District of Columbia. For more information on P3, visit www.p3powergroup.com. The comments contained in this filing represent the position of P3 as an organization, but not necessarily the views of any particular member with respect to any issue.

Respectfully submitted,

On behalf of the PJM Power Providers Group

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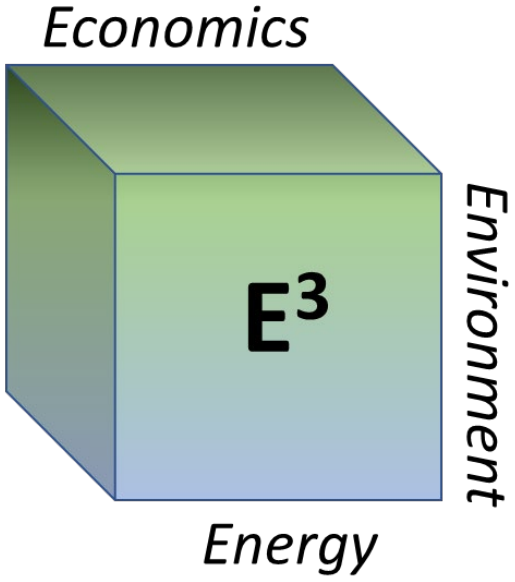
Attachment: Paper of Dr. Paul Sotkiewicz



E- Cubed Policy Associates, LLC

Prospective Minimum Offer Price Rule Price Floors and Cost-Effectiveness of the PSEG/Exelon Fixed Resource Requirement Plan for New Jersey

July 22, 2020

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Acknowledgements and Disclaimers

This paper was prepared at the request of the PJM Power Providers Group ("P3") in response to the Supplemental Comments of PSEG and Exelon Generation submitted June 24, 2020 and the accompanying report by the Northbridge Group entitled "Evaluation of the PJM IMM's Potential Impacts of the Creation of New Jersey FRRs" dated May 2020 in the *Investigation of Resource Adequacy Alternatives*, BPU Docket No. EO20030203. The views and results expressed herein are those of Paul M. Sotkiewicz, Ph.D. and not necessarily those of P3 or any of its members, or any other clients of E-Cubed Policy Associates, LLC.

Executive Summary

PSEG and Exelon Generation ("EXC") filed supplemental comments and responses in the BPU Docket on June 24, 2020. Accompanying the PSEG/EXC submission was an analysis from Northbridge Group ("Northbridge") to rebut the report of the PJM Independent Market Monitor ("IMM") report on the potential costs of a Fixed Resource Requirement ("FRR") plan for New Jersey as a whole, and for various load zones within New Jersey (PSEG, JCPL, and AECO).

This whitepaper shows that many of the assertions made and conclusion reached by the Northbridge analysis are misleading, logically flawed, undocumented, or simply incorrect. Furthermore, the Northbridge analysis fails to directly address the Tiered FRR supported by PSEG/EXC in comparison to the IMM results, rendering the Northbridge work meaningless for regulatory decision making regarding the wisdom of New Jersey moving in whole, or in part, toward an FRR plan.

In response to the Northbridge analysis, I offer the following conclusions:

1. Contrary to the assertions and conclusions reached by Northbridge, almost all state supported "clean energy" resources would clear the RPM auction under the Minimum Offer Price Rule ("MOPR") rules that PJM is currently in the process of implementing.
    a. For the Salem and Hope Creek nuclear units, the resource specific offer floor ***using the updated forward energy price curves for Delivery Years 2022/2023 through 2025/2026*** is estimated to be from as much as $48/MW-day to as low as $0/MW-day when those forward curves are adjusted for potential pricing under PJM's reserve pricing reforms. See **Table 3** and **Table 4**.
    b. For solar resources, using NREL data and the aforementioned forward price curves and taking advantage of the 30-year life that PJM allows for Resource-specific MOPR exemptions, the MOPR offer floor is estimated to be as high as $75/MW-day for the 2022/2023 BRA and fall to just below $40/MW-day for the 2025/2026 Delivery Year. Adjusting for potential effects of PJM reserve pricing reforms reduces the MOPR floor prices fall to $61/MW-day for the 2022/2023 BRA and fall further to just below $25/MW-day for the 2025/2026. These results are consistent with solar developer's assertions that they can clear in the RPM BRA even under MOPR. See **Table 6** and **Table 7**.
    c. The MOPR floor prices for nuclear and solar are well below prices observed in EMAAC over the past ten Base Residual Auctions ("BRA") from 2012/2013 to 2021/2022 making it a certainty that they will clear under MOPR in future years. The minimum price in EMAAC has been $119/MW-day over the past ten BRAs.

d. Only offshore wind would not clear in the RPM BRA, but its capacity value is only 286 MW UCAP in 2025 and 910 MW UCAP in 2030 according to Northbridge's data. If one accounts for the likelihood that the effective load carrying capability ("ELCC") methods will be used to measure the capacity value of intermittent, variable resources in the future, the capacity value of this offshore wind will be diminished in the future.
e. In 2025, of the new clean energy resources identified by Northbridge, 4254 MW UCAP, all but 286 MW UCAP (93 percent) will clear in the RPM Capacity Market. Note that this number does not include storage resources since storage can charge from carbon-emitting resources running,
f. In 2030, of the 5,978 MW of clean energy resources identified by Northbridge, all but 910 MW UCAP (85 percent) would clear in the RPM capacity market even under MOPR.

