Markets Report

MC Webinar
March 20, 2023
• PJM Wholesale Cost in 2023 is $50.75/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 February, temperatures were above average for most of the month. Thus, the sum of Heating and Cooling Degree Days was below its historic average. (Slides 8-10)

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

• In February, uplift exceeded $800,000 on one day. (Slides 25 & 26)
Executive Summary

- Load-weighted average LMP for 2023 is $31.19/MWh: (Slides 35-37)
  - February 2023 was $26.00/MWh, which is lower than February 2022 ($46.80/MWh) and also lower than February 2021 ($41.60/MWh).

- There were no 5-minute intervals that experienced shortage pricing in February. (Slides 33-34)

- FTR revenue adequacy for the month of February is 100% and the 2022-2023 Planning Year is currently funded at 100%. (Slides 52-55)

- Congestion values have been trending upwards. However, 2023’s values are lower than recent months. (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, 2021. 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

Charts showing TWh and Heating Degree Days + Cooling Degree Days for months from Feb22 to Feb23.
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 February = $4.24
Load Forecast Error - Monthly Absolute Error, 10:00 Forecast
Load Forecast Error - February 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.

On February 7th, the morning peak was over-forecasted by over 5%, as temperatures came in cooler than expected, and the eastern areas experienced a significant temperature drop from the previous morning. The forecast performed well the rest of the month, primarily due to mild temperatures and adjustments made by staff for the severely cold days of February 3rd and 4th.
'Other' includes Hydro, Oil, Solar, Wind, and Other
Monthly Generation by Fuel, Other

*Other* includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Daily Generation by Fuel - February

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

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

(Uplift)
Daily Uplift

• In February, uplift exceeded $800,000 on one day – February 3\textsuperscript{rd}.

• Contributing factors to uplift were:
  o Conservative operations
  o Localized congestion

• More information on Uplift can be found on the PJM website at [Drivers of Uplift](#)
Uplift as a Percent of Energy Costs

The diagram shows the uplift as a percent of energy costs over time from February 21 to February 23. The graph indicates fluctuations in uplift percentage, with peaks and troughs throughout the period. The highest uplift is observed in April 21, and the lowest is seen in December 22. The uplift generally remains below 1.5% with some periods dipping below 0.5%.
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

$/MWh

- RTO
- East
- West

FEB21 | MAY21 | AUG21 | NOV21 | FEB22 | MAY22 | AUG22 | NOV22 | FEB23
Energy Market

LMP Summary
Shortage Pricing Intervals

Count of Shortage Intervals

- MAD Primary Reserves
- MAD Synchronized Reserves
- RTO Primary Reserves
- RTO Synchronized Reserves

Dates:
- MAR22
- APR22
- MAY22
- JUN22
- JUL22
- AUG22
- SEP22
- OCT22
- NOV22
- DEC22
- JAN23
- FEB23
Information on constraints and shadow prices can be found here:

http://dataminer2.pjm.com/feed/rt_marginal_value
Monthly Load-Weighted Average Real-time LMP

$/MWh

- $42 (FEB21)
- $26 (MAR21)
- $27 (APR21)
- $29 (MAY21)
- $34 (JUN21)
- $37 (JUL21)
- $47 (AUG21)
- $50 (SEP21)
- $58 (OCT21)
- $63 (NOV21)
- $64 (DEC21)
- $39 (FEB22)
- $47 (MAR22)
- $44 (APR22)
- $64 (MAY22)
- $33 (JUN22)
- $98 (JUL22)
- $114 (AUG22)
- $78 (SEP22)
- $56 (OCT22)
- $53 (NOV22)
- $142 (DEC22)
- $36 (JAN23)
- $26 (FEB23)
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
Demand Side Response Estimated Revenue

- Capacity
- Ancillary Services
- Emergency Energy
- Economic Energy
- Economic Energy Incentives
- Capacity Bonus Payment
- Price Responsive Demand Credits

$ Millions


2012: $1,200
2013: $900
2014: $600
2015: $300
2016: $0
2017: $0
2018: $0
2019: $0
2020: $0
2021: $0
2022: $0
2023: $0
*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

MW

FEB21 MAY21 AUG21 NOV21 FEB22 MAY22 AUG22 NOV22 FEB23

1,000 1,500 2,000 2,500 3,000
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

![Graph showing the number of submitted and cleared bids over months from February 2021 to February 2023. The y-axis represents the number of bids in millions, ranging from 0 to 2.0. The x-axis represents the months. Submitted bids are indicated by dark blue bars, while cleared bids are indicated by green bars.]
Virtual Bids (INC & DEC) - Total Volume

MWh ( Millions)

