Objectives

- Overview of the 2016/2017 Market Efficiency Base Case
- Congestion Results
  - Review simulated congestion results
  - M2M Constraints
- Proposal Analysis Process Overview
- Next Steps
Market Efficiency Timeline

- **Year 0**
  - Develop Assumptions (Y1, Y5)
  - Market Efficiency Analysis (Y1, Y5) (Accelerations and Modifications)
  - Identify and evaluate Solution Options (Accelerations and Modifications)

- **Year 1**
  - 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)
  - Independent Consultant reviews of buildability
  - Adjustments to solution options by PJM on analysis
  - 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
### 2016-2017 24-Month Market Efficiency Cycle Timeline

<table>
<thead>
<tr>
<th>Item</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Term Proposal Window</td>
<td>November 2016 - February 2017</td>
</tr>
<tr>
<td>Analysis of Proposed Solutions</td>
<td>March 2017 - November 2017</td>
</tr>
<tr>
<td>Determination of Final Projects</td>
<td>December 2017</td>
</tr>
</tbody>
</table>
Market Efficiency Update

• Market Efficiency cases (first draft) were posted on 09/14/2016
  – PROMOD cases, and supporting documentation were posted on Market Efficiency Web page

• Proposal window to open on November 1, 2016
  – PJM received stakeholder feedback on PROMOD model by October 15, 2016
  – Base Congestion Results posted
  – PJM is in the process of concluding the problem statement
  – Final Base Case to be posted before November 1, 2016

• Market Efficiency Questions
  – Send to the RTEP e-mail distribution (rtep@pjm.com) with “Market Efficiency” in the subject line header
Overview of Base Case

• Base case updates based on stakeholders feedback:
  • PJM Generator Data
  • MISO Flowgates
  • External Model

• Additional base case updates:
  • Reactive Limits
  • PS North Wheel Reform

• Files to be posted by November 1, 2016:
  • Market Efficiency Test Case and Test Results
  • Market Efficiency Benefit/Cost Evaluation Spreadsheet
  • ARR Allocation MW Spreadsheet
  • Case Descriptions
Congestion Results Overview
Simulated Base Case Congestion

• Includes congestion results for simulation years 2017, 2021, 2024 and 2027

• System congestion has declined due to RTEP enhancements, lower load forecast and fuel price impacts

• Base congestion results posted on Market Efficiency website at below link:
**Simulated Energy Market Congestion Results**