2. Given most of the state supported "clean energy" capacity would clear in the RPM capacity, Northbridge's conclusion that New Jersey would be forced to pay twice for capacity cannot be supported in any meaningful way, but for a small fraction of capacity that would amount to $17 million in 2025 and $55 million in 2030.[1]
3. Northbridge fails to examine the PSEG/EXC Tiered FRR proposal. This is not surprising as the results as shown previously in comments submitted by P3 and the July 15, 2020 IMM analysis show how much more expensive this would be. The entire cost of the PSEG/EXC proposal could range between $600 million as just released by the PJM IMM[2] and as much as $700 million as shown in my earlier prepared comments.[3] These costs would add up to $9.03/MWh to New Jersey customer bills.
4. Northbridge's assertion that New Jersey customers would have to increase their state support for clean energy resources, should they not clear in the RPM Auction is a red herring. New Jersey has already committed to paying for offshore wind and other clean energy resources will clear under MOPR.
5. Northbridge's attempt at a market power analysis is incomplete, undocumented, and misses the main features of the PSEG/EXC proposal to only target clean resources in the EMAAC and MAAC LDAs. When only clean resources are considered, there are far fewer

[1] This is the value of the uncleared offshore wind resources at a price of $166/MW-day for EMAAC observed in the 2021/2022 BRA. *See* https://pjm.com/-/media/markets-ops/rpm/rpm-auction-info/rpm-auctions-resource-clearing-price-summary.ashx?la=en

[2] Monitoring Analytics, Independent Market Monitor for PJM ("PJM IMM") or ("IMM"), *Answer* in *Investigation of Resource Adequacy Alternatives,* BPU Docket No. EO20030203, July 15, 2020. ("IMM Answer")

[3] Paul M. Sotkiewicz, Ph.D, *Prepared Comments of Paul M. Sotkiewicz, Ph.D.*, On Behalf of the PJM Power Providers Group ("P3") in *Investigation of Resource Adequacy Alternatives,* BPU Docket No. EO20030203, June 24, 2020. ("Sotkiewicz Comments")

resources from which to choose and the market is far more concentrated in favor of PSEG and EXC.

Introduction and Background

On March 27, 2020, the New Jersey Board of Public Utilities ("BPU") or ("Board") initiated its *Investigation of Resource Adequacy Alternatives* to request written comments on possibilities for other resource adequacy paths, such as the Fixed Resource Requirement ("FRR"), outside of the PJM Reliability Pricing Model ("RPM") Capacity Market construct in order to ensure clean energy resources could be counted toward resource adequacy in New Jersey.[4]

Initial comments were filed by parties on May 20, 2020. In it is initial comments, PSEG/EXC proposed a Tiered procurement approach for implementing an FRR plan that would favor "clean energy resources."[5] The Tiered FRR proposal included resources subject to MOPR in the first tier and then other energy resources that may be needed to satisfy the FRR in the second tier.[6]

Supplemental/reply comments were submitted on June 24, 2020. Accompanying the PSEG/EXC supplemental comments,[7] was an analysis provided by the Northbridge Group in the response to a report submitted by the PJM IMM on May 20, 2020.

Capacity Purchases for the Energy Master Plan are an Environmental Policy Choice and Not a Resource Adequacy Imperative

Northbridge in its analysis notes, "New Jersey needs to procure 11,500 MW of clean capacity by 2030."[8] While this may be the goal from the New Jersey Energy Master Plan ("EMP") and undertaken for environmental policy reasons, it is essential to understand that this 11,500 MW of nameplate capacity is not being pursued for resource adequacy reasons.

Recent PJM RPM clearing prices indicate strongly there is no resource adequacy problem in New Jersey as prices in EMAAC continue to clear below the Net CONE value, and the total of local capacity and imported capacity into the EMAAC region are more than sufficient to meet

[4] *Investigation of Resource Adequacy Alternatives*, Request for Written Comments, Docket No. EO20030203 (Mar. 27, 2020) (the "Request for Comments")

[5] For the purpose of this paper, clean energy resources will be taken to mean those resource with zero emissions of carbon dioxide.

[6] PSEG and Exelon Generation Company, LLC ("PSEG/EXC Proposal"), Joint Comments in Investigation of Resource Adequacy Alternatives BPU Docket No. EO20030203, May 20, 2020 at 3, 7-8. This approach would favor clean energy resources in the second tier over other resources.

[7] PSEG and Exelon Generation Company, LLC, *Joint Reply Comments of PSEG and Exelon Generation Company LLC, Investigation of Resource Adequacy Alternatives,* BPU Docket No. EO20030203, June 24, 2020. ("PSEG/EXC Reply"). *See also* Northbridge Group, John Hutchinson and Frank Huntowski, *Evaluation of the PJM IMM's Potential Impacts of the Creation of New Jersey FRRs*, May 2020 attached to PSEG/EXC Reply. ("Northbridge")

[8] Northbridge at 4.

New Jersey's resource adequacy objectives. For the 2021/2022 BRA, EMAAC had a reliability requirement of 35,994 MW UCAP, cleared 29,288 MW UCAP of internal capacity and imported nearly 9,000 MW of additional capacity from MAAC.[9]

Defining Clean Energy Resources

From Table 3 in the Northbridge analysis, clean energy resources are implicitly defined as those resources that do not have any post generation carbon emissions associated with their injections of energy into the system as evidenced by citing nuclear, solar, and wind resources. Northbridge includes energy storage as a "clean energy resource" as well in its analysis.

