Markets Report

MC Webinar
April 25, 2022
PJM Wholesale Cost for 2022 YTD is $79.37/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 March, 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 March. (Slides 8-10)

In March, uplift exceeded $800,000 on one day. (Slides 24 & 25)
Executive Summary

- Load-weighted average LMP for 2022 YTD is $54.61/MWh: (Slides 33 & 34)
  - March 2022 was $43.60/MWh, which is higher than March 2021 ($26.30/MWh) and March 2020 ($17.90/MWh).

- There were five 5-minute intervals that experienced shortage pricing in March. (Slides 31 & 32)

- FTR revenue adequacy for the month of March is 100% and the 2021-2022 Planning Year is currently funded at 98%. (Slides 49-52)

- Congestion values have been trending upwards. March’s value is much more in line with recent history than January’s. (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>
<th>Total</th>
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<tr>
<td>2018</td>
<td>$37.83</td>
<td>$11.89</td>
<td>$8.84</td>
<td>$60.00</td>
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<td>$27.15</td>
<td>$11.05</td>
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<td>$21.65</td>
<td>$9.45</td>
<td>$11.03</td>
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<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>$54.16</td>
<td>$11.71</td>
<td>$11.98</td>
<td>$79.37</td>
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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

Heating Degree Days + Cooling Degree Days


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Historic Average Weather and Energy versus Current Month - Daily

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

% Deviation from Monthly Average Fuel Price

- Average Gas - $4.47
- Average Coal - $4.79
- Average Oil - $24.16
- Average LMP - $43.14

Fuel Price Source: S&P Global Platts
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

![Chart showing monthly absolute error for different time periods and load conditions. The chart includes bars for All Hours and Peak Hours Only, as well as separate sections for Winter and Summer. The 25-month average is indicated by dashed lines.]

- **2020**
  - All Hours: 3.0%
  - Peak Hours Only: 2.5%
  - Winter: 2.0%
  - Summer: 1.5%
- **2021**
  - All Hours: 2.5%
  - Peak Hours Only: 2.0%
  - Winter: 1.5%
  - Summer: 1.0%
- **2022**
  - All Hours: 2.0%
  - Peak Hours Only: 1.5%
  - Winter: 1.0%
  - Summer: 0.5%

- **25-month Average**
  - Blue dashed line:
  - All Hours: 2.0%
  - Peak Hours Only: 1.5%
  - Winter: 1.0%
  - Summer: 0.5%
Load Forecast Error - March Daily Peaks, 10:00 Forecast

- Error at Peak Hour
- Weekend / Holiday

The chart illustrates the load forecast error for March daily peaks, specifically at 10:00. The bars indicate the percentage error at various peak hours, with separate sections for error at peak hours and weekend/holiday periods. The data is presented for each day of the month from 1 to 31.
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.

- On March 12, a large storm was impacting the PJM footprint with snow, rain and a dramatic drop in temperature from the day prior. This dynamic weather, coupled with impacts to behind-the-meter solar production, lead to larger than normal error in our forecast models. On March 16, the morning peak forecast was impacted by model error, due in part to the Daylight Saving Time shift the weekend before, and over-forecasted temperatures in the Western zones.
Monthly Generation by Fuel

'Mother' 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, Other - March

'Mother' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Operating Reserve
(Uplift)
Zonal Uplift - March

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

$ Millions

- AECO
- AEP
- APS
- ATSI
- BGE
- COMED
- DAY
- DEOK
- DOM
- DPL
- DUQ
- EKPC
- JCPL
- METED
- PECO
- PENIEC
- PEPCO
- PPL
- PSEG
• In March, uplift exceeded $800,000 on one day – March 23rd.
• Contributing factors to uplift were:
  • A localized issue not allocated to members

More information on Uplift can be found on the PJM website at [Drivers of Uplift](#)
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

MAR20 MAY20 AUG20 NOV20 MAR21 MAY21 AUG21 NOV21 MAR22
<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>Wednesday, March 2, 2022</td>
<td>17:25 - 17:30</td>
<td>RTO Synchronized Reserves; MAD Synchronized Reserves</td>
<td>$653.14</td>
<td>$166.68</td>
</tr>
<tr>
<td>Wednesday, March 2, 2022</td>
<td>17:30 - 17:35</td>
<td>RTO Synchronized Reserves; MAD Synchronized Reserves</td>
<td>$875.00</td>
<td>$166.68</td>
</tr>
<tr>
<td>Saturday, March 12, 2022</td>
<td>10:20 - 10:25</td>
<td>RTO Synchronized Reserves; MAD Synchronized Reserves</td>
<td>$740.58</td>
<td>$139.27</td>
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<tr>
<td>Sunday, March 20, 2022</td>
<td>19:40 - 19:45</td>
<td>RTO Synchronized Reserves; MAD Synchronized Reserves</td>
<td>$639.00</td>
<td>$122.90</td>
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<tr>
<td>Monday, March 21, 2022</td>
<td>6:40 - 6:45</td>
<td>RTO Synchronized Reserves</td>
<td>$324.73</td>
<td>$100.33</td>
</tr>
</tbody>
</table>

Information on constraints and shadow prices can be found here:

