Markets Report

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Members Committee
May 7, 2019
PJM Wholesale Cost through March 2019 is $53.85/MWh, down from full-year 2018 costs of $59.96/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 7-16)

In March, temperatures were below average at the start of the month, thus the sum of Heating and Cooling Degree Days was above its historic average (Slides 8-10).

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

In March uplift exceeded $800,000 on one day – March 6th. (Slides 21 & 22)
• Load-weighted average LMP through March 2019 is $30.16/MWh: (Slides 28-29)
  – March 2019 was $29.90/MWh, which is somewhat lower, but in line with, March 2018 ($33.10/MWh) and March 2017 ($32.30/MWh).

• In June 2017, the calculation of FTR surplus was changed to no longer include Balancing congestion and Market to Market payments. (Slide 45)

• FTR revenue adequacy for the month of March is 100% and the 2018-2019 Planning Year is currently fully funded. (Slides 44-47)

• Congestion remained at relatively low levels in March. (Slide 45)

• Regulation and Synchronized Reserve market costs have generally tracked with energy prices over time. (Slides 60-62)
Markets Report
PJM Wholesale Cost

<table>
<thead>
<tr>
<th>Year</th>
<th>Energy</th>
<th>Reliability Capacity</th>
<th>Transmission</th>
<th>Other</th>
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<tbody>
<tr>
<td>2015</td>
<td>$36.25</td>
<td>$11.14</td>
<td>$6.93</td>
<td>$55.89</td>
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<td>2016</td>
<td>$29.27</td>
<td>$9.39</td>
<td>$7.53</td>
<td>$47.49</td>
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<td>2017</td>
<td>$31.06</td>
<td>$8.73</td>
<td>$8.58</td>
<td>$49.64</td>
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<td>2018</td>
<td>$37.83</td>
<td>$11.89</td>
<td>$8.84</td>
<td>$59.96</td>
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<tr>
<td>2019</td>
<td>$30.16</td>
<td>$13.45</td>
<td>$9.08</td>
<td>$53.85</td>
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</table>
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, 2018. 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

Chart shows a comparison of energy consumption and degree days for different months.

- Mar18 to Mar19: TWh
- Apr18 to Apr19: TWh
- May18 to May19: TWh
- Jun18 to Jun19: TWh
- Jul18 to Jul19: TWh
- Aug18 to Aug19: TWh
- Sep18 to Sep19: TWh
- Oct18 to Oct19: TWh
- Nov18 to Nov19: TWh
- Dec18 to Dec19: TWh
- Jan19 to Jan19: TWh
- Feb19 to Feb19: TWh
- Mar19 to Mar19: TWh

Heating Degree Days + Cooling Degree Days

- 0 to 1,250
- 0 to 1,000
- 0 to 750
- 0 to 500
- 0 to 250
- 0 to 0
Historic Average Weather and Energy versus Current Month - Daily
Average Fuel Prices - Daily

Fuel Price Source: S&P Global Platts

- Average Gas - $2.91
- Average Coal - $2.32
- Average Oil - $13.23
- Average LMP - $29.41
Positive values represent days when the DA daily average price was higher than RT. Negative values represent days when the DA price was lower.
Monthly Generation by Fuel

'Mother' includes Hydro, Oil, Solar, Wind, and Other
Monthly Generation by Fuel, Other

'MOther' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Daily Generation by Fuel - March

'MOther' includes Hydro, Oil, Solar, Wind, and Other
Daily Generation by Fuel, Other - March

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

- $2.5
- $2.0
- $1.5
- $1.0
- $0.5
- $0.0

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

$ Millions

• In March uplift exceeded $800,000 on one day; March 6\textsuperscript{th}.

• Contributing factors to uplift were:
  – Localized congestion
  – High load levels
  – Load forecast error associated with the morning peak

More information on Uplift can be found on PJM’s website at [Drivers of Uplift](www.pjm.com)
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

MAR17  MAY17  AUG17  NOV17  MAR18  MAY18  AUG18  NOV18  MAR19
Deviations Balancing Operating Reserve Rates

$/MWh

- RTO
- East
- West

MAR17  MAY17  AUG17  NOV17  MAR18  MAY18  AUG18  NOV18  MAR19
Energy Market

LMP Summary
Load-Weighted Average LMP

$ per MWh

January 2018 had the highest Load-Weighted Average LMP of $84.