Northbridge makes an unsupportable assumption because energy storage may not be necessarily a be linked to only zero emitting resources when it charges. For example, if the wind is not blowing and neither is the sun shining, energy storage is charged from emitting resources. All else equal, given economic dispatch, it is likely that the energy being used to charge storage is not zero emitting at the margin, but its production has been facilitated by associated emitting resources.[10]

For this reason, in this analysis energy storage is omitted as a clean energy resource. Making this adjustment reduces the nameplate capacity "needed" from 11,500 MW to about 10,000 MW by 2030 instead of 11,500 MW.

Clean Energy Resources Already in Service

Northbridge in its analysis includes already existing nuclear resources as "needing to be procured," but these resources are already in commercial operation, economically viable, and profitable. At best, including existing nuclear as needing to be procured [through an FRR] is misleading since it is already in operation providing carbon free energy. The nameplate capacity of the Salem and Hope Creek nuclear units is 3,470 MW according to Northbridge. Moreover, by all indications, these resources have continued to clear in PJM RPM BRAs and were already

[9] PJM, *Planning Period Parameters for the 2021/2022 Base Residual Auction*, https://pjm.com/-/media/markets-ops/rpm/rpm-auction-info/2021-2022/2021-2022-bra-planning-period-parameters.ashx?la=en. *See also* PJM, *2021/2022 Base Residual Auction Results*, https://pjm.com/-/media/markets-ops/rpm/rpm-auction-info/2021-2022/2021-2022-base-residual-auction-results.ashx?la=en.

[10] Unlike solar resources discussed below, battery storage does not seem to have a 30-year life, but according to NREL only has a 15-year life. *See* National Renewable Energy Laboratory ("NREL"), *Advanced Technology Baseline 2020.* Available online at https://atb.nrel.gov/electricity/2020/data.php and the spreadsheet at https://atb.nrel.gov/electricity/2020/files/2020-ATB-Data.xlsm ("NREL ATB"), "Storage" tab. This makes the Net CONE much higher and unlikely to clear in RPM under MOPR. Additionally, the best cost estimates are for 4-hour battery storage, but in PJM, summer performance is measured over a 5-hour period, which would require a slower discharge rate (lower capacity value) further making storage more expensive. Finally, PJM has not indicated or reported any Capacity Storage Resources that have offered or cleared to date as they do with Demand Resources and Energy Efficiency Resources.

included as a cleared capacity resource, even before the payment of ZECs was approved by the BPU.

Subtracting the in-service nuclear capacity from the clean energy resources that "need to be procured" and leaving out energy storage for the reasons stated above, means that New Jersey only needs to procure an incremental 6,530 MW (installed capacity value) of clean energy capacity by 2030.

Capacity Value of Increment Clean Energy Resources by 2030

Table 3 shows that the clean energy resources consist of offshore wind and utility scale solar resources. By 2030, the nameplate capacity of the offshore wind commitment is 3,500 MW, but these resources would only have a capacity value of 910 MW UCAP, a discount of 74 percent. New Jersey's solar goal is 3,000 MW of nameplate capacity by 2030, which would have a capacity value of 1,650 MW UCAP.

In total, the capacity value of incremental "clean" energy resources to be procured by 2030 is only 2,560 MW UCAP. Thus, the discussion over whether to opt out of the RPM capacity market is about only 2,560 MW UCAP of capacity, and not the headline value of 11,500 MW as asserted by Northbridge.

Furthermore, it is likely that in the future the capacity value of intermittent, variable resources such as wind and solar and storage will not be what is stated by Northbridge or recognized by PJM today. There is currently an ongoing discussion within the PJM stakeholder process, that was initiated by FERC, on the capacity value of storage and renewable resources using the ELCC methodology. PJM's recent modeling work shows that as wind and solar penetration increase the capacity value declines, but as the amount of 4-hour storage increases, its capacity value does increase.[11] I do not attempt to make such adjustments in this whitepaper, but it is essential to consider when thinking about the future capacity value of clean energy resources.

Nuclear and Utility Scale Solar will Clear the RPM Capacity Market under MOPR

In its supplemental comments, PSEG/EXC state, "the effect of the MOPR is to deny capacity revenue to State-supported resources by raising the price they are allowed to bid in the PJM capacity auction to a level that is higher than the likely market price."[12] Northbridge, in its

[11] Patricio Rocha-Garrido, *Public 1st Draft ELCC Results and the Process to Provide Preliminary ELCC Results*, Presented to the PJM Capacity Capability Senior Task Force, July 10, 2020, at 3-4. Available at https://pjm.com/-/media/committees-groups/task-forces/ccstf/2020/20200710/20200710-item-05-first-draft-prelim-ELCC-results.ashx. Wider penetration of solar resources results in declining capacity values from 64 percent to 27 percent as solar goes from 7 GW to 40 GW. For 4-hour storage, the capacity value at lower penetrations 0.4 GW is about 50 percent and increases to 67 percent at higher penetrations (5 GW).

[12] PSEG/EXC Supplemental Comments at 10.

analysis claims, "The FRR provides the only mechanism going forward to monetize clean capacity which is a customer benefit of up to $400 million per year."[13]

First, state-supported resources if they are economic, can clear in the RPM BRA using the Resource Specific MOPR exemption process that will be in place in PJM. In fact, both PSEG/EXC and Northbridge incorrectly assumes that any state-supported resource that is, by definition, inefficient and not cost-effective and therefore cannot clear competitively in the RPM Capacity Market. The explicit statements and implicit assumption are simply wrong.