<table>
<thead>
<tr>
<th>Constraint</th>
<th>kV</th>
<th>FromArea</th>
<th>ToArea</th>
<th>Type</th>
<th>Historical</th>
<th>2017 ($mil)</th>
<th>2021 ($mil)</th>
<th>2024 ($mil)</th>
<th>2027 ($mil)</th>
<th>Avg 2021, 2024 ($mil)</th>
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<tr>
<td>AP South Interface</td>
<td>INTERFACE</td>
<td>Yes</td>
<td></td>
<td>$33.2</td>
<td></td>
<td>$ 34.5</td>
<td>$ 30.5</td>
<td>$ 32.3</td>
<td>$ 32.5</td>
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<tr>
<td>Bagley to Graceton 230kV</td>
<td>INTERFACE</td>
<td>Yes</td>
<td></td>
<td>$12.5</td>
<td></td>
<td>$ 24.3</td>
<td>$ 38.6</td>
<td>$ 44.6</td>
<td>$ 31.4</td>
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<tr>
<td>5004/5005 Interface</td>
<td>INTERFACE</td>
<td>Yes</td>
<td></td>
<td>$ 25.4</td>
<td></td>
<td>$ 31.7</td>
<td>$ 19.7</td>
<td>$ 16.4</td>
<td>$ 25.7</td>
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<tr>
<td>Graceton to Conaston 230kV</td>
<td>INTERFACE</td>
<td>Yes</td>
<td></td>
<td>$ 15.8</td>
<td></td>
<td>$ 26.2</td>
<td>$ 24.1</td>
<td>$ 19.1</td>
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<tr>
<td>Susquehanna to Harwood 230 kV</td>
<td>INTERFACE</td>
<td>Yes</td>
<td></td>
<td>$ -</td>
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<td>$  6.0</td>
<td>$  8.1</td>
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<td>$  7.0</td>
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<tr>
<td>R11 Ring Bus A to Red Oak A 230kV</td>
<td>INTERFACE</td>
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<td></td>
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<td>$  3.0</td>
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<tr>
<td>Central Interface</td>
<td>INTERFACE</td>
<td>Yes</td>
<td></td>
<td>$  4.3</td>
<td></td>
<td>$  4.2</td>
<td>$  3.1</td>
<td>$  3.9</td>
<td>$  3.7</td>
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<td>Peach Bottom to Conastone 500 kV</td>
<td>INTERFACE</td>
<td>Yes</td>
<td></td>
<td>$ 40.0</td>
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<td>$  1.4</td>
<td>$  5.7</td>
<td>$  1.7</td>
<td>$  3.6</td>
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<tr>
<td>AEP-DOM Interface</td>
<td>INTERFACE</td>
<td>Yes</td>
<td></td>
<td>$  0.1</td>
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<td>$  1.2</td>
<td>$  3.6</td>
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<tr>
<td>15U.S.A.P. to Peters 138 kV</td>
<td>APS</td>
<td>DUQ</td>
<td></td>
<td>$  3.5</td>
<td></td>
<td>$  1.0</td>
<td>$  2.2</td>
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<td>$  1.6</td>
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<tr>
<td>Maple to Hoytdale 138 kV</td>
<td>FE-ATSI</td>
<td>FE-ATSI</td>
<td></td>
<td>$  0.3</td>
<td></td>
<td>$  1.0</td>
<td>$  1.5</td>
<td>$  2.3</td>
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<tr>
<td>N Philadelphia 8 to Master 230kV</td>
<td>PECO</td>
<td>PECO</td>
<td></td>
<td>$ -</td>
<td></td>
<td>$  0.6</td>
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<td>Bosserman to Olive 138kV</td>
<td>AEP</td>
<td>AEP</td>
<td>M2M</td>
<td>$ -</td>
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<td>Edwards Ferry to Dickerson Station &quot;D&quot; 230 kV</td>
<td>PEPCO</td>
<td>DOM</td>
<td></td>
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<td>$  0.8</td>
<td>$  0.3</td>
<td>$  0.9</td>
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<td>Roseland to Cedar Grove 230 kV</td>
<td>PSEG</td>
<td>PSEG</td>
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<td>$  0.6</td>
<td>$  0.4</td>
<td>$  0.6</td>
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<tr>
<td>Furnace Run TR 500/230 kV</td>
<td>PECO</td>
<td>PECO</td>
<td>PJM TR</td>
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<td></td>
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<td>$  0.6</td>
<td>$  0.2</td>
<td>$  0.4</td>
<td></td>
</tr>
<tr>
<td>NWest to Conastone 230 kV</td>
<td>BGE</td>
<td>BGE</td>
<td></td>
<td>$ -</td>
<td></td>
<td>$  0.1</td>
<td>$  0.6</td>
<td>$  0.4</td>
<td>$  0.3</td>
<td></td>
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<tr>
<td>South Christiansburg to Claytor Lake 138 kV</td>
<td>AEP</td>
<td>AEP</td>
<td>PJM FG</td>
<td>$  0.1</td>
<td></td>
<td>$  0.2</td>
<td>$  0.4</td>
<td>$  0.2</td>
<td>$  0.3</td>
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<tr>
<td>Pumphrey TR 230/115 kV</td>
<td>BGE</td>
<td>BGE</td>
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<td>$  0.1</td>
<td>$  0.1</td>
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<tr>
<td>Proffit DP to Charlottesville 230 kV</td>
<td>DOM</td>
<td>DOM</td>
<td>PJM FG</td>
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<td>$  0.4</td>
<td>$  0.2</td>
<td>$  0.1</td>
<td>$  0.3</td>
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</table>

Note: Congestion shown for top 20 PJM constraints sorted by average congestion for years 2021 and 2024
Interregional Congestion

- Targeted Market Efficiency Projects (TMEP) are not included in the long term window

- Per PJM - MISO JOA, Interregional Proposals must be submitted to both PJM and MISO Regional Windows

- PJM and MISO will follow the effective JOA language when analyzing and recommending Interregional Proposals
Proposal Analysis - Process Overview
Proposal Study Approach

• Step 1: Review submitted project data
  – PJM will contact project sponsor for further clarification as needed

• Step 2: First pass of project evaluations assuming proposer supplied data

• Step 3: Group projects by target congestion driver

• Step 4: Perform detailed analysis
  – Analyze proposals including mid cycle incremental updates
  – Sensitivity runs: load forecast, gas forecast, etc.
Project Selection – Multiple Proposals per Congestion Driver

Start

Review proposals

Perform B/C

Does project pass B/C?

Yes

No

Not Recommended

Project Not Recommended

Does project reduce or fix congestion driver?

