UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

PJM Interconnection LLC	**)**	**ER18-1314-000**

Affidavit of Michael Goggin, Grid Strategies LLC

On Behalf of the Sustainable FERC Project, Natural Resources Defense Council, and Sierra Club

May 7, 2018

I. Introduction

1. I am an independent consultant specializing in wholesale electricity markets and transmission policy. Previously, I have served as the Senior Director of Research for the American Wind Energy Association (AWEA). My biography can be found at https://gridstrategiesllc.com/about/.

2. I was asked to calculate the cost of the redundant capacity that would be procured due to PJM's MOPR-Ex proposal. PJM's MOPR-Ex proposal threatens to exclude nuclear and renewable resources that benefit from state policies from participation in the capacity market. My estimate calculates the rough costs should that occur.

II. PJM's MOPR-Ex proposal would impose significant costs on consumers by procuring redundant capacity to replace capacity excluded from the capacity market

3. I have determined that PJM's MOPR-Ex proposal would result in the procurement of roughly between $14 billion and $24.6 billion of redundant capacity over roughly the next 10 years.[1] These costs would utility be borne by PJM customers, translating to a cost of between $216 and $379 for each of the 65 million people in the PJM footprint.[2]

4. These estimates assume that all resources receiving revenue pursuant to state programs would be excluded from participation in the capacity market under MOPR-Ex. The range in costs accounts for the fact that it was not possible to precisely determine whether resources procured as part of state Renewable Portfolio Standard (RPS) policies would be able to use the exemptions in the MOPR-Ex proposal to participate in the capacity market.[3] The lower-end $14 billion cost assumes resources contracted under state RPSs are able to use the exemptions and participate in the capacity market. The higher-end $24.6 billion cost assumes those resources are barred from participation in the capacity market. It is likely that some, but not all, renewable resources will be able to use the exemptions, so the actual cost impact from the MOPR-Ex proposal will most likely falls between those two numbers.

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[1] The roughly 10-year time horizon reflects the timeline on which most currently adopted RPSs and nuclear support policies will operate.

[2] This cost per customer calculation is not intended to be a precise estimate of what retail customers would pay, which would require detailed modeling of impacts on capacity market clearing prices and a deep examination of how capacity costs are reflected through to retail rates in different states. Rather, it is simply intended to give a sense of the scale of PJM's proposal with relation to its impact on retail customers.

[3] The proposed exemptions are listed here: https://www.pjm.com/-/media/committees-groups/committees/mc/20180125/20180125-item-02-mopr-ex-proposal.ashx

A. Calculating the lower-end cost impact from PJM's MOPR-Ex Proposal

5. To determine the lower bound of cost impacts from PJM's proposal, I considered only the capacity of the five Illinois nuclear plant in PJM and two nuclear plants in New Jersey.[4] The nameplate capacity for the five Illinois nuclear plants in PJM – Braidwood, Byron, Dresden, LaSalle, and Quad Cities generation stations - total 11,276 MW.[5] The nameplate capacity for the two nuclear plants in New Jersey that will continue to operate after 2019 - Hope Creek and Salem- total 3,631 MW. PJM calculates that nuclear plants have 98.397% availability for purposes of computing the share of nameplate capacity that receives credit in the capacity market,[6] so those seven nuclear plants have an accredited capacity of 14,668 MW in PJM's capacity market.

6. To calculate the cost of replacing that capacity, I assume that enough natural gas combustion turbines are built to provide an equal amount of accredited capacity. I assume the use of combustion turbines (CTs), instead of combined cycle (CC) power plants, because while CC plants are built to provide both energy and capacity, CTs are built almost entirely to provide capacity and not energy. This is evidenced by their very low capacity factors.[7] Therefore, CTs better represent the cost of replacement capacity than CC plants do.

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[4] As of the time of this filing, legislation to support New Jersey's nuclear power plants and advance greater penetration of renewable resources remains pending. This analysis assumes that Governor Murphy will sign this legislation into law.

[5] Clinton Power Station is located within the MISO footprint in Illinois.