Prior to the recent FERC Order on Reserve Shortage Pricing,[14] the PJM IMM noted that default MOPR price floor for multi-unit nuclear facilities is $0/MW-day.[15] Furthermore, the on-shore wind and solar developers in PJM have asserted the using the Resource Specific MOPR, and a 30-year project life, that they will also clear in the RPM Capacity Market under MOPR.[16] If renewable developers believe they can clear under MOPR, and the IMM has shown with public data that multi-unit nuclear facilities will clear under the MOPR without any issue, it is simply untrue, and concerns are unwarranted because most state-supported resources in New Jersey will clear in upcoming RPM Capacity auctions.

MOPR Resource Specific Price Floor Estimates for Nuclear

Northbridge asserts that, "Based on recent FERC decisions, the MOPR floor price will increase due to two factors related to how energy revenues are estimated: 1) the use of unit-specific prices versus zonal prices and 2) the use of forward prices versus historical prices."[17] While this assertion may be true for the upcoming 2022/2023 BRA, it does not change the fact that the Salem and Hope Creek nuclear units will easily clear in the upcoming BRAs, nor does it indicate anything about future prospects for clearing future BRAs for Delivery Years beyond 2022/2023. As such, Northbridge's assertion is misleading.

In fact, as market conditions change, it is entirely possible that there is a recovery from the current recession due to the Covid-19 pandemic, forward prices may be much higher and the

[13] Northbridge at 5. The $400 million is based upon all the resources it considers clean energy resources in 2030, which includes energy storage at the 2021/2022 EMAAC BRA price of $166/MW-day.
[14] 171 FERC ¶ 61,153, *PJM Interconnection, LLC, Order on Proposed Tariff and Operating Agreement Revisions* in Docket No. EL19-58 and ER19-1486 (May 21, 2020) ("Reserve Shortage Pricing Order").
[15] Joe Bowring, *CONE and ACR Values – Preliminary,* Presented to the MIC Special Session – Capacity Market MOPR Order, January 28, 2020 at 3-4. Available at https://pjm.com/-/media/committees-groups/committees/mic/2020/20200128-special/20200128-item-04b-cone-and-acr-values-preliminary.ashx.
[16] Gabel & Associates, Prepared by Michael Borgatti, Adrian Kimbrough, and Emma Nix, *Minimum Offer Price Rule Unit-Specific Inputs*, presented to the PJM Markets Implementation Committee, February 28, 2020. Available online at https://pjm.com/-/media/committees-groups/committees/mic/2020/20200228-mopr/20200228-item-04b-mopr-unit-specific-inputs.ashx. ("Gabel").
[17] Northbridge at 5.

Resource Specific MOPR floor prices for the nuclear units will be even lower than those calculated below.[18]

Table 1: Western Hub Forward Prices and Salem/Hope Creek Forward Prices Adjusting for Basis to Western Hub

Delivery Year	Western Hub ATC ($/MWh)	Salem/Hope Creek ATC ($/MWh)
22/23 ATC	$27.30	$23.19
23/24 ATC	$27.26	$23.15
24/25 ATC	$27.89	$23.78
25/26 ATC	$27.99	$23.88

Table 1 shows the around the clock ("ATC") PJM Western Hub forward prices by Delivery Year from the Intercontinental Exchange[19] and then using the basis of -$4.11 between Western Hub and the Salem and Hope Creek busses for the 2019/2020 Delivery Year[20] estimated the ATC prices for Salem and Hope Creek for Delivery Years 2022/2023 through 2025/2026. **Table 1** shows that the pricing at the Salem and Hope Creek busses with a 15 percent discount to Western Hub.

[18] Reserve Shortage Pricing Order PP 308-324. Specifically, in P 310 the Commission states, "We find that the significant reserve market reforms adopted herein, and in particular the changes to the shape of the ORDCs and the increase to the Reserve Penalty Factors that anchor those ORDCs, have fundamentally changed the design of the PJM reserve market in a way that will impact the amount of reserves procured, the price paid for those reserves, related energy prices, and energy and ancillary services revenues received by resources participating in those markets. These changes will be particularly pronounced during times of shortage. The impact of these changes must be recognized in the E&AS Offset estimate—a variable that is fundamental in determining the amount of capacity procured by the PJM capacity market and the prices paid to resources that supply capacity." In P 313 the Commission further states, "Specifically, the replacement rate adopted herein increases the Reserve Penalty Factors more than two-fold and removes the cap on the additivity of Reserve Penalty Factors, while simultaneously adding a new reserve product (with its own Reserve Penalty Factor). While these changes are just and reasonable, as discussed above, by design they increase the potential for very high prices during extreme shortage conditions. If such conditions were to occur, the energy and ancillary services revenues received during that shortage period would not necessarily be representative of the revenues a generation developer could expect to earn in the future, and thus a backward looking offset could be inappropriately distorted."

[19] Intercontinental Exchange ("ICE"), ICE FUTURES U.S. - ENERGY DIV End of Day Reports available at https://www.theice.com/marketdata/reports/142. Closing Prices for PJM Western Hub Fixed Forward Peak (PJC) and Fixed Forward Off-Peak (PJD) were pulled for the June 12, 2020 closing date.

[20] PJM, Data Miner 2, Day-ahead LMP for June 1, 2019 hour beginning 00:00 EPT to May 31, 2020 hour beginning 23:00 EPT for Western Hub and the Salem and Hope Creek generator busses. The basis is the average over all hours of the year. Available at https://dataminer2.pjm.com/feed/da_hrl_lmps.

