Markets Report

MC Webinar
October 23, 2023
• PJM Wholesale Cost in 2023 is $50.00/MWh, down from full-year 2022 costs of $102.56/MWh. (Slides 5 & 6)

• Slides pertaining to weather conditions, in addition to slides showing average fuel prices, generation on-line fuel mixes, and System Marginal Prices have been combined into a Market Conditions section. (Slides 8-22)

• In September, temperatures were slightly below average for most of the month. Thus, the sum of Heating and Cooling Degree Days was also below its historic average. (Slides 8-10)

• Energy use was also below its historic average for September. (Slides 8-10)

• In September, uplift exceeded $800,000 on nine days. (Slides 26 & 27)
Executive Summary

- Load-weighted average LMP for 2023 is $30.87/MWh: (Slides 35-37)
  - September 2023 was $31.60/MWh, which is much lower than September 2022 ($78.30/MWh) and also lower than September 2021 ($49.60/MWh).
- There was one 5-minute intervals that experienced shortage pricing in September. (Slide 34, Report Appendix)
- FTR revenue adequacy for the month of September is 98% and the 2023-2024 Planning Year is currently funded at 100%. (Slides 52-55)
- Congestion values have been trending lower in 2023 as compared to 2022. (Slide 53)
- Regulation and Synchronized Reserve market costs have generally tracked with energy prices over time. (Slides 69-71)
Markets Report
PJM Wholesale Cost

<table>
<thead>
<tr>
<th>Year</th>
<th>Energy</th>
<th>Reliability Capacity</th>
<th>Transmission</th>
<th>Other</th>
<th>Total</th>
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<tbody>
<tr>
<td>2019</td>
<td>$27.15</td>
<td>$11.05</td>
<td>$9.52</td>
<td>$48.98</td>
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<tr>
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<td>$21.65</td>
<td>$9.45</td>
<td>$11.03</td>
<td>$43.41</td>
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<tr>
<td>2021</td>
<td>$39.79</td>
<td>$11.04</td>
<td>$11.72</td>
<td>$64.07</td>
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<td>2022</td>
<td>$80.17</td>
<td>$8.00</td>
<td>$12.50</td>
<td>$102.56</td>
<td></td>
</tr>
<tr>
<td>2023</td>
<td>$30.67</td>
<td></td>
<td>$13.53</td>
<td>$50.00</td>
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PJM Wholesale Cost - Other

<table>
<thead>
<tr>
<th>Year</th>
<th>Regulation</th>
<th>Operating Reserve</th>
<th>PJM Cost</th>
<th>Reactive</th>
<th>Transmission Owner Control</th>
<th>Synchronized Reserve</th>
<th>Black Start</th>
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<tbody>
<tr>
<td>2019</td>
<td>$0.44</td>
<td>$0.38</td>
<td>$0.38</td>
<td>$0.23</td>
<td>$0.38</td>
<td>$0.44</td>
<td>$0.18</td>
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<td>2020</td>
<td>$0.47</td>
<td>$0.38</td>
<td>$0.38</td>
<td>$0.23</td>
<td>$0.38</td>
<td>$0.47</td>
<td>$0.18</td>
</tr>
<tr>
<td>2021</td>
<td>$0.47</td>
<td>$0.38</td>
<td>$0.38</td>
<td>$0.23</td>
<td>$0.38</td>
<td>$0.47</td>
<td>$0.18</td>
</tr>
<tr>
<td>2022</td>
<td>$0.40</td>
<td>$0.37</td>
<td>$0.40</td>
<td>$0.20</td>
<td>$0.37</td>
<td>$0.40</td>
<td>$0.17</td>
</tr>
<tr>
<td>2023</td>
<td>$0.49</td>
<td>$0.20</td>
<td>$0.40</td>
<td>$0.17</td>
<td>$0.20</td>
<td>$0.49</td>
<td>$0.17</td>
</tr>
</tbody>
</table>
Market Conditions
The weather parameter shown in the following slide is a monthly sum of daily Heating Degree Days (HDD) and Cooling Degree Days (CDD).

Degree days represent a deviation from a baseline temperature, in this case 60 degrees for HDD and 65 degrees for CDD. As temperatures get more extreme, colder or hotter, either HDDs or CDDs, respectively, will increase.

Typically, winter months will only record HDDs, while summer months will only record CDDs. Shoulder months may have both HDDs and CDDs.

Degree Days are calculated using a daily load weighting that weights values from stations in each TO zone according to the zonal contribution to the RTO peak on that day.

