Markets Report

MC Webinar
June 27, 2022
PJM Wholesale Cost for 2022 YTD is $88.21/MWh, up from full-year 2021 costs of $64.07/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 8-19)

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

Energy use was also above its historic average for May. (Slides 8-10)

In May, uplift exceeded $800,000 on four days. (Slides 24 & 25)
Executive Summary

• Load-weighted average LMP for 2022 YTD is $61.39/MWh: (Slides 33 & 34)
  – May 2022 was $83.20/MWh, which is higher than May 2021 ($29.40/MWh) and May 2020 ($18.30/MWh).

• There was one 5-minute interval that experienced shortage pricing in May. (Slides 31 & 32)

• FTR revenue adequacy for the month of May is 100% and the 2021-2022 Planning Year is currently funded at 99.8%. (Slides 49-52)

• May’s congestion values are in-line with January’s, however, both months are higher than others in recent history. (Slide 50)

• Regulation and Synchronized Reserve market costs have generally tracked with energy prices over time. (Slides 65-67)
Markets Report
PJM Wholesale Cost

<table>
<thead>
<tr>
<th>Year</th>
<th>Energy</th>
<th>Reliability Capacity</th>
<th>Transmission</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>$60.00</td>
<td>$11.89</td>
<td>$37.83</td>
<td></td>
</tr>
<tr>
<td>2019</td>
<td>$48.98</td>
<td>$11.05</td>
<td>$27.15</td>
<td></td>
</tr>
<tr>
<td>2020</td>
<td>$43.41</td>
<td>$11.03</td>
<td>$21.65</td>
<td></td>
</tr>
<tr>
<td>2021</td>
<td>$64.07</td>
<td>$11.04</td>
<td>$39.79</td>
<td></td>
</tr>
<tr>
<td>2022</td>
<td>$88.21</td>
<td>$12.44</td>
<td>$61.39</td>
<td>$12.72</td>
</tr>
</tbody>
</table>
PJM Wholesale Cost - Other

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

$/MWh

2018: $1.44
- Regulation: $0.41
- Operating Reserve: $0.25
- PJM Cost: $0.36
- Reactive: $0.18

2019: $1.26
- Regulation: $0.44
- Operating Reserve: $0.38
- PJM Cost: $0.38
- Reactive: $0.18

2020: $1.28
- Regulation: $0.47
- Operating Reserve: $0.38
- PJM Cost: $0.38
- Reactive: $0.18

2021: $1.51
- Regulation: $0.47
- Operating Reserve: $0.23
- PJM Cost: $0.32
- Reactive: $0.18

2022: $1.66
- Regulation: $0.50
- Operating Reserve: $0.18
- PJM Cost: $0.40
- Reactive: $0.18
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

TWh vs Heating Degree Days + Cooling Degree Days

- May 21
- Jun 21
- Jul 21
- Aug 21
- Sep 21
- Oct 21
- Nov 21
- Dec 21
- Jan 22
- Feb 22
- Mar 22
- Apr 22
- May 22
Average Fuel Prices - Daily

% Deviation from Monthly Average Fuel Price

% Deviation from Monthly Average LMP

Fuel Price Source: S&P Global Platts

Average Gas - $7.50
Average Coal - $5.48
Average Oil - $28.60
Average LMP - $82.03
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 diagram shows the load forecast error for different months and years. It includes data for all hours and peak hours only, categorized by winter and summer. The graph also compares these errors with a 25-month average.

- **2020**: January to December
- **2021**: January to December
- **2022**: January to May

The error percentages range from 0% to 3%, with different bars representing different months and years. The data is color-coded for clarity, with blue for all hours and grey for peak hours only, further divided into blue for winter and grey for summer.

The 25-month average is indicated by dashed lines for both all hours and peak hours, allowing for comparison of recent error rates against historical averages.
Load Forecast Error - May 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.

• *May is often a challenging month as we transition between seasons, moving from a double peak to a traditional summer curve, and this month was especially challenging due to a number of periods of unseasonable heat. This hot weather, paired with storm activity and temperature forecast error, made the task of load forecasting particularly difficult.*

• On May 10 and 11, hot weather impacted the western zones of PJM including temperatures above 90 in ComEd. The heat was not well forecasted, especially on the 11th, resulting in load that came in quite a bit higher than expected.

• On May 20 and 21 we saw another period of hot weather, with temperatures above 90 in the East this time. Unlike earlier in the month, temperatures were over-forecasted. This was exacerbated in some zones by stormy weather, the timing of which can be tricky to predict with 100% accuracy.
Monthly Generation by Fuel

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

'Mother' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Operating Reserve
(Uplift)
• In May, uplift exceeded $800,000 on four days – May 21, 26, 30 & 31
• Contributing factors to uplift were:
  • Hot Weather Alerts
  • Localized congestion

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
• 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

MAY20 JUL20 OCT20 JAN21 MAY21 JUL21 OCT21 JAN22 MAY22

RTO
East
West
Deviations Balancing Operating Reserve Rates

$\text{$/MWh}$

- RTO
- East
- West

$\text{MAY20}$, $\text{JUL20}$, $\text{OCT20}$, $\text{JAN21}$, $\text{MAY21}$, $\text{JUL21}$, $\text{OCT21}$, $\text{JAN22}$, $\text{MAY22}$
Energy Market

LMP Summary
<table>
<thead>
<tr>
<th>Date</th>
<th>5-Minute Interval</th>
<th>Reserve Penalty Factors</th>
<th>5-Minute Interval SMP</th>
<th>Hourly Integrated SMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday, May 16, 2022</td>
<td>15:55 - 16:00</td>
<td>RTO Synchronized Reserves; MAD Synchronized Reserves</td>
<td>$700.24</td>
<td>$148.45</td>
</tr>
</tbody>
</table>