Load-Weighted Average LMP

$/MWh

- MAR20: $18
- APR20: $18
- MAY20: $18
- JUN20: $20
- JUL20: $27
- AUG20: $25
- SEP20: $20
- OCT20: $22
- NOV20: $21
- DEC20: $26
- JAN21: $25
- FEB21: $42
- MAR21: $26
- APR21: $27
- MAY21: $29
- JUN21: $34
- JUL21: $37
- AUG21: $47
- SEP21: $50
- OCT21: $58
- NOV21: $63
- DEC21: $39
- JAN22: $47
- FEB22: $44
- MAR22: $44
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. 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

Graph showing the change in total registered MW from March 2020 to March 2022.
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
Virtual Bids (INCs & DECs) - Total Volume

MWh (Millions)

Submitted MWh
Cleared MWh

MAR20 APR20 MAY20 JUN20 JUL20 AUG20 SEP20 OCT20 NOV20 DEC20 JAN21 FEB21 MAR21 APR21 MAY21 JUN21 JUL21 AUG21 SEP21 OCT21 NOV21 DEC21 JAN22 FEB22 MAR22
Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions
Up-To-Congestion Transactions - Total Volume

MWh (Millions)

- Submitted MWh
- Cleared MWh

Monthly transactions for MWh (Millions) from March 2020 to March 2022.
INCs, DECs and Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

MONTH

- MAR20
- APR20
- MAY20
- JUN20
- JUL20
- AUG20
- SEP20
- OCT20
- NOV20
- DEC20
- JAN21
- FEB21
- MAR21
- APR21
- MAY21
- JUN21
- JUL21
- AUG21
- SEP21
- OCT21
- NOV21
- DEC21
- JAN22
- FEB22
- MAR22
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>
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<td>March, 2022</td>
<td>$6,536,951</td>
<td>100%</td>
</tr>
<tr>
<td>2022</td>
<td>$59,330,522</td>
<td>100%</td>
</tr>
<tr>
<td>2021/2022</td>
<td>$-40,154,879</td>
<td>98%</td>
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</tbody>
</table>
Monthly FTR Payout Ratio

- MAR20
- APR20
- MAY20
- JUN20
- JUL20
- AUG20
- SEP20
- OCT20
- NOV20
- DEC20
- JAN21
- FEB21
- MAR21
- APR21
- MAY21
- JUN21
- JUL21
- AUG21
- SEP21
- OCT21
- NOV21
- DEC21
- JAN22
- FEB22
- MAR22
Ten Most Heavily Congested Transmission Facilities - Overall, March

The ten most heavily congested facilities account for 62% of total congestion for March.
Ten Most Heavily Congested Transmission Facilities - Overall, 2022

The ten most heavily congested facilities account for 59% of total congestion for 2022.

- BED-BLA Interface (EHV)
- Cumberland-Juniata 230 (PPL)
- Greys Point-Harmony 1021B 115 (DOM)
- APSOUTH Interface (EHV)
- Frackville-Siegfried 230 (PPL)
- Nottingham Reactor 230 (PECO)
- Lenox-N Meshoppen 115 (PN)
- AEP-DOM Interface (EHV)
- Prest-Tibb 138 kV (MISO)
- Cedar Sub-Roseland 230 Y (PSEG)

The ten most heavily congested facilities account for 59% of total congestion for 2022.
Energy Market

Interchange/Seams Summary
Monthly Average MISO Interface Pricing

$/MWh

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

MAR20, MAY20, AUG20, NOV20, MAR21, MAY21, AUG21, NOV21, MAR22
Positive values represent hours when the PJM price was higher. Negative values represent hours when the PJM price was lower.
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 March = $-3.49
Percent of hours in which the direction of flow is consistent with price differentials = 66.80%
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 March = $-2.28
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

<table>
<thead>
<tr>
<th>Month</th>
<th>MAR20</th>
<th>APR20</th>
<th>MAY20</th>
<th>JUN20</th>
<th>JUL20</th>
<th>AUG20</th>
<th>SEP20</th>
<th>OCT20</th>
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<th>MAY21</th>
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<td>$ Millions</td>
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Load-Adjusted Synchronized Reserve and Synchronous Condenser Costs

- **Synchronized Reserve Market Payments / MWh**
- **Synchronous Condenser Payments / MWh**
DR Participation in PJM Regulation Markets

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

- **$ Millions**

- **MWh**

<table>
<thead>
<tr>
<th>Month</th>
<th>MAR20</th>
<th>APR20</th>
<th>MAY20</th>
<th>JUN20</th>
<th>JUL20</th>
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**Note:** The graph shows the monthly payments and MWh cleared from March 2020 to March 2022 in PJM Regulation Markets.
DR Participation in PJM Synchronized Reserve Markets

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

$ Millions

- MAR20
- APR20
- MAY20
- JUN20
- JUL20
- AUG20
- SEP20
- OCT20
- NOV20
- DEC20
- JAN21
- FEB21
- MAR21
- APR21
- MAY21
- JUN21
- JUL21
- AUG21
- SEP21
- OCT21
- NOV21
- DEC21
- JAN22
- FEB22
- MAR22

MWh

- 0
- 50,000
- 100,000
- 150,000
- 200,000
Jennifer Warner-Freeman
Jennifer.Freeman@pjm.com

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(610) 666 – 8980
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