Average values use data from 1998 to the most recent complete year, in this case, 2022. Averages include load data for all of TO zones in the current RTO footprint.
Historic Average Weather and Energy versus Current Month
Historic Average Weather and Energy versus Current Month - Daily

- Daily Energy as a Percent of the Historic Average for September
- Daily HDD + CDD as a Percent of the Historic Average for September
- Daily Temperature as a Percent of the Historic Average for September
Average Fuel Prices - Daily

Fuel Price Source: S&P Global Platts

- Average Gas: $1.76
- Average Coal: $2.51
- Average Oil: $20.81
- Average LMP: $30.80
Daily Difference Between Day-Ahead and Real-Time System Marginal Prices

Positive values represent days when the DA daily average price was higher than RT. Negative values represent days when the DA price was lower.

Average price difference for September = $-0.37
Load Forecast Error - Monthly Absolute Error, 10:00 Forecast

- All Hours
- Peak Hours Only
- Winter
- Summer
- 25-month Average
- 25-month Average

<table>
<thead>
<tr>
<th>Month</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep</td>
<td>1.5%</td>
<td>1.5%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Oct</td>
<td>1.0%</td>
<td>1.0%</td>
<td>1.0%</td>
</tr>
<tr>
<td>Nov</td>
<td>1.5%</td>
<td>1.5%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Dec</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Jan</td>
<td>1.5%</td>
<td>1.5%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Feb</td>
<td>1.5%</td>
<td>1.5%</td>
<td>1.5%</td>
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<tr>
<td>Mar</td>
<td>1.5%</td>
<td>1.5%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Apr</td>
<td>1.5%</td>
<td>1.5%</td>
<td>1.5%</td>
</tr>
<tr>
<td>May</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Jun</td>
<td>1.5%</td>
<td>1.5%</td>
<td>1.5%</td>
</tr>
<tr>
<td>Jul</td>
<td>2.0%</td>
<td>2.0%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Aug</td>
<td>1.5%</td>
<td>1.5%</td>
<td>1.5%</td>
</tr>
</tbody>
</table>
Load Forecast Error - September Daily Peaks, 10:00 Forecast
• PJM prepares a day-ahead load forecast at 10:00 am for use by our members.
• This forecast is not used to clear the day-ahead market and is not utilized for the reliability tools that run subsequent to the day-ahead market.

Load was under forecast on 9/9 and 9/13 due to temperatures coming in several degrees warmer than forecast; on 9/9, the traditional evening peak forecast was over forecast; however the true peak of the day occurred much earlier due to severe thunderstorm impact, leading to under forecasting.

On 9/5 and 9/6, temperatures in the Midwest came in several degrees below forecast, leading to over forecasting at peak. Some model error played a role in over forecasting these days as well, but model error played the majority of the role in the over forecasting error seen on 9/21 and 9/22.
Monthly Generation by Fuel

'Mother' includes Hydro, Oil, Solar, Wind, and Other
'Other' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Daily Generation by Fuel - September

MWh

- Coal
- Natural Gas
- Nuclear
- Other

‘Other’ includes Hydro, Oil, Solar, Wind, and Other
Daily Generation by Fuel, Other - September

'Mother' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
'Renewable' includes Wind, Solar, Hydro, and Other Renewables. 'Clean' includes Renewable and Nuclear.
Operating Reserve

(Uplift)
• In September, uplift exceeded $800,000 on 9 days -

• Contributing factors to uplift were:

  The higher uplift numbers continue to come from a combination of steam that was needed to help support the north to south flows, coupled with a conservative approach to higher load days stemming from the unseasonal Hot Weather in the early part of the month. This was then compounded by needs for steam to support outages on subsequent days.

• More information on Uplift can be found on the PJM website at Drivers of Uplift
Uplift as a Percent of Energy Costs
Percent of Total CT, CC and Steam Hours with LMP < Offer

- CT
- CC & Steam
Beginning in December 2008, the daily Balancing Operating Reserves (BOR) rate was replaced with six different BOR rates: RTO BOR for Reliability Rate, RTO BOR for Deviations Rate, East BOR for Reliability Rate, East BOR for Deviations Rate, West BOR for Reliability Rate, West BOR for Deviations Rate.

