Markets Report

MC Webinar
July 24, 2023
PJM Wholesale Cost in 2023 is $49.87/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 June, temperatures were 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 June. (Slides 8-10)

In June, uplift exceeded $800,000 on one day. (Slides 25 & 26)
• Load-weighted average LMP for 2023 is $29.33/MWh: (Slides 34-36)
  – June 2023 was $27.10/MWh, which is much lower than June 2022 ($97.90/MWh) and also lower than June 2021 ($34.10/MWh).

• There were no 5-minute intervals that experienced shortage pricing in June. (Slides 33, Report Appendix)

• FTR revenue adequacy for the month of June is 100% and the 2023-2024 Planning Year is currently funded at 100%. (Slides 51-54)

• Congestion values have been trending lower in 2023 as compared to 2022. (Slide 52)

• Regulation and Synchronized Reserve market costs have generally tracked with energy prices over time. (Slides 68-70)
Markets Report
PJM Wholesale Cost - Other

- Regulation
- Operating Reserve
- PJM Cost
- Reactive
- Transmission Owner Control
- Synchronized Reserve
- Black Start

$/MWh

- 2019: $1.26
- 2020: $1.28
- 2021: $1.51
- 2022: $1.89
- 2023: $1.42
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

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

TWh

Heating Degree Days + Cooling Degree Days
Historic Average Weather and Energy versus Current Month - Daily
Average Fuel Prices - Monthly

Fuel Price Source: S&P Global Platts
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 June = $0.34
Load Forecast Error - June Daily Peaks, 10:00 Forecast

- Error at Peak Hour
- Weekend / Holiday

Graph showing forecast errors for June daily peaks at 10:00. The x-axis represents days of the month (1-30), and the y-axis represents forecast error percentages ranging from -10% to 10%. The chart highlights the deviations from actual peak loads, with bars indicating whether the forecast was higher or lower than expected.
• 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.

For the most part, barring two days, days in which error which exceeded 3% saw over-forecast load. These conditions were due to a combination of factors throughout the month:
• smoke impacting and limiting temperatures from reaching their forecast high and leading to over-forecast model output
• scattered showers and thunderstorms in a less predictable weather pattern
• holiday influence and post-holiday impacts (June 19 and June 20) and being conservative with the load forecast after analysis of historical data

In the two cases, June 2 and June 24, under-forecasting was observed due to model error rooted in unusually warm temperatures; for some regions, the observed temperatures came in higher than forecast temperatures, and for other regions, load models struggled to solve for the high temperatures, leading to under-forecasting. It is also important to note that one day, June 2, temperatures ended up being the highest load of the year for that point in time.
'Other' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Daily Generation by Fuel - June

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

'Mother' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Operating Reserve

(Uplift)
Monthly Uplift - $/MWh Load

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

$/MWh

$0.0

$0.2

$0.4

$0.6

$0.8

$1.0

$1.2

JUN21 - JUN23
• In June, uplift exceeded $800,000 on one day -
• Contributing factors to uplift were:
  Constraint control, localized congestion, and reactive support
• More information on Uplift can be found on the PJM website at [Drivers of Uplift](https://www.pjm.com)
Uplift as a Percent of Energy Costs

- Uplift $/Energy $ from June 21 to June 23.
Percent of Total CT, CC and Steam Hours with LMP < Offer
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

$/MWh

- RTO
- East
- West

JUN21  AUG21  NOV21  MAR22  JUN22  AUG22  NOV22  MAR23  JUN23
Deviations Balancing Operating Reserve Rates

$/MWh

- RTO
- East
- West

JUN21 AUG21 NOV21 MAR22 JUN22 AUG22 NOV22 MAR23 JUN23
Energy Market

LMP Summary
Shortage Pricing Intervals

Information on constraints and shadow prices can be found here
Daily Load-Weighted Average DA & RT LMP

($/MWh)

