Markets Report

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• PJM Wholesale Cost through August 2018 was $60.90/MWh, up from full-year 2017 costs of $49.64/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 August, temperatures were above average throughout most of the month, thus the sum of Heating and Cooling Degree Days was above its historic average (Slides 8-10).

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

• In August, uplift exceeded $800,000 on 1 day; August 6th. (Slides 20 & 21)
• Load-weighted average LMP through August 2018 is $39.96/MWh: (Slides 28-29)
  – August 2018 was $34.26/MWh, which is somewhat higher than August 2017 ($27.73/MWh), but in line with August 2016 ($35.59/MWh).

• In June 2017, the calculation of FTR surplus was changed to no longer include Balancing congestion and Market to Market payments. (Slide 46)

• FTR revenue adequacy for the month of August is 100% and the 2018-2019 Planning Year is currently fully funded. (Slides 45-47)

• Congestion remained at relatively low levels in August. (Slide 44)

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

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

<table>
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<tr>
<th>Year</th>
<th>Regulation</th>
<th>Operating Reserve</th>
<th>PJM Cost</th>
<th>Reactive</th>
<th>Transmission Owner Control</th>
<th>Synchronized Reserve</th>
<th>Black Start</th>
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<tbody>
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<td>2014</td>
<td>$0.32</td>
<td>$1.23</td>
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<td>$0.39</td>
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Market Conditions
The weather parameter shown in the following slides 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, 2017. 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**

The chart compares the energy consumption and degree days for each month from August 2017 to August 2018, showing trends in energy usage and temperature adjustments.
Historic Average Weather and Energy versus Current Month - Daily

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

Fuel Price Source: S&P Global Platts

- Average Gas - $2.80
- Average Coal - $2.26
- Average Oil - $14.23
- Average LMP - $33.92
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 - August

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

'Mother' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Positive values represent days when the DA daily average price was higher than RT. Negative values represent days when the DA price was lower.
Operating Reserve
(Uplift)
Monthly Uplift - $/MWh Load

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

$/MWh

AUG16, SEP16, OCT16, NOV16, DEC16, JAN17, FEB17, MAR17, APR17, MAY17, JUN17, JUL17, AUG17, SEP17, OCT17, NOV17, DEC17, JAN18, FEB18, MAR18, APR18, MAY18, JUN18, JUL18, AUG18
• In August uplift exceeded $800,000 on 1 day; August 6\textsuperscript{th}.

• Contributing factors to uplift were:
  – High system load
  – Load forecasting error

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

- 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 | PENLECO | PEPCO | PPL | PSEG |
Percent of Total CC, CT 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.
Deviations Balancing Operating Reserve Rates

$/MWh

RTO
East
West

AUG16  OCT16  JAN17  MAY17  AUG17  OCT17  JAN18  MAY18  AUG18
Energy Market
LMP Summary
LMP Price Posting Suspensions and Reruns

- Percentage of Intervals Price Posting Suspended
- Percentage of Intervals Rerun prior to Final LMP Posting

Percentage of 5-Minute Intervals

|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
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

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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 total registered MW in PJM's Economic Demand Response from AUG16 to AUG18. The graph indicates fluctuations in MW from 2016 to 2018, with a significant drop in AUG17 and a gradual increase by AUG18.](image-url)
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
Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

Data for months from AUG16 to AUG18 is displayed in the chart.
Up-To-Congestion Transactions - Total Volume

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

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions
INCs, DEC’s and Up-To-Congestion Transactions - Total Volume
Energy Market

Congestion and FTR Summary
FTR Revenue vs. FTR Target Allocation

- **Total FTR Revenues**
- **Total FTR Targets**

$ Millions

- AUG16, SEP16, OCT16, NOV16, DEC16, JAN17, FEB17, MAR17, APR17, MAY17, JUN17, JUL17, AUG17, SEP17, OCT17, NOV17, DEC17, JAN18, FEB18, MAR18, APR18, MAY18, JUN18, JUL18, AUG18

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<table>
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<tr>
<th>Period</th>
<th>Surplus / Underfunding</th>
<th>Payout Ratio</th>
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<td>August, 2018</td>
<td>$10,390,251</td>
<td>100%</td>
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<tr>
<td>2018</td>
<td>$322,182,552</td>
<td>100%</td>
</tr>
<tr>
<td>2018/2019</td>
<td>$34,001,111</td>
<td>100%</td>
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Ten Most Heavily Congested Transmission Facilities - Overall, August

The ten most heavily congested facilities account for 53% of total congestion for August.
Ten Most Heavily Congested Transmission Facilities - Overall, 2018

The ten most heavily congested facilities account for 48% of total congestion for 2018.
Energy Market

Interchange/Seams Summary
Monthly Average NYISO Interface Pricing

- **PJM NYISO Price (RT)**
- **NYISO PJM Price (RT)**
- **PJM NYISO Price (DA)**
- **NYISO PJM Price (DA)**

<table>
<thead>
<tr>
<th>Period</th>
<th>PJM NYISO Price (RT)</th>
<th>NYISO PJM Price (RT)</th>
<th>PJM NYISO Price (DA)</th>
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<td>$20</td>
<td>$20</td>
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<tr>
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<td>MAY18</td>
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<tr>
<td>AUG18</td>
<td>$20</td>
<td>$20</td>
<td>$20</td>
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</table>
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 August = $-1.16
Percent of hours in which the direction of flow is consistent with price differentials = 56.85%
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 August = $-1.16
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 August = $0.89
Percent of hours in which the direction of flow is consistent with price differentials = 48.79%
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
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

Chart showing costs in millions from AUG16 to AUG18.
Load-Adjusted Synchronized Reserve and Synchronous Condenser Costs
DR Participation in PJM Regulation Markets

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

$ Millions

- AUG16
- SEP16
- OCT16
- NOV16
- DEC16
- JAN17
- FEB17
- MAR17
- APR17
- MAY17
- JUN17
- JUL17
- AUG17
- SEP17
- OCT17
- NOV17
- DEC17
- JAN18
- FEB18
- MAR18
- APR18
- MAY18
- JUN18
- JUL18
- AUG18

MWh

- 0
- 2,500
- 5,000
- 7,500
- 10,000
Regulation Market Daily Prices and Charges

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

The graph shows the daily charges and prices from 01 AUG 2018 to 31 AUG 2018, with peaks and troughs indicating the fluctuation in costs and prices.