



Capacity Market Reform: PJM's Initial Proposal

CIFP - Resource Adequacy
March 29, 2023

This is an initial proposal for Stage 1 of the CIFP.

It should be considered a reflection of our current thinking that we seek to enhance throughout this process.

There are parts of the solution where we feel stronger than others.

- We'll be transparent about what those are and why.

There are areas where we chose a design option but recognize it may have shortcomings. We want to collaboratively resolve those.

The capacity market is a complex topic. We look forward to collaborating on a solution through this process.

We want to get to the best answer.

PJM's priorities for its proposal follow the areas identified in the Board letter.

- Enhance modeling of winter risks (and more generally)
- Review of the CP structure and alignment with MSOC
- Align accreditation with reliability contribution
- Align these changes with FRR

We included some other items:

- Reliability metric: LOLE to EUE
- Capacity must offer requirements
- Forward-looking E&AS Offset

Proposed design continues to focus the capacity product on resources' contribution to reliability and ability to perform when needed during hours of highest reliability risk



Reliability Risk Modeling

Enhance reliability risk modeling, especially that of winter risks

- Enhance risk modeling by explicitly modeling how forced outage and other de-rates vary with temperature (increasing in extreme cold and hot)
- Expand weather history in reliability modeling to 50+ years to better represent the full distribution of summer and winter weather outcomes
- Move to Expected Unserved Energy (EUE) as the primary reliability metric
- Collectively, we believe these enhancements will result in models that better reflect the likelihood and severity of extreme weather event risk so those events are properly weighted when determining procurement target and in accreditation

RTO Reserve Requirement

- Modeling improvements (hourly, extended weather history, etc.)
- Target criteria based on the “equivalent” EUE observed in our models when at 1-in-10 LOLE
- Change to not rely on emergency imports to meet target EUE criteria

LDA Reserve Requirement (CETO study)

- Modeling improvements (hourly, extended weather history, etc.)
- Target criteria based on similar level of additional risk relative to the RTO accepted today for LDAs
- Require earlier notification of intent to offer planned generation