Reliability rates are charged to all real-time load and exports, whereas deviation rates, as before, are charged only to real-time deviations. RTO rates are charged to the whole footprint, whereas East and West rate adders are charged based on location.
Reliability Balancing Operating Reserve Rates
Deviations Balancing Operating Reserve Rates

- RTO
- East
- West

$/MWh

SEP21 DEC21 MAR22 JUN22 SEP22 DEC22 MAR23 JUN23 SEP23
Energy Market

LMP Summary
Information on constraints and shadow prices can be found here
Monthly Load-Weighted Average Real-time LMP

$/MWh

SEP21 | OCT21 | NOV21 | DEC21 | JAN22 | FEB22 | MAR22 | APR22 | MAY22 | JUN22 | JUL22 | AUG22 | SEP22 | OCT22 | NOV22 | DEC22

$50 | $58 | $63 | $39 | $47 | $44 | $64 | $83 | $98 | $93 | $114 | $78 | $56 | $53 | $142

$36 | $26 | $28 | $29 | $28 | $27 | $37 | $31 | $32
Fuel Cost Adjusted LMP (Referenced to 1999 Fuel Prices)
LMP Price Posting Suspensions and Reruns

- Percentage of Intervals Price Posting Suspended
- Percentage of Intervals Rerun prior to Final LMP Posting

Percentage of 5-Minute Intervals

<table>
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<tr>
<th>Month</th>
<th>Price Posting Suspended (%)</th>
<th>Rerun (%)</th>
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<td>SEP21</td>
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<tr>
<td>NOV21</td>
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<td>SEP23</td>
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Energy Market

Demand Response Summary
Demand Side Response Estimated Revenue

$ Millions

- Capacity
- Ancillary Services
- Emergency Energy
- Economic Energy
- Economic Energy Incentives
- Capacity Bonus Payment
- Test Emergency Energy

Year: 2014-2023

- Capacity
- Ancillary Services
- Emergency Energy
- Economic Energy
- Economic Energy Incentives
- Capacity Bonus Payment
- Test Emergency Energy

$ Millions

2014: $600
2015: $900
2016: $900
2017: $600
2018: $300
2019: $300
2020: $300
2021: $300
2022: $300
2023: $300
Economic Demand Response Activity

*Data for the last few months are subject to significant change due to the settlement window.
Total Registered MW in PJM's Economic Demand Response
Energy Market
Virtual Activity Summary
The following six charts depict trends in submitted and cleared virtual and up-to-congestion transactions, in terms of number and volume, into the PJM Energy Market. The first two of these charts show the submitted and cleared increment and decrement bids (virtual transactions or virtuals) and they are the same as what was previously being presented in this report. The two charts after them display the trends in submitted and cleared up-to-congestion transactions into the PJM Energy Market. The last two of these six charts combine the virtual and up-to-congestion transactions and show the sum of these two categories.

To clarify what a bid or transaction is, please consider the following example: An offer (increment, decrement or up-to-congestion) of 10 MW, valid for eight hours for a given day, is captured in the charts as eight submitted bids/transactions and 80 submitted MWh. If this offer fully clears for three of the hours it was submitted for, it shows in the charts as three cleared bids/transactions and 30 cleared MWh.
Virtual Bids (INCs & DECs) - Total Number

Number of Bids (Millions)

Submitted Bids
Cleared Bids

SEP21  OCT21  NOV21  DEC21  JAN22  FEB22  MAR22  APR22  MAY22  JUN22  JUL22  AUG22  SEP22  OCT22  NOV22  DEC22  JAN23  FEB23  MAR23  APR23  MAY23  JUN23  JUL23  AUG23  SEP23
Virtual Bids (INC & DEC) - Total Volume

MWh (Millions)

Submitted MWh
Cleared MWh

SEP21 OCT21 NOV21 DEC21 JAN22 FEB22 MAR22 APR22 MAY22 JUN22 JUL22 AUG22 SEP22 OCT22 NOV22 DEC22 JAN23 FEB23 MAR23 APR23 MAY23 JUN23 JUL23 AUG23 SEP23
Up-To-Congestion Transactions - Total Number
INCs, DECs and Up-To-Congestion Transactions - Total Number
INCs, DECs and Up-To-Congestion Transactions - Total Volume

MWh (Millions)

Submitted MWh

Cleared MWh

SEP21
OCT21
NOV21
DEC21
JAN22
FEB22
MAR22
APR22
MAY22
JUN22
JUL22
AUG22
SEP22
OCT22
NOV22
DEC22
JAN23
FEB23
MAR23
APR23
MAY23
JUN23
JUL23
AUG23
SEP23
Energy Market

