UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

PJM Interconnection, L.L.C.	)	Docket No. ER21-278-000
PJM Interconnection, L.L.C.	)	Docket No. EL19-100-000
	)	(not consolidated)

COMMENTS AND MOTIONS OF THE INDEPENDENT MARKET MONITOR FOR PJM

Pursuant to Rule 211 of the Commission's Rules and Regulations,[1] Monitoring Analytics, LLC, acting in its capacity as the Independent Market Monitor ("Market Monitor") for PJM Interconnection, L.L.C. ("PJM"),[2] submits these comments responding to the filing submitted by PJM Interconnection, L.L.C. ("PJM") on October 30, 2020 ("October 30th Filing"). The October 30th Filing proposes revisions to the PJM market rules to apply an Effective Load Carrying Capability ("ELCC") approach for determining the amount of capacity that variable (intermittent), limited duration (storage), and combination (hybrid) resources may provide. The October 30th Filing is intended in part to establish a different participation model for electric storage.[3] After consolidation with the RAA revisions

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1 18 CFR § 385.211 (2019).

2 Capitalized terms used herein and not otherwise defined have the meaning used in the PJM Open Access Transmission Tariff ("OATT"), the PJM Operating Agreement ("OA") or the PJM Reliability Assurance Agreement ("RAA").

3 This filing is intended to establish PJM market rules that comply with Order No. 841, which provides in the relevant part: "RTO/ISO market rules that limit the services that electric storage

proposed in Docket No. ER20-584, the scope of the proceeding has expanded to consider the basis of capacity MW determinations of additional resource types.

The ELCC approach proposed in the October 30th Filing is flawed and should be rejected. The flawed design reflects, in part, the haste with which it was created. The flaws include strong constraints on PJM's ability to take corrective actions in the future. The ELCC as proposed will be difficult to unwind and will lock PJM customers into overpaying for ELCC resources and lock out new and innovative technologies for as long as 19 years.[4] The proposal includes "the general principle that the floor values already issued for a specific resource generally would not be changed."[5] This period is effectively forever in the life of the PJM capacity market.[6]

Careful evaluation, well beyond what has been done to date, is required before it can be concluded that an ELCC approach would be a better way to define the reliability contributions of intermittent and storage resources. Any ELCC design must be built on

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resources are technically capable of providing may create barriers to the participation of electric storage resources in the RTO/ISO markets." *Electric Storage Participation in Markets Operated by Regional Transmission Organizations and Independent System Operators*, Order No. 841, 162 FERC ¶ 61,127 at P 19 (2018), *order on reh'g*, Order No. 841-A, 167 FERC ¶ 61,154 (2019), *aff'd sub nom.* Nat'l Ass'n of Regul. Util. Comm'rs v. FERC, 964 F.3d 1177 (D.C. Cir. 2020) ("Order No. 841"). In the course of PJM compliance proceedings on Order No. 841, the Commission initiated an investigation of "the justness and reasonableness of PJM's methodologies to determine the capability of all types of Generation Capacity Resources." *PJM Interconnection, L.L.C.*, 171 FERC ¶ 61,015 (2020) ("April 10th Order"). The compliance proceedings concerning Order No. 841 were held in abeyance in order to provide PJM and stakeholders time to develop and implement proposed ELCC rules. April 10th Order at PP 34–35. The investigation continues in abeyance pending the outcome of this proceeding.

4 The RAA revisions call for a review of the ELCC floor rules by the end of 2026. By that point the 2029/2030 RPM BRA will be complete. Capacity values for new resources that cleared in the 2029/2030 RPM BRA will be subject to ELCC floors through the 2041/2042 Delivery Year.

5 October 30th Filing, Attachment (Redlines), proposed RAA Schedule 9.1 Sect. J(3)(f).

6 Language apparently intended to limit the absolute right to ELCC floors is also included but there is no question about whether ELCC values are locked in for a significant period. *See id.*

basic economic principles including recognizing the role of marginal concepts, dynamic interaction effects among resource types and the way in which a capacity market would actually clear. In addition, a reasonable ELCC design would not shift risks to new entrants and customers from incumbents. Such risk shifting is inconsistent with equity, efficient markets and efficient incentives for technological innovation. For example, what would happen to the proposed ELCC paradigm if hydrogen storage becomes economic and the fixed ELCC values are dramatically inconsistent with economic reality?

PJM should implement the current rule that determines the potential capacity value of Electric Storage Resources ("ESR") based on the maximum output sustainable over a 10 hour continuous period. Such a requirement is consistent with the requirements of Order No. 841. There is no reason for further delay of the paper hearing established in Docket No. EL19-100 or for taking action on the RAA revisions proposed in Docket No. ER20-584.