Table 2 shows the avoidable costs as reported by the EPA in its Integrated Planning Model for Salem and Hope Creek on average[21] and translates these costs into $/MW-day.[22]

Table 2: Salem and Hope Creek Fuel and Avoidable Costs

Fuel Cost ($/MWh)	Avoidable Costs ($/kW-yr)	Avoidable Costs ($/MW-day)
$5.69	**$155.27**	**$425.40**

The fuel costs in **Table 2** are taken from stated nuclear fuel costs provided by PSEG in its 2019 10-K filing and divided by the MWh output provided by PSEG in the same 2019 10-K filing.[23]

Table 3: Salem and Hope Creek Estimated Net Energy Revenues and Resource Specific MOPR Floors Prices

Delivery Year	EAS Offset ($/MW-Day)	*MOPR Floor ($/MWh)*
22/23 ATC	$377.96	***$47.44***
23/24 ATC	$377.06	***$48.34***
24/25 ATC	$390.69	***$34.71***
25/26 ATC	$392.90	***$32.50***

To determine the Energy and Ancillary Service ("EAS") Offset in **Table 3** the fuel costs in **Table 2** were subtracted from the Salem and Hope Creek bus ATC bus prices in **Table 1** and multiplied by 8760 hours in the year and discounted to a 90 percent capacity factor. The MOPR Floor price in **Table 3** is just the avoidable cost in **Table 2** less the EAS Offset in **Table 3**.

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[21] United States Environmental Protection Agency ("US EPA"), *Documentation for EPA's Power Sector Modeling Platform v6 Using the Integrated Planning Model*, May 2018. Available online at https://www.epa.gov/sites/production/files/2018- 08/documents/epa_platform_v6_documentation_-_all_chapters_august_23_2018_updated_table_6-2.pdf. Chapter 4, Generation Resources, Table 4-47 Characteristics of Existing Nuclear Units, available as a spreadsheet at https://www.epa.gov/sites/production/files/2018-05/table_4-47_characteristics_of_existing_nuclear_units_in_epa_platform_v6.xlsx. ("IPM v6 Table 4-47").

[22] This is equal to the avoidable costs in Table 2 in $/kW-yr multiplied by 1000 and then divided by 365.

[23] Public Service Enterprise Group, Inc. Form 10-K for the Fiscal Year Ended December 31, 2019 ("PSEG 10-K") at 77, Consolidated Statements of Cash Flows, Amortization of nuclear Fuel. For 2019 respectively the fuel cost was $178 million. Divided by MWh of generation for the PSEG fleet as observed in 2018, controlling for outages at Salem, provides the fuel cost. Filing available at https://www.sec.gov/ix?doc=/Archives/edgar/data/81033/000078878420000004/pseg201910k.htm. *See also* Public Service Enterprise Group*, PSEG Earnings Conference Call4thQuarter & Full Year 2019,* February 26, 2020 at 25. Available at https://www.sec.gov/Archives/edgar/data/81033/000119312520049323/d894238dex991.htm.

The estimated Resource specific floor prices are well below the RPM BRA Capacity pricing for EMAAC observed in the 2021/2022 BRA, and well below any EMAAC prices that have come out of a BRA that have all been at least $119/MW-day since the 2012/2013 Delivery Year.

Potential Impact of PJM Reserve Pricing Reforms on Nuclear MOPR Floors

Recently, PJM received a FERC order approving its proposed Reserve Market Pricing design to the Day-ahead and Real-time reserve markets to implement a more comprehensive operating reserve demand curve design.[24] As part of this proposal PJM ran simulations for the entirety of its proposal which were estimated to increase average LMPs by $1.96/MWh.[25]

Given the Reserve Shortage Pricing Order was issued on May 21, 2020, and the forward prices used here are from June 12, 2020, and with the current economic events surrounding the COVID-19 pandemic, it is possible that the forward curves for energy in PJM have not been able to fully account for the higher anticipated energy market revenues. Hence, the analysis in **Table 4** and **Table 7** on page 13 below that include the PJM estimates for higher LMPs provides a lower bound to the MOPR floor prices for nuclear and solar facilities offering into the RPM Capacity Market.

If the PJM simulated price increases from reserve market price changes are added to the forward energy prices, this increases the EAS Offset and reduces the Resource Specific MOPR floor prices as shown in **Table 4**. With the adjustment to the energy market prices, the MOPR floors effectively drop to zero and virtually guarantee that the Salem and Hope Creek units will clear under MOPR for the foreseeable future.

Table 4: EAS Offset and MOPR Floor Values for Salem and Hope Creek Adjusting for PJM Simulated LPM Increases due to Reserve Pricing Reforms

Delivery Year	EAS Offset ($/MW-Day)	*MOPR Floor ($/MWh)*
22/23	$420.29	***$5.11***
23/24	$419.39	***$6.01***
24/25	$433.03	***$0.00***
25/26	$435.23	***$0.00***

[24] Reserve Shortage Pricing Order PP 308-324.

[25] PJM Interconnection LLC, *Enhanced Price Formation in Reserve Markets in PJM Interconnection, LLC,* in Docket No. EL19-58 March 29, 2019, Attachment D, Affidavit of Adam Keech, Table 4.

