Informational Posting:
Simulation Analysis of PJM CIFP-RA Filing

Market Implementation Committee

January 10, 2024

Purpose of This Document

- This document provides information regarding results of simulation analysis PJM has conducted comparing potential clearing results under the Status Quo RPM BRA design with those under the CIFP-RA filed changes
- The analysis analytically demonstrates (for one potential set of market conditions, as recently observed) the reliability benefits expected from the filed changes relative to status quo
- Further, this analysis is responsive to stakeholder requests for analysis to better understand potential clearing, pricing, and reliability outcomes under the filed changes, including LDA-level impacts and outcomes

Caveats:
- The simulation results are not intended to represent a forecast of future auction outcomes.
- The analysis and results may be different under different assumptions.

Overview of Market Design Comparison & Assumptions

Status Quo	CIFP Rerun
2024/2025 BRA based on current market rules	2024/2025 BRA offered costs, with updated accreditation and VRR curves reflecting proposed changes

- **Both cases** use the most recent 2024/2025 BRA information
  - Offers, load forecasts, resource mix in risk modeling, etc.
  - Energy Efficiency Resources shift the VRR curves by the cleared amount and remain as supply offers
- **Status Quo:** 2024/25 BRA parameters and results
- **CIFP Rerun**: Resource accreditation (MW UCAP) updated consistent with the proposed reforms, and resource offers ($/MW-day) translated to maintain the total cost ($) in 24/25 BRA offers
  - Example: An 8 MW UCAP resource offered at $50/MW-day, reflecting costs of $400/day; if now accredited at 5 MW UCAP, the offer would be adjusted to $80/MW-day corresponding to the same $400/day

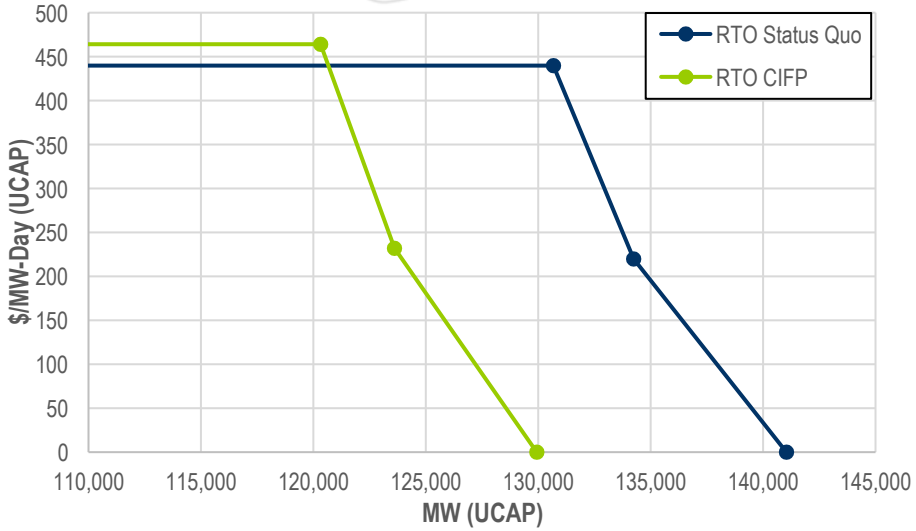
Updates to the Demand Curve

- Overview of updates to the Variable Resource Requirement (VRR) Curves in the CIFP Rerun provided in the table below
  - Additional details on proposed reforms described in ER24-99

	Status Quo	CIFP Rerun
FPR	1.0894	1.00365
CETO	Based on current 1-in-25 year LOLE requirement	Based on Normalized EUE requirement
VRR MW	VRR curve points based on Reliability Requirement and factors dependent on IRM	VRR curve points based on Reliability Requirement and Tariff-defined factors
VRR Price ($/MW-day, UCAP)	Net CONE converted to $/MW-day (UCAP) using pool-wide avg. EFORd	Net CONE converted to $/MW-day (UCAP) using ELCC class rating of Reference Resource

Updates to the Demand Curve (*cont'd*)

- **Reliability Requirements** decreased primarily due to changes in accreditation
- VRR curves (for RTO and LDAs):
  - Shift left (relative to Status Quo) due to the decrease in Accredited UCAP of supply
  - Scale up (relative to Status Quo) due to higher $ cost per MW UCAP for Reference Resource