The fundamental issue in the PJM market is how best to integrate intermittent renewable resources and storage resources and various combinations thereof in the capacity market and in particular how to evaluate the reliability contribution of such resources so that they can be compared to existing resources in a market for a defined and homogeneous capacity product. There are a variety of ways to do that. Currently, PJM discounts the capacity contribution of renewable resources based on analysis of the periods such resources do and do not generate power. PJM also proposed to use the maximum output that an energy storage resource could sustain over a 10 hour discharge period for determining the potential capacity of a storage resource in PJM's Capacity Market. ELCC is an approach, developed as a tool for resource planning by vertically integrated utilities in the 1960s, that could also be used.[7] But there is significant debate, even among proponents of ELCC, about what applying ELCC correctly actually means. For example, does it mean

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[7] Garver, L. L., "Effective Load Carrying Capability of Generating Units," IEEE Transactions on Power Apparatus and Systems, (Aug 1966).

that ELCC should be applied to all resources rather than just intermittent resources? It is clear that the discussion about what ELCC really means and how it should be done correctly never occurred fully in the PJM process. That is required. After that phase of analysis, which would require significant work, there are further and more detailed questions about what applying ELCC correctly means. If PJM prefers an ELCC approach, PJM should start a process to fairly and analytically address each part of the ELCC approach rather than rushing to implement an incomplete approach based on inadequate development and data.

It is clearly a difficult and complex task to implement ELCC correctly. It is easy to make fundamental mistakes. Implementing ELCC incorrectly will create significant issues and, based on PJM's plan to lock in the results of its early mistakes, will create errors that will significantly distort markets and impose costs and risks on new entrants and customers for a very long time.

The PJM approach is designed explicitly to shift risks from incumbent investors to new entrants. The PJM approach also shifts risks to customers. This is incompatible with the market paradigm under which the Commission regulates wholesale power markets. Intermittent and storage technologies are competitive and will continue to evolve in innovative and unexpected ways to become even more competitive. Creating a bias against new technologies is inconsistent with the stated goals of the Commission as well as rational market policy. The purpose of Order No. 841 is to eliminate such biases. The goal should be to ensure that intermittent and storage resources have full opportunities to participate in PJM markets. In the name of reducing risk to investors in existing technologies, the October 30th Filing fails to provide such opportunities to the new and innovative technologies that are already under development and those that we cannot yet imagine.

The process for rule development already favors incumbents over new entrants who do not participate in the arcane rituals of the stakeholder process. The October 30th Filing proposes to create an inefficient market design supported by incumbents who will benefit. The proposed design should be rejected and the current rules should be implemented. If

PJM prefers to pursue an ELCC approach, PJM should be directed to develop an approach that provides incentives to innovation and that continues to place risk and reward on investors who are best equipped to bear it, rather than on customers.

I. BACKGROUND

Under the Commission's Rules, PJM "must have tariff provisions providing a participation model for electric storage resources."[8] Under the Commission rules, PJM should allow resources of all types to provide the energy and capacity that they are "technically capable of providing," participate in competitive price formation and operate in accordance with bidding parameters that reflect their operational characteristics. Order No. 841 required the proper integration of electric storage into the competitive markets. It did not require distortions of the competitive market design or the creation of discriminatory preferences, which would not have been consistent with regulation through competition under the Federal Power Act.

On December 3, 2018, PJM submitted two filings in compliance with Order No. 841, in Docket Nos. ER19-462-000 and ER19-469-000.

In the compliance filing in Docket No. ER19-462, PJM proposed changes.[9] By letter order issued February 1, 2019, the Commission approved the changes.

In the compliance filing in Docket No. ER19-469, PJM explained, with the implementation of certain changes to the PJM manuals and tariff revisions, its rules would provide and fully support an acceptable participation model.[10]

By order issued October 17, 2019 ("October 17th Order), the Commission largely accepted PJM's representations and proposed revisions in Docket No. ER19-469.[11] The

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8 18 CFR § 35.28(g)(9)(i).

9 *See* PJM Compliance Filing, ER20-462-000 at 2.

10 *See* PJM Compliance Fling, ER20-469-000.

October 17th Order found (at P 174) that the PJM rules did not appropriately account for an Energy Storage Resource's State of Charge, Maximum State of Charge, and Minimum State of Charge through bidding parameters or other means in both its day-ahead and real-time market dispatch, as required by Order No. 841. The October 17th Order further found (at P 220) that PJM did not adequately describe the services that constitute Dispatched Charging Energy. The October 17th Order required an additional compliance filing in Docket No. ER19-469, which PJM filed December 16, 2019. The Commission approved, in part, the additional compliance filing by order issued July 16, 2020, and ordered an additional compliance filing.[12] PJM filed an additional compliance filing in Docket No. ER20-469-000 on October 13, 2020, which is now pending.[13]

In the October 17th Order, the Commission also initiated an investigation of whether, under Section 206 of the Federal Power Act, PJM's minimum run time rules and procedures are just and reasonable. As a preliminary matter, the October 17th Order directed PJM (at PP 140, 143) to "submit Tariff provisions reflecting the minimum run-time rules and procedures currently specified in its Manual for every resource." The Commission directed that PJM and other interested parties may file briefs in the new docket defined by the investigation, EL19-100, addressing PJM's application of the minimum run time rules and procedures to Capacity Storage Resources.[14]

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11 *PJM Interconnection, L.L.C.*, 169 FERC ¶ 61,049 ("October 17th Order"). The October 17th Order found (at P 138): "PJM's Tariff satisfies Order No. 841's general directive with respect to allowing electric storage resources to de-rate their capacity to meet minimum run-time requirements."