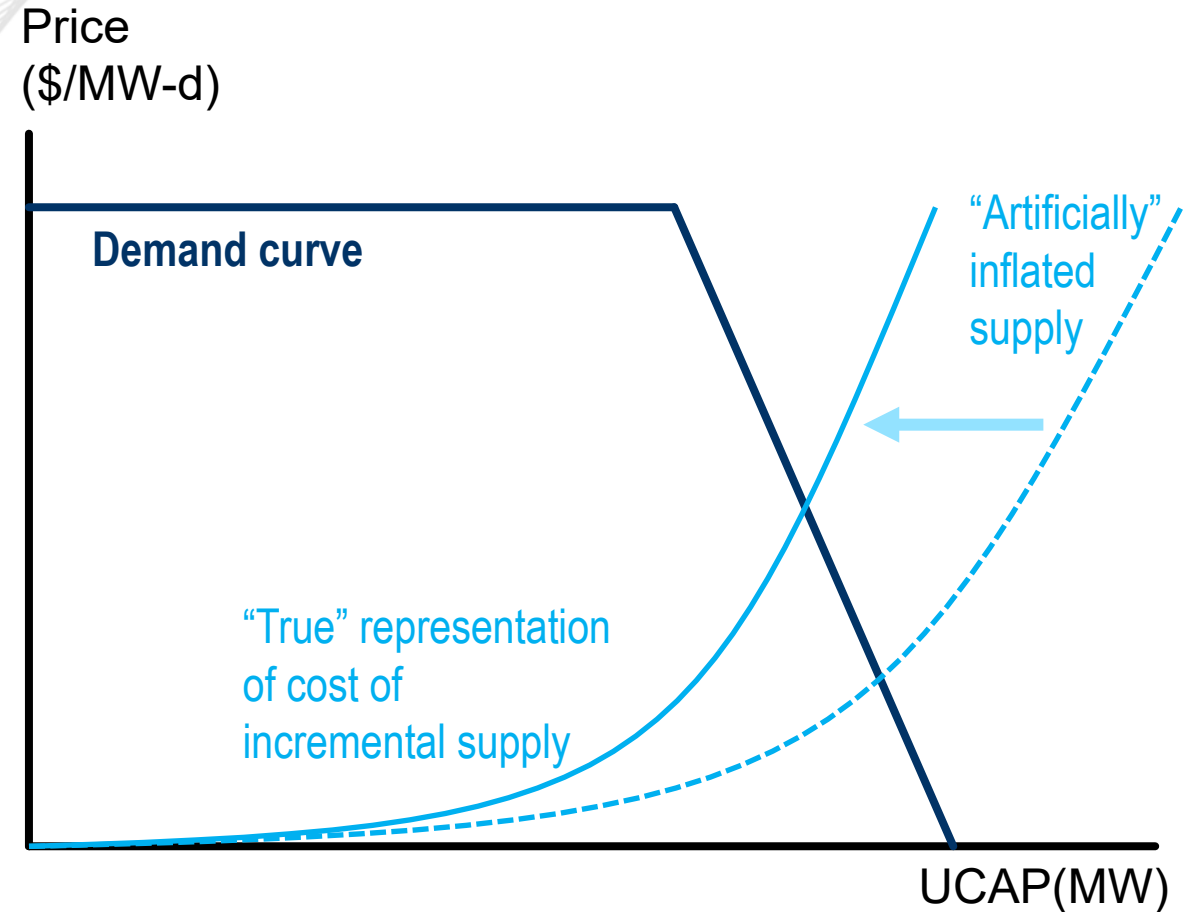
Capacity Accreditation

Motivation:

Accreditation that over-states resources' contribution to reliability artificially **inflates supply**, **harms reliability**, **inappropriately depresses clearing prices** and **introduces risk of uneconomic retirement**.

Improving accreditation framework:

- Improves reliability
- Aligns resource compensation with their relative contribution to reliability
- Aligns market results with the resource adequacy disposition of the region



Proposal: Marginal Accreditation Framework (Marginal ELCC or Marginal Reliability Impact) incorporating weather-correlated outages.

Improves accreditation to better capture resources' contribution during system risks and more accurately and equitably determine resources' relative contributions to resource adequacy.

- Consistently account for supply-side availability risks for all resource types
 - Enhance modeling of winter & extreme weather risks by extending weather history to better understand & characterize extremes, and reflect risks driven by combination of generator performance and load
- Marginal Accreditation: Accredit each resource to reflect its expected incremental contribution to system reliability during periods of risk

Thermal Resources

- Adjust for temperature-dependent forced outage rates and impact of correlated outages
- Model historical performance of individual resources and across classes & fleet under normal and extreme conditions

Demand Response

Account for availability limitations coinciding with periods of risk

Intermittents and Storage

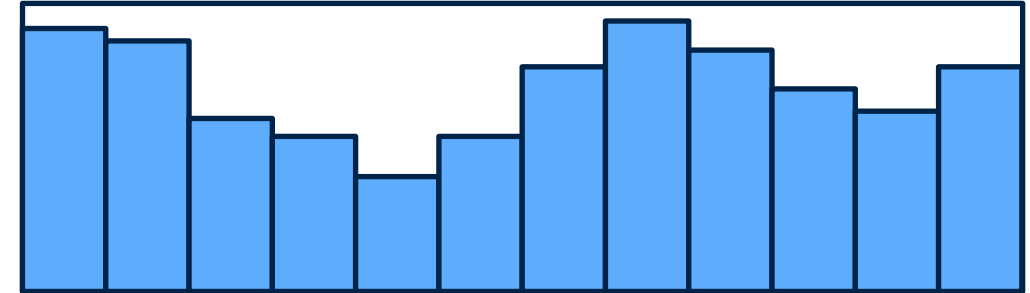
Modeled as today, but accreditation will reflect different patterns of risks and changing risk weighting

Resource receives single annual accreditation...