[6] https://www.pjm.com/-/media/planning/res-adeq/res-reports/2012-2016-pjm-generating-unit-class-average-values.ashx?la=en

[7] U.S. Energy Information Administration, "Table 6.7.A. Capacity Factors for Utility Scale Generators Primarily Using Fossil Fuels, January 2013-February 2018" https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_a

7. PJM calculates that gas combustion turbines have a capacity market availability rate of 88.687%,[8] so 16,539 MW of nameplate CT capacity would be needed to provide the equivalent 14,668 MW of accredited capacity. Using a regional CT installed cost of $848,500/MW, the midpoint of the $799,000-898,000/MW range reported by Brattle for the PJM region,[9] indicates a cost of $14.033 billion for 16,539 MW of nameplate capacity. This $14 billion is thus the low-end estimate, assuming that all renewable resources are able to use the MOPR-Ex RPS exemption to participate in the capacity market and only nuclear plants receiving state subsidies are impacted by the MOPR-Ex proposal.

B. Calculating the higher-end cost impacts of PJM's MOPR-Ex Proposal

8. The high-end estimate includes the associated capacity and replacement costs of the seven nuclear plants discussed above, as well as all renewable capacity that will be built under state RPS policies after this year (2018). This high-end estimate reflects the rough cost of MOPR-Ex without the RPS exemption. To determine the amount of RPS demand remaining pursuant to currently enacted or imminently pending state policies, I used the AWEA 2017 assessment database, which compiles data concerning these policies to inform members on the amount of market demand.[10] I updated that assessment to account for pending legislation in New Jersey that is likely to be adopted imminently[11], Maryland state laws and regulations (to reflect Offshore Renewable Energy Credits (ORECs) that were awarded), and Illinois (because AWEA does not group Illinois with PJM for the purposes of its state RPS analysis).

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[8] https://www.pjm.com/-/media/planning/res-adeq/res-reports/2012-2016-pjm-generating-unit-class-average-values.ashx?la=en

[9] http://www.pjm.com/-/media/library/reports-notices/special-reports/2018/20180420-pjm-2018-variable-resource-requirement-curve-study.ashx?la=en

[10] https://www.awea.org/rps2017

[11] N.J. Stat. § 48:3-49 et seq. (last revision S.2313)

9. Maryland law calls for up to 2.5% of state electricity demand to be met by offshore wind, which would require just over 1.53 million MWh of ORECs. The state awarded 368 MW of ORECs to two projects in 2017,[12] so those resources would be exempt from MOPR-Ex as they were contracted before the end of 2018. Assuming a 40% capacity factor (CF) for offshore wind, that leaves around 70 MW of remaining offshore capacity under the OREC program. At a 27% capacity value, that equals 18.83 MW of accredited capacity.[13]

10. New Jersey recently updated its state RPS to include 3,500 MW of offshore wind, a solar carveout equal to 5.3% of electricity demand, and an overall RPS level of 50%.[14] At 27% capacity value (per PJM's capacity value above), the offshore requirement equates to 945 MW of accredited capacity. The 5.3% solar carveout equals 3,868,298 MWh of RECs or the annual production of 2,598 MW at the region's typical 17% CF.[15] This is equal to 1,559 MW of accredited capacity at PJM's 60% capacity value.[16]

11. After the offshore and solar carveouts, there would be 9,204,661 MWh of outstanding RECs that would likely be almost entirely provided by a mixture of onshore wind and solar. Historically, onshore wind has accounted for around 75% of New Jersey's RPS procurement. I conservatively assume that that ratio will continue. However, if onshore wind captures a lower share than 75%, as is likely given recent cost trends for solar PV, then my estimate underestimates the capacity value of NJ's RPS resource mix, as onshore wind's 13%

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[12]Maryland Public Service Commission, "Maryland PSC Awards ORECs to Two Offshore Wind Developers", May 11, 2017, http://www.psc.state.md.us/wp-content/uploads/PSC-Awards-ORECs-to-US-Wind-Skipjack.pdf

[13]See page 29 at https://www.pjm.com/-/media/committees-groups/subcommittees/irs/postings/pjm-pris-task-3a-part-f-capacity-valuation.ashx?la=en

[14] See New Jersey Senate Bill 2313, http://www.njleg.state.nj.us/2018/Bills/S2500/2313_I1.HTM.

[15] http://euanmearns.com/solar-pv-capacity-factors-in-the-us-the-eia-data/

[16]https://www.pjm.com/-/media/committees-groups/subcommittees/irs/postings/pjm-pris-task-3a-part-f-capacity-valuation.ashx?la=en, http://www.pjm.com/-/media/planning/res-adeq/class-average-wind-capacity-factors.ashx?la=en

capacity value is markedly lower than the capacity value of other renewable resources. Using a 75% onshore wind and 25% solar mix to meet the remaining RPS demand equals 2,440 MW of nameplate onshore wind capacity and 1,545 MW of nameplate solar. This is equivalent to 317 MW and 927 MW of accredited capacity at PJM's 13% and 60% capacity values.

