Markets Report

MC Webinar
January 25, 2020
• PJM Wholesale Cost for 2020 is $43.41/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 December, temperatures fluctuated around average for most of the month. Thus, the sum of Heating and Cooling Degree Days was close 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 December, uplift exceeded $800,000 on four days – December 7th and December 16th -18th.(Slides 24 & 25)

• Load-weighted average LMP for 2020 is $21.65/MWh: (Slides 31 & 32)
  – December 2020 was $25.50/MWh, which is lower than December 2019 ($22.50/MWh) and December 2018 ($31.00/MWh).

• FTR revenue adequacy for the month of December is 88% and the 2020-2021 Planning Year is currently funded at 98%. (Slides 47-50)

• Congestion remains low and similar to the values observed last December. (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

$\text{MWh}$

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<thead>
<tr>
<th>Year</th>
<th>Regulation</th>
<th>Operating Reserve</th>
<th>PJM Cost</th>
<th>Reactive</th>
<th>Reactive</th>
<th>Synchronized Reserve</th>
<th>Black Start</th>
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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

Heating Degree Days + Cooling Degree Days

TWh


0  | 20  | 40  | 60  | 80  | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240

0  | 250 | 500 | 750 | 1000 | 1250 |
Historic Average Weather and Energy versus Current Month - Daily

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

Percent of Daily Average

0% 50% 100% 150% 200% 250% 300%

Average Fuel Prices - Daily

- Average Gas: $2.43
- Average Coal: $1.76
- Average Oil: $9.66
- Average LMP: $25.29

% Deviation from Monthly Average Fuel 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.
Load Forecast Error – Monthly Absolute Error, 10:00 Forecast

The chart above illustrates the monthly absolute error for load forecasts from December 2018 to December 2020. The data is categorized by All Hours, Peak Hours Only, Winter, and Summer. The 25-month average is also indicated for both All Hours and Peak Hours Only. The error percentages are shown for each month, revealing variations across the years and seasons.

- **All Hours** generally show a more consistent error rate across months and years.
- **Peak Hours Only** exhibit higher variability, with notable peaks in certain months.
- **Winter** and **Summer** periods display distinct error profiles, with summer months often showing increased error variability.

The chart helps in understanding the accuracy of forecasts and identifying trends in prediction errors over time and across different seasons.
Load Forecast Error – December Daily Peaks, 10:00 Forecast
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.

- During first three weeks of the month, the day ahead forecast generally underestimated loads. Weather model error and load forecast model error contributed to this roughly equally. This timeframe experienced some of coldest temperatures since last winter, as well as significant snowfall, which together likely hindered accuracy of both model types.

- The holiday week, beginning Dec. 25, experienced higher-than-average forecast error, likely due to human behavior and some abnormal weather patterns. In addition to being a holiday, Christmas (and some hours extending into the morning of Dec. 26) was severely impacted by the rapid onset of a cold front.

- Much of the over-forecasting at the end of the month is likely related to shifts in behavior of humans and institutions, such as work vacations and school breaks.
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 - December

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

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

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

The chart illustrates the financial breakdown across various entities for the months of December. Each bar represents the contribution of different operational reserves and costs for entities such as AECO, AEP, APS, ATSI, BGE, COMED, DAY, DEOK, DOM, DPL, DUQ, EKPC, JCPL, METED, PECO, PENELC, PEPCO, PPL, and PSEG.
In November, uplift exceeded $800,000 on four days – December 7th and December 16th - 18th.

Contributing factors to uplift were:

- Load forecast error
- Weather 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.
Deviation Balancing Operating Reserve Rates

$/MWh

- RTO
- East
- West

DEC18  MAR19  JUN19  SEP19  DEC19  MAR20  JUN20  AUG20  DEC20
Energy Market
LMP Summary
Load-Weighted Average LMP

$/MWh

DEC18  JAN19  FEB19  MAR19  APR19  MAY19  JUN19  JUL19  AUG19  SEP19  OCT19  NOV19  DEC19  JAN20  FEB20  MAR20  APR20  MAY20  JUN20  JUL20  AUG20  SEP20  OCT20  NOV20  DEC20

$31  $32  $28  $30  $26  $24  $23  $30  $24  $29  $28  $27  $23  $22  $19  $18  $18  $20  $20  $25  $27  $20  $22  $21  $26
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
Energy Market

Demand Response Summary
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

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Virtual Bids (INCs & DECs) - Total Volume

- Submitted MWh
- Cleared MWh

MWh (Millions)

DEC18 | JAN19 | FEB19 | MAR19 | APR19 | MAY19 | JUN19 | JUL19 | AUG19 | SEP19 | OCT19 | NOV19 | DEC19 | JAN20 | FEB20 | MAR20 | APR20 | MAY20 | JUN20 | JUL20 | AUG20 | SEP20 | OCT20 | NOV20 | DEC20
Up-To-Congestion Transactions - Total Number

Number of Transactions (Millions)

- Submitted Transactions
- Cleared Transactions

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Up-To-Congestion Transactions - Total Volume

MWh (Millions)

- Submitted MWh
- Cleared MWh

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INCs, DECs and Up-To-Congestion Transactions - Total Number
INCs, DECs and Up-To-Congestion Transactions - Total Volume
Energy Market

Congestion and FTR Summary
## FTR Funding

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<th>Surplus / Underfunding</th>
<th>Payout Ratio</th>
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<td>December, 2020</td>
<td>$-10,925,356</td>
<td>88%</td>
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<tr>
<td>2020</td>
<td>$54,735,331</td>
<td>100%</td>
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<tr>
<td>2020/2021</td>
<td>$-12,172,158</td>
<td>98%</td>
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FTR Revenue vs. FTR Target Allocation

- Total FTR Revenues
- Total FTR Targets

$ Millions

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Planning Period FTR Payout

Planning Period FTR Payout Ratio

- 2006
- 2007
- 2008
- 2009
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021

PJM©2021
The ten most heavily congested facilities account for 62% of total congestion for December.
The ten most heavily congested facilities account for 43% of total congestion for 2020.
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)

DEC18  MAR19  JUN19  SEP19  DEC19  MAR20  JUN20  AUG20  DEC20
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 = $-1.52
Percent of hours in which the direction of flow is consistent with price differentials = 60.48%
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.
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 = $-1.00
Percent of hours in which the direction of flow is consistent with price differentials = 55.11%
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 = $-1.74
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

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Synchronized Reserve Market Payments
Synchronous Condenser Payments
Load-Adjusted Synchronized Reserve and Synchronous Condenser Costs

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

Bar chart showing the costs from December 2018 to December 2020.
DR Participation in PJM Synchronized Reserve Markets

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

Graph showing data from December 2018 to December 2020.
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)