

LMP Verification and Transparency

Vijay Shah

Sr. Engineer, Real-Time Market Operations

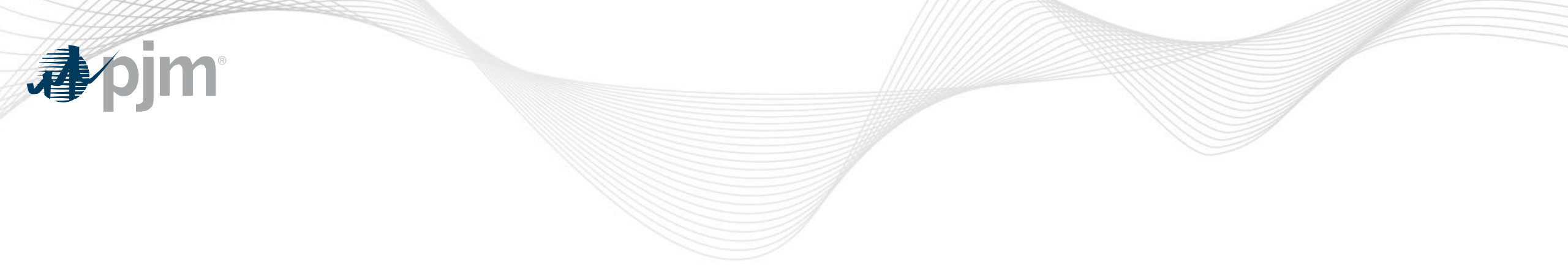
Markets Implementation Committee

February 5, 2020

- Identify and implement efficiencies in the current price verification process
- Utilize the current Five Minute Dispatch and Pricing special sessions to inform stakeholders of the areas in need of greater transparency
- Minimize Market Operator discretion with the proposed changes
- PJM is seeking stakeholder feedback on the LMP posting process as it applies to Real Time LMP and next day LMPs postings

- Market Operators perform verification during and after the operating day is complete
 - May rerun LPC cases to correct any issues identified during the verification process
- Verified prices are posted the next business day to DataMiner2 and used in settlements
- Goal is to post verified prices by 10:30 AM the next business day; otherwise notify market participants of any delays

- Does the timing of when verified LMPs for the previous day are posted impact your business?
- Do you value accuracy or timeliness or both?
 - Accuracy: Accept the posted prices in Real-Time as near finalized
 - Timeliness: Consistently posting by 10 AM with best available information

A decorative graphic at the top of the page consists of multiple thin, grey, wavy lines that create a sense of motion and depth, flowing across the top of the slide.

Appendix

Education and Potential Changes

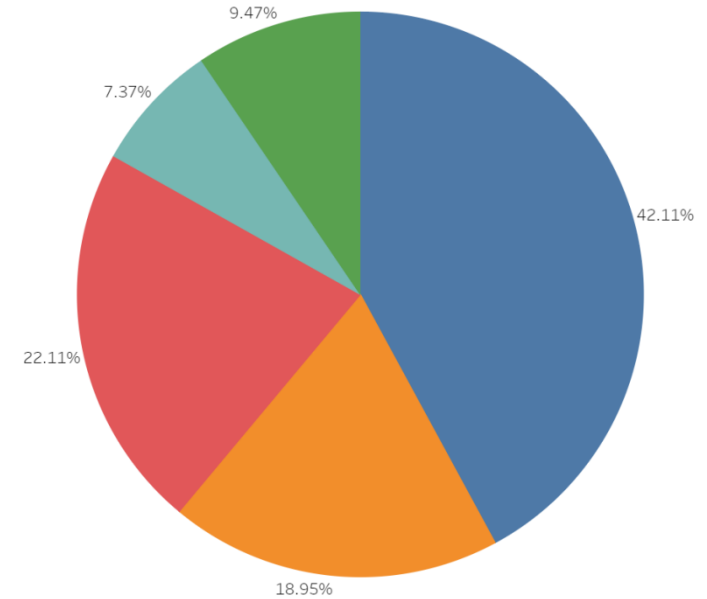
- Reproduce prices for Off SCED period
- Output Consistency Check (OCC)
- Logic for De-energized pnodes
- Language Clarifications for Price Repostings
 - Section 1.10.8 (E) of Attachment K of Operating Agreement

- Time period where Dispatchers are unable to dispatch the system using RTSCED application due to scheduled or unscheduled events
- During such periods:
 - Dispatchers decide when to go Off SCED and come back On SCED control
 - An all-call is made to notify GOs and TOs that PJM is manually controlling the system
 - EMS system is used to send zonal dispatch rates (drates) via AGC to manage generation
 - Drates are calculated in the EMS system based on current total generation output and anticipated required total generation
 - Transmission constraints are manually controlled
 - M2M constraint coordination is suspended
 - CTS coordination is suspended
 - Current regulation assignments may be carried forward