12. The incremental renewable build under the Illinois RPS is driven through the procurements of 3 million additional wind RECs and 3 million additional solar RECs through 2030. Using a 17% CF for PV,[17] as assumed by the state, and a 37.6% CF for wind, as assumed by AWEA's report based on observed trends, yields nameplate capacities of 911 MW of wind and 2,015 MW of solar. This is equal to 118 MW and 1,209 MW of accredited capacity respectively.

13. In 2017, AWEA had projected that all parts of PJM, except Illinois had enough remaining RPS demand to drive 10,500 MW of new wind capacity. However, AWEA assumed that only 5,400 MW was likely to be met by wind, with the remainder likely met by solar due to recent cost and deployment trends.[18] Because the New Jersey and Maryland ORECs are accounted for separately above, I subtracted from AWEA's 5,400 MW of likely wind builds both the 1,600 MW of new wind AWEA had projected would have been driven under the old NJ RPS and the roughly 70 MW of remaining OREC capacity I accounted for above. That leaves 3,730 MW of remaining nameplate wind builds driven by RPS requirements, or at PJM's 13% capacity value, a total of 485 MW of accredited wind capacity.

14. To calculate the remaining non-wind RPS demand in the region, I also subtracted out AWEA's calculated 2,133 MW of wind-equivalent MW[19] of new renewable capacity demand

[17] https://www2.illinois.gov/sites/ipa/Documents/2018ProcurementPlan/20180227-REC-Pricing-Model-Update.pdf
[18] https://www.awea.org/rps2017
[19] AWEA calculates the required wind capacity assuming a regional wind capacity factor of around 34%.

remaining under the old New Jersey RPS. Subtracting out the other 3,800 MW of wind capacity (3,730 MW from preceding paragraph plus the remaining 70 MW of Maryland ORECs) leaves 4,567 MW of wind-equivalent RPS driven capacity left to be accounted for. I assumed solar provides this remaining non-wind RPS supply, given recent cost trends for solar and the fact that the region's resource potential for other eligible renewables, like biomass, has already largely been developed. Since the regional capacity factor of solar is half that of wind (17% CF versus a 34% CF for eastern PJM), the 4,567 MW of non-wind capacity equals 9,134 MW of solar capacity. At PJM's 60% capacity value, that equals 5,480 MW of accredited capacity.

	Nameplate Capacity (MW)	Capacity Value	Accredited Capacity (MW)
NJ nukes	3,631	98.397%	3,573
IL PJM nukes	11,276	98.397%	11,095
MD post-2018 ORECs	70	27.00%	19
NJ generic RPS, wind	2,440	13.00%	317
NJ generic RPS, solar	1,545	60.00%	927
NJ solar carveout	2,598	60.00%	1,559
NJ offshore wind	3,500	27.00%	945
Incremental IL RPS demand 2019-2030, wind	911	13.00%	118
Incremental IL RPS demand 2019-2030, solar	2,015	60.00%	1,209
Other post-2018 state RPS demand, wind	3,730	13.00%	485
Other post-2018 state RPS demand, solar	9,134	60.00%	5,480
Total Accredited Capacity (MW)			**25,727**

15. As shown in the table above, these state-supported nuclear and RPS resources have a combined 25,727 MW of accredited capacity. at PJM's 88.687% capacity value for gas CTs that is equal to 29,009 MW of nameplate CT capacity. Using an installed cost of $848,500/MW,[20] this represents a cost of $24.614 billion. This $24.6 billion figure represents

[20] As discussed earlier in this affidavit, this is the midpoint of the $799,000-898,000/MW range reported for PJM ,http://www.pjm.com/-/media/library/reports-notices/special-reports/2018/20180420-pjm-2018-variable-resource-requirement-curve-study.ashx?la=en

the high-end estimate of cost impacts from PJM's MOPR-Ex proposal, assuming that no RPS-driven renewable resources are able to use the MOPR-Ex exemptions and are therefore barred from the capacity market.

This concludes my affidavit.

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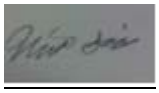
Verification of Michael Goggin

On Behalf of the Sustainable FERC Project, Natural Resources Defense Council, and Sierra Club

I, Michael Goggin, declare under penalty of perjury that the attached affidavit is true and correct to the best of my knowledge, information and belief.



Michael Goggin

Execution Date: May 7, 2018