ICAP = 100

UCAP = 80



In auction clearing, unit is still represented based on their total annual contribution: “average contribution during periods of risk” or equivalently “capacity contribution throughout the year, with contributions during riskier periods receiving higher weight”

ICAP	100	100	100	100	100	100	100	100	100	100	100	100	
Performance	90	85	60	50	30	50	75	90	80	70	65	75	Totals
Risk Weighting	.1	.1	.01	.01	.01	.05	.28	.3	.05	.01	.01	.07	100%
UCAP Contribution	9	8.5	.6	.5	.3	2.5	21	27	4	.7	.7	5.3	80 UCAP

Annual accreditation corresponds to the resource’s expected contribution over time (seasons/months/hours) and across scenarios (with contribution during any given hour capped at CIRs)

Historical paradigm:

Focused on planning for the (summer) peak given concentration of risk at that time

With the use of ELCC for certain resources, we started down a path of fully recognizing resources differential contributions to reliability over time and across scenarios

New paradigm:

Identify the least-cost, efficient portfolio of resources that – in aggregate – is expected to provide resource and energy adequacy in every hour of the year, across all potentially anticipatable scenarios, up to the target reliability metric

1 Characterize resources' historical performance:

- **Individual** performance (forced outages, ambient de-rates, production capability, etc.) as a function of temperature (and other weather for wind/solar back-casts)
- **Class** and **fleet** performance as a function of temperature
Correlated outages for any reason are observed as class/fleet outage rates substantially above the “typical range,” i.e., outliers relative to the statistical distribution of class/fleet outage rates expected given independent random draws of individual performance expectations

2 Model system resource adequacy under thousands of alternative histories, each with:

- One alternative weather history, reflecting distribution of uncertainty given 50 years' of history
- One alternative load history, reflecting distribution of load forecasts given weather, time/date, etc.
- One alternative realization of capacity resource performance, reflecting distribution of potential performance of individual “independent” resources and adjusted for historically observed correlations

3 Extract: patterns of system reliability risk throughout the year

- Summer vs. winter? Morning vs. midday vs. evening? Long vs. short events? Deep vs. shallow?

4 Extract: each resources' contribution to avoiding load shed in each alternative history

RESULT

Resource-specific accreditation reflecting reliability-neutral “exchange rate” across resources and resource types while maintaining target reliability metric

Capturing Correlated Outage Risk in Accreditation

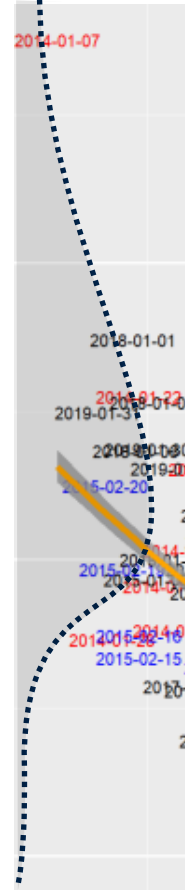


System-wide outage rate distribution

Independent draws given resources' forced outage rates yield artificially narrow distribution of system-wide outage rates given weather

But relatively severe system-wide outcomes happen (relatively) frequently under extreme weather

And severe weather occurs rarely but **much** more often than never



System-wide outage rate distribution

Proposed approach uses the observed empirical correlation of outages to adjust resource performance during extreme weather

And proposed approach better characterizes frequency of extreme events by extending our weather history

We are currently implementing the proposed approach to develop:

- Expected distribution of annual risk across seasons
- Indicative estimates of resource accredited values

We propose to benchmark model outcomes against historical data, comparing historical risk outcomes to model predictions (understanding data limitations given that “near misses” are relatively rare, and actual load shed even more so). Will seek to answer:

- *Is the pattern of risk experienced over the last decade within the statistical range of what the model would report (given historical resource mix) if the model accurately captured patterns of risk?*

Proposal: Winterization standard applied to accreditation.