Estimated MOPR Floors for Utility Scale Solar

While Northbridge concedes that the nuclear units will clear in the upcoming BRA, there is no indication they believe utility scale solar will clear in the RPM BRA. However, solar developers in PJM think they can clear under a Resource Specific MOPR using a 30-year project life which is allowed under the recently approved MOPR rules.[26] The Gabel presentation concludes that the MOPR floor for utility scale solar should be as low as $77/MW-day using PJM assumptions and the Lazard estimate for energy market revenues of $213/MW-day.[27] Furthermore, if the Lazard market proxies are used then the MOPR floor price falls to $0/MW-day.[28]

NREL in its 2020 Advanced Technology Baseline database ("NREL ATB") provides the capital costs and information regarding the cost of capital, asset life, the charge rate to recover the cost of the investment inclusive of depreciation.[29]

Table 5 shows the utility scale solar capital cost from the NREL ATB and calculates the Gross CONE value based on NREL assumptions. The underlying weighted average cost of capital is 5.72 percent with a 30-year project life. The capital cost is assumed to decline over time with continued cost and technological improvements as reflected in **Table 5**.

Table 5: Utility Scale Solar Capital Costs and Implied Gross CONE at a 60% Capacity Value Using NREL ATB Costs of Capital and a 30-Year Life

Delivery Year	Capital Cost ($/kW installed)	Gross Cone ($/MW-day)[30]
22/23	$1,250	$253.41
23/24	$1,198	$242.93
24/25	$1,147	$232.44
25/26	$1,095	$221.96

Solar resources obviously do not produce energy at night, so over the course of the year, the best a solar resource could acheive is a 50 percent capacity factor. But energy production needs to be further discounted by the fact that solar radiance varies over the daylight hours. On the

[26] Gabel at 7.
[27] *Id.*
[28] *Id*.
[29] National Renewable Energy Laboratory ("NREL"), *Advanced Technology Baseline 2020.* Available online at https://atb.nrel.gov/electricity/2020/data.php and the spreadsheet at https://atb.nrel.gov/electricity/2020/files/2020-ATB-Data.xlsm ("NREL ATB").
[30] The Gross CONE value is the Capital cost divided by 0.6 and then multiplied by 1000 and multiplied by the fixed charge rate of 0.044394 and the divided by 365. The fixed charge rate include the cost of capital and depreciation.

other hand, solar will operate largely during peak hours except on weekends. This means that most of the energy produced by solar will face peak prices rather than off-peak prices. The forward price estimates are provided in **Table 6**.[31]

The estimated EAS offset in **Table 6** is derived from running at mostly during peak hours but with an implied overall capacity factor for energy of about 30 percent.[32]

Table 6: Estimated Average Forward Prices, Energy and Ancillary Service Offset, and MOPR Floor Price for Utility Scale Solar in New Jersey

Delivery Year	Expected Price for New Jersey Solar ($/MWh)	Estimated EAS Offset ($/MW-day)	*Estimated MOPR Floor Price ($/MW-day)*
22/23	$24.78	$178.43	***$74.98***
23/24	$24.71	$177.88	***$65.04***
24/25	$25.36	$182.56	***$49.88***
25/26	$25.46	$183.29	***$38.67***

The end result is a MOPR floor price for utility scale solar that only declines over time due to declining installation costs more than any large uptick in EAS revenues, from $75/MW-day in 2022/2023 to under $40/MW-day in 2025/2026. Again, these prices are far below the lowest clearing price observed in EMAAC over the past ten BRAs, thus it appears certain that utility scale solar in EMAAC would clear in the RPM Capacity Market even with MOPR.

Potential Impact of PJM Reserve Pricing Reforms on Utility Scale Solar MOPR Floors

Much like the impact PJM's Reserve Pricing reforms might have on Nuclear MOPR floors, reducing the floors because net energy revenues would increase, utility scale solar projects would see a similar increase in energy revenues. Adding $1.96/MWh to the prices shown in **Table 6** results in the updated EAS Offset and MOPR floors for utility scale solar shown **Table 7**.

The results in **Table 7** including additional energy market revenues that may be available to utility scale solar only makes it more certain that these resources will be able to clear PJM BRAs now and in the future in spite of MOPR.

[31] *See supra* note 19. The forward prices are taken from ICE and are developed from the same forward curves and basis differential to the nuclear units. The difference in this case is that since solar runs mostly on-peak and during the day, the prices are a combined set of peak with a 5/7 weighting and off-peak prices weighted by 2/7.

[32] Given the patterns of sunlight, assume the sun is out half the hours of the year in total. Then for those hours, the solar resource operates at a 60 percent capacity factor which results in an overall 30 percent capacity factor for energy during the year.

Table 7: New Jersey Utility Scale Solar Estimated EAS Offset and Estimated MOPR Floors Prices Accounting for the Energy Market Impacts of PJM Reserve Pricing Reforms

Delivery Year	Expected Price for New Jersey Solar ($/MWh)	Estimated EAS Offset ($/MW-day)	*Estimated MOPR Floor Price ($/MW-day)*
22/23	$24.78	$192.54	***$60.87***
23/24	$24.71	$192.00	***$50.93***
24/25	$25.36	$196.68	***$35.77***
25/26	$25.46	$197.40	***$24.56***

"Clean" Capacity is Not Being Excluded from the Market, and Most of it is Economic and will Clear Under MOPR

As shown above, nuclear and utility scale solar facilities are economic and will be able to provide capacity for New Jersey customers under the current MOPR and PJM's proposed implementation of it. In fact, for the data provided by Northbridge, 93 percent of clean resources will clear in 2025 and 85 percent will clear in 2030. The one resource in jeopardy of not clearing is offshore wind which is uneconomic from a capacity market perspective. The implied capacity price for off-shore wind is nearly $2947/MW-day.[33] This value is close to that provided by the IMM, who calculates a capacity price of about $3100/MW-day.[34] Fortunately, Off Shore wind contributes only a small part of New Jersey's capacity resource needs.