12 *See PJM Interconnection, L.L.C.*, 172 FERC ¶ 61,029.

13 The compliance filing included revisions to OA Schedule 1 § 1.4A.1(g) in order to eliminate "any ambiguity regarding the prohibition on any distribution-connected ESR paying twice for the same charging energy." *See* Compliance Filing, Docket No. ER20-469 at 5.

14 The October 17th Order noted (at P 141): "[C]ommenters argue that: (1) it is unduly discriminatory to apply a 10-hour minimum run-time requirement to Capacity Storage Resources, while only applying a 4-hour minimum run-time requirement to intermittent resources; (2) PJM's 10-hour

In Docket No. ER20-584, on December 12, 2019, PJM filed revisions to the RAA "to incorporate rules pertaining to qualifications for all Capacity Resources." The filed revisions are the current PJM rules, incorporated into the RAA per the Commission's directive.

By order issued April 10, 2020 ("April 10th Order'),[15] the Commission granted (at P 33) a motion of NextEra to consolidate its investigation in Docket No. EL19-100 with Docket No. ER20-584, finding that "there are common issues of law and fact regarding PJM's methodologies to determine the capability of Capacity Storage Resources and of all other resource types," and (at PP 142–143) set the matter for paper hearing.

In the April 10th Order, the Commission also granted PJM's request that the paper hearing and its proposed RAA revisions be held in abeyance, based on PJM's intention "to pursue an Effective Load Carrying Capability ("ELCC") approach with PJM stakeholders for calculating the capability of resources (such as Energy Storage Resources[footnote omitted]) in the PJM Reliability Pricing Model ("RPM")."[16] PJM claimed such an ELCC approach "could potentially address the issues identified by the Commission in the October 17 Order initiating these proceedings." The Commission determined that PJM must file the ELCC revisions or submit its initial brief by October 30, 2020. The Commission explained: "[granting a period of abeyance] will permit PJM and the PJM stakeholders' time to consider a methodology or methodologies to apply to all resource types while also allowing for such rules to become effective in advance of the next capacity auction. … If PJM makes an FPA section 205 filing on or before October 30, 2020 with a proposed methodology or

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minimum run-time requirement is not based on a sound consideration of physical and operational characteristics of Capacity Storage Resources; and (3) multiple PJM Tariff provisions differ in the treatment of Capacity Storage Resources and Generation Capacity Resources, even though PJM contends in its Data Request Response that Capacity Storage Resources are Generation Capacity Resources.

15 *PJM Interconnection, L.L.C.*, 171 FERC ¶ 61,015 ("April 10th Order").

16 *Id*. at PP 34–35.

methodologies to determine the capability of all resource types for Capacity Resource qualification purposes, the instant consolidated proceedings will be held in further abeyance until Commission action on that filing."[17] PJM submitted the October 30th Filing, extending the period of abeyance of the investigation and paper hearing.

II. COMMENTS

There was and is no reason for PJM to rush to complete and implement an inadequate and flawed ELCC filing. The rush is a direct result of actions taken by PJM.

A. Issues

There are three basic issues with PJM's proposed approach to implementing an ELCC method.

The actual ELCC values are not adequately grounded on actual data. Even more importantly, PJM's approach fails to recognize the interdependence of ELCC values in a market. ELCC values are a complex function and depend on the interaction of all resource offers in an actual capacity market.

PJM proposes to lock in or guarantee ELCC levels for resource classes rather than letting the market determine the ELCC values. Such a lock in approach is specifically designed to shift risks from investors to customers, and shifts risks from incumbents to new, more technologically advanced entrants. This is inefficient and contravenes basic market principles. [18]

PJM fails to define the capacity market clearing so that the optimal value and mix of resources can be defined by the market. PJM imposes static, predefined values instead.

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[17] *Id*.

[18] PJM introduces a new terms, ELCC resource and accredited UCAP. An ELCC resource is a resource for which the new rules apply and the accredited UCAP is the maximum amount an ELCC resource can offer into a RPM auction or assume through a replacement transaction.

These values will be wrong, by definition and inconsistent with an efficient competitive market outcome.

B. Definition

ELCC means effective load carrying capability. That means contribution to reliability. That means contribution to capacity. That means the degree to which a resource can substitute for any other resource in the PJM Capacity Market.

ELCC is a number, between zero and one, which when multiplied by the installed capacity of a resource results in the amount of capacity that can be sold in the PJM Capacity Market and can therefore substitute for, or replace, any other MW of capacity in that market.

PJM proposes to use its ELCC method only for specific, defined resource classes. But there is no reason that a properly designed ELCC method should not be applied to all resources in the PJM capacity mix.

