Markets Report

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Executive Summary

- PJM Wholesale Cost through July 2019 is $50.97/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 July, temperatures were above average for most of the month, only getting below average for a few days. Thus, the sum of Heating and Cooling Degree Days was well above its historic average. (Slides 8-10)
- Because temperatures were very warm, Energy use was above its historic average. (Slides 8-10)
- In July uplift exceeded $800,000 on two days – July 1st and July 10th. (Slides 21 & 22)
• Load-weighted average LMP through July 2019 is $27.89/MWh: (Slides 28-29)
  – July 2019 was $29.82/MWh, which is lower than both July 2018 ($32.90/MWh) and July 2017 ($32.95/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 July is 100% and the 2019-2020 Planning Year is currently fully funded. (Slides 44-47)

• Congestion increased over the levels seen over the last several months but is very much in line with levels seen last July. (Slide 45)

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

$\text{$/MWh}$

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

<table>
<thead>
<tr>
<th>Year</th>
<th>$\text{$/MWh}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>$1.56$</td>
</tr>
<tr>
<td>2016</td>
<td>$1.20$</td>
</tr>
<tr>
<td>2017</td>
<td>$1.31$</td>
</tr>
<tr>
<td>2018</td>
<td>$1.44$</td>
</tr>
<tr>
<td>2019</td>
<td>$1.23$</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, 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

TWh vs Heating Degree Days + Cooling Degree Days

- Jul18, Aug18, Sep18, Oct18, Nov18, Dec18, Jan19, Feb19, Mar19, Apr19, May19, Jun19, Jul19
Historic Average Weather and Energy versus Current Month - Daily

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

% Deviation from Monthly Average Fuel Price

Fuel Price Source: S&P Global Platts

- Average Gas - $2.11
- Average Coal - $1.94
- Average Oil - $13.05
- Average LMP - $29.77
Positive values represent days when the DA daily average price was higher than RT. Negative values represent days when the DA price was lower.

Daily Difference Between Day-Ahead and Real-Time System Marginal Prices

Average price difference for July = -$0.37
Monthly Generation by Fuel

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

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

'Mother' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Operating Reserve
(Uplift)
• In July uplift exceeded $800,000 on two days; July 1\textsuperscript{st} and July 10\textsuperscript{th}.

• Contributing factors to uplift were:
  – Short-term LMP volatility
  – Congestion control

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

JUL17 SEP17 DEC17 MAR18 JUL18 SEP18 DEC18 MAR19 JUL19

- RTO
- East
- West
Deviations Balancing Operating Reserve Rates

$/MWh

- RTO
- East
- West

JUL17 SEP17 DEC17 MAR18 JUL18 SEP18 DEC18 MAR19 JUL19
Energy Market

LMP Summary
Fuel Cost Adjusted LMP (Referenced to 1999 Fuel Prices)
Energy Market

Demand Response Summary
Demand Side Response Estimated Revenue

$ Millions

- Capacity
- Ancillary Services
- Emergency Energy
- Economic Energy
- Economic Energy Incentives


$0 $100 $200 $300 $400 $500 $600 $700 $800 $900
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 Volume

- Submitted MWh
- Cleared MWh

MWh (Millions)
Up-To-Congestion Transactions - Total Volume

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

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

JUL17  AUG17  SEP17  OCT17  NOV17  DEC17  JAN18  FEB18  MAR18  APR18  MAY18  JUN18  JUL18  AUG18  SEP18  OCT18  NOV18  DEC18  JAN19  FEB19  MAR19  APR19  MAY19  JUN19  JUL19

0  1  2  3  4  5  6  7  8  9  10
INCs, DECs and Up-To-Congestion Transactions - Total Volume

MWh (Millions)