Thus, Northbridge's claim that, "clean capacity is artificially excluded from the market, PJM will contract with redundant emitting resources through RPM"[35] is simply not true except for offshore wind. The capacity value of that wind is $17 million is 2025 and is projected to be $55 million in 2030 based on the 2021/2022 EMAAC BRA prices. But at the implied capacity cost of just over $300 million, it is easy to see why this capacity is uneconomic.[36]

[33] This value is backed out the $105/MWh contract for offshore wind with Orsted. Subtracting out the energy revenues of about $23.50/MWh, about the midpoint of prices faced by the nuclear units, leaves $81.50/MWh to cover capacity costs. Assuming class 3 wind speeds for a fixed tower from NREL and the average production is 3,775,000 MWh per MW of nameplate capacity. Multiply the $81.50/MWh to account for capacity by total annual output and then multiply by the 1100 MW of nameplate capacity and divide by 365 and divide by 0.26 (capacity value) to arrive at $2947/MW-day.

[34] IMM Answer at 5.

[35] Northbridge at 5.

[36] At $105/MWh contract price and subtract PJM energy revenues of about $23.50/MWh, about the midpoint of prices faced by the nuclear units, leaves $81.50/MWh to cover capacity costs. Assuming class 3 wind speeds for a fixed tower from NREL and the average production is 3,775,000 MWh per MW of nameplate capacity. Multiply the $81.50/MWh to account for capacity by total annual output to get $308,738,155 that must be covered by capacity payments.

Clean Energy Resources Will Continue to Get Credit for their Capacity Value

In its supplemental comments PSEG/EXC state, "Assuming that offshore wind, new utility-scale solar, and storage are unable to clear in the PJM capacity market and thus go uncompensated for their capacity."[37] The key word here is "assuming:" neither PSEG/EXC nor Northbridge actually provided any analysis that clean energy resources would not clear in the RPM Capacity Market as was provided above.

Given that utility scale solar and nuclear will be able to clear the RPM BRA given their Resource Specific MOPR values relative to pricing in the EMAAC LDA, it is axiomatic that these resources will get credit for their capacity value. The only Clean Energy Resource that would not clear under MOPR is offshore wind, which would only contribute286 MW UCAP in 2025 and 910 MW UCAP by 2030 before adjusting for diminishing capacity value under an ELCC methodology being discussed at PJM.

The So-Called "Double Payment" for Preferred Clean Energy Resources is Overstated

In its analysis Northbridge states, "if the state-supported clean capacity is prevented from clearing in RPM, the state program payments to those resources must increase by exactly the same amount as the foregone capacity revenue in order to maintain the target level of resource deployment at the same cost, i.e. customers must "double-pay" for the unused capacity."[38]

This statement is misleading for multiple reasons:

- First, existing wind and solar are exempt from MOPR, and to the extent they are already receiving state support through RECs or other subsidies and have been clearing as capacity resources, there is no need for any extra payments.
- Second, existing nuclear units should easily clear under the resource specific MOPR, assuming they are offered economically, as shown above, and there is every indication they have been clearing as capacity resources in past BRAs.
- Third, utility scale solar, as shown above, can also clear under a resource specific MOPR using a 30-year life and given the low cost of capital and thus will be able to get credit for capacity.
- The OREC price is already set at a level that is indifferent to the capacity price.

Furthermore, it is not clear what the capacity value of wind and solar resources will be in the future as PJM is currently engaged in a FERC initiated stakeholder discussion on the value of

[37] PSEG/EXC Supplemental comments at 10.
[38] Northbridge at 4.

capacity through the use of the Effective Load Carrying Capability ("ELCC") discussion.[39] In valuing intermittent or energy limited capacity using ELCC, the greater the penetration of intermittent renewable or energy limited resources, the lower is the capacity value of those resources.[40] Thus the current capacity values of renewable resources could change and be further reduced over time due to ELCC as wind and solar penetration increases.

Finally, as noted in previous comments and testimony, it may not be worth the risk for renewable resources to take on capacity obligations given the intermittent nature of renewable output and the risk that Capacity Performance events could occur when the renewable resource is unable to produce energy.[41] In other words, it is not entirely clear that renewable generation owners would even want to take on capacity obligations as assumed by PSEG/EXC and Northbridge.

In summary, the issue of double payment is at best overstated, and possibly even a non-issue if renewable resource owners do not take on capacity obligations due to the inherent risks they would take on with a capacity obligation.

Northbridge Does Not Directly Address the Costs or Design of the PSEG/EXC Tiered Proposal

In no part of the Northbridge analysis is the PSEG/EXC Tiered FRR proposal addressed, nor is the implication of PSEG/EXC being willing to give up ZECs for an FRR capacity payment addressed at all. So while PSEG/EXC assume the answer that resources subject to MOPR will be unable to clear to come up with their "cost savings" from choosing an FRR option to ensure the capacity subject to MOPR is counted, they nowhere discuss the potential costs of moving to its FRR proposal as discussed previously by commenters and noted by the IMM in its recent response.