- **Resources that fail to winterize receive no winter capacity commitment, no winter capacity obligation, and an annual accredited value reflecting zero winter performance.**
 - Example: If 30% of modeled risk is in winter, non-winterized resource accredited value could not exceed 70% of ICAP
- **Require attestation from resource owners demonstrating compliance with the winterization standard.**

Proposed Standard: Set minimum winterization requirements, exceeding NERC minimum requirements ([EOP-012-1](#)) and aligned with IRC comments ([IRC comments](#))

- IRC comments propose adjusting the definition Extreme Cold Weather Temperature (ECWT) from what was proposed in the reliability standard.
- As proposed by NERC, ECWT is, “the temperature equal to the lowest 0.2 percentile of the hourly temperatures measured in December, January, and February from 1/1/2000 through the date the temperature is calculated.”
- The IRC proposed two alternatives to the standard in EOP-012-1 that PJM is supportive of. Replace “lowest 0.2 percentile” with (a) “lowest six hour average temperature”, or, (b) replace the “0.2” with “0.02”

Proposal: No standard at this time; fuel unavailability considered in correlated outage modeling in accreditation.

- **We are actively discussing this but do not have a workable proposal for a fuel security standard at this time. We believe fuel unavailability that is driven by extreme weather will be captured, although not explicitly, through our correlated outage modeling in marginal accreditation.**

We continue to work on this issue internally and are reviewing the work being done in ISONE.

Reliability Requirement in UCAP

- Procurement target should reflect the quantity of accredited UCAP needed to meet reliability criteria
 - Reduced by shifting certain supply-side risks accounted for on the demand-side today into accreditation
 - Reduced by moving from average to marginal ELCC

Prices denominated in \$/MW UCAP

- Market Seller offers may be impacted on a \$/MW-day (UCAP) basis
- Administrative prices may be impacted on a \$/MW-day (UCAP) basis, such as the reference resource Net CONE used in the VRR

Performance obligations

- Impacts Expected Performance throughout the year
- Informs calculation of variable baseline of Expected Performance



Performance Assessments and Testing

Today we are proposing a Performance Assessment structure that follows the concepts we have in place today with some changes.

We are actively discussing “pay-as-you-go” approaches where resources are only compensated for capacity upon delivery and interested in how others view these.

- We believe there could be benefits to these frameworks.
- There are details underlying these that need careful thought. We have not gotten all the way through that yet.
- We are interested in how others think about the incentives of these approaches.

We'll share our thinking on this on future slides.

Multi-tiered framework of performance assessments and testing to help ensure delivery of the capacity that has been committed through forward auctions

- **Daily Commitment Deficiency Assessment** – Retain existing assessment of unit's in-service MW and capacity value to meet their daily capacity commitment.
- **Generator Summer / Winter Rating Tests** – Enhance existing assessment of unit's capability to operate at their committed ICAP in the season. Proposed improvements to this assessment include:
 - Require physical demonstration of capability in each season
 - Remove excusals for inability to test to committed ICAP in each season
 - Allow for PJM initiated testing with advanced notice to owner
- **Energy Market Must Offer Obligation Assessment** – New proposed assessment of compliance with obligation to make available capacity accessible to PJM for scheduling.
- **PAIs** – Enhanced assessment of performance during times of relative system stress with tiered assessment periods and non-performance charges.

Proposal: Tiered assessment periods with tiered non-performance charge rates.

Tier 1 Trigger: All intervals where there is a real-time reserve shortages AND declaration of a real-time emergency procedure more severe than Pre-Emergency DR.

Tier 2 Trigger: If there are less than 360 Tier 1 intervals, remaining intervals up to 360 total will be determined based on the tightest real-time operating reserve intervals for the year.

- Tier 1 intervals are intended to identify non-transient reserve shortages and are viewed as the periods of reliability risk during the year.
- Tier 2 intervals ensure that capacity resources have their performance assessed each year at times that most closely represent times of reliability risk for that year.
- Both interval types would retain the CP structure of an exchange of penalties and bonuses between capacity market suppliers.
- This structure would remove local transmission emergencies and deployment of pre-emergency DR as PAI triggers.
- PAIs could be locational based on the current modeling of PJM's reserve markets.