	RTO	MAAC	EMAAC	SWMAAC	PS	PS NORTH	DPL SOUTH	PEPCO	ATSI	ATSI-Cleveland	COMED	BGE	PL	DAYTON	DEOK
Reliability Requirement Status Quo*	132,056	63,518	35,415	14,299	11,166	5,715	3,153	7,151	14,434	5,374	23,859	7,514	10,214	3,922	6,589
Reliability Requirement CIFP Rerun*	121,661	56,641	31,998	13,877	10,743	5,412	2,941	6,740	13,352	5,249	22,732	7,024	9,187	3,660	5,731
Delta	(10,395)	(6,877)	(3,417)	(422)	(423)	(303)	(212)	(411)	(1,082)	(125)	(1,127)	(490)	(1,027)	(262)	(858)

* Note: For comparison purposes, the data in the table excludes EE (i.e. no add-back to the Reliability Requirement)

Updates to the Supply Curve

- Assumed the same supply stack as used in the 2024/2025 BRA
  - Updated offers to reflect changes in accreditation
  - No changes to offers based on proposed changes to MSOC and Forward EAS
- No retirements or new entry are reflected in the supply curve

	Status Quo	CIFP Rerun
Offer MW (UCAP)	24/25 BRA Offered UCAP	24/25 BRA Offered ICAP MW × Proposed Accredited UCAP Factors
Offer Price ($/MW-day, UCAP)	24/25 BRA Offer Price	$\frac{\text{24/25 BRA Offer Price} \times \text{24/25 BRA Offered UCAP}}{\text{Proposed UCAP MW}}$

Summary of Auction Clearing Results

	Status Quo		CIFP Rerun			
LDA	Clearing Price	Cleared MW UCAP	Clearing Price	Cleared MW UCAP	Delta Price	Delta MW
RTO	**$28.92**	147,811	**$47.70**	136,539	$18.78	-11,272
MAAC	**$49.49**	70,498	$47.70	63,254	($1.79)	-7,245
EMAAC	**$54.95**	39,303	$47.70	35,740	($7.25)	-3,563
SWMAAC	$49.49	16,243	$47.70	15,418	($1.79)	-825
PSEG	$54.95	12,471	$47.70	12,039	($7.25)	-432
PS-NORTH	$54.95	6,366	$47.70	6,055	($7.25)	-311
DPL-SOUTH	**$90.64**	3,398	**$101.30**	3,172	$10.66	-226
PEPCO	$49.49	7,941	$47.70	7,511	($1.79)	-430
ATSI	$28.92	15,893	$47.70	14,716	$18.78	-1,177
ATSI-CLEVELAND	$28.92	5,756	$47.70	5,603	$18.78	-154
BGE	**$73.00**	8,243	**$76.30**	7,730	$3.30	-513
COMED	$28.92	26,388	$47.70	25,248	$18.78	-1,141
DAY	$28.92	4286	$47.70	3,996	$18.78	-290
DEOK	**$96.24**	7,059	$47.70	6,378	($48.54)	-681
PPL	$49.49	11,171	$47.70	10,084	($1.79)	-1,087

Note: Clearing Prices shown in red when the VRR curve binds for the respective LDA (CETL binds)

