Markets Report

Rami Dirani
Senior Economist, Market Analysis
November 20, 2017
• PJM Wholesale Cost through October 2017 was $48.63/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)
• In October, uplift exceeded $800,000 on three days; October 9, 10 & 11 (slides 10 & 11)
• Load-weighted average LMP for 2017 year to date is $30.24/MWh: (Slide 20)
  – October 2017 was $28.26/MWh, which is seasonally in line with both October 2016 ($28.13/MWh) and October 2015 ($28.22/MWh).
• In October, the sum of Heating and Cooling Degree Days was slightly below its historic average. Energy use was also below its historic average. (Slides 18-19)
The decrease in MWs registered in PJM’s Economic Demand Response is primarily administrative and due to registrations expiring and not yet renewing. (Slide 25)

In June, the calculation of FTR surplus was changed to no longer include Balancing congestion and Market to Market payments. (Slide 35)

FTR revenue adequacy for the month of October is 77% and the 2017-2018 Planning Year remains fully funded. (Slides 36-38)

Congestion levels remain historically low. (Slide 35)

Regulation and Synchronized Reserve market costs have generally tracked with energy prices over time. (Slides 50-52)
Markets Report
PJM Wholesale Cost - Other

<table>
<thead>
<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>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>$0.24</td>
<td>$1.02</td>
<td>$0.35</td>
<td>$0.32</td>
<td>$0.32</td>
<td>$0.32</td>
<td>$0.24</td>
</tr>
<tr>
<td>2014</td>
<td>$0.32</td>
<td>$1.23</td>
<td>$0.32</td>
<td>$0.32</td>
<td>$0.39</td>
<td>$0.17</td>
<td>$0.32</td>
</tr>
<tr>
<td>2015</td>
<td>$0.23</td>
<td>$1.56</td>
<td>$0.35</td>
<td>$0.32</td>
<td>$0.32</td>
<td>$0.17</td>
<td>$0.23</td>
</tr>
<tr>
<td>2016</td>
<td>$0.39</td>
<td>$1.20</td>
<td>$0.39</td>
<td>$0.32</td>
<td>$0.32</td>
<td>$0.17</td>
<td>$0.39</td>
</tr>
<tr>
<td>2017</td>
<td>$0.42</td>
<td>$1.26</td>
<td>$0.32</td>
<td>$0.32</td>
<td>$0.32</td>
<td>$0.15</td>
<td>$0.42</td>
</tr>
</tbody>
</table>
Operating Reserve
Days exceeding $800,000 of uplift in October were the 9\textsuperscript{th}, 10\textsuperscript{th} and 11\textsuperscript{th}.

Contributing factors to uplift on these days were:
- Outages and overall system congestion during outage season
- Increased Load & Reserve MW requirements associated with system conditions and warmer weather compared to an otherwise mild month
- Load Forecasting associated with the warmer weather
Percent of Total CC, CT 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.
Deviation Balancing Operating Reserve Rates
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, 2015. Averages include load data for all of TO zones in the current RTO footprint.
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
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.
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

MWh (Millions)

- Submitted MWh
- Cleared MWh

OCT15 - OCT17
Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

OCT15, NOV15, DEC15, JAN16, FEB16, MAR16, APR16, MAY16, JUN16, JUL16, AUG16, SEP16, OCT16, NOV16, DEC16, JAN17, FEB17, MAR17, APR17, MAY17, JUN17, JUL17, AUG17, SEP17, OCT17
INCs, DECs and Up-To-Congestion Transactions - Total Number
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>
<tr>
<td>October, 2017</td>
<td>$-15,612,430</td>
<td>77%</td>
</tr>
<tr>
<td>2017</td>
<td>$52,624,568</td>
<td>100%</td>
</tr>
<tr>
<td>2017/2018</td>
<td>$3,182,871</td>
<td>100%</td>
</tr>
</tbody>
</table>
Ten Most Heavily Congested Transmission Facilities - Overall, October

- Conastone-Otter Creek 230 (BGE-ME)
- Braid-East Frankfort 345 2003 (COMED)
- Emilie-Falls 138 (PECO)
- TMI 500/230 1 (METED)
- Butler-Shanor Manor 138 (APS)
- Conastone-Peach Bottom 500 (EHV)
- Cherry Valley 345/138 TR82 (COMED)
- Nucor-Whitestown 345 (MISO)
- Cedar Grove-Clifton 230 B (PSEG)
- Dumont-Stillwell 345 (AEP)
Energy Market

Interchange/Seams Summary
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 October = $-0.05
Percent of hours in which the direction of flow is consistent with price differentials = 47.72%
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 October = $-0.85
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 October = $0.95
Percent of hours in which the direction of flow is consistent with price differentials = 55.11%
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 October = $2.40
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

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)