BACKGROUND

- In January and February of 2019, PJM staff worked with state Public Utility Commission staff that supports the Organization of PJM States, Inc. ("OPSI") to construct a simulation of PJM's Reserve Price Formation proposal ("proposal", "final proposal")[1].

- Specifically, OPSI desired additional simulations that would evaluate PJM's proposal under higher demand scenarios than PJM had previously tested.

- Previous versions of PJM's simulations[2,3], one on PJM's proposal as of September 2018 and the other based on PJM's proposal as of December 2018, evaluated the respective PJM proposals based on actual, realized system conditions from Delivery Year June 1, 2017 – May 31, 2018.

- Simultaneously to the OPSI simulation request, PJM simulated its final proposal based on actual, realized system conditions. Because calendar year 2018 data was available – which represented a more current snapshot of the system[4] itself – PJM elected to use the calendar year January 1, 2018 – December 31, 2018 for simulation of its final proposal.

- To ensure PJM was able to provide the simulation within a reasonable time frame, PJM isolated the 11 days of differential between the PJM final proposal simulation and the OPSI simulation. For an annual effect, the analyst can incorporate the 11-days of escalated load under the OPSI scenario into the simulation results of the PJM final proposal.

- Detailed results of the OPSI simulation request are in the accompanying XLSX spreadsheet. The OPSI simulation results, this memo, and the PJM final proposal results will be posted publically on PJM's website[5].

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[1] PJM Final Proposal - PJM Reserve Market Proposal Draft Operating Agreement Language Posted for the 3/14/19 Stakeholder Meeting; 3/14/19; https://www.pjm.com/-/media/committees-groups/task-forces/epfstf/20190314-pf/20190314-pjm-proposed-tariff-reserve-market-filing.ashx

[2] PJM Proposal Iteration #1, Fall 2018 - Original Simulation Data & Simulation Results Presentation – 9/26/18 EPFSTF meeting; Simulation Data with Synch. Reserve Market Clearing Prices – 10/12/18 EPFSTF meeting; Simulation Results with Hourly Data & Simulation Results with Hourly Data Presentation – 11/1/2018 EPFSTF meeting.

[3] PJM Proposal Iteration #2, Winter 2018 - Simulation Results Data - Price Formation Proposal & Simulation Results - Summary Price Formation Proposal – 12/14/18 EPFSTF meeting.

[4] As of June 1, 2018 PJM saw approximately 5,400 megawatts of capacity added to the system and 4,800 megawatts of capacity deactivate from the system. The changes, therefore would not be captured in a Delivery Year 2017/18 simulation cycle. (PJM New Service Queue/Generation Interconnection: https://www.pjm.com/planning/services-requests/interconnection-queues.aspx; PJM Generation Deactivation: https://www.pjm.com/planning/services-requests/gen-deactivations.aspx)

[5] For example: One-Time Data Requests, https://www.pjm.com/markets-and-operations/form-data-request/one-time-data-requests.aspx; and/or, PJM Energy Price Formation Senior Task Force, https://www.pjm.com/committees-and-groups/task-forces/epfstf.aspx

SIMULATION SCENARIO

- TIMELINE: PJM Final Proposal Simulation - January 1, 2018 – December 31, 2018;
  OPSI Simulation (to demonstrate proposal performance under escalated demand) August 27, 2018 – September 6, 2018; (+ January 2019).

- PERIODS OF ESCALATED DEMAND:

  - In 2018, the PJM system demand peak was realized during August 27 – September 6. Those 11 days saw demand escalated, at OPSI's request, resulting in the following simulation schedule:

    - August 27 – August 30 escalated by 4%;

    - August 31 – September 3 escalated by 6%; and,

    - September 4 – September 6 escalated by 8%

- BASE CASE: The 'Base Case' (or "Escalated Base Case") represents the 11-day period, with the above noted escalated load schedule, run against PJM's ***current*** reserve market design. It is important to note that a separate Base Case was required for the OPSI simulation to reflect how the current market design would similarly respond to the same escalated load conditions by which the PJM final proposal is being compared.

