Markets Report

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PJM Wholesale Cost for January 2019 was $59.96/MWh, down from full-year 2018 costs of $59.96/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 January, temperatures were below average for much 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 January uplift exceeded $800,000 on four days; January 21st-22nd and 30th-31st. (Slides 21 & 22)
Executive Summary

- Load-weighted average LMP for January 2019 is $32.14/MWh: (Slides 28-29)
  - January 2019 was $32.1/MWh, which is considerably lower than January 2018 ($83.6/MWh) but in line with January 2016 ($32.6/MWh).

- In June 2017, the calculation of FTR surplus was changed to no longer include Balancing congestion and Market to Market payments. (Slide 45)

- FTR revenue adequacy for the month of January is 100% and the 2018-2019 Planning Year is currently fully funded. (Slides 44-47)

- Congestion remained at relatively low levels in January. (Slide 45)

- Regulation and Synchronized Reserve market costs have generally tracked with energy prices over time. (Slides 60-62)
Markets Report
The chart presents the PJM Wholesale Cost - Other for the years 2015 to 2019. The costs are categorized into different components:

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

Each column represents a year, and the bar graphs show the cost breakdown for that year in $/MWh. The costs vary significantly from year to year, reflecting changes in these components.
Market Conditions
• 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, 2018. 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 shows the comparison of energy consumption and degree days for each month from January 2018 to January 2019. The bars represent the total energy consumption for each month, while the line graph shows the degree days for heating and cooling. The data is presented in terawatt-hours (TWh) and degree days.
Historic Average Weather and Energy versus Current Month - Daily

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

Fuel Price Source: S&P Global Platts

- Average Gas - $3.57
- Average Coal - $2.45
- Average Oil - $12.41
- Average LMP - $31.04
Positive values represent days when the DA daily average price was higher than RT. Negative values represent days when the DA price was lower.

Average price difference for January = $1.85
'Other' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Daily Generation by Fuel - January

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

'Other' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Operating Reserve

(Uplift)
Monthly Uplift - $/MWh Load

- Day-Ahead Operating Reserve
- Balancing Operating Reserve
- Reactive
- Blackstart
- Lost Opportunity Cost
• In January uplift exceeded $800,000 on four days; January 21\textsuperscript{st}-22\textsuperscript{nd} and 30\textsuperscript{th}-31\textsuperscript{st}.

• Contributing factors to uplift were:
  o Extreme cold weather conditions
    o High load levels
    o Unit and equipment trippings
  o Load forecast error
  o Localized reliability and transfer interface constraints
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

$\text{$/MWh}$

- **RTO**
- **East**
- **West**

- **X-axis**: Jan 17 to Jan 19 (months)
- **Y-axis**: $0.00 to $0.20

- Peaks in Jan 17, Jan 18, Apr 18, Jul 18, and Jan 19.
Deviations Balancing Operating Reserve Rates

$/MWh

RTO
East
West

JAN17  APR17  JUL17  OCT17  JAN18  APR18  JUL18  OCT18  JAN19
Energy Market
LMP Summary
Load-Weighted Average LMP

<table>
<thead>
<tr>
<th>Month</th>
<th>Price ($/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAN17</td>
<td>$33</td>
</tr>
<tr>
<td>FEB17</td>
<td>$26</td>
</tr>
<tr>
<td>MAR17</td>
<td>$29</td>
</tr>
<tr>
<td>APR17</td>
<td>$32</td>
</tr>
<tr>
<td>MAY17</td>
<td>$32</td>
</tr>
<tr>
<td>JUN17</td>
<td>$28</td>
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<td>JUL17</td>
<td>$33</td>
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<td>AUG17</td>
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<td>SEP17</td>
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<tr>
<td>OCT17</td>
<td>$28</td>
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<td>NOV17</td>
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<td>DEC17</td>
<td>$41</td>
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<td>JAN18</td>
<td>$84</td>
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<td>FEB18</td>
<td>$26</td>
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<td>MAR18</td>
<td>$33</td>
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<td>APR18</td>
<td>$35</td>
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<td>NOV18</td>
<td>$33</td>
</tr>
<tr>
<td>DEC18</td>
<td>$31</td>
</tr>
<tr>
<td>JAN19</td>
<td>$32</td>
</tr>
</tbody>
</table>
Fuel Cost Adjusted LMP (Referenced to 1999 Fuel Prices)
Energy Market

Demand Response Summary
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 & DEC) - Total Number

Number of Bids (Millions)

