Markets Report

MC Webinar
September 18, 2023
• PJM Wholesale Cost in 2023 is $50.01/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 August, 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 August. (Slides 8-10)

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

• Load-weighted average LMP for 2023 is $30.79/MWh: (Slides 35-36)
  – August 2023 was $31.30/MWh, which is much lower than August 2022 ($113.80/MWh) and also lower than August 2021 ($47.40/MWh).

• There were no 5-minute intervals that experienced shortage pricing in August. (Slides 34, Report Appendix)

• FTR revenue adequacy for the month of August is 100% 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
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, 2020. Averages include load data for all of TO zones in the current RTO footprint.
Historic Average Weather and Energy versus Current Month

- **Current Month Total Energy**
- **Current Month HDD+CDD**
- **Average Monthly Total Energy**
- **Average Monthly HDD + CDD**

![Graph showing Historic Average Weather and Energy versus Current Month](image-url)
Historic Average Weather and Energy versus Current Month - Daily

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

Fuel Price Source: S&P Global Platts
Average Fuel Prices - Daily

Fuel Price Source: S&P Global Platts

- Average Gas: $1.70
- Average Coal: $2.52
- Average Oil: $19.78
- Average LMP: $31.10
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.
Load Forecast Error - Monthly Absolute Error, 10:00 Forecast

The graph shows the monthly absolute error for load forecasts with data for 2021, 2022, and 2023. It compares all hours, peak hours only, winter, summer, 25-month average, and 25-month average. The data indicates variations in error rates across different months and years.
Load Forecast Error - August Daily Peaks, 10:00 Forecast

- Error at Peak Hour
- Weekend / Holiday
Load Forecast Error

- 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.

Over-forecasting peak load occurred on 8/2, 8/3, and 8/5. On 8/2, temperatures and humidity forecasts came in lower than anticipated, leading to lower loads. Cloud cover kept temperatures cooler than expected on 8/3 and 8/5, leading to lower loads there.

Peak load was under-forecast on 8/6 due to temperature forecast error; source of temperature error on 8/6 was due to series of expected storms which did not ultimately materialize, allowing temperature to climb higher than forecast.
'Other' includes Hydro, Oil, Solar, Wind, and Other
'Other' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Daily Generation by Fuel - August

'Mother' includes Hydro, Oil, Solar, Wind, and Other
Daily Generation by Fuel, Other - August

'Mother' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Percent of Renewable and Clean Generation

'Renewable' includes Wind, Solar, Hydro, and Other Renewables. 'Clean' includes Renewable and Nuclear.
Operating Reserve
(Uplift)
Monthly Uplift - $/MWh Load

- Day-Ahead Operating Reserve
- Balancing Operating Reserve
- Reactive
- Blackstart
- Lost Opportunity Cost

$/MWh

Month:
- AUG21
- SEP21
- OCT21
- NOV21
- DEC21
- JAN22
- FEB22
- MAR22
- APR22
- MAY22
- JUN22
- JUL22
- AUG22
- SEP22
- OCT22
- NOV22
- DEC22
- JAN23
- FEB23
- MAR23
- APR23
- MAY23
- JUN23
- JUL23
- AUG23
• In August, uplift exceeded $800,000 on six days -

• Contributing factors to uplift were:

  The hot weather and higher loads necessitated the running of additional steam to support localized congestion limiting the north to south flows.

• More information on Uplift can be found on the PJM website at [Drivers of Uplift](#)
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.
Deviations Balancing Operating Reserve Rates

$/MWh

- RTO
- East
- West

AUG21 OCT21 JAN22 MAY22 AUG22 OCT22 JAN23 MAY23 AUG23
Energy Market

LMP Summary
Shortage Pricing Intervals

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

$/MWh

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<tr>
<th>Month</th>
<th>Apr22</th>
<th>May22</th>
<th>Jun22</th>
<th>Jul22</th>
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Daily Load-Weighted Average DA & RT LMP

- Load-Weighted DA LMP
- Load-Weighted RT LMP

The graph illustrates the daily load-weighted average day-ahead (DA) and real-time (RT) LMP prices from August 1st to August 31st.
Fuel Cost Adjusted LMP (Referenced to 1999 Fuel Prices)
Spikes seen in March and April 2021 are incorrect and due to a software bug which has since been fixed.
Energy Market

Demand Response Summary
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 (INC & DECs) - Total Number

Number of Bids (Millions)

- Submitted Bids
- Cleared Bids

| AUG21 | SEP21 | OCT21 | NOV21 | DEC21 | JAN22 | FEB22 | MAR22 | APR22 | MAY22 | JUN22 | JUL22 | AUG22 | SEP22 | OCT22 | NOV22 | DEC22 | JAN23 | FEB23 | MAR23 | APR23 | MAY23 | JUN23 | JUL23 | AUG23 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
Virtual Bids (INC & DEC) - Total Volume

