Markets Report

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MC Webinar
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• PJM Wholesale Cost for 2016 was $47.49/MWh, down from full-year 2015 costs of $55.89/MWh. The bulk of the decrease is made up of Energy costs down $7/MWh from 2015. (Slides 5 & 6)

• Operating Reserve cost contribution to wholesale energy costs is at its lowest level in the 2011-2016 time period. The value in 2016 was $.17/MWh, which is less than half the value in 2015. (Slide 6)

• Load-weighted average LMP for 2016 was $29.27/MWh: (Slide 18)
  – December 2016 was $32.6/MWh, which is seasonally in line with December 2014 ($33.2). December 2015 was considerably lower ($25.1), however, weather in December 2015 was unseasonably mild.

• In December, both energy and the sum of Heating and Cooling Degree Days were slightly above their historic averages. (Slides 16-17)
• The large decrease in the MWs registered in PJM’s Economic Demand Response, starting in June and continuing through December, is due to a combination of economic reasons and updated, per-site estimates of reductions achieved from mass-market programs. (Slide 23)

• Total cleared MWh of virtual bids (INCs and DECs) have been slowly increasing since July 2015. After increases in December 2015 and January 2016, total cleared MWh of UTC transactions have been fluctuating around a new, higher level in 2016. (Slides 27-32 and data appendix)

• FTR revenue adequacy for the month of December is 100%. The 2016-2017 Planning Year is fully funded. (Slides 33-36)

• 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

- 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

DEC14  MAR15  JUN15  SEP15  DEC15  MAR16  JUN16  AUG16  DEC16

RTO
East
West
Deviations Balancing Operating Reserve Rates

$/MWh

- RTO
- East
- West

DEC14  MAR15  JUN15  SEP15  DEC15  MAR16  JUN16  AUG16  DEC16
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.
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 graph shows a comparison of historic average energy consumption and weather conditions against the current month. The y-axis represents TWh (Terawatt-hours) while the x-axis represents the months from December 2015 to December 2016. The graph includes a line indicating heating degree days + cooling degree days.
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 (INC & DECs) - Total Number

- Submitted Bids
- Cleared Bids

Number of Bids (Millions)

Virtual Bids (INC & DEC) - Total Volume

- Submitted MWh
- Cleared MWh

MWh (Millions)

<table>
<thead>
<tr>
<th>Month</th>
<th>DEC14</th>
<th>JAN15</th>
<th>FEB15</th>
<th>MAR15</th>
<th>APR15</th>
<th>MAY15</th>
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<th>DEC15</th>
<th>JAN16</th>
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Up-To-Congestion Transactions - Total Volume

Submitted MWh
Clear MWh

MWh (Millions)

DEC14 JAN15 FEB15 MAR15 APR15 MAY15 JUN15 JUL15 AUG15 SEP15 OCT15 NOV15 DEC15 JAN16 FEB16 MAR16 APR16 MAY16 JUN16 JUL16 AUG16 SEP16 OCT16 NOV16 DEC16

0 40 80 120 160 200
INCs, DECs and Up-To-Congestion Transactions - Total Volume

- Submitted MWh
- Cleared MWh

MWh (Millions)

- DEC14
- JAN15
- FEB15
- MAR15
- APR15
- MAY15
- JUN15
- JUL15
- AUG15
- SEP15
- OCT15
- NOV15
- DEC15
- JAN16
- FEB16
- MAR16
- APR16
- MAY16
- JUN16
- JUL16
- AUG16
- SEP16
- OCT16
- NOV16
- DEC16
Energy Market

Congestion and FTR Summary
Monthly FTR Payout
<table>
<thead>
<tr>
<th>Period</th>
<th>Surplus / Underfunding</th>
<th>Payout Ratio</th>
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<tr>
<td>December, 2016</td>
<td>$10,040,467</td>
<td>100%</td>
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<tr>
<td>2016</td>
<td>$60,604,290</td>
<td>100%</td>
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<tr>
<td>2016/2017</td>
<td>$65,844,730</td>
<td>100%</td>
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Ten Most Heavily Congested Transmission Facilities - Overall, December
Ten Most Heavily Congested Transmission Facilities - Overall, 2016

- Conastone-Northwest 2 230 (BGE)
- Graceton 230/115 T1 (BGE)
- Bagley-Graceton 230 (BGE)
- Cherry Valley 345/138 TR81 (COMED)
- Cherry Valley 345/138 TR82 (COMED)
- Braid-East Frankfort 2003 345 (COMED)
- Conastone-Peach Bottom 500 (EHV)
- Magnetation-Reynolds 138 (MISO)
- Dixon-McGirr Rd 10714 138 (COMED)
- Milford-Steele 230 (DPL)
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)

DEC14  MAR15  JUN15  SEP15  DEC15  MAR16  JUN16  AUG16  DEC16
Monthly Average NYISO Interface Pricing

- PJM NYISO Price (RT)
- NYISO PJM Price (RT)
- PJM NYISO Price (DA)
- NYISO PJM Price (DA)
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 = $-2.20
Percent of hours in which the direction of flow is consistent with price differentials = 70.83%
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 = $-1.96
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 = $1.31
Percent of hours in which the direction of flow is consistent with price differentials = 47.45%
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.
Negative M2M Credit represents PJM payment to MISO
PJM-NYISO Market-to-Market Coordination Settlement

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.
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)
DR Participation in PJM Synchronized Reserve Markets
Regulation Market Daily Prices and Charges

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

The graph shows the daily prices and charges from 01DEC16 to 31DEC16, with a focus on the changes in millions of dollars and prices per MWh.