Markets Report

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• PJM Wholesale Cost for 2017 was $49.64/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 December, uplift exceeded $800,000 on six days; December 13th and 27th-31st (slides 10 & 11)

• Load-weighted average LMP for calendar year 2017 is $31.06/MWh: (Slide 17)
  – December 2017 was $40.77/MWh, which is seasonally in line with both December 2016 ($32.57/MWh) and December 2015 ($25.10/MWh).

• In December, due to cold weather at the end of the month, the sum of Heating and Cooling Degree Days was above its historic average. Energy use was also above its historic average. (Slides 18-19)
The decrease in MWs registered in PJM’s Economic Demand Response is primarily due to registrations expiring and not 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 December is 100% and the 2017-2018 Planning Year remains fully funded. (Slides 35-38)

Congestion levels remain historically low, however, are comparatively high in December due to the cold weather. (Slide 35)

Regulation and Synchronized Reserve market costs have generally tracked with energy prices over time. (Slides 51-53)
Markets Report
PJM Wholesale Cost

<table>
<thead>
<tr>
<th>Year</th>
<th>Energy</th>
<th>Reliability Capacity</th>
<th>Transmission</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>$38.67</td>
<td>$7.10</td>
<td>$5.00</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>$36.25</td>
<td>$11.14</td>
<td>$6.93</td>
<td>$5.75</td>
</tr>
<tr>
<td>2015</td>
<td>$36.25</td>
<td>$11.14</td>
<td>$6.93</td>
<td>$5.75</td>
</tr>
<tr>
<td>2016</td>
<td>$31.06</td>
<td>$8.73</td>
<td>$7.63</td>
<td>$8.58</td>
</tr>
<tr>
<td>2017</td>
<td>$31.06</td>
<td>$8.73</td>
<td>$8.58</td>
<td></td>
</tr>
</tbody>
</table>
Operating Reserve
• Days exceeding $800,000 of uplift in December were the 13\textsuperscript{th} and 27\textsuperscript{th}-31\textsuperscript{st}.

• Contributing factors to uplift on the 13\textsuperscript{th} were:
  o Outages and overall system congestion

• Contributing factors to uplift on the 27\textsuperscript{th}-31\textsuperscript{st} were:
  o Extended cold weather throughout the PJM footprint
  o High loads with resulting LMPs and forecasting difficulty
  o Overall system conditions
    o Internal transfer interfaces
    o External interchange flows
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.
Reliability Balancing Operating Reserve Rates
Deviations Balancing Operating Reserve Rates

$\$/MWh

RTO
East
West

DEC15  MAR16  MAY16  AUG16  NOV16  MAR17  JUN17  AUG17  DEC17
Energy Market
LMP Summary
Load-Weighted Average LMP
• 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, 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

TWh

Heating Degree Days + Cooling Degree Days

Dec16 Jan17 Feb17 Mar17 Apr17 May17 Jun17 Jul17 Aug17 Sep17 Oct17 Nov17 Dec17

0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 400 420 440 460 480 500 520 540 560 580 600 620 640 660 680 700 720 740 760 780 800 820 840 860 880 900 920 940 960 980 1000 1020 1040 1060 1080 1100 1120 1140 1160 1180 1200 1220 1240 1250

0 250 500 750 1000 1250
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

MW


2,200  |  2,400  |  2,600  |  2,800  |  3,000  |  3,200  |  3,400  |  3,600

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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 & DEC) - Total Number

Number of Bids (Millions)

- Submitted Bids
- Cleared Bids

Month:
- DEC15, JAN16, FEB16, MAR16, APR16, MAY16, JUN16, JUL16, AUG16, SEP16, OCT16, NOV16, DEC16, JAN17, FEB17, MAR17, APR17, MAY17, JUN17, JUL17, AUG17, SEP17, OCT17, NOV17, DEC17
Virtual Bids (INCs & DECs) - Total Volume

- **Submitted MWh**
- **Cleared MWh**
Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

|   | DEC16 | JAN16 | FEB16 | MAR16 | APR16 | MAY16 | JUN16 | JUL16 | AUG16 | SEP16 | OCT16 | NOV16 | DEC16 | JAN17 | FEB17 | MAR17 | APR17 | MAY17 | JUN17 | JUL17 | AUG17 | SEP17 | OCT17 | NOV17 | DEC17 |
|---|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|   |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
Up-To-Congestion Transactions - Total Volume

Submitted MWh

Cleared MWh

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

MWh ( Millions )

- Submitted MWh
- Cleared MWh

Energy Market

Congestion and FTR Summary
## FTR Funding

<table>
<thead>
<tr>
<th>Period</th>
<th>Surplus / Underfunding</th>
<th>Payout Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>December, 2017</td>
<td>$61,253,364</td>
<td>100%</td>
</tr>
<tr>
<td>2017</td>
<td>$124,043,792</td>
<td>100%</td>
</tr>
<tr>
<td>2017/2018</td>
<td>$74,602,095</td>
<td>100%</td>
</tr>
</tbody>
</table>
Planning Period FTR Payout

Planning Period FTR Payout Ratio

- 2003
- 2004
- 2005
- 2006
- 2007
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Ten Most Heavily Congested Transmission Facilities - Overall, December

- 50045005 Interface (EHV)
- Carson-Rawlings 500 511 (DOM)
- APSOUTH Interface (EHV)
- Person-Sedge Hill 230 296C (DOM)
- Miami Fort-Tanners Creek 345 (AEP IM-DEOK)
- Cedar Grove-Clifton 230 B (PSEG)
- AEP-DOM Interface (EHV)
- Byron-Cherry Valley 345 0621 6 (COMED)
- Conastone-Peach Bottom 500 (EHV)
- Kent- Vaughn 69 (DPL)

Chart showing congestion levels for each facility with categories for Total, Day-ahead, Balancing, and M2M.
Ten Most Heavily Congested Transmission Facilities - Overall, 2017
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)

DEC15  MAR16  MAY16  AUG16  NOV16  MAR17  JUN17  AUG17  DEC17
Monthly Average NYISO Interface Pricing
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 December = $2.10
Percent of hours in which the direction of flow is consistent with price differentials = 35.48%
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 December = $1.22
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 December = $4.26
Percent of hours in which the direction of flow is consistent with price differentials = 45.16%
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 December = $0.43
Negative M2M Credit represents PJM payment to MISO.
Negative M2M Credit represents PJM payment to NYISO.
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

DEC15  JAN16  FEB16  MAR16  APR16  MAY16  JUN16  JUL16  AUG16  SEP16  OCT16  NOV16  DEC16  JAN17  FEB17  MAR17  APR17  MAY17  JUN17  JUL17  AUG17  SEP17  OCT17  NOV17  DEC17
DR Participation in PJM Synchronized Reserve Markets

![Chart showing DR Participation in PJM Synchronized Reserve Markets]

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

Graph details:
- **Y-axis**: $ Millions
- **X-axis**: Months
- **Data Range**: December 2015 to December 2017

Note: The chart illustrates the dynamics of total payments and MWh cleared over the specified period, highlighting trends and variations in DR participation within PJM's synchronized reserve markets.