The chart shows the average LMP for each month from March 2017 to March 2019.
Fuel Cost Adjusted LMP (Referenced to 1999 Fuel Prices)
LMP Price Posting Suspensions and Reruns

- Percentage of Intervals Price Posting Suspended
- Percentage of Intervals Rerun prior to Final LMP Posting
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 (INCs & DECs) - Total Number

Number of Bids (Millions)

Submitted Bids
Cleared Bids

MAR17 APR17 MAY17 JUN17 JUL17 AUG17 SEP17 OCT17 NOV17 DEC17 JAN18 FEB18 MAR18 APR18 MAY18 JUN18 JUL18 AUG18 SEP18 OCT18 NOV18 DEC18 JAN19 FEB19 MAR19
Up-To-Congestion Transactions - Total Number

![Chart showing the number of transactions over time, with categories for Submitted Transactions and Cleared Transactions. The chart displays data from March 2017 to March 2019.]
Up-To-Congestion Transactions - Total Volume
INCds, DECs and Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

Month:
- MAR17
- APR17
- MAY17
- JUN17
- JUL17
- AUG17
- SEP17
- OCT17
- NOV17
- DEC17
- JAN18
- FEB18
- MAR18
- APR18
- MAY18
- JUN18
- JUL18
- AUG18
- SEP18
- OCT18
- NOV18
- DEC18
- JAN19
- FEB19
- MAR19
INCs, DECs and Up-To-Congestion Transactions - Total Volume

MWh (Millions)

- Submitted MWh
- Cleared MWh
Energy Market

Congestion and FTR Summary
<table>
<thead>
<tr>
<th>Period</th>
<th>Surplus / Underfunding</th>
<th>Payout Ratio</th>
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<tr>
<td>March, 2019</td>
<td>$12,131,182</td>
<td>100%</td>
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<tr>
<td>2019</td>
<td>$48,176,088</td>
<td>100%</td>
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<tr>
<td>2018/2019</td>
<td>$80,053,067</td>
<td>100%</td>
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<tr>
<td>Month</td>
<td>MAR17</td>
<td>APR17</td>
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Planning Period FTR Payout

Planning Period FTR Payout Ratio

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<tbody>
<tr>
<td>0%</td>
<td>100%</td>
<td>90%</td>
<td>80%</td>
<td>70%</td>
<td>60%</td>
<td>50%</td>
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<td>30%</td>
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<td>40%</td>
<td>50%</td>
<td>60%</td>
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The ten most heavily congested facilities account for 65% of total congestion for March.
Ten Most Heavily Congested Transmission Facilities - Overall, 2019

The ten most heavily congested facilities account for 53% of total congestion for 2019.
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)

MAR17  MAY17  AUG17  NOV17  MAR18  MAY18  AUG18  NOV18  MAR19
Monthly Average NYISO Interface Pricing

$/MWh

- PJM NYISO Price (RT)
- NYISO PJM Price (RT)
- PJM NYISO Price (DA)
- NYISO PJM Price (DA)
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 March = $1.00
Percent of hours in which the direction of flow is consistent with price differentials = 45.97%
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 March = $-1.15
Percent of hours in which the direction of flow is consistent with price differentials = 65.59%
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 = $-1.29
Negative M2M Credit represents PJM payment to MISO.
Negative M2M Credit represents PJM payment to NYISO.
Ancillary Service Market

Summary
Regulation Costs

$ Millions

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<tr>
<td>Value</td>
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Synchronized Reserve and Synchronous Condenser Costs

$ Millions

- Synchronized Reserve Market Payments
- Synchronous Condenser Payments
Load-Adjusted Synchronized Reserve and Synchronous Condenser Costs

Cents/MWh

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

Months: MAR17, APR17, MAY17, JUN17, JUL17, AUG17, SEP17, OCT17, NOV17, DEC17, JAN18, FEB18, MAR18, APR18, MAY18, JUN18, JUL18, AUG18, SEP18, OCT18, NOV18, DEC18, JAN19, FEB19, MAR19
DR Participation in PJM Regulation Markets

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

$ Millions

$0.0  $0.2  $0.4  $0.6

MWh

0  5,000  10,000  15,000

MAR17 APR17 MAY17 JUN17 JUL17 AUG17 SEP17 OCT17 NOV17 DEC17 JAN18 FEB18 MAR18 APR18 MAY18 JUN18 JUL18 AUG18 SEP18 OCT18 NOV18 DEC18 JAN19 FEB19 MAR19
Synchronized Reserve Market Daily Prices and Charges

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

$ Millions

$0.5

$0.4

$0.3

$0.2

$0.1

$0.0

01MAR19 02MAR19 03MAR19 04MAR19 05MAR19 06MAR19 07MAR19 08MAR19 09MAR19 10MAR19 11MAR19 12MAR19 13MAR19 14MAR19 15MAR19 16MAR19 17MAR19 18MAR19 19MAR19 20MAR19 21MAR19 22MAR19 23MAR19 24MAR19 25MAR19 26MAR19 27MAR19 28MAR19 29MAR19 30MAR19 31MAR19

$250

$200

$150

$100

$50

$0