PJM proposes to, in its aggregate model without transmission constraints, start with all expected thermal and ELCC resources, calculate the LOLE and increase the load until the LOLE is increased to the reliability target of 1 in 10. PJM then replaces all the ELCC resources with the level of "perfect generation" resources required to meet the same target LOLE. The ratio of the MW of perfect generation resources to the MW of ELCC resources is the ELCC.[19]

But this ELCC value is a single aggregate ELCC value for the diverse group of ELCC resources which includes solar generators, wind generators, storage resources and combination resources. PJM recognizes that the ELCC method does not calculate ELCC for the distinct resources classes or for the individual resources.[20] [21]

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[19] *Attachment C Affidavit of Dr. Patricio Rocha Garrido*, October 30th Filing at 22. Perfect generation is available 8,760 hours per year.

[20] *Id*. at 24.

To allocate the ELCC to the separate ELCC resource classes, PJM does two more ELCC calculations for each class of resources. One calculation defines an ELCC for the resource class with the assumption that there are no other ELCC resource classes in the system, and a second calculation that includes the other ELCC classes in the baseline while changing only one ELCC class.[22] Based on these two ELCC values for each resource class, PJM will allocate the original ELCC to the resource classes such that the sum of the individual class ELCC values sums up to the originally determined ELCC value.

The models used in this exercise by PJM are still in the relatively early stages of development. They will continue to evolve and become more accurate and sophisticated. The models ignore transmission constraints. The models rely on assumptions about expected levels of generation investment and retirements. For example, PJM did not test the model for the impacts of significant coal or nuclear retirements, both of which would have significant impacts on ELCC values.

The models also rely on performance data for individual resources and for resource classes. None of the modeling means anything if the input data is not highly accurate. But PJM does not have good input data. PJM, tellingly, refers to its data on the performance of the ELCC technologies as "putative data."[23] Putative means, inter alia: imagined; postulated; hypothetical.[24] Presumably PJM uses the more arcane term putative rather than directly stating that the data is imaginary because this approach is unsupportable as the basis for establishing long lived ELCC values.

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21 This is an accurate statement but is a byproduct of PJM's exogenous ELCC method. An ELCC method that simultaneously clears the capacity market and determines the ELCC does not have this limitation.

22 *Id*. at 25.

23 October 30th Filing, Attachment A (Redlines), proposed RAA Schedule 9.1 Sects. A–G.

24 Oxford English Dictionary <*https://www.oed.com/*> Accessed Nov. 19, 2020.

This absence of accurate data alone should disqualify the proposed method for use in calculating capacity values for intermittent and storage resources, especially when the values will persist for 10 years. At the very least, PJM should run this method in parallel for the next few capacity auctions.

PJM's approach will define ELCC values ex ante on a resource class basis. The assumed ex ante resource mix is not a function of how the capacity market clears. There is no interaction among offers or resource types and no simultaneous determination of ELCC values.

The ex ante ELCC values will always be wrong. Accurate predictions about the level of resources are not possible and the market clearing interaction effects are ignored. If an ELCC approach is to be explored, it should do so reflecting the actual, dynamic interactive effects among resource classes in the capacity market and use actual performance data.

C. Issue: ELCC Values

PJM's proposed ELCC method will apply only to intermittent resources, storage resources that cannot operate on a continuous basis for a 24 hour period, and combination or hybrid resources, collectively termed ELCC resources. The October 30th Filing defines these as: variable resource; limited duration resource; and combination resource. PJM defines thermal resources that can operate continuously at maximum capability for a 24 hour period as unlimited resources.[25] Table 1 shows ELCC values that PJM has calculated and posted for stakeholder meetings and Table 2 includes the assumed capacity levels used in the ELCC calculations.

PJM's results illustrate the issues with its approach. PJM's calculated ELCC of 1.0 for an eight hour battery is simply implausible, as are the other storage results. These ELCC values mean that, per PJM's calculations, a four hour battery is the approximate equivalent

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[25] *See* October 30th Filing, Attachment A (Redlines), proposed RAA Art. 1.

of a new, efficient gas fired combined cycle plant in its contribution to meeting load. The same conclusion is reached for an eight hour battery.

Table 1 PJM ELCC[26]

Scenario	Wind	Solar	Storage (4 Hour)	Storage (8 hour)	Solar + Storage Hybrid (open Loop)	Solar + Storage Hybrid (Closed Loop)	Hydro w/o Storage	Landfill Gas	Hydro w/ Storage
1	10%	65%	92%	100%	97%	97%	49%	58%	100%
2	9%	59%	86%	98%	96%	96%	48%	59%	97%
3	9%	49%	74%	95%	86%	86%	51%	63%	97%
4	9%	40%	75%	93%	85%	85%	51%	62%	94%
5	9%	33%	81%	94%	74%	73%	51%	61%	92%
6	9%	27%	79%	94%	71%	71%	51%	59%	94%

Table 2 Assumed capacity levels (GW) for PJM ELCC calculations[27]