MWh (Millions)

- Submitted MWh
- Cleared MWh

AUG21 | SEP21 | OCT21 | NOV21 | DEC21 | JAN22 | FEB22 | MAR22 | APR22 | MAY22 | JUN22 | JUL22 | AUG22 | SEP22 | OCT22 | NOV22 | DEC22 | JAN23 | FEB23 | MAR23 | APR23 | MAY23 | JUN23 | JUL23 | AUG23
Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

<table>
<thead>
<tr>
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<th>SEP21</th>
<th>OCT21</th>
<th>NOV21</th>
<th>DEC21</th>
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Up-To-Congestion Transactions - Total Volume

MWh (Millions)

- Submitted MWh
- Cleared MWh
INCs, DECs and Up-To-Congestion Transactions - Total Number
INCs, DECs and Up-To-Congestion Transactions - Total Volume
Energy Market

Congestion and FTR Summary
<table>
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<th>Period</th>
<th>Surplus / Underfunding</th>
<th>Payout Ratio</th>
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<tr>
<td>August 2023</td>
<td>$16,556,467</td>
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<tr>
<td>2023</td>
<td>$156,084,020</td>
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<tr>
<td>2023/2024</td>
<td>$56,322,436</td>
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FTR Revenue vs. FTR Target Allocation
The ten most heavily congested facilities account for 82% of total congestion for August.
Ten Most Heavily Congested Transmission Facilities - Overall, 2023

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
Monthly Average MISO Interface Pricing

$/MW/h

- PJM MISO Price (RT)
- MISO PJM Price (RT)
- PJM MISO Price (DA)
- MISO PJM Price (DA)

Dates: AUG21, OCT21, JAN22, MAY22, AUG22, OCT22, JAN23, MAY23, AUG23
Monthly Average NYISO Interface Pricing

- PJM NYISO Price (RT)
- NYISO PJM Price (RT)
- PJM NYISO Price (DA)
- NYISO PJM Price (DA)

$/MWh

AUG21 OCT21 JAN22 MAY22 AUG22 OCT22 JAN23 MAY23 AUG23
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 August = $-2.22
Percent of hours in which the direction of flow is consistent with price differentials = 60.08%
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 August = $-1.60
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 August = $-3.67
Percent of hours in which the direction of flow is consistent with price differentials = 75.94%
Hourly difference between PJM and NYISO ~ DA - $

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

Average price difference for August = $-2.67
PJM-MISO Market-to-Market Coordination Settlement

- **Net M2M Credit ~ MISO ($ Millions)**
- **Net M2M Credit ~ MISO/Total FTR Targets (%)**

*Negative M2M Credit represents PJM payment to MISO*
PJM-NYISO Market-to-Market Coordination Settlement

Negative M2M Credit represents PJM payment to NYISO

Net M2M Credit ~ NYISO ($ Millions)
Net M2M Credit ~ NYISO/Total FTR Targets (%)

$ Millions
-3.0
-2.0
-1.0
0.0
1.0
2.0
3.0

1.5%
1.0%
0.5%
0.0%
-0.5%
-1.0%
-1.5%

AUG21 SEP21 OCT21 NOV21 DEC21 JAN22 FEB22 MAR22 APR22 MAY22 JUN22 JUL22 AUG22 SEP22 OCT22 NOV22 DEC22 JAN23 FEB23 MAR23 APR23 MAY23 JUN23 JUL23 AUG23

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Ancillary Service Market Summary
Synchronized Reserve and Synchronous Condenser Costs

![Bar Chart]

- **Synchronized Reserve Market Payments**
- **Synchronous Condenser Payments**

<table>
<thead>
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<th>Month</th>
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<th>SEP21</th>
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<td>10</td>
<td>5</td>
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Load-Adjusted Synchronized Reserve and Synchronous Condenser Costs
DR Participation in PJM Regulation Markets

The chart illustrates the total payments in millions and the MWh cleared from August 2021 to August 2023. The Y-axis represents $ Millions, while the X-axis lists the months from August 2021 to August 2023. The dark blue bars indicate total payments, and the green line represents MWh cleared.

- Total Payments ($ Millions):
  - Highest in August 2022
  - Lowest in November 2022

- MWh Cleared (MWh):
  - Peaks in November 2022 and August 2023
  - Lowest in January 2022

The data shows a significant variation in payments and MWh cleared across the specified months.
DR Participation in PJM Synchronized Reserve Markets
Regulation Market Daily Prices and Charges
Synchronized Reserve Market Daily Prices and Charges

- Total Daily Synchronized Reserve Charges ($ Millions)
- Minimum Interval Price ($/MWh)
- Average Interval Price ($/MWh)
- Maximum Interval Price ($/MWh)
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