Load-Weighted DA LMP
Load-Weighted RT LMP

01 Jun 23 to 30 Jun 23
Fuel Cost Adjusted LMP (Referenced to 1999 Fuel Prices)
Energy Market

Demand Response Summary
Demand Side Response Estimated Revenue

<table>
<thead>
<tr>
<th>Year</th>
<th>Capacity</th>
<th>Ancillary Services</th>
<th>Emergency Energy</th>
<th>Economic Energy</th>
<th>Economic Energy Incentives</th>
<th>Capacity Bonus Payment</th>
<th>Price Responsive Demand Credits</th>
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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
Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions
INCs, DECs and Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

- JUN21
- JUL21
- AUG21
- SEP21
- OCT21
- NOV21
- DEC21
- JAN22
- FEB22
- MAR22
- APR22
- MAY22
- JUN22
- JUL22
- AUG22
- SEP22
- OCT22
- NOV22
- DEC22
- JAN23
- FEB23
- MAR23
- APR23
- MAY23
- JUN23
INCs, DECs and Up-To-Congestion Transactions - Total Volume

Submitted MWh

Cleared MWh

MWh (Millions)

JUN21 JUL21 AUG21 SEP21 OCT21 NOV21 DEC21 JAN22 FEB22 MAR22 APR22 MAY22 JUN22 JUL22 AUG22 SEP22 OCT22 NOV22 DEC22 JAN23 FEB23 MAR23 APR23 MAY23 JUN23
Energy Market

Congestion and FTR Summary
## FTR Funding

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<th>Period</th>
<th>Surplus / Underfunding</th>
<th>Payout Ratio</th>
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<td>June 2023</td>
<td>$9,334,935</td>
<td>100%</td>
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<tr>
<td>2023</td>
<td>$109,096,518</td>
<td>100%</td>
</tr>
<tr>
<td>2023/2024</td>
<td>$9,334,935</td>
<td>100%</td>
</tr>
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FTR Revenue vs. FTR Target Allocation

- Total FTR Revenues
- Total FTR Targets

$ Millions

JUN21, JUL21, AUG21, SEP21, OCT21, NOV21, DEC21, JAN22, FEB22, MAR22, APR22, MAY22, JUN22, JUL22, AUG22, SEP22, OCT22, NOV22, DEC22, JAN23, FEB23, MAR23, APR23, MAY23, JUN23
Planning Period FTR Payout Ratio

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<td>80%</td>
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Ten Most Heavily Congested Transmission Facilities - Overall, June

The ten most heavily congested facilities account for 67% of total congestion for June.
The ten most heavily congested facilities account for 59% of total congestion for 2023.
Energy Market

Interchange/Seams Summary
Monthly Average MISO Interface Pricing

$/MW\cdot h$

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

Dates: JUN21 to JUN23
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 June = $-0.94
Percent of hours in which the direction of flow is consistent with price differentials = 57.64%
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.
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 June = $-0.56
Percent of hours in which the direction of flow is consistent with price differentials = 64.03%

Average + 1 Standard Deviation
Average - 1 Standard Deviation
Hourly Difference Between PJM and NYISO 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 June = $-3.49
PJM-MISO Market-to-Market Coordination Settlement

Negative M2M Credit represents PJM payment to MISO
Negative M2M Credit represents PJM payment to NYISO
Ancillary Service Market

Summary
Synchronized Reserve and Synchronous Condenser Costs

- Synchronized Reserve Market Payments
- Synchronous Condenser Payments

$ Millions

- JUN21
- JUL21
- AUG21
- SEP21
- OCT21
- NOV21
- DEC21
- JAN22
- FEB22
- MAR22
- APR22
- MAY22
- JUN22
- JUL22
- AUG22
- SEP22
- OCT22
- NOV22
- DEC22
- JAN23
- FEB23
- MAR23
- APR23
- MAY23
- JUN23
Load-Adjusted Synchronized Reserve and Synchronous Condenser Costs
DR Participation in PJM Synchronized Reserve Markets

Total Payments ($ Millions)
MWh Cleared (MWh)

$ Millions

JUN21 JUL21 AUG21 SEP21 OCT21 NOV21 DEC21 JAN22 FEB22 MAR22 APR22 MAY22 JUN22 JUL22 AUG22 SEP22 OCT22 NOV22 DEC22 JAN23 FEB23 MAR23 APR23 MAY23 JUN23
Regulation Market Daily Prices and Charges

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