<table>
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<tr>
<th>Month</th>
<th>Submitted MWh</th>
<th>Cleared MWh</th>
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<tbody>
<tr>
<td>JUL17</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>AUG17</td>
<td>120</td>
<td>30</td>
</tr>
<tr>
<td>SEP17</td>
<td>150</td>
<td>40</td>
</tr>
<tr>
<td>OCT17</td>
<td>180</td>
<td>50</td>
</tr>
<tr>
<td>NOV17</td>
<td>210</td>
<td>60</td>
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<tr>
<td>DEC17</td>
<td>240</td>
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<td>JAN18</td>
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<td>MAR18</td>
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<td>APR18</td>
<td>360</td>
<td>110</td>
</tr>
<tr>
<td>MAY18</td>
<td>390</td>
<td>120</td>
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<tr>
<td>JUN18</td>
<td>420</td>
<td>130</td>
</tr>
<tr>
<td>JUL18</td>
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</tr>
<tr>
<td>AUG18</td>
<td>480</td>
<td>150</td>
</tr>
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<td>SEP18</td>
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<td>160</td>
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<tr>
<td>OCT18</td>
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<td>170</td>
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<tr>
<td>NOV18</td>
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<td>DEC18</td>
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<td>750</td>
<td>240</td>
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<tr>
<td>JUN19</td>
<td>780</td>
<td>250</td>
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Submitted MWh
Cleared MWh
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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<tr>
<td>July, 2019</td>
<td>$9,963,674</td>
<td>100%</td>
</tr>
<tr>
<td>2019</td>
<td>$102,481,985</td>
<td>100%</td>
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<tr>
<td>2019/2020</td>
<td>$22,682,148</td>
<td>100%</td>
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FTR Revenue vs. FTR Target Allocation

$ Millions

- Total FTR Revenues
- Total FTR Targets

For each month from JUL17 to JUL19, the graph shows the comparison between total FTR revenues and targets, with the x-axis representing the months and the y-axis showing the millions of dollars.
Planning Period FTR Payout

Planning Period FTR Payout Ratio
Ten Most Heavily Congested Transmission Facilities - Overall, July

Overall, July 2019
The ten most heavily congested facilities account for 53% of total congestion for July.

- Cool Springs–Milford 230 (DPL S)
- Conastone–Peach Bottom 500 (EHV)
- Cedar Creek–Red Lion 230 (DPL S)
- Miami Fort–Tanners Creek 345 (AEP IM–DEOK)
- Riverside–115011 115 (BGE)
- Bagley–Graceton 230 2313 (BGE)
- Faceroock Serial Device 69 (PPL)
- Big Grave Ck–Geo Washington 138 (AEP AP)
- Lakin–Sporn 138 (AEP AP)
- Pierce–Pierce DK 345 (DEOK)
The ten most heavily congested transmission facilities account for 45% 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)

JUL17  SEP17  DEC17  MAR18  JUL18  SEP18  DEC18  MAR19  JUL19
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 July = $-1.73
Percent of hours in which the direction of flow is consistent with price differentials = 56.32%
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.

Average price difference for July = $-0.47
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 July = $-0.14
Percent of hours in which the direction of flow is consistent with price differentials = 57.93%
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 July = $-1.55
Negative M2M Credit represents PJM payment to MISO
Negative M2M Credit represents PJM payment to NYISO
Ancillary Service Market
Summary
Regulation Costs

$ Millions

JUL17 | AUG17 | SEP17 | OCT17 | NOV17 | DEC17 | JAN18 | FEB18 | MAR18 | APR18 | MAY18 | JUN18 | JUL18 | AUG18 | SEP18 | OCT18 | NOV18 | DEC18 | JAN19 | FEB19 | MAR19 | APR19 | MAY19 | JUN19 | JUL19

$0 | $5 | $10 | $15 | $20 | $25 | $30 | $35 | $40 | $45 | $50
Synchronized Reserve and Synchronous Condenser Costs

![Chart showing synchronized reserve and synchronous condenser costs over time.](image-url)
Load-Adjusted Synchronized Reserve and Synchronous Condenser Costs
DR Participation in PJM Synchronized Reserve Markets

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

Graph showing the trend of total payments and MWh cleared from July 2017 to July 2019.
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)