Markets Report

MC Webinar
February 22, 2021
• PJM Wholesale Cost for 2021 is $45.92/MWh, up from full-year 2020 costs of $43.41/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 8-19)

• In January, temperatures fluctuated around average to above average for most of the month. Thus, the sum of Heating and Cooling Degree Days was below its historic average. (Slides 8-10)

• Because of mild weather and continued Corona Virus impacts, Energy use remained below the historic average. (Slides 8-10)
Executive Summary

• In January, uplift exceeded $800,000 on one day – January 1st. (Slides 24 & 25)
• Load-weighted average LMP for 2021 is $25.33/MWh: (Slides 31 & 32)
  – January 2021 was $25.33/MWh, which is higher than January 2020 ($22.00/MWh) but lower than January 2019 ($32.10/MWh).
• FTR revenue adequacy for the month of January is 100% and the 2020-2021 Planning Year is currently funded at 98%. (Slides 47-50)
• Congestion remains low, however, somewhat higher than values observed last January. (Slide 48)
• Regulation and Synchronized Reserve market costs have generally tracked with energy prices over time. (Slides 63-65)
Markets Report
PJM Wholesale Cost - Other

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

$/MWh

2017: $1.31
   - Regulation: $0.13
   - Operating Reserve: $0.16
   - PJM Cost: $0.36
   - Reactive: $0.42
   - Transmission Owner Control: $0.36
   - Synchronized Reserve: $0.25

2018: $1.44
   - Regulation: $0.18
   - Operating Reserve: $0.18
   - PJM Cost: $0.36
   - Reactive: $0.41
   - Transmission Owner Control: $0.36
   - Synchronized Reserve: $0.25

2019: $1.26
   - Regulation: $0.18
   - Operating Reserve: $0.18
   - PJM Cost: $0.38
   - Reactive: $0.44
   - Transmission Owner Control: $0.38
   - Synchronized Reserve: $0.25

2020: $1.28
   - Regulation: $0.18
   - Operating Reserve: $0.18
   - PJM Cost: $0.38
   - Reactive: $0.47
   - Transmission Owner Control: $0.38
   - Synchronized Reserve: $0.25

2021: $1.20
   - Regulation: $0.18
   - Operating Reserve: $0.18
   - PJM Cost: $0.38
   - Reactive: $0.43
   - Transmission Owner Control: $0.38
   - Synchronized Reserve: $0.25
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, 2020. 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 vs. Heating Degree Days + Cooling 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

Average Gas – $2.58
Average Coal – $1.79
Average Oil – $10.38
Average LMP – $25.24

% Deviation from Monthly Average Price

Fuel Price Source: S&P Global Platts
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 = $0.12
Load Forecast Error – Monthly Absolute Error, 10:00 Forecast

- All Hours
- Peak Hours Only
- Winter
- Summer
- 25-month Average
- 25-month Average

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2019

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2021

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PJM prepares a day-ahead load forecast at 10:00 am for use by our members.

This forecast is not used to clear the day-ahead market and is not utilized for the reliability tools that run subsequent to the day-ahead market.

- The load forecast generally performed well in January, as models adapted to colder weather conditions. Peak error exceeded 3% on the Sunday before Martin Luther King Day as operators prepared forecasts for the holiday with anticipated unusual conditions.

- For Jan. 11, load model error and temperature forecast error both contributed roughly equally to under-forecasting throughout the day.
Monthly Generation by Fuel

'Mother' includes Hydro, Oil, Solar, Wind, and Other
Monthly Generation by Fuel, Other

'Mother' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
'Other' includes Flywheels, Multiple Fuels, Storage, and Other Renewables
Operating Reserve
(Uplift)
Monthly Uplift

- Day-Ahead Operating Reserve
- Balancing Operating Reserve
- Reactive
- Blackstart
- Lost Opportunity Cost

$ Millions

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<tr>
<th>Month</th>
<th>JAN19</th>
<th>FEB19</th>
<th>MAR19</th>
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Monthly Uplift - $/MWh Load