But the cost savings are assumed and not based on any analysis as noted above, and in reality the only capacity that will not clear under MOPR is offshore wind so that the only "cost savings" would be the value of the offshore wind of $17 million in 2025 and $55 million in 2030.[42]

As noted by the previous comments and analysis, the PSEG/EXC FRR proposal could result in additional costs of over $700 million per year, with implied capacity prices of $438/MW-day payable to the Salem and Hope Creek nuclear units and nearly $400/MW-day prices paid to

[39] *See* PJM Capacity Capability Senior Task Force page at https://pjm.com/committees-and-groups/task-forces/ccstf.aspx.
[40] *See supra* note 11.
[41] Sotkiewicz Comments PP 55-58.
[42] *See supra* note 1.

other clean energy resources procured under Tier 1 and Tier 2 procurements proposed by PSEG/EXC.

The PJM IMM in its recent response draws similar conclusions with capacity prices payable to the Salem and Hope Creek nuclear units of $413/MW-day and additional costs of about $600 million, assuming a JCPL only FRR plan.

Whether the FRR plan includes JCPL only or a wider area with JCPL plus Atlantic City Electric ("AECO"), for example, the additional costs to New Jersey customers will be in the hundreds of millions of dollars.

PSEG/EXC and Northbridge Fail to Address Market Power Concerns Associated with the Tiered FRR Proposal

Northbridge in its analysis criticizes the PJM IMM regarding its market power analysis stating, "The IMM's overly restrictive locational assumptions result in a misleading market power analysis. For example, the IMM contends that there are market power concerns in the JCPL zone based on several indicators, but all of the IMM's JCPL zone analysis is irrelevant."[43]

First, the IMM's initial FRR analysis did not have the benefit of examining PSEG/EXC's FRR proposal, so to attack the analysis as irrelevant is not fair to the IMM. Thus, any such criticisms of the IMM are not valid.

While criticizing the IMM market power analysis, Northbridge fails to offer an alternative market power analysis. Such an analysis would include ownership concentrations, and especially for the proponents of the Tiered FRR, PSEG and EXC. Instead, Northbridge only offers a disingenuous discussion of total MW UCAP capacity in EMAAC and MAAC relative to the size of the capacity needs in JCPL.[44] Even more egregious is that the source of data is not documented, and includes no analysis of ownership concentration.

From the size of the numbers presented in their Table 4, Northbridge appears to include all capacity in EMAAC and MAAC and not just "clean energy resources" which is the target capacity in the PSEG/EXC proposal. However, mysteriously on the following page Northbridge without explanation changes the set of generation resource to "clean energy resources" in the subsequent figures,[45] as opposed to tables, and without source documentation, to show available "clean energy resources " and gas resources. Such a presentation makes it difficult, if

[43] Northbridge at 8.
[44] *Id*. Table 4
[45] Northbridge at 9.

not impossible, to replicate the work shown to verify the competitiveness of the market. There was still no discussion of the concentration ownership shares of generation by PSEG and EXC.

Finally, contrary to PSEG/EXC assertion that market power concerns are misplaced, they offer no formal plan for how to address market power concerns nor even examine the ownership concentration issue. [46] PSEG/EXC only offer that the BPU could engage in prudence reviews if a Tier 1 resource tries to exercise market power, or they could look to an expanded portfolio of resources such as natural gas resources in Tier 2 which are not zero emitting. Such "solutions" avoid the fact that jointly, PSEG/EXC control all Tier 1 resource that can offer into the 2022/2023 and 2023/2024 BRAs, allowing them to name their price, and that even beyond 2024/2025, with the offshore wind project, PSEG/EXC would jointly control 94 percent of all capacity for Tier 1.[47] Moreover, as the Board already experienced in deliberations related to ZEC's, prudency reviews are of little value when PSEG's threatens to close plants if they do not receive a certain level of subsidy.

In short, market power under any FRR would be a problem, but it is magnified under the Tiered procurement proposal offered by PSEG/EXC and New Jersey can avoid this easily by remaining within the RPM Capacity Market Auction framework where nuclear and utility scale solar would clear, even under MOPR, as they are competitive within the market.

Conclusions: Remaining in the RPM Capacity Market Auction Framework is the Lowest Cost Option for New Jersey to Meet its Clean Energy Goals

PSEG/EXC and Northbridge would have the BPU believe that they can create an FRR plan that would be a lower cost than the PJM RPM Capacity Market. But PSEG/EXC and Northbridge have provided no analysis and no detailed plan that would support such a conclusion. The best that PSEG/EXC can offer are vague notions and platitudes regarding cost minimization, but no way to get there.

Other analyses offered previously in comments and just recently by the PJM IMM show the costs could be $600-$700 million more for New Jersey electricity customers than by staying in the PJM Capacity Market. Given the PJM 2020 Forecast load for the New Jersey zones, this would add an unnecessary $7.75/MWh to $9.03/MWh to the average New Jersey electricity customer's bill.[48]

The analysis presented herein shows there is no need to "eliminate the impacts of MOPR", nor would an FRR for JCPL alone as proposed by PSEG/EXC be more cost effective that remaining in

[46] PSEG/EXC Supplemental Comments at 15-18.
[47] Sotkiewicz Comments PP 73-75
[48] PJM 2020 Load Forecast Data available at https://pjm.com/-/media/library/reports-notices/load-forecast/2020-load-report-data.ashx?la=en. The 2020 loads were summed up for PS, AE, RECO, and JCPL.

the RPM Capacity Market. Existing nuclear and utility scale solar are profitable looking into the future even in the absence of REC and ZEC payments.

Even if the BPU continued to approve REC payments to utility scale solar and ZEC payments to existing nuclear facilities, despite the fact RECs/ZECs are not needed for the solar and nuclear resources to be profitable in the PJM market, these resources would clear the PJM RPM Capacity Market Auctions even subject to MOPR.