- ISOLATED DATES: The simulations for the PJM final proposal identically covered 354 days of calendar year 2018 (and January 2019) of OPSI's request. To ensure PJM was able to provide the simulation within a reasonable time frame, PJM isolated the 11 days of differential between the PJM final proposal simulation and the OPSI simulation. For an annual effect, the analyst can incorporate the 11-days of escalated load under the OPSI scenario into the simulation results of the PJM final proposal.

SCENARIO COMMENTARY

- For perspective, under the requested scenario, PJM would experience a system peak of approximately 160,500 megawatts. This would represent the largest all-time system peak operated under a single wholesale electricity market design[6].

- Of the 11 total days of escalated load conditions, PJM would experience 15-hours, over three days, where system demand would reach a top-10 all-time peak. Those demand levels would range from about 155,200 megawatts to 160,500 megawatts.

[6] This peak would rank as PJM's fourth all-time highest peak when accounting for the coincident peak load for transmission zones that had not yet integrated into the PJM system. Those transmission zones include: American Transmission System, Inc. (FirstEnergy Ohio operating companies); Duke Energy Ohio Kentucky; and East Kentucky Power Cooperative. These systems integrated in 2011, 2012 and 2013, respectively. Top 10 All-time Summer/Winter Peak Load Days; 2/19/19; https://www.pjm.com/-/media/markets-ops/ops-analysis/top-10-all-time-summer-winter-peak-load-days.ashx?la=en

RESULTS COMMENTARY

IMPACT ON LMPs

- Relative to the ‘Escalated Base Case’, the PJM final proposal resulted in lower overall average PJM-wide daily generation-weighted locational marginal prices (LMPs).

- Daily PJM average generation-weighted LMPs decreased in each of the 11 days of escalated demand. Decreases ranged from $0.17/megawatt-hour (MWh) to $130/MWh. The weighted average decrease is approximately $15/MWh.

- This reflects the change in commitment and dispatch realized under PJM final proposal. For instance, while 2,633 more megawatt-hours were committed for energy and reserves on the highest priced day of September 5, PJM, daily generation-weighted average LMPs dropped by $130/MWh.

- Put another way, under the ‘Escalated Base Case’ LMPs averaged $522/MWh and saw 3,229,149 MWh of energy produced. This results in a production cost of $1.6 billion. Conversely, under the PJM final proposal, LMPs averaged $392/MWh and saw 3,231,782 MWh of energy produced. This results in a production cost of $1.2 billion.

- Generation-weighted zonal daily average LMPs also reflect reductions over this term. The most marked decrease occurs on September 5, where all 19 transmission zones saw an average decrease of roughly 25 percent over the escalated base case. In pricing terms, generation-weighted zonal daily average LMPs decreased under the PJM final proposal between $89/megawatt-hour to $199/megawatt-hour over the escalated base case.

IMPACT ON TOTAL SYSTEM PRODUCTION COST

- The PJM final proposal results in lower overall bid production costs during the 11-day escalated period. The ‘Escalated Base Case’ resulted in total generator LMP payments of $5,258,907,244. Under the PJM final proposal case, total generator LMP payments were $4,709,078,404. Given the elevated demand scenario, PJM’s final proposal results in an overall decrease of $549,828,839; reflecting a -10.5 percent change in generator payments.

- This energy market system savings occurs in conjunction with a 20 percent reduction in uplift[7] and a relatively modest $44,483,670 uptick in total reserve market revenue[8] compared to the Escalated Base Case scenario.

[7] Uplift in both the Escalated Base Case and the OPSI simulation request are relatively low. This is due to extreme load conditions where most resources are called upon, thus limiting any out-of-market action options.

[8] The increase in synchronized reserve revenue is: $34,759,077; the increase in non-synchronized reserve revenue is: $5,568,449; and, the added cost of real-time thirty-minute reserve revenue (a product which does not presently exist) is: $4,156,143.

CONCLUSION

- By carrying additional reserves under extreme conditions, the PJM final proposal moderates peak pricing.
- For completeness, the simulation of PJM's final proposal – which assesses all 365 days of calendar year 2018 (and January 2019 dates) – reflects the total system costs for all load conditions.