Congestion and FTR Summary
<table>
<thead>
<tr>
<th>Period</th>
<th>Surplus / Underfunding</th>
<th>Payout Ratio</th>
</tr>
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<tbody>
<tr>
<td>September 2023</td>
<td>$-3,677,584</td>
<td>98%</td>
</tr>
<tr>
<td>2023</td>
<td>$152,406,436</td>
<td>100%</td>
</tr>
<tr>
<td>2023/2024</td>
<td>$52,644,852</td>
<td>100%</td>
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</table>
Monthly FTR Payout
The ten most heavily congested facilities account for 77% of total congestion for September.
Ten Most Heavily Congested Transmission Facilities - Overall, 2023

Nottingham Reactor 230 (PECO)
Conastone-Northwest 230 2322 (BGE)
Graceton-Safe Harbor 230 (BGE)
Cool Springs-Milford 230 (DPL S)
Dresden 345/138 T81 (COMED)
Lenox-N Meshoppen 115 (PN)
APSOUTH Interface (EHV)
Cedar Creek-Silver Run 230 (DPL)
Allen IM-RPMone 345 (AEP OH IM)
Conastone 500/230 2 (BGE)

The ten most heavily congested facilities account for 57% of total congestion for 2023.
Balancing Congestion Charge Revenues (BLI 2215)
Energy Market

Interchange/Seams Summary
Hourly Difference Between PJM and MISO Real-Time Prices

Positive values represent hours when the PJM price was higher. Negative values represent hours when the PJM price was lower.

Average price difference for September = $-2.60
Percent of hours in which the direction of flow is consistent with price differentials = 65.69%
Hourly Difference Between PJM and MISO Day-Ahead Prices

Positive values represent hours when the PJM price was higher. Negative values represent hours when the PJM price was lower.

Average price difference for September = $-0.99
Hourly Difference Between PJM and NYISO Real-Time Prices

Positive values represent hours when the PJM price was higher. Negative values represent hours when the PJM price was lower.

Average price difference for September = $-2.25
Percent of hours in which the direction of flow is consistent with price differentials = 71.94%
Positive values represent hours when the PJM price was higher. Negative values represent hours when the PJM price was lower.
PJM-MISO Market-to-Market Coordination Settlement

Negative M2M Credit represents PJM payment to MISO

Net M2M Credit ~ MISO ($ Millions)
Net M2M Credit ~ MISO/Total FTR Targets (%)
Negative M2M Credit represents PJM payment to NYISO.
Ancillary Service Market

Summary
Regulation Costs

$ Millions

SEP21 | OCT21 | NOV21 | DEC21 | JAN22 | FEB22 | MAR22 | APR22 | MAY22 | JUN22 | JUL22 | AUG22 | SEP22 | OCT22 | NOV22 | DEC22 | JAN23 | FEB23 | MAR23 | APR23 | MAY23 | JUN23 | JUL23 | AUG23 | SEP23
Synchronized Reserve and Synchronous Condenser Costs

$ Millions

- Synchronized Reserve Market Payments
- Synchronous Condenser Payments

- Sep 21
- Oct 21
- Nov 21
- Dec 21
- Jan 22
- Feb 22
- Mar 22
- Apr 22
- May 22
- Jun 22
- Jul 22
- Aug 22
- Sep 22
- Oct 22
- Nov 22
- Dec 22
- Jan 23
- Feb 23
- Mar 23
- Apr 23
- May 23
- Jun 23
- Jul 23
- Aug 23
- Sep 23
DR Participation in PJM Regulation Markets

- Total Payments ($ Millions)
- MWh Cleared (MWh)

$ Millions

MWh

SEP21 OCT21 NOV21 DEC21 JAN22 FEB22 MAR22 APR22 MAY22 JUN22 JUL22 AUG22 SEP22 OCT22 NOV22 DEC22 JAN23 FEB23 MAR23 APR23 MAY23 JUN23 JUL23 AUG23 SEP23
DR Participation in PJM Synchronized Reserve Markets

![Chart showing DR participation in PJM Synchronized Reserve Markets with bars and lines for Total Payments ($ Millions) and MWh Cleared (MWh).]
Regulation Market Daily Prices and Charges

- Total Daily Regulation Charges ($ Millions)
- Minimum Interval Price ($/MWh)
- Average Interval Price ($/MWh)
- Maximum Interval Price ($/MWh)
Jennifer Warner-Freeman
Jennifer.Freeman@pjm.com

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(866) 400 – 8980
custsvc@pjm.com