Markets Report

MC Webinar
December 14, 2020
• PJM Wholesale Cost through November 2020 is $43.14/MWh, down from full-year 2019 costs of $48.98/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 November, temperatures were milder than 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)
• In November, uplift exceeded $800,000 on two days – November 18th & 19th. (Slides 24 & 25)

• Load-weighted average LMP through November 2020 is $21.26/MWh: (Slides 31 & 32)
  – November 2020 was $20.70/MWh, which is lower than November 2019 ($27.20/MWh) and November 2018 ($33.40/MWh).

• FTR revenue adequacy for the month of November is 99% and the 2020-2021 Planning Year is currently funded at 99%. (Slides 47-50)

• Congestion remains low and lower than the values observed last November. (Slide 48)

• Regulation and Synchronized Reserve market costs have generally tracked with energy prices over time. (Slides 63-65)
Markets Report
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, 2019. 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

<table>
<thead>
<tr>
<th>Month</th>
<th>TWh</th>
<th>Heating Degree Days + Cooling Degree Days</th>
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<tbody>
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<tr>
<td>Nov20</td>
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</tbody>
</table>
Historic Average Weather and Energy versus Current Month - Daily

- **Daily Energy as a Percent of the Historic Average for November**
- **Daily HDD + CDD as a Percent of the Historic Average for November**
- **Daily Temperature as a Percent of the Historic Average for November**

The graph shows the daily energy and temperature as a percentage of the historic average for November. The data is represented from 01 Nov 2020 to 30 Nov 2020.
Average Fuel Prices - Daily

- Average Gas - $1.76
- Average Coal - $1.72
- Average Oil - $8.37
- Average LMP - $20.49

Fuel Price Source: S&P Global Platts
Daily Difference Between Day-Ahead and Real-Time System Marginal Prices

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 November = $-0.25
Load Forecast Error – October Daily Peaks, 10:00 Forecast

- Error at Peak Hour
- Weekend / Holiday
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 following days had load forecast error exceeding 3%:

• November 30 - The primary cause was model error from our neural net model, likely due in part to unexpected cold weather
Monthly Generation by Fuel

'Mother' includes Hydro, Oil, Solar, Wind, and Other
'Other' includes Flywheels, Multiple Fuels, Storage, and Other Renewables.
Daily Generation by Fuel - November

'Mother' includes Hydro, Oil, Solar, Wind, and Other
'Other' includes Flywheels, Multiple Fuels, Storage, and Other Renewables.
Operating Reserve
(Uplift)
In November, uplift exceeded $800,000 on two days – November 18\textsuperscript{th} and 19\textsuperscript{th}.

Contributing factors to uplift were:

- Load forecast error
- Localized congestions

More information on Uplift can be found on PJM’s website at 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

NOV18  JAN19  MAY19  AUG19  NOV19  JAN20  MAY20  AUG20  NOV20
Energy Market

LMP Summary
Fuel Cost Adjusted LMP (Referenced to 1999 Fuel Prices)
LMP Price Posting Suspensions and Reruns

- Percentage of Intervals Price Posting Suspended
- Percentage of Intervals Rerun prior to Final LMP Posting

Percentage of 5-Minute Intervals

- NOV18
- DEC18
- JAN19
- FEB19
- MAR19
- APR19
- MAY19
- JUN19
- JUL19
- AUG19
- SEP19
- OCT19
- NOV19
- DEC19
- JAN20
- FEB20
- MAR20
- APR20
- MAY20
- JUN20
- JUL20
- NOV20
Energy Market

Demand Response Summary
Demand Side Response Estimated Revenue

$ Millions

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

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<td>$400</td>
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*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

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<tr>
<th>Year</th>
<th>Value</th>
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<tr>
<td>JAN19</td>
<td>2,400</td>
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<td>AUG19</td>
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<td>MAY20</td>
<td>1,000</td>
</tr>
<tr>
<td>AUG20</td>
<td>1,500</td>
</tr>
<tr>
<td>NOV20</td>
<td>1,150</td>
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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 (INCs & DECs) - Total Number

- Submitted Bids
- Cleared Bids

Number of Bids (Millions)

- NOV18
- DEC18
- JAN19
- FEB19
- MAR19
- APR19
- MAY19
- JUN19
- JUL19
- AUG19
- SEP19
- OCT19
- NOV19
- DEC19
- JAN20
- FEB20
- MAR20
- APR20
- MAY20
- JUN20
- JUL20
- AUG20
- SEP20
- OCT20
- NOV20
Virtual Bids (INCs & DECs) - Total Volume