Scenario	Wind	Solar	Storage (4, 6, or 10 Hour)	Storage (8 hour)	Solar + Storage Hybrid (open Loop)	Solar + Storage Hybrid (Closed Loop)	Hydro w/o Storage	Landfill Gas	Hydro w/ Storage
1	12.0	7.0	0.4	5.0	0.3	0.3	0.7	0.3	2.0
2	15.0	11.0	0.9	5.0	0.5	0.5	0.7	0.3	2.0
3	19.0	16.0	1.5	5.0	0.8	0.8	0.7	0.3	2.0
4	22.0	22.0	2.0	5.0	1.0	1.0	0.7	0.3	2.0
5	23.0	31.0	3.0	5.0	2.0	2.0	0.7	0.3	2.0
6	25.0	40.0	5.0	5.0	2.0	2.0	0.7	0.3	2.0

The October 30th Filing indicates that fixed ELCC capacity values will be defined by PJM and available to Capacity Market Sellers 150 days, or approximately five months, prior to an RPM auction, which would require data to be available and analysis to begin six to seven months prior an RPM auction.[28]

The October 30th Filing does not explain how the capacity mix will be determined prior to the ELCC analysis. The exact basis for the capacity mix assumptions should be made explicit.

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[26] "Capacity Capability Senior Task Force Presentation," at 15, Melissa Pilong, PJM, (September 17, 2020) <*https://pjm.com/-/media/committees-groups/committees/mrc/2020/20200917/20200917-item-04-1-ccstf-presentation.ashx*>.

[27] *Id*. at 14.

[28] October 30th Filing at 62.

The October 30th Filing does not provide details on how the ICAP levels of the ELCC resources will be established. If PJM assumes 10 GW of wind for the ELCC analysis and 15 GW clear in the RPM Base Residual Auction the ELCC capacity value will not be correct. If PJM assumes 10 GW of wind for the ELCC analysis and 5 GW clear in the RPM Base Residual Auction, the capacity value will not be correct. The result could understate or overstate the ELCC value for wind or other resource types.

Regardless, this ex ante determination of the resource mix cannot be correct for the next auction because the actual mix that results from the auction is a function of the market clearing process. The ELCC values will be guaranteed for 10 years. The ex ante determination prior to year one of the resource mix cannot be correct for the next 10 years.

The ELCC analysis includes too many MW of unlimited resources. PJM includes MW of unlimited resources that did not clear in the capacity market and that should not have been included in the ELCC analysis because they were not part of the market solution to which the ELCC is being added. In addition, a significant level of the uncleared MW are at risk and should not be assumed to remain in service, regardless. As an example, the 2021/2022 RPM Base Residual Auction committed for RPM and FRR 160.9 GW ICAP of capacity from unlimited resources from the 183.3 GW of available capacity from unlimited resources.[29] PJM appears to include the full 183.3 GW in its ELCC analysis. PJM must explain why this is consistent with the ELCC approach and provide details on how they would choose the size and make up of the unlimited resource fleet.

1. PJM's Data and Modeling Are Not Sufficient to Determine ELCC Values

PJM's analysis and resulting ELCC values are not adequately based on actual data for actual resource behavior. Details like the effect of adding resources in specific locations

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[29] "Analysis of the 2021/2020 RPM Base Residual Auction: Revised," Tables 9, 21 and 22, <*http://www.monitoringanalytics.com/reports/Reports/2018/IMM_Analysis_of_the_20212022_RPM_BRA_Revised_20180824.pdf*>.

are ignored, as are any of the potential interactions among resources based on network location. PJM's ELCC method does not model transmission limits and assumes away all transmission related reliability issues within the PJM footprint. This means that the model assumes, and the resulting ELCC values are the result of, a uniform distribution of all resource additions across the system.

Where historical output/behavioral data on specific resource types are missing, it is backcasted.[30] Backcasted means to assume historical behavior based on a combination of current information and historical weather data.[31] PJM states (at 25) that it will use actual values for load and actual and putative values for variable resource output from June 1, 2012, through the most recent delivery year for which data exists. However, data essential to the ELCC analysis and to the participation of specific new types of resources with little, if any operational history, such as limited use storage or hybrid (combined) resources, will be putative.[32] The ELCC analysis and results are heavily dependent on hypothetical data rather than actual data.

PJM does not have four hour limited use storage resources on its system participating in its reserve or energy markets. The limited use storage resources currently on PJM's system (less than 10 hour limited use) are participating in PJM's Regulation Market. There are no combined (hybrid) resources. While PJM's dependence on hypothetical data is unavoidable, PJM's uses of that data to create very long lived commitments is avoidable and should be avoided.

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30 *See* PJM at 25–28.

31 Given that weather is local and PJM is assuming no transmission constraints and therefore no locational differences, the basis for the weather assumptions is not clear.

32 See PJM at 25–28.

D. Issue: Locked in ELCC Values

The October 30th Filing proposes that PJM calculate floor values for each ELCC class. The floor values, described euphemistically as a transition mechanism, will serve as a lower bound on the ELCC class ratings. Each specific resource class that clears in a given year will be guaranteed that its ELCC value will never be reduced until after the 13th auction, regardless of whether the actual ELCC value declines.

