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PJM Five Coincident Peaks (5CP) and Capacity Charges: A Data Science Approach

Introduction

With rising electricity rates, strategic and optimized electrical usage at the Central Utility Plant (CUP) has become increasingly important for reducing operational costs. One of the major contributors to these costs that the CUP can actively manage is PJM capacity charges. By integrating PJM forecasting with CUP operations, the plant can strategically reduce its peak load contribution (PLC) during critical grid events and lessen the impact of rising capacity prices.

PJM Capacity Charges

PJM Interconnection is the regional transmission organization (RTO) responsible for coordinating and ensuring the reliable operation of the bulk electric grid across 13 states and the District of Columbia. PJM conducts Base Residual Auctions (BRAs), where electrical generators commit capacity resources to meet projected system peak demand. The BRA establishes capacity clearing prices (in $/MW-day) three years in advance. For example, the 2024 BRA establishes the clearing prices for the 2027/2028 delivery year.

In recent years, rapid load growth from data centers and uncertainty in future load forecasting have caused BRA clearing prices to increase dramatically, rising from $49.49/MW-day in 2024/2025 to $269.92/MW-day and $329.17/MW-day for the 2025/2026 and 2026/2027 delivery years, respectively. These prices are expected to substantially rise again once a price cap agreement expires after the 2027/2028 delivery year.

PJM passes these costs to customers through the capacity charge, which is based on the customer's Peak Load Contribution (PLC) rather than monthly electrical consumption. The PLC represents the customer's average electrical demand during the five highest coincident peak load hours across the entire PJM system during the summer season (June through September), referred to as the Five Coincident Peaks (5CP).

$$PLC = \frac{1}{5}\sum_{i=1}^{5} P_i$$

Where:

$P_i = campus\ electrical\ demand\ during\ the\ i^{th}\ PJM\ CP\ event$

Customers that reduce their electrical usage during these five system-wide peak events will lower their PLC value and reduce future capacity charges.

$$Capacity\ Charge = PLC[MW] \times ClearingPrice\left[\frac{\$}{MWday}\right] \times Days$$

CP Forecasting and Tracking

Reducing the electrical capacity charge requires strategic planning throughout the CP season, as cost savings are only realized if electrical demand is reduced during the season's five CP events, thereby lowering the PLC. This requires advance identification of potential CP events with sufficient time to execute electrical load reduction strategies, such as Thermal Energy Storage System (TESS) discharges.

To support this effort, DSAIAB developed a CP forecasting and tracking tool in Databricks using historical, real-time, and 7-day forecasted PJM load data retrieved through the PJM API. An initial threshold is established using the upper-tail (90th percentile) distribution of the previous season's PJM daily peak loads, and any forecasted or historical daily peak exceeding this threshold is identified as a potential CP candidate. A rolling CP register stores the five highest PJM daily peak loads observed during the season. Once populated, any new daily peak exceeding the current minimum value in the register replaces it, ensuring only the five highest seasonal peaks are retained.

Throughout the season, the 7-day PJM forecaster is continuously evaluated, and any forecasted daily peak exceeding the minimum value currently stored in the CP register is flagged and communicated to the CUP as a potential CP event requiring operational review and possible load-shedding action.

CP Register: $\boldsymbol{S = \{x_{(1)}, x_{(2)}, x_{(3)}, x_{(4)}, x_{(5)}\}}$

Daily Peak: $\boldsymbol{x_i = PJM\ daily\ peak\ [MW]}$

Alert Logic:
$$\boldsymbol{A = \begin{cases} 1, & |S| < 5 \ \wedge \ x > Initial\ Threshold \\ 1, & |S| = 5 \ \wedge x > \min(S) \\ 0, & otherwise \end{cases}}$$

Conclusion

The CP forecasting and tracking program reduced the CUP's PLC by approximately 25% since the 2025/2026 BRA clearing price increase, resulting in over $1.5 million in avoided electrical costs. These results demonstrate the value of integrating PJM forecasting with operational load reduction strategies to mitigate rising capacity charges.

Further Reading

1. Monitoring Analytics. (2024). *Analysis of the 2027/2028 RPM Base Residual Auction: Part A*. Monitoring Analytics, LLC.