- Day-Ahead Operating Reserve
- Balancing Operating Reserve
- Reactive
- Blackstart
- Lost Opportunity Cost
Daily Uplift - January

$ Millions

Day-Ahead Operating Reserve
Balancing Operating Reserve
Reactive
Blackstart
Lost Opportunity Cost

01 JAN 2021
02 JAN 2021
03 JAN 2021
04 JAN 2021
05 JAN 2021
06 JAN 2021
07 JAN 2021
08 JAN 2021
09 JAN 2021
10 JAN 2021
11 JAN 2021
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21 JAN 2021
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24 JAN 2021
25 JAN 2021
26 JAN 2021
27 JAN 2021
28 JAN 2021
29 JAN 2021
30 JAN 2021
31 JAN 2021
In January, uplift exceeded $800,000 on one day – January 1\textsuperscript{st}.

Contributing factors to uplift were:

- Load forecast error
- Regional icing conditions

More information on Uplift can be found on PJM’s website at \textit{Drivers of Uplift}
Percent of Total CT, CC 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

$/MWh

- RTO
- East
- West

JAN19 | APR19 | JUL19 | OCT19 | JAN20 | APR20 | JUL20 | OCT20 | JAN21

$0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00 | $0.00

$0.05 | $0.05 | $0.05 | $0.05 | $0.05 | $0.05 | $0.05 | $0.05 | $0.05

$0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10 | $0.10

$0.15 | $0.15 | $0.15 | $0.15 | $0.15 | $0.15 | $0.15 | $0.15 | $0.15

$0.20 | $0.20 | $0.20 | $0.20 | $0.20 | $0.20 | $0.20 | $0.20 | $0.20
Energy Market

LMP Summary
Load-Weighted Average LMP

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<th>LMP ($/MWh)</th>
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<td>FEB19</td>
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<tr>
<td>MAR19</td>
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<td>JAN21</td>
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Fuel Cost Adjusted LMP (Referenced to 1999 Fuel Prices)
Energy Market

Demand Response Summary
Demand Side Response Estimated Revenue

$ Millions

- Capacity
- Ancillary Services
- Emergency Energy
- Economic Energy
- Economic Energy Incentives
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 Number

Number of Bids (Millions)

- Submitted Bids
- Cleared Bids
Virtual Bids (INCs & DECs) - Total Volume

- Submitted MWh
- Cleared MWh

MWh (Millions)

| JAN19 | FEB19 | MAR19 | APR19 | MAY19 | JUN19 | JUL19 | AUG19 | SEP19 | OCT19 | NOV19 | DEC19 | JAN20 | FEB20 | MAR20 | APR20 | MAY20 | JUN20 | JUL20 | AUG20 | SEP20 | OCT20 | NOV20 | DEC20 | JAN21 |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 5      | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     | 5     |
Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

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

MWh (Millions)

Submitted MWh
Cleared MWh

JAN19  FEB19  MAR19  APR19  MAY19  JUN19  JUL19  AUG19  SEP19  OCT19  NOV19  DEC19  JAN20  FEB20  MAR20  APR20  MAY20  JUN20  JUL20  AUG20  SEP20  OCT20  NOV20  DEC20  JAN21
INCs, DECs and Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions
Energy Market

Congestion and FTR Summary
<table>
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<tr>
<th>Period</th>
<th>Surplus / Underfunding</th>
<th>Payout Ratio</th>
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<tr>
<td>January, 2021</td>
<td>$1,063,054</td>
<td>100%</td>
</tr>
<tr>
<td>2021</td>
<td>$1,063,054</td>
<td>100%</td>
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<tr>
<td>2020/2021</td>
<td>$-11,109,105</td>
<td>98%</td>
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FTR Revenue vs. FTR Target Allocation