Information on constraints and shadow prices can be found here:

http://dataminer2.pjm.com/feed/rt_marginal_value
Fuel Cost Adjusted LMP (Referenced to 1999 Fuel Prices)
LMP Price Posting Suspensions and Reruns

Spikes seen in March and April 2021 are incorrect and due to a software bug which has since been fixed. The February 2022 rate is due to reruns for the Lanexa-Dunsville outage.
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.
Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

Month: MAY20, JUN20, JUL20, AUG20, SEP20, OCT20, NOV20, DEC20, JAN21, FEB21, MAR21, APR21, MAY21, JUN21, JUL21, AUG21, SEP21, OCT21, NOV21, DEC21, JAN22, FEB22, MAR22, APR22, MAY22
Up-To-Congestion Transactions - Total Volume

MWh (Millions)

- Submitted MWh
- Cleared MWh

MAY20  JUN20  JUL20  AUG20  SEP20  OCT20  NOV20  DEC20  JAN21  FEB21  MAR21  APR21  MAY21  JUN21  JUL21  AUG21  SEP21  OCT21  NOV21  DEC21  JAN22  FEB22  MAR22  APR22  MAY22
INCs, DECs and Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

<table>
<thead>
<tr>
<th>Month</th>
<th>MAY20</th>
<th>JUN20</th>
<th>JUL20</th>
<th>AUG20</th>
<th>SEP20</th>
<th>OCT20</th>
<th>NOV20</th>
<th>DEC20</th>
<th>JAN20</th>
<th>FEB21</th>
<th>MAR21</th>
<th>APR21</th>
<th>MAY21</th>
<th>JUN21</th>
<th>JUL21</th>
<th>AUG21</th>
<th>SEP21</th>
<th>OCT21</th>
<th>NOV21</th>
<th>DEC21</th>
<th>JAN22</th>
<th>FEB22</th>
<th>MAR22</th>
<th>APR22</th>
<th>MAY22</th>
</tr>
</thead>
</table>
INCs, DECs and Up-To-Congestion Transactions - Total Volume
Energy Market

Congestion and FTR Summary
<table>
<thead>
<tr>
<th>Period</th>
<th>Surplus / Underfunding</th>
<th>Payout Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>May, 2022</td>
<td>$34,545,897</td>
<td>100%</td>
</tr>
<tr>
<td>2022</td>
<td>$94,106,021</td>
<td>100%</td>
</tr>
<tr>
<td>2021/2022</td>
<td>$-5,379,381</td>
<td>100%</td>
</tr>
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</table>
FTR Revenue vs. FTR Target Allocation

$ Millions

- Total FTR Revenues
- Total FTR Targets

MAY20, JUN20, JUL20, AUG20, SEP20, OCT20, NOV20, DEC20, JAN21, FEB21, MAR21, APR21, MAY21, JUN21, JUL21, AUG21, SEP21, OCT21, NOV21, DEC21, JAN22, FEB22, MAR22, APR22, MAY22
The ten most heavily congested facilities account for 91% of total congestion for May.

Ten Most Heavily Congested Transmission Facilities - Overall, May

- Brambleton-Evergreen 230 (DOM)
- Clark-Idylwood 202A 230 (DOM N)
- Nottingham Reactor 230 (PECO)
- Cumberland-Juniata 230 (PPL)
- Ashburn-Cochrane Mills 227A 230 (DOM)
- Lafayette South-Shadeland 138 (MISO)
- Graceton-Safe Harbor 230 (BGE)
- Prest-Tibb 138 kV (MISO)
- Bedford-5103 7 115 (COMED)
- Michigan City-Trail Creek 138 (MISO)
The ten most heavily congested facilities account for 60% of total congestion for 2022.
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 May = $-2.12
Percent of hours in which the direction of flow is consistent with price differentials = 54.17%
Positive values represent hours when the PJM price was higher. Negative values represent hours when the PJM price was lower.

Average price difference for May = $-2.21
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 May = $-2.15
Percent of hours in which the direction of flow is consistent with price differentials = 51.48%
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.
Negative M2M Credit represents PJM payment to MISO
PJM-NYISO Market-to-Market Coordination Settlement

Negative M2M Credit represents PJM payment to NYISO
Ancillary Service Market

Summary
Synchronized Reserve and Synchronous Condenser Costs

$ Millions

Synchronized Reserve Market Payments
Synchronous Condenser Payments

MAY20 | JUN20 | JUL20 | AUG20 | SEP20 | OCT20 | NOV20 | DEC20 | JAN21 | FEB21 | MAR21 | MAY21 | JUN21 | JUL21 | AUG21 | SEP21 | OCT21 | NOV21 | DEC21 | JAN22 | FEB22 | MAR22 | APR22 | MAY22

$0 | $1 | $2 | $3 | $4 | $5 | $6 | $7 | $8 | $9 | $10 | $11 | $12 | $13 | $14 | $15
Load-Adjusted Synchronized Reserve and Synchronous Condenser Costs
DR Participation in PJM Regulation Markets

- Total Payments ($ Millions)
- MWh Cleared (MWh)
DR Participation in PJM Synchronized Reserve Markets

$ Millions

MWh

Total Payments ($ Millions)
MWh Cleared (MWh)

MAY20 JUN20 JUL20 AUG20 SEP20 OCT20 NOV20 DEC20 JAN21 FEB21 MAR21 APR21 MAY21 JUN21 JUL21 AUG21 SEP21 OCT21 NOV21 DEC21 JAN22 FEB22 MAR22 APR22 MAY22

0 50,000 100,000 150,000 200,000

0 $0.0 $0.5 $1.0 $1.5 $2.0
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