Each combination of delivery year and ELCC class will be associated with a unique 13 year schedule of ELCC floor values. The first 10 years of a particular ELCC floor schedule are established in the five month period prior to the start of the delivery year. Then in each of the next three years, an additional ELCC floor is added to the schedule filling in the remaining three years of the schedule. Each ELCC resource will be associated with the ELCC floor schedule corresponding to the resource's ELCC class and first delivery year for which the resource satisfies certain milestones in the New Services Queue.[33] One point of confusion regarding the applicable floor schedule is that a new resource could clear for a delivery year in an auction somewhere between two and three years prior to the ELCC class floor being established for the delivery year.

PJM's ELCC floor calculations are based on a forecast of ELCC resource type MW in 10 years. The ELCC class floors in each year are based on ELCC class MW interpolated between the current year and year 10. The ELCC floor analysis will use the year one capacity forecast and two times the year 10 capacity forecast. For years two through nine, the ELCC floor forecast will use the capacity amount corresponding to an exponential function defined by the year one and year 10 assumed values.[34]

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[33] October 30th Filing, Attachment A (Redlines), proposed RAA Schedule 9.1 Sect. J(1).

[34] The assumed capacity values used by PJM for the ELCC floor analysis are given by the following formula: $C_i = F_1 \left(2 \cdot F_{10}/F_1\right)^{(i-1)/9}$ for i = 1, …, 10, where F_1 is the year 1 forecast capacity value and F_{10} is the year 10 forecast capacity value.

1. ELCC Floors Are Not Consistent with Competitive Market Principles

The ELCC class rating floors are explicitly designed to shift market risk away from developers and owners of existing ELCC resources. Developers and owners of ELCC resources should bear the risk of a potentially decreasing capacity value. Developers and owners must react to changing market conditions. Resources employing new technology will be at a disadvantage relative to old resources due to the ELCC floors. Customers will pay more for inefficient, old technology and be denied the benefits of innovation.

2. Floors Will Make the System Less Reliable and Are Not Sustainable

An ELCC floor will be binding if a current year ELCC class rating is below the corresponding ELCC class floor. For example, suppose as part of the 2023/2024 ELCC analysis which PJM estimates will be performed in 2021, the 2026/2027 ELCC floor for solar resources is calculated to be 45 percent. Then in late 2025, the ELCC analysis for the upcoming 2026/2027 Delivery Year finds an ELCC solar class rating of 40 percent. Then for all solar capacity that is locked in at 45 percent, an ELCC class rating of 45 percent rather than 40 percent will be used in the accredited UCAP calculation. This simple example shows that a binding ELCC floor means a group of resource will be credited with a capacity level that exceeds the true capability of the resources. To balance this out PJM will take capacity away from a different group of resource that have an ELCC class rating that exceeds the ELCC floor. Table 1 shows an example in which 20 GW of solar capacity is eligible to offer into the RPM auction for delivery year X. The solar resources are grouped together according to the ELCC floors. Group A includes the oldest resources and has the highest floor value, Group C includes the newest resources and has the lowest floor value, and Group B consists of resources that came online somewhere in the middle. In Table 1, the ELCC analysis for delivery year X returns an ELCC class rating of 50.0 percent, which means in total the solar generators have a capacity value of 10 GW. To honor the Group A floor of 60 percent, 500 MW in excess of the true carrying capability of the Group A resources is assigned to Group A. To even things out, Group C is credited with 3,500 MW of

ELCC capacity which is 500 MW less than the true carrying capability of the Group C resources.

In the example in Table 2, the Group C floor is 45 percent. The Group A resources still require an extra 500 MW but there are only 400 MW in excess of the amount that must be credited to Group C. Solar capacity is not able to cover the capacity guaranteed by the ELCC floors. Under the PJM ELCC rules, another class of resources would be required to cover the missing solar capacity by having their ELCC reduced.

Table 3 ELCC Floor Example 1

	Group A	Group B	Group C
Solar Nameplate Capacity (MW) for Delivery Year X	5,000	7,000	8,000
ELCC Floor Established in Prior Years for Delivery Year X	60.0%	50.0%	40.0%
Realized ELCC rating for Solar for Delivery Year X		50.0%	
Realized ELCC Solar Capacity (MW) for Delivery Year X		10,000	
Accredited UCAP (MW) for Delivery Year X	3,000	3,500	3,500
Realized ELCC rating by Group for Delivery Year X	60.0%	50.0%	43.8%

Table 4 ELCC Floor Example 2

	Group A	Group B	Group C
Solar Nameplate Capacity (MW) for Delivery Year X	5,000	7,000	8,000
ELCC Floor Established in Prior Years for Delivery Year X	60.0%	50.0%	45.0%
Realized ELCC rating for Solar for Delivery Year X		50.0%	
Realized ELCC Solar Capacity (MW) for Delivery Year X		10,000	
Accredited UCAP (MW) for Delivery Year X	3,000	3,500	3,600
Realized ELCC rating by Group for Delivery Year X	60.0%	50.0%	45.0%

It is likely that, within the duration of the floors, a large number of ELCC resources are credited with capacity values in excess of the true carrying capability, and there are not enough ELCC resources with nonbinding ELCC floors to make up the difference. A resolution to this potential outcome is not included in the proposed RAA revisions. The solution would be to require the procurement of additional capacity from unlimited resources which would be paid for by customers.

