Markets Report

Jennifer Warner-Freeman
Senior Economist, Market Analysis
MC Webinar
September 25, 2017
• PJM Wholesale Cost through August 2017 was $47.80/MWh, up from full-year 2016 costs of $47.49/MWh. (Slides 5 & 6)

• Operating Reserve cost contribution to wholesale energy costs remains at its lowest level in the 2011-2017 time period. (Slide 6)

• Load-weighted average LMP for 2017 year to date is $30/MWh: (Slide 18)
  – August 2017 was $28/MWh, which is lower than August 2016 ($36) but in line, seasonally, with August 2015 ($30).

• In July and August, the sum of Heating and Cooling Degree Days was about below its historic average, indicating mild weather. Energy use also below its historic average. (Slides 16-17)
• The decrease in MWs registered in PJM’s Economic Demand Response is primarily administrative and due to registrations expiring and not yet renewing. (Slide 23)

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

• FTR revenue adequacy for the month of August is 100% and the 2017-2018 Planning Year remains fully funded. (Slides 33-36)

• Congestion levels remain historically low. (Slide 33)

• Due to a database issue at the time this report was generated, the Market-to-Market Coordination Settlement graphs on slides 45-46 are only up-to-date through the end of July.

• Regulation and Synchronized Reserve market costs have generally tracked with energy prices over time. (Slides 49-51)
Markets Report
Operating Reserve
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

AUG15 OCT15 JAN16 MAY16 JUL16 OCT16 JAN17 MAY17 AUG17

RTO East West
Energy Market

LMP Summary
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, 2016. 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

Graph showing TWh and Heating Degree Days + Cooling Degree Days for Aug16 to Aug17.
Fuel Cost Adjusted LMP (Referenced to 1999 Fuel Prices)
In September 2014, the method for calculating LMP re-run intervals was changed to only include intervals that actually impacted LMP.
Energy Market

Demand Response Summary
Demand Side Response Estimated Revenue

Capacity revenue prior to RPM implementation on 6-01-2007 estimated based on average daily ALM capacity credits and weighted average daily PJM capacity market clearing price.
*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)

AUG15  SEP15  OCT15  NOV15  DEC15  JAN16  FEB16  MAR16  APR16  MAY16  JUN16  JUL16  AUG16  SEP16  OCT16  NOV16  DEC16  JAN17  FEB17  MAR17  APR17  MAY17  JUN17  JUL17  AUG17
Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

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

- Submitted MWh
- Cleared MWh

MWh (Millions)
INCs, DECs and Up-To-Congestion Transactions - Total Number

![Bar Chart: Submitted Transactions vs Cleared Transactions]

- **Submitted Transactions**
- **Cleared Transactions**

Number of Transactions (Millions)

- AUG15
- SEP15
- OCT15
- NOV15
- DEC15
- JAN16
- FEB16
- MAR16
- APR16
- MAY16
- JUN16
- JUL16
- AUG16
- SEP16
- OCT16
- NOV16
- DEC16
- JAN17
- FEB17
- MAR17
- APR17
- MAY17
- JUN17
- JUL17
- AUG17
INCs, DECs and Up-To-Congestion Transactions - Total Volume

MWh (Millions)

- Submitted MWh
- Cleared MWh

<table>
<thead>
<tr>
<th>Month</th>
<th>AUG15</th>
<th>SEP15</th>
<th>OCT15</th>
<th>NOV15</th>
<th>DEC15</th>
<th>JAN16</th>
<th>FEB16</th>
<th>MAR16</th>
<th>APR16</th>
<th>MAY16</th>
<th>JUN16</th>
<th>JUL16</th>
<th>AUG16</th>
<th>SEP16</th>
<th>OCT16</th>
<th>NOV16</th>
<th>DEC16</th>
<th>JAN17</th>
<th>FEB17</th>
<th>MAR17</th>
<th>APR17</th>
<th>MAY17</th>
<th>JUN17</th>
<th>JUL17</th>
<th>AUG17</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Energy Market

Congestion and FTR Summary
FTR Revenue vs. FTR Target Allocation

$ Millions

<table>
<thead>
<tr>
<th>$0</th>
<th>$50</th>
<th>$100</th>
<th>$150</th>
<th>$200</th>
</tr>
</thead>
</table>

- **Total FTR Revenues**
- **Total FTR Targets**
<table>
<thead>
<tr>
<th>Period</th>
<th>Surplus / Underfunding</th>
<th>Payout Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>August, 2017</td>
<td>$3,964,858</td>
<td>100%</td>
</tr>
<tr>
<td>2017</td>
<td>$64,411,803</td>
<td>100%</td>
</tr>
<tr>
<td>2017/2018</td>
<td>$14,970,106</td>
<td>100%</td>
</tr>
</tbody>
</table>
Ten Most Heavily Congested Transmission Facilities - Overall, August

- Graceton-Safe Harbor (BGE)
- Conastone-Peach Bottom 500 (EHV)
- Emilie-Falls 138 (PECO)
- Ohio Central-W Coshocton 138 (AEP)
- Butler-Shanor Manor 138 (APS)
- Braid-East Frankfort 345 2003 (COMED)
- Brunner Island-Yorkana 230 (PPL)
- Greenfield-Lakeview 138 (ATSI)
- Havana E Havana S 138 (MISO)
- Zion-Pleasant Priarie 345 2221 (COMED)
Energy Market

Interchange/Seams Summary
Monthly Average MISO Interface Pricing

$/MWh

AUG15 OCT15 JAN16 MAY16 JUL16 OCT16 JAN17 MAY17 AUG17

PJM MISO Price (RT)
MISO PJM Price (RT)
PJM MISO Price (DA)
MISO PJM Price (DA)
Monthly Average NYISO Interface Pricing

$/MWh

PJM NYISO Price (RT)
NYISO PJM Price (RT)
PJM NYISO Price (DA)
NYISO PJM Price (DA)

AUG15 OCT15 JAN16 MAY16 JUL16 OCT16 JAN17 MAY17 AUG17
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 = $-1.19
Percent of hours in which the direction of flow is consistent with price differentials = 66.13%
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 = $-0.63
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 = $1.50
Percent of hours in which the direction of flow is consistent with price differentials = 50.00%
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 August = $0.64
Negative M2M Credit represents PJM payment to MISO

Net M2M Credit ~ MISO ($ Millions)
Net M2M Credit ~ MISO/Total FTR Targets (%)
PJM-NYISO Market-to-Market Coordination Settlement

- Negative M2M Credit represents PJM payment to NYISO

Diagram showing financial data for August 2015 to July 2017 with specific months showing significant values.
Ancillary Service Market

Summary
Average Synchronous Condenser Payments equals the 36-month rolling average plus one standard deviation.
Load-Adjusted Synchronized Reserve and Synchronous Condenser Costs

Average Synchronous Condenser Payments equals the 36-month rolling average plus one standard deviation.
DR Participation in PJM Regulation Markets

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

$ Millions

$0.3

$0.2

$0.1

$0.0

MWh

9,000

6,000

3,000

0

AUG15
SEP15
OCT15
NOV15
DEC15
JAN16
FEB16
MAR16
APR16
MAY16
JUN16
JUL16
AUG16
SEP16
OCT16
NOV16
DEC16
JAN17
FEB17
MAR17
APR17
MAY17
JUN17
JUL17
AUG17
DR Participation in PJM Synchronized Reserve Markets

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