Tier 1: Maintain non-performance charge rate based on Net CONE and 30 hours

$$\text{Tier 1 Non-Performance Charge Rate} = \frac{(\text{Net CONE} * \# \text{ days in the Delivery Year})}{(30 \text{ hours} * 12 \text{ settlement intervals})}$$

Floored at Tier 2 Penalty Rate

Tier 2: Weighted average clearing price

$$\text{Tier 2 Non-Performance Charge Rate} = \frac{(\text{Weighted Average Resource Clearing Price} * \# \text{ days in the Delivery Year})}{(30 \text{ hours} * 12 \text{ settlement intervals})}$$

Propose to base the annual stop-loss off of the auction revenues rather than Net CONE to limit financial exposure in years where the clearing price is significantly below Net CONE

$$\text{Total Annual Stop-loss} = 1.5 \text{ times resource's annual capacity revenues}$$

This includes Tier 1 and Tier 2 PAI Net Non-Performance Charges.

$$\text{Tier 2 Annual Stop-loss} = \text{resource's annual capacity revenues}$$

- Today, the “static” annual UCAP MW commitment of a generator is used as the baseline for setting a resource’s Expected Performance during PAIs (adjusted by the balancing ratio), regardless of when the PAIs occur
- This approach does not reflect *any* expected differences in unit performance across the year
 - This can significantly increase the financial risk of non-performance even when resources perform as expected and modeled in accreditation

Concept: Better align Expected Performance for PAIs with expected performance that drove the accredited level.

Proposal: Resource-specific monthly baselines to better align Expected Performance during PAIs with the underlying capability modeled for resources in the accreditation process.

Baselines will reflect risk-weighted capability expected of resources and aligned with accreditation assumptions.

Each resource will receive 12, monthly baselines from which their performance will be assessed during Tier 1 and Tier 2 PAIs.

Proposal: Excuse generators that operate as PJM requested.

- Operating as requested means:
 - The resource came online when scheduled within at least 110% of its startup and notification time parameters when called.
 - Following dispatch will be determined via comparison of the LMP to the corresponding output on the resource's offer curve.
- Continue to excuse resources on approved planned and maintenance outages

Improve clarity and transparency of PAI rules in the governing documents and/or manuals.

Proposal:

- Exclude Net Imports from the assessment for Tier 2 PAIs
- Adjust the PAI Balancing Ratio to reflect monthly variable baselines of assessed resources and excusals
- Remove the option to adjust commitments after a PAI through retroactive replacement transactions
- Apply the same penalty structure to all participants for PAIs – remove the option for FRR Entities to elect a physical penalty

PJM believes that the value of capacity is not uniform across the delivery year and that it is more important during periods of reliability risk.

There is a version of this model where 100% of capacity revenues are paid out across a set number of hours, maybe 30, instead of 8760.

Discussion questions:

- What does it mean to provide capacity on a day...specifically?
- Does this lessen or increase complexity?
- Does the removal of direct traceability of resource-specific baselines and obligations create some uneasiness with regard to reliability?
- Do incentives change meaningfully when revenues are guaranteed and there is risk of claw back vs. no guaranteed revenues and then need to earn them?
- How do incentives change if a resource cannot lose money but can only gain?
- Would the removal of a large capacity penalty reduce incentives to do things in real-time such as procure fuel?
 - We believe this issue may be able to be addressed more directly through other market structures.



Market Power Mitigation Rules

Proposal: MSOC reforms from Fall 2022 + Other Changes

- 1 MSOC reforms [proposed by PJM](#) and presented to stakeholders in 2022 that included:
 - Improvements to the unit-specific MSOC calculation to help ensure sellers are able to reflect their full costs of taking on a capacity commitment, including any opportunity costs
 - Clarifications around CPQR in the tariff
 - Improvements to the unit-specific review process
- 2 Move to a forward-looking E&AS offset calculation
- 3 Remove categorical exemptions for Existing Generation Capacity Resources that currently apply to intermittent and storage resources
- 4 Modify mitigation rules for Planned Generation Capacity Resources to enable up to unit-specific or default technology-specific Net CONE prices when triggered

Topics not included in CIFP Proposal

There are topics within the scope of the RASTF that are not included in our CIFP proposal, but continue to be important to PJM for further consideration and discussion with stakeholders beyond the timeline of the CIFP, including:

- **Seasonal capacity market construct**

We believe this is a good long-term objective but believe its scope is too large for the timeline we are on.

- **Locational accreditation**

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