3. ELCC Floor Calculations Are Not Just and Reasonable

The assumed capacity levels in PJM's ELCC analysis should reflect expectations of capacity for which there will be a PJM capacity obligation. PJM does not address the forecast of the unlimited resource fleet for the floor calculations which will necessarily require forecasting new resource and retirements over a 10 year period. PJM cannot accurately forecast the necessary inputs for the floor calculations. Given the level of uncertainty regarding the inputs to the floor calculations, the Commission should have no confidence that the resulting ELCC floor values will be just and reasonable. Amplifying the risk of the ELCC floor provisions are the revisions to the RAA which make it clear that the floors, once established, are binding and will not be changed for the 13 year duration except in an extraordinary circumstance of PJM discontinuing the use of the ELCC method or that PJM ceases to assign unforced capacity values to ELCC resources.[35]

E. Issue: ELCC in the Capacity Market

1. Average ELCC versus Marginal ELCC

PJM's proposal incorrectly uses average ELCC rather than marginal ELCC values for determining unit specific contributions to total contributed capacity by class, for determining what resources will offer into the PJM Capacity Market, for determining UCAP obligations of cleared resources, for determining market clearing prices for ELCC affected resources and for determining potential performance penalties for ELCC affected resources. While PJM recognizes that marginal ELCC values are essential to develop an economically efficient signal to the market for entry and exit of capacity resources (PJM at 22), PJM erroneously concluded (PJM at 22) that "the use of marginal ELCC values does not generally credit a portfolio of resources for its total contribution to resource adequacy."

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[35] October 30th Filing, Attachment A (Redlines), proposed RAA Schedule 9.1 Sect. J(3)(f).

The theory behind ELCC analysis, requires the use of marginal, rather than average, ELCC values for determining unit specific contributions to total contributed capacity by class, for determining UCAP obligations of cleared resources, for determining market clearing prices for ELCC affected resources and for determining potential performance penalties for ELCC affected resources. It is generally recognized that marginal ELCC values will decline as additional ELCC resources are added. PJM's failure to use marginal rather than average ELCC values in its market evaluations of resources in the capacity market will cause the market to overvalue, over compensate and over procure that resource type in question. The use of average rather than marginal ELCC values will cause PJM's capacity market results to be incorrect and inefficient, at the expense of the PJM customers and non-ELCC resources competing with ELCC resources.

The ELCC analysis, properly done, would provide an ELCC function that determines the total amount of capacity being provided by an evaluated resource for a specific amount of that resource given the interactions with all other resources levels assumed to exists concurrently. The resulting ELCC function for any resource type with an output limitation would show decreasing returns to adding capacity from that resource type, holding all other resource levels constant. An ELCC function that provides decreasing returns for additions of the resource type indicates declining marginal ELCC value for that resource type, and function for which the average ELCC values of the resource type will be higher than the marginal ELCC values. This observation does not justify using average ELCC values rather than marginal ELCC values.

Properly functioning and efficient markets clear on the basis of marginal values, with marginal costs (prices) equaling marginal value, not average prices equaling average values. In a properly functioning capacity market that includes ELCC the market would set prices, compensation and MW obligations based on marginal ELCC, not average ELCC, values.

Using the marginal rather than average ELCC value in market clearing results in every resource receiving the same price per MW of provided equivalent load carrying

capacity, the correct assignment of capacity obligations per MW of cleared of a ELCC adjusted resource and the correct allocation of any penalties for non performance.

Under this approach, the total amount of ELCC adjusted MW provided by a resource class would be based on the ELCC function or the area under the marginal ELCC curve, which is the derivative of the ELCC function relative to the limited resource being evaluated. The area under the marginal ELCC curve for a given MW amount is the total amount of capacity provided by that MW amount. It is the total effective capacity provided by that amount of MW. This is the same value that PJM erroneously asserts (PJM at 22) can be found only by using the average ELCC valuation of resources. Contrary to PJM's assertions (PJM at 22), the marginal ELCC framework credits a portfolio of resources for its total contribution to resource adequacy and does so in a way that is consistent with efficient market clearing, efficient market signals and the efficient allocation of resource obligations.

2. ELCC Analysis Is Not Applicable to Storage Resources

ELCC analysis is dependent on assumptions about the behavior/output of the resources.

It is logically possible to use ELCC analysis for calculating the load carrying capability of non dispatchable intermittent resources because the output of these resources is caused by predictable factors exogenous to decisions by the unit's owners. For fully dispatchable units, such as thermal units, resource output is assumed to be available (subject to modeled outages) whenever needed.