- Loss or degradation of PJM systems:
 - EMS capabilities
 - Telemetry (ICCP)
 - State Estimator
 - Dispatch tools and systems
- Miscellaneous/other
- Information Technology Impacts
 - Data transfer failures
 - Loss of internet
 - Network loss or degradations
 - Servers or database outages
 - System upgrades
 - Security patching
 - Code releases

- LMPs and Ancillary Services prices may need to be calculated for the impacted intervals
 - Use an approved RT SCED case closest to the event as reference case
 - Modify case input data to reflect the zonal dispatch rates communicated during the Off SCED period
 - Manually controlled constraints are reflected in the formation of LMPs
- During Off SCED periods, prices posted to the Operational Data page may be stale
 - May not reflect the current state of the system

Year	Number of Events	Total Number of 5 minute intervals	% of 5 minute intervals per year
2013	15	270	0.26%
2014	11	100	0.10%
2015	15	115	0.11%
2016	15	486	0.46%
2017	20	124	0.12%
2018	16	241	0.23%
2019	6	63	0.06%



Man Disp Duration (# of Events)

- < 30 Minutes (40)
- 30 to 59 Minutes (18)
- 60 to 89 Minutes (21)
- 90 to 119 Minutes (7)
- > 120 Minutes (9)

- Very small number of Off SCED events over the past 6 years
- Average of 0.5% intervals per year over the past 6 years
- 90% of the total events are less than 2 hours long
 - 61% of the total events are less than 1 hour

- Overall process to calculate prices for the impacted LPC intervals is manual and cumbersome
 - Time consuming
 - Lack of Transparency
- EMS dispatch rates sent out during Off SCED control may not align with LMPs calculated through the optimization engine
- Depending on the severity/duration of the event, it may cause delays in posting verified prices the next business day

- Create an automated and transparent process to calculate prices for the pricing intervals impacted by the Off SCED event
- Carry the latest approved pricing case prior to the Off SCED event for the duration of the Off SCED period
 - Continue binding constraints based on the latest approved pricing case
 - LPC case may be adjusted for system conditions
 - I.E Shortage, Voltage Reduction and Manual Load Dump actions
- Provide member visibility for pricing intervals where Off SCED control occurred

- Reasonability check of the LPC solution performed automatically in real-time for every LPC case.
- If the solution passes the OCC check, data is posted for market participants
- If the solution fails the OCC check, no data is posted for the given interval
- OCC check failures will be further investigated to determine if prices need to be revised
- Predefined thresholds established to prevent posting intervals with suspect LMPs
 - Balance between posting suspect prices versus accurate prices

- Price bounding thresholds:
 - Total LMP: Maximum (\$6000) and minimum (-\$2000)
 - SRMCP: Maximum (\$1701) and minimum (\$0)
 - PRMCP: Maximum (\$851) and minimum (\$0)
 - Reg MCP: Maximum (\$6000) and minimum (\$0)
 - Price differences between RTSCED and LPC cases (\$0.01)
 - Energy LMP, SRMCP, and PRMCP
 - Maximum (45%) and minimum (-30%) Loss Percentage LMP

- Thresholds are predefined based on historical prices
 - Default values are subject to review at PJM discretion
- Post prices for **all** approved pricing intervals in Real Time
 - Any solution outside of the pre-defined thresholds will be posted with an indicator to notify stakeholders the solution is subject to additional review

- Required to produce LMPs for all pricing nodes (pnodes) in the PJM network model for all intervals, including de-energized pnodes
- Automated dead bus replacement logic in LPC is used to find the closest suitable live pnode for a given de-energized pnode
 - Same station, same voltage level
 - Same station, different voltage level
 - Nearest neighboring station
 - If the automated process cannot find a suitable replacement the pnode is manually replaced as part of the LMP verification process
 - PJM Operators will review de-energized pnodes that are replaced by the engine to determine if a more optimal bus should be used

- PJM is currently investigating improvements the Market Clearing Engine's ability to find suitable replacement for de-energized pnodes
- The logic will continue to be automated as part of case execution
 - Based on Dijkstra algorithm to find a suitable replacement through least resistant path
 - Offers a more robust way to find a suitable replacement for de-energized pnodes
 - Help minimize operator intervention and manual bus replacements
 - Implemented in both the Day Ahead and Real Time Market Clearing Engines

- Clarify the language in the Operating Agreement (OA) for correcting prices that are posted.
 - Section 1.10.8 – Attached K
 - Not all supported information can be posted due to confidentiality reasons