Market Efficiency Update

Transmission Expansion Advisory Committee
June 7, 2018
### Market Efficiency Timeline

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<th>Year 0</th>
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**12-month cycle**
- Develop Assumptions (Y1, Y5)
- Market Efficiency Analysis (Y1, Y5) (Accelerations and Modifications)
- Final Review with TEAC and approval by Board

**24-month cycle**
- Develop Assumptions (Y1, Y5, Y8, Y11, Y15)
- Market Efficiency Criteria Analysis (Y1, Y5, Y8, Y11, Y15)
- Market Efficiency Analysis (Y1, Y5, Y8, Y11, Y15)
- Identify proposed solutions
- Update significant assumptions (Y0, Y4, Y7, Y10, Y14)
- Analysis of market solutions and support of benefits of reliability solutions (Y0, Y4, Y7, Y10, Y14)
- Independent Consultant reviews of buildability
- Adjustments to solution options by PJM on analysis

**12-month cycle**
- Develop Assumptions (Y1, Y5)
- Market Efficiency Analysis (Y1, Y5) (Accelerations and Modifications)
- Identify and evaluate Solution Options (Accelerations and Modifications)
- Final Review with TEAC and approval by Board
2018/19 RTEP Long Term Window
Market Simulation Input Data

• Study Years*
  – 2019 and 2023 to study approved RTEP projects for accelerations and modifications
  – 2019, 2023, 2026, 2029, and 2033 to study new system enhancements

• Underlying input data based on March 2018 PROMOD IV Data Release from ABB
  – Load forecast based on PJM 2018 Load Forecast Report
  – Fuel/Emissions price forecasts from ABB, May 2018 update
  – Generation Expansion consistent with the machine list included in the Planning 2023 RTEP Powerflow

• Simulations performed using PROMOD IV v11.1.13 engine

*May change based on the outcome of the Market Efficiency Process Enhancement Task Force (MEPETF)
Key Input Parameters

- Fuel Prices Forecast
- Emissions Prices Forecast
- Load and Energy Forecast
- Demand Resource
- Future Generation
- Transmission Constraints
- Financial Parameters
  - Carrying Charge rate and Discount rate
2018 Market Efficiency Powerflow Models

- 2019 topology for PJM and external world based on the 2019 Summer Peak load flow case from the 2017 MMWG series
- 2023 and later PJM topology will be based on the 2023 Summer Peak load flow case from 2018 RTEP series
- External world representation will be updated as necessary in coordination with the Interregional Planning group
- PJM topology will include all RTEP upgrades approved through February 2018
Load & Energy Input Data

- PJM zonal peak and energy forecast from 2018 Load Forecast Report

### 2018 PJM Peak Load and Energy Forecast

<table>
<thead>
<tr>
<th>Load</th>
<th>2019</th>
<th>2023</th>
<th>2026</th>
<th>2029</th>
<th>2033</th>
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<tbody>
<tr>
<td>Peak (MW)</td>
<td>152,479</td>
<td>153,632</td>
<td>155,724</td>
<td>158,624</td>
<td>162,095</td>
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<tr>
<td>Energy (GWh)</td>
<td>809,000</td>
<td>816,817</td>
<td>828,788</td>
<td>845,058</td>
<td>864,236</td>
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Notes:
1. Peak and energy values from PJM Load Forecast Report Table B-1 and Table E-1, respectively.
2. Model inputs are at the zonal level, to the extent zonal load shapes create different diversity - modeled PJM peak load may vary.
Comparison 2017 and 2018 PJM Load Forecasts

PJM RTO Summer Peak Forecast

- 2017 Forecast
- 2018 Forecast

PJM RTO Annual Net Energy Forecast

- 2017 Forecast
- 2018 Forecast
 Demand Resource Input Data

- Model zonal demand resources consistent with Table B-7 of the 2018 Load Forecast Report.

<table>
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<tr>
<th>Demand Resource (MW)</th>
<th>2019</th>
<th>2023</th>
<th>2026</th>
<th>2029</th>
<th>2033</th>
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<tr>
<td>2018 PJM Demand Resource Forecast</td>
<td>9,113</td>
<td>7,747</td>
<td>7,862</td>
<td>7,989</td>
<td>8,179</td>
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</table>
• Generation included in Market Efficiency models include all ISAs and FSAs*

• Machine list posted at January TEAC
  – http://pjm.com/-/media/committees-groups/committees/teac/20180111/20180111-informational-teac-machines-list.ashx

*May change based on the outcome of the Market Efficiency Process Enhancement Task Force (MEPETF)
Future Generation

PJM Market Efficiency Reserve Margin - Preliminary

Note: Generation includes existing and projected PJM internal capacity resources. Model informed by 2023 Machines List.
Fuel Price Assumptions

- **Coal**
- **Gas**
- **OIL-H**
- **OIL-L**

The graph shows the projected fuel prices from 2018 to 2032, with different trends for each fuel type. Coal prices are expected to rise steadily, while gas prices show a more moderate increase. OIL-H and OIL-L prices also trend upwards, but at different rates.
Emission Price Assumptions – CO2

CO2 Emission Price Assumptions

$/Ton

2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032

RGGI CO2 National CO2
Emission Price Assumptions – SO2

SO\textsubscript{2} Emission Price Assumptions

![Graph showing SO\textsubscript{2} Emission Price Assumptions]

- CSAPR Group 1 SO\textsubscript{2}
Emission Price Assumptions – NOx

NOx Emission Price Assumptions

CSAPR Annual NOx
CSAPR Seasonal NOx (May - Sep)

$/Ton

2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032
Transmission Constraints

- **Thermal Constraints**
  - NERC Book of Flowgates
  - Planning study results for monitored facilities and monitored/contingency pair facilities
  - Historical PJM congestion events

- **Voltage Constraints**
  - PJM reactive interface limits
  - MW limits based on historical values and voltage stability analysis
  - RTEP upgrades impact future reactive interface limits
Financial Parameters

- Discount rate and levelized Carrying Charge rate are developed using information contained in TO Formula Rate sheets (Attachment H) \(^1\)
  - Discount rate based on weighted average after-tax embedded cost of capital
  - Levelized annual carrying charge rate based on weighted average levelized plant carrying charge rate

- Updated values for the financial parameters to be posted before the opening of the 2018/19 Long-Term Window

- Carrying Charge rate calculation details can be found on the Transmission Cost Information Center page

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<th>Step</th>
<th>Timeline</th>
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<tbody>
<tr>
<td>Build Base Case</td>
<td>June – July 2018</td>
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<tr>
<td>Post Preview Base Case</td>
<td>July 2018</td>
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<td>Stakeholders Feedback</td>
<td>August – September 2018</td>
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<td>Identify Congestion Drivers</td>
<td>September 2018</td>
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<td>Post Final Base Case and Target Congestion Drivers</td>
<td>October 2018</td>
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<td>Long Term Proposal Window</td>
<td>November 2018 - February 2019</td>
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<td>Analysis of Proposed Solutions</td>
<td>March - November 2019</td>
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<td>Final TEAC Review and Board Approval</td>
<td>November - December 2019</td>
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Market Efficiency Data Posting


- During October 2018 PJM will post
  - Market Efficiency Case Files for all study years
    - Access requires CEII confirmation (PJM and MISO)
    - Access requires PROMOD vendor (ABB) confirmation
    - XML Format
  - Reference Files
    - Input Assumptions Summary
    - Updated Modeling Document will provide details of setup and modeling methods
• Revision History