But ELCC analysis is not applicable to limited duration storage resources as proposed by PJM. PJM's ELCC valuation limited duration storage is dependent on very strong behavioral assumptions about these resources and when they will use their limited capacity to inject power into the grid. PJM assumes that individual battery owners, each with their own incentives, will collectively behave perfectly. PJM's calculated ELCC values for storage depend entirely on this unsupported and unsupportable assumption.

Under PJM's modeling assumptions, the output of limited duration storage (batteries) is only used "in hours in which all output from Unlimited Resources and available output from Variable Resources is insufficient to meet load."[36]

PJM claims (at 3) that this assumption "conservatively simulates the behavior of limited duration resources and combined resources." PJM notes (at 30) in the same discussion, the resulting analysis is intended to maximize the apparent reliability benefit, and resulting ELCC values, of limited duration storage resources.

The assumption is not conservative. The assumption is extreme. There is no basis for this assumption that limited duration storage resources will reserve their output for those hours when output from Unlimited Resources and available output from Variable Resources is insufficient to meet load. Rather than assuming standard profit maximizing behavior from limited duration resources, PJM assumes that storage will have, from a system reliability perspective, perfect behavior under all market conditions.

3. ELCC Calculations in the Capacity Market

An efficient implementation of the ELCC method requires that resource specific ELCC values be determined simultaneously with the clearing of the RPM auction.[37] [38] This approach requires the construction of a multivariable ELCC function or ELCC surface, constructed prior to an RPM auction and then used as an input into the auction. The capacity market can then be cleared efficiently and the cleared quantities and prices will reflect a marginal ELCC approach.

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[36] *See* PJM at 30.

[37] "ELCC – IMM Proposal, Capacity Capability Senior Task Force," Independent Market Monitor for PJM Interconnection, L.L.C. (August 12, 2020), <*http://www.monitoringanalytics.com/reports/Presentations/2020/IMM_CCSTF_ELCC_IMM_Proposal_20200812.pdf*>.

[38] "ELCC Comments – IMM, Markets and Reliability Committee," Independent Market Monitor for PJM Interconnection, L.L.C. (September 19, 2020), <*http://www.monitoringanalytics.com/reports/Presentations/2020/IMM_MRC_ELCC_IMM_Comments_20200919.pdf*>.

An ELCC surface can be constructed by applying the ELCC analysis to a range of possible values for each resource type. For example, if there were just two ELCC classes, say solar and wind, then the ELCC surface could be defined as

$$\mathrm{ELCC} = \mathrm{f}(\mathrm{X}, \mathrm{W}, \mathrm{S})$$

where X represents the installed capacity of unlimited resources, W represents the installed capacity of the wind resources and S represents the installed capacity of the solar resources. An approximation to the ELCC surface could be obtained by the running the ELCC analysis for various combinations of X, W and S, and then employing an interpolation algorithm to complete the approximation.[39]

The surface reflects the fact that ELCC values are a function of the offers from other limited and unlimited resources. When the market clears, it accounts for these interactions and reaches an optimal solution based on the information that defines in the surface.

Capacity offers from ELCC resources would vary according to the ELCC value. Continuing with the example, consider a 100 MW (nameplate) wind resource that offers into the capacity market at $20 per MW-day. If the resource clears the market, the resource must clear at a price no lower than its offer. If the market clears at a marginal ELCC of 12 percent, then the resource must be paid at least an amount corresponding to its effective offer at a 12 percent ELCC. The resource's effective offer at a 12 percent marginal ELCC is $166.67 per MW-day.[40]

F. PJM Should Implement an Acceptable Participation Model Now.

PJM has had an acceptable participation model for ESR and other resources. The filings in this proceeding have improved and clarified certain aspects of PJM's rules and

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[39] By assuming a smooth ELCC surface, an approximation method could be designed to achieve a high level of accuracy.

[40] An offer of $20 per MW-day for 100 MW (nameplate) or $2000 per day is equivalent to an offer of $166.67 per MW for 12 MW (UCAP) where 12.0 percent is the marginal ELCC rate.

would, if accepted, incorporate those rules into the tariff. The October 30th Filing is flawed and should not be approved. The October 30th Filing was proposed as an alternative to continued compliance filings following the issuance of Order No. 841. The October 30th Filing presents an unacceptable alternative. ELCC, as defined in the October 30th Filing, does not constitute an acceptable participation model and cannot be, without substantial additional effort in the stakeholder process. There is no reason to defer moving forward immediately with implementation of the PJM's filings in Docket Nos. ER19-469 and ER20-584 and conclude the paper hearing in Docket No. EL19-100.

III. CONCLUSION

The Market Monitor respectfully requests that the Commission afford due consideration to these comments as it resolves the issues raised in this proceeding.

Respectfully submitted,

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Dated: November 20, 2020

CERTIFICATE OF SERVICE

I hereby certify that I have this day served the foregoing document upon each person designated on the official service list compiled by the Secretary in this proceeding.

Dated at Eagleville, Pennsylvania,
this 20th day of November, 2020.

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