- **Total FTR Revenues**
- **Total FTR Targets**

$ Millions

- JAN19
- FEB19
- MAR19
- APR19
- MAY19
- JUN19
- JUL19
- AUG19
- SEP19
- OCT19
- NOV19
- DEC19
- JAN20
- FEB20
- MAR20
- APR20
- MAY20
- JUN20
- JUL20
- AUG20
- SEP20
- OCT20
- NOV20
- DEC20
- JAN21
Ten Most Heavily Congested Transmission Facilities - Overall, January

The ten most heavily congested facilities account for 78% of total congestion for January.
Ten Most Heavily Congested Transmission Facilities - Overall, 2021

<table>
<thead>
<tr>
<th>Facility Name</th>
<th>Total Congestion</th>
<th>Day-Ahead Congestion</th>
<th>Balancing Congestion</th>
<th>Market-to-Market Credit</th>
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<tbody>
<tr>
<td>Bagley-Graceton 230 2313 (BGE)</td>
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<td>Bagley-Raphael Road 230 5 (BGE)</td>
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<td>Cumberland-Juniata 230 (PPL)</td>
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<td>Rock Island-Sub 85 161 (MISO)</td>
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<td>Dauphin-Juniata 230 (PPL)</td>
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<td>Gore-Stonewall 138 (APS)</td>
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<td>Maroa-E Goose Creek 345 (MISO)</td>
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<td>Cedar Sub-William 230 F (PSEG)</td>
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The ten most heavily congested facilities account for 78% of total congestion for 2021.
Energy Market

Interchange/Seams Summary
Monthly Average MISO Interface Pricing

$/MWh

$0
$10
$20
$30
$40
$50

JAN19 APR19 JUL19 OCT19 JAN20 APR20 JUL20 OCT20 JAN21

- PJM MISO Price (RT)
- MISO PJM Price (RT)
- PJM MISO Price (DA)
- MISO 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 January = $-0.60
Percent of hours in which the direction of flow is consistent with price differentials = 53.09%
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 = $-0.16
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 = $4.74
Percent of hours in which the direction of flow is consistent with price differentials = 52.82%
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 January = $-0.74
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

$ Millions

- Synchronized Reserve Market Payments
- Synchronous Condenser Payments

JAN19, FEB19, MAR19, APR19, MAY19, JUN19, JUL19, AUG19, SEP19, OCT19, NOV19, DEC19, JAN20, FEB20, MAR20, APR20, MAY20, JUN20, JUL20, AUG20, SEP20, OCT20, NOV20, DEC20, JAN21
Load-Adjusted Synchronized Reserve and Synchronous Condenser Costs

Cents/MWh

Synchronized Reserve Market Payments / MWh
Synchronous Condenser Payments / MWh

JAN19  FEB19  MAR19  APR19  MAY19  JUN19  JUL19  AUG19  SEP19  OCT19  NOV19  DEC19  JAN20  FEB20  MAR20  APR20  MAY20  JUN20  JUL20  AUG20  SEP20  OCT20  NOV20  DEC20  JAN21
DR Participation in PJM Synchronized Reserve Markets

$ Millions

$0.0 $0.2 $0.4 $0.6 $0.8 $1.0

MWh

150,000 120,000 90,000 60,000 30,000 0

JAN19 FEB19 MAR19 APR19 MAY19 JUN19 JUL19 AUG19 SEP19 OCT19 NOV19 DEC19 JAN20 FEB20 MAR20 APR20 MAY20 JUN20 JUL20 AUG20 SEP20 OCT20 NOV20 DEC20 JAN21

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

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

$ Millions

$0.8

$0.6

$0.4

$0.2

$0.0

$0

$150

$300

$450

$600

01JAN21
02JAN21
03JAN21
04JAN21
05JAN21
06JAN21
07JAN21
08JAN21
09JAN21
10JAN21
11JAN21
12JAN21
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31JAN21

$/MWh
Synchronized Reserve Market Daily Prices and Charges

- Total Daily Synchronized Reserve Charges ($ Millions)
- Minimum Interval Price ($/MWh)
- Average Interval Price ($/MWh)
- Maximum Interval Price ($/MWh)