MWh (Millions)

- Submitted MWh
- Cleared MWh

Month: NOV18, DEC18, JAN19, FEB19, MAR19, APR19, MAY19, JUN19, JUL19, AUG19, SEP19, OCT19, NOV19, DEC19, JAN20, FEB20, MAR20, APR20, MAY20, JUN20, JUL20, AUG20, SEP20, OCT20, NOV20
INCs, DECs and Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

Submitted Transactions
Cleared Transactions
INCs, DECs and Up-To-Congestion Transactions - Total Volume

MWh (Millions)

Submitted MWh
Cleared MWh
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>November, 2020</td>
<td>$-749,238</td>
<td>99%</td>
</tr>
<tr>
<td>2020</td>
<td>$63,359,912</td>
<td>100%</td>
</tr>
<tr>
<td>2020/2021</td>
<td>$-3,547,577</td>
<td>99%</td>
</tr>
</tbody>
</table>
Monthly FTR Payout Ratio

- NOV18
- DEC18
- JAN19
- FEB19
- MAR19
- APR19
- MAY19
- JUN19
- JUL19
- AUG19
- SEP19
- OCT19
- NOV19
- DEC19
- JAN20
- FEB20
- MAR20
- APR20
- MAY20
- JUN20
- JUL20
- AUG20
- SEP20
- OCT20
- NOV20

The chart shows the monthly FTR payout ratio from November 2018 to November 2020.
Ten Most Heavily Congested Transmission Facilities - Overall, November

The ten most heavily congested facilities account for 70% of total congestion for November.

- TMI 500/230 1 (METED)
- E Lima-Haviland 138 (AEP OH)
- Bagley-Graceton 230 2313 (BGE)
- Cumberland-Juniata 230 (PPL)
- Champ-Mohomet 138 (MISO)
- N Coulterville 230/138 (MISO)
- Graceton-Safe Harbor 230 (BGE)
- Conastone-Otter Creek 230 (BGE-ME)
- Ashburn-Pleasant View 230 274D (DOM)
The ten most heavily congested facilities account for 46% of total congestion for 2020.
Energy Market

Interchange/Seams Summary
Monthly Average NYISO Interface Pricing

$/MWh

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

NOV18  JAN19  MAY19  AUG19  NOV19  JAN20  MAY20  AUG20  NOV20

$0  $10  $20  $30  $40  $50
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 November = $-1.30
Percent of hours in which the direction of flow is consistent with price differentials = 78.75%
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 November = $-2.26
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 November = $2.46
Percent of hours in which the direction of flow is consistent with price differentials = 59.03%
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 November = $1.69
PJM-MISO Market-to-Market Coordination Settlement

Negative M2M Credit represents PJM payment to MISO
Negative M2M Credit represents PJM payment to NYISO
Ancillary Service Market

Summary
Regulation Costs

$ Millions

$0 $5 $10 $15 $20

month

NOV 18 DEC 18 JAN 19 FEB 19 MAR 19 APR 19 MAY 19 JUN 19 JUL 19 AUG 19 SEP 19 OCT 19 NOV 19 DEC 19 JAN 20 FEB 20 MAR 20 APR 20 MAY 20 JUN 20 JUL 20 AUG 20 SEP 20 OCT 20 NOV 20
Synchronized Reserve and Synchronous Condenser Costs

$ Millions

<table>
<thead>
<tr>
<th>Month</th>
<th>Synchronized Reserve Market Payments</th>
<th>Synchronous Condenser Payments</th>
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<tbody>
<tr>
<td>Nov18</td>
<td>$4</td>
<td>$1</td>
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<td>Dec18</td>
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<tr>
<td>Nov20</td>
<td>$4</td>
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Load-Adjusted Synchronized Reserve and Synchronous Condenser Costs

- Synchronized Reserve Market Payments / MWh
- Synchronous Condenser Payments / MWh

Cents/MWh

DR Participation in PJM Regulation Markets

![Chart showing total payments ($ Millions) and MWh cleared (MWh) over time from November 2018 to November 2020. The chart indicates fluctuations in payment amounts and MWh cleared throughout the period.]
DR Participation in PJM Synchronized Reserve Markets

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

$ Millions vs MWh over time from November 2018 to November 2020.