Submitted MWh
Cleared MWh

FEB21  MAR21  APR21  MAY21  JUN21  JUL21  AUG21  SEP21  OCT21  NOV21  DEC21  JAN22  FEB22  MAR22  APR22  MAY22  JUN22  JUL22  AUG22  SEP22  OCT22  NOV22  DEC22  JAN23  FEB23
Up-To-Congestion Transactions - Total Number

![Graph showing Up-To-Congestion Transactions with months and bars indicating number of transactions (Submitted Transactions and Cleared Transactions).](image-url)
Up-To-Congestion Transactions - Total Volume

MWh (Millions)

- Submitted MWh
- Cleared MWh

FEB21 | MAR21 | APR21 | MAY21 | JUN21 | JUL21 | AUG21 | SEP21 | OCT21 | NOV21 | DEC21 | JAN22 | FEB22 | MAR22 | APR22 | MAY22 | JUN22 | JUL22 | AUG22 | SEP22 | OCT22 | NOV22 | DEC22 | JAN23 | FEB23

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

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

Month: FEB21, MAR21, APR21, MAY21, JUN21, JUL21, AUG21, SEP21, OCT21, NOV21, DEC21, JAN22, FEB22, MAR22, APR22, MAY22, JUN22, JUL22, AUG22, SEP22, OCT22, NOV22, DEC22, JAN23, FEB23
INCs, DECs and Up-To-Congestion Transactions - Total Volume

![Chart showing INCs, DECs and Up-To-Congestion Transactions - Total Volume]

- **Submitted MWh**
- **Cleared MWh**

**MWh (Millions)**

- **FEB21**
- **MAR21**
- **APR21**
- **MAY21**
- **JUN21**
- **JUL21**
- **AUG21**
- **SEP21**
- **OCT21**
- **NOV21**
- **DEC21**
- **JAN22**
- **FEB22**
- **MAR22**
- **APR22**
- **MAY22**
- **JUN22**
- **JUL22**
- **AUG22**
- **SEP22**
- **OCT22**
- **NOV22**
- **DEC22**
- **JAN23**
- **FEB23**
Energy Market

Congestion and FTR Summary
<table>
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<tr>
<th>Period</th>
<th>Surplus / Underfunding</th>
<th>Payout Ratio</th>
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</thead>
<tbody>
<tr>
<td>February 2023</td>
<td>$37,599,790</td>
<td>100%</td>
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<tr>
<td>2023</td>
<td>$54,593,558</td>
<td>100%</td>
</tr>
<tr>
<td>2022/2023</td>
<td>$188,138,248</td>
<td>100%</td>
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</tbody>
</table>
FTR Revenue vs. FTR Target Allocation

- Total FTR Revenues
- Total FTR Targets

$ Millions

$0 $100 $200 $300 $400 $500

FEB21 MAR21 APR21 MAY21 JUN21 JUL21 AUG21 SEP21 OCT21 NOV21 DEC21 JAN22 FEB22 MAR22 APR22 MAY22 JUN22 JUL22 AUG22 SEP22 OCT22 NOV22 DEC22 JAN23 FEB23
Planning Period FTR Payout Ratio

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<td>Payout Ratio</td>
<td>100%</td>
<td>100%</td>
<td>80%</td>
<td>60%</td>
<td>50%</td>
<td>40%</td>
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Ten Most Heavily Congested Transmission Facilities - Overall, February

The ten most heavily congested facilities account for 62% of total congestion for February.
The ten most heavily congested facilities account for 60% 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)
Monthly Average NYISO Interface Pricing

$/MWh

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

FEB21 MAY21 AUG21 NOV21 FEB22 MAY22 AUG22 NOV22 FEB23
Positive values represent hours when the PJM price was higher. Negative values represent hours when the PJM price was lower.

Average price difference for February = $-1.59
Percent of hours in which the direction of flow is consistent with price differentials = 61.46%
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 February = $-2.07
Percent of hours in which the direction of flow is consistent with price differentials = 60.27%
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 February = $-5.55
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

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<th>Month</th>
<th>Value</th>
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<td>JAN23</td>
<td>$90</td>
</tr>
<tr>
<td>FEB23</td>
<td>$95</td>
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Load-Adjusted Synchronized Reserve and Synchronous Condenser Costs

Cents/MWh

- Synchronized Reserve Market Payments / MWh
- Synchronous Condenser Payments / MWh

Month: FEB21, MAR21, APR21, MAY21, JUN21, JUL21, AUG21, SEP21, OCT21, NOV21, DEC21, JAN22, FEB22, MAR22, APR22, MAY22, JUN22, JUL22, AUG22, SEP22, OCT22, NOV22, DEC22, JAN23, FEB23
DR Participation in PJM Synchronized Reserve Markets

![Bar chart showing Total Payments ($ Millions) and MWh Cleared (MWh) over time from FEB21 to FEB23.](chart.png)
Regulation Market Daily Prices and Charges

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

Member Hotline
(610) 666 – 8980
(866) 400 – 8980
custsvc@pjm.com