- Submitted Bids
- Cleared Bids

JAN17, FEB17, MAR17, APR17, MAY17, JUN17, JUL17, AUG17, SEP17, OCT17, NOV17, DEC17, JAN18, FEB18, MAR18, APR18, MAY18, JUN18, JUL18, AUG18, SEP18, OCT18, NOV18, DEC18, JAN19
Virtual Bids (INC & DEC) - Total Volume

MWh (Millions)

Submitted MWh
Cleared MWh

JAN17
FEB17
MAR17
APR17
MAY17
JUN17
JUL17
AUG17
SEP17
OCT17
NOV17
DEC17
JAN18
FEB18
MAR18
APR18
MAY18
JUN18
JUL18
AUG18
SEP18
OCT18
NOV18
DEC18
JAN19
Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

JAN17 | FEB17 | MAR17 | APR17 | MAY17 | JUN17 | JUL17 | AUG17 | SEP17 | OCT17 | NOV17 | DEC17 | JAN18 | FEB18 | MAR18 | APR18 | MAY18 | JUN18 | JUL18 | AUG18 | SEP18 | OCT18 | NOV18 | DEC18 | JAN19
INCs, DECs and Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

JAN17 | FEB17 | MAR17 | APR17 | MAY17 | JUN17 | JUL17 | AUG17 | SEP17 | OCT17 | NOV17 | DEC17 | JAN18 | FEB18 | MAR18 | APR18 | MAY18 | JUN18 | JUL18 | AUG18 | SEP18 | OCT18 | NOV18 | DEC18 | JAN19
INCs, DECs and Up-To-Congestion Transactions - Total Volume

- Submitted MWh
- Cleared MWh
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>January, 2019</td>
<td>$17,626,779</td>
<td>100%</td>
</tr>
<tr>
<td>2019</td>
<td>$17,626,779</td>
<td>100%</td>
</tr>
<tr>
<td>2018/2019</td>
<td>$49,503,759</td>
<td>100%</td>
</tr>
</tbody>
</table>
Ten Most Heavily Congested Transmission Facilities - Overall, January

The ten most heavily congested facilities account for 62% of total congestion for January.
The ten most heavily congested facilities account for 62% of total congestion for 2019.
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)

JAN17  APR17  JUL17  OCT17  JAN18  APR18  JUL18  OCT18  JAN19
Monthly Average NYISO Interface Pricing

$/MWh

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

JAN17  APR17  JUL17  OCT17  JAN18  APR18  JUL18  OCT18  JAN19
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 January = $-2.82
Percent of hours in which the direction of flow is consistent with price differentials = 64.78%
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 January = $-2.87
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 January = $0.84
Percent of hours in which the direction of flow is consistent with price differentials = 56.45%
Positive values represent hours when the PJM price was higher. Negative values represent hours when the PJM price was lower.

Average price difference for January = $-2.52
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
Regulation Costs

$ Millions

JAN17  FEB17  MAR17  APR17  MAY17
JUN17  JUL17  AUG17  SEP17  OCT17
NOV17  DEC17  JAN18  FEB18  MAR18
APR18  MAY18  JUN18  JUL18  AUG18
SEP18  OCT18  NOV18  DEC18  JAN19

$0  $10  $20  $30  $40  $50
Synchronized Reserve and Synchronous Condenser Costs

- Synchronized Reserve Market Payments
- Synchronous Condenser Payments

$ Millions

JAN17 FEB17 MAR17 APR17 MAY17 JUN17 JUL17 AUG17 SEP17 OCT17 NOV17 DEC17 JAN18 FEB18 MAR18 APR18 MAY18 JUN18 JUL18 AUG18 SEP18 OCT18 NOV18 DEC18 JAN19
Load-Adjusted Synchronized Reserve and Synchronous Condenser Costs
DR Participation in PJM Regulation Markets

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

Chart showing the comparison of Total Payments and MWh Cleared from JAN17 to JAN19.
DR Participation in PJM Synchronized Reserve Markets

- Total Payments ($ Millions)
- MWh Cleared (MWh)
Regulation Market Daily Prices and Charges

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

$ Millions

$0.0

$0.2

$0.4

$0.6

$0.8

$1.0

$ Millions

$0

$50

$100

$150

$200

$250

01JAN19  02JAN19  03JAN19  04JAN19  05JAN19  06JAN19  07JAN19  08JAN19  09JAN19  10JAN19  11JAN19  12JAN19  13JAN19  14JAN19  15JAN19  16JAN19  17JAN19  18JAN19  19JAN19  20JAN19  21JAN19  22JAN19  23JAN19  24JAN19  25JAN19  26JAN19  27JAN19  28JAN19  29JAN19  30JAN19  31JAN19
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)