Preliminary Annual Zonal Costs

Zone	Base Residual Auction					CIFP Rerun				
	Base Zonal UCAP Obligation (MW)	Adjusted Preliminary Zonal Capacity Price ($/MW-day)	Base Zonal CTR Credit Rate ($/MW-UCAP Obligation-day)	Preliminary Zonal Net Load Price ($/MW-day)	Preliminary Zonal Annual Cost ($/year)	Base Zonal UCAP Obligation (MW)	Adjusted Preliminary Zonal Capacity Price ($/MW-day)	Base Zonal CTR Credit Rate ($/MW-UCAP Obligation-day)	Preliminary Zonal Net Load Price ($/MW-day)	Preliminary Zonal Annual Cost ($/year)
AE	2,918.7	$55.14	$0.65	$54.50	$58,056,997	2,696.1	$47.81	$0.00	$47.81	$47,050,047
AEP ***	13,441.3	$28.99	$0.00	$28.99	$142,241,507	12,416.3	$47.81	$0.00	$47.81	$216,675,902
APS	10,384.0	$28.99	$0.00	$28.99	$109,887,697	9,592.1	$47.81	$0.00	$47.81	$167,391,476
ATSI	14,616.7	$28.99	$0.00	$28.99	$154,679,647	13,502.0	$47.81	$0.00	$47.81	$235,622,870
BGE	7,556.5	$73.87	$14.04	$59.83	$165,020,181	6,980.3	$77.12	$18.18	$58.94	$150,166,855
COMED	24,122.2	$28.99	$0.00	$28.99	$255,271,630	22,282.7	$47.81	$0.00	$47.81	$388,854,223
DAYTON	3,831.2	$28.99	$0.00	$28.99	$40,543,217	3,539.0	$47.81	$0.00	$47.81	$61,759,316
DEOK ***	5,230.4	$96.31	$38.81	$57.50	$109,776,921	4,831.6	$47.81	$0.00	$47.81	$84,315,012
DLCO	3,258.1	$28.99	$0.00	$28.99	$34,479,116	3,009.7	$47.81	$0.00	$47.81	$52,521,895
DOM	3,805.6	$28.99	$0.00	$28.99	$40,271,987	3,515.4	$47.81	$0.00	$47.81	$61,346,151
DPL	4,607.4	$66.15	$0.07	$66.07	$111,117,775	4,256.1	$63.14	$0.12	$63.02	$97,899,417
EKPC ***	2,906.2	$28.99	$0.00	$28.99	$30,755,168	2,684.6	$47.81	$0.00	$47.81	$46,849,220
JCPL	6,794.9	$55.14	$0.65	$54.50	$135,159,786	6,276.8	$47.81	$0.00	$47.81	$109,535,020
METED	3,478.4	$49.68	$0.00	$49.68	$63,072,466	3,213.1	$47.81	$0.00	$47.81	$56,071,732
OVEC	85.2	$28.99	$0.00	$28.99	$901,246	78.7	$47.81	$0.00	$47.81	$1,372,865
PECO	9,892.5	$55.14	$0.65	$54.50	$196,774,257	9,138.1	$47.81	$0.00	$47.81	$159,468,083
PENLC	3,294.6	$49.68	$0.00	$49.68	$59,741,251	3,043.4	$47.81	$0.00	$47.81	$53,110,266
PEPCO	6,976.2	$49.68	$0.00	$49.68	$126,497,908	6,444.2	$47.81	$0.00	$47.81	$112,457,261
PL	8,552.9	$49.68	$0.00	$49.68	$155,088,994	7,900.7	$47.81	$0.00	$47.81	$137,874,877
PS	11,270.9	$55.14	$0.65	$54.50	$224,193,422	10,411.4	$47.81	$0.00	$47.81	$181,688,885
RECO	455.0	$55.14	$0.65	$54.50	$9,050,987	420.3	$47.81	$0.00	$47.81	$7,335,022
Total	**147,478.9**				**$2,222,582,158**	**136,232.7**				**$2,429,366,395**

Preliminary Annual Zonal Costs (cont'd)

- Delta values are calculated by subtracting CIFP Rerun values from the Status Quo values for each column
- The total UCAP obligation decreased by 11,246.2 MW from 147,479 MW in the status quo case, to 136,233 MW in the CIFP rerun, a 7.6% decrease.
- The total preliminary zonal annual cost increases by $207 million from $2.2 billion in the status quo case, to $2.4 billion in the CIFP rerun, a 9.3% increase

Zone	CIFP Rerun - Status Quo				
	Delta Base Zonal UCAP Obligation (MW)	Delta Adjusted Preliminary Zonal Capacity Price ($/MW-day)	Delta Base Zonal CTR Credit Rate ($/MW-UCAP Obligation-day)	Delta Preliminary Zonal Net Load Price ($/MW-day)	Delta Preliminary Zonal Annual Cost ($/year)
AE	(222.6)	-$7.33	-$0.65	-$6.69	-$11,006,950
AEP ***	(1,025.0)	$18.82	$0.00	$18.82	$74,434,395
APS	(791.8)	$18.82	$0.00	$18.82	$57,503,780
ATSI	(1,114.6)	$18.82	$0.00	$18.82	$80,943,223
BGE	(576.2)	$3.24	$4.13	-$0.89	-$14,853,326
COMED	(1,839.5)	$18.82	$0.00	$18.82	$133,582,594
DAYTON	(292.2)	$18.82	$0.00	$18.82	$21,216,099
DEOK ***	(398.9)	-$48.50	-$38.81	-$9.69	-$25,461,909
DLCO	(248.5)	$18.82	$0.00	$18.82	$18,042,779
DOM	(290.2)	$18.82	$0.00	$18.82	$21,074,165
DPL	(351.3)	-$3.01	$0.05	-$3.05	-$13,218,358
EKPC ***	(221.6)	$18.82	$0.00	$18.82	$16,094,053
JCPL	(518.2)	-$7.33	-$0.65	-$6.69	-$25,624,767
METED	(265.2)	-$1.87	$0.00	-$1.87	-$7,000,734
OVEC	(6.5)	$18.82	$0.00	$18.82	$471,619
PECO	(754.4)	-$7.33	-$0.65	-$6.69	-$37,306,173
PENLC	(251.2)	-$1.87	$0.00	-$1.87	-$6,630,986
PEPCO	(532.0)	-$1.87	$0.00	-$1.87	-$14,040,647
PL	(652.2)	-$1.87	$0.00	-$1.87	-$17,214,117
PS	(859.5)	-$7.33	-$0.65	-$6.69	-$42,504,537
RECO	(34.7)	-$7.33	-$0.65	-$6.69	-$1,715,965
Total	**(11,246.2)**				**$206,784,237**

Notable changes

	Status Quo	CIFP Rerun	MW Delta	Percent Delta
Reliability Requirement	132,056	121,661	-10,395	-7.9%
Offered UCAP MW*	148,946	136,782	-12,164	-8.2%
Cleared UCAP MW*	140,143	128,628	-11,515	-8.2%
Cleared UCAP MW w/ Status Quo cleared MW translated to CIFP accredited UCAP values*	127,398	128,628	+1,229.6	+1.0%

* For comparison purposes, the data in the table above excludes EE (i.e. no add-back to the Rel. Req. and not included in supply)

- The last row in the table above converts the cleared Status Quo resources for the actual 2024/2025 BRA into the proposed new accredited UCAP values (i.e. the cleared set of resources under status quo had an original total UCAP value of 140,143 MW and that same set of resources is accredited at 127,398 MW under the proposed accreditation and risk modeling).
- Comparing the updated Status Quo cleared UCAP value (127,398) to the amount cleared in the CIFP Rerun case (128,628) shows an increase of 1,229.6 MW UCAP, or a 1.0% increase, in the CIFP Rerun case. In other words, when assessing the total resource adequacy value of both the status quo and CIFP Rerun cases under the enhanced risk modeling, the resources procured under status quo are shown to provide less resource adequacy value than the resources procured in the CIFP Rerun case.

Auction Results and Reliability

- **Status Quo** 2024/2025 RPM BRA RTO *actual clearing results without EE*: **140,143 UCAP MW** at **28.92 $/MW-day**
- Under the enhanced risk modeling of Status Quo BRA clearing outcomes, we expect ~0.015 LOLE with an EUE of **~83 MWh/year**

- **CIFP Rerun** auction results: **128,628 UCAP MW** at **$47.70 $/MW-day**
- Under the filed changes of resources cleared in the 2024/2025 CIFP Rerun simulation, we expect ~0.009 LOLE with an EUE of **~43 MWh/year**

- **Key Takeaway:** Risk modeling and accreditation improvements improve reliability, even at excess reserve margins, and correctly value resources by enabling the market to identify and procure the low-hanging fruit of reliability beyond the margin.

Informational Posting: Simulation Analysis of Proposed Capacity Changes

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Acronyms

Acronym	Term & Definition
BRA	**Base Residual Auction**
CETO	**Capacity Emergency Transfer Objective** is the amount of electric energy that a given area must be able to import in order to remain within a loss of load expectation of one event in 25 years when the area is experiencing a localized capacity emergency.
CIFP	**Critical Issue Fast Path – Resource Adequacy**
EE	**Energy Efficiency**
EUE	**Expected Unserved Energy**
ELCC	**Effective Load Carrying Capability**
FPR	**Forecast Pool Requirement** is the PJM installed reserve margin expressed in unforced capacity terms. The FPR is applied to a peak load forecast in order to establish the level of unforced capacity (UCAP) that will provide an acceptable level of reliability.
FRR	**Fixed Resource Requirement** is defined as an alternative method for an eligible load-serving entity to meet a fixed resource requirement with its own capacity resources as opposed to having PJM procure capacity resources on the load-serving entity's behalf in RPM auctions.
ICAP	**Installed Capacity** is defined as a MW value based on the summer net dependable capability of a unit and within the capacity interconnection right limits of the bus to which it is connected.

PJM Glossary

Acronyms (cont'd)

Acronym	Term & Definition
IRM	**Installed Reserve Margin** is the Percentage value used to establish the level of installed capacity resources that provide an acceptable level of reliability.
LOLE	**Loss of Load Expectation** defines the adequacy of capacity for the entire PJM footprint based on load exceeding available capacity, on average, only once in 10 years.
RPM	**Reliability Pricing Model**
UCAP	**Unforced Capacity** is defined as the MW value of a capacity resource in the PJM Capacity Market.
VRR	**Variable Resource Requirement**

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