Yes

No

Not Recommended based on congestion driver, Hold for other consideration

Project Not Recommended

Is the project competitive?

Yes

No

Further Analysis is required

Project Not Recommended

Does project cause additional unacceptable congestion?

Yes

No

Sensitivity Analysis Other Factors considered*

No

May be Recommended

Yes

Project Recommended

Does project require additional upgrades?

Yes

No

Does Reliability and Constructability Analysis (if necessary) require additional changes?

Yes

No

Finish

Project Recommended

* Other factors considered such as PJM Overall Production Cost, load Payments, and congestion

PJM TEAC 10/25/2016
Objective of PJM Market Efficiency:

Operating Agreement : 1.5.7 (b) Following PJM Board consideration of the assumptions, the Office of the Interconnection shall perform a market efficiency analysis to compare the costs and benefits of: (i) accelerating reliability-based enhancements or expansions already included in the Regional Transmission Plan that if accelerated also could relieve one or more economic constraints; (ii) modifying reliability–based enhancements or expansions already included in the Regional Transmission Plan that as modified would relieve one or more economic constraints; and (iii) adding new enhancements or expansions that could relieve one or more economic constraints, but for which no reliability-based need has been identified. Economic constraints include, but are not limited to, constraints that cause: (1) significant historical gross congestion; (2) pro-ration of Stage 1B ARR requests as described in section 7.4.2(c) of Schedule 1 of this Agreement; or (3) significant simulated congestion as forecasted in the market efficiency analysis. The timeline for the market efficiency analysis and comparison of the costs and benefits for items 1.5.7(b)(i-iii) is described in the PJM Manuals.

1.5.7 (c) The process for conducting the market efficiency analysis described in subsection (b) above shall include the following:
(i) The Office of the Interconnection shall identify and provide to the Transmission Expansion Advisory Committee a list of economic constraints to be evaluated in the market efficiency analysis.

Economic Justification for Market Efficiency

1.5.6 Development of the Recommended Regional Transmission Expansion Plan.
(h) The recommended plan shall identify enhancements and expansions that relieve transmission constraints and which, in the judgment of the Office of the Interconnection, are economically justified. Such economic expansions and enhancements shall be developed in accordance with the procedures, criteria and analyses described in Sections 1.5.7 and 1.5.8 of this Schedule 6.
Proposal Selection Criteria

- Project must reduce or relieve economic congestion on identified PJM constraints.

- Project’s Benefit/Cost Ratio >1.25.
  - Various scenario analysis may be performed

- Cost
  - Consistent with the OA Schedule 6 section 1.5.7 (g), for a Market Efficiency proposal with costs in excess of $50 million, an independent review of such costs will be performed.

- Projects may be further analyzed for other secondary considerations
  - Zonal/Total Savings
  - Risk Evaluation
  - Sensitivity Evaluation
  - Reliability Impacts
Market Efficiency - Project Consideration

- **Primary (Tariff – OA Schedule 6 section 1.5.7):**
  - Benefits (d)
    - $B/C \geq 1.25$
  - Total Cost (g)
    - Accuracy when the cost $\geq 50M$
Market Efficiency - Project Consideration

- **Other (Tariff - OA Schedule 6 section 1.5.7)**:
  - Zonal/Total Savings Metrics (e)
    - Energy Production Cost (Fuel, Variable)
    - Load Energy Payments (MW X LMP)
    - Auction Revenue Rights Credits ($ARR \times \Delta LMP$)
    - Capacity Credits
  - Risks
    - Constructability (Siting, Permitting)
    - Cost Accuracy
    - Schedule
Market Efficiency - Project Consideration

• Other (Tariff – OA Schedule 6 Section 1.5.3)
  – Sensitivities for modeling assumption variations
    • Load Forecast Variations
    • Transfer Level Variations
    • Fuel Cost Forecast Variations
    • Generation/DR Levels (i.e. retirements)
  – Scenario Analyses
    • Constructability
    • Public Policy Objectives (i.e. renewable penetration)
## Sensitivity Ranges

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Load Sensitivity</td>
<td>Plus or Minus 2%</td>
</tr>
<tr>
<td>Gas Sensitivity</td>
<td>Plus or Minus $1</td>
</tr>
<tr>
<td>Potential FSA Sensitivity</td>
<td>To be decided</td>
</tr>
</tbody>
</table>
## Next Steps

<table>
<thead>
<tr>
<th>Milestone</th>
<th>Schedule 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post Problem Statement and Congestion Drivers</td>
<td>End of October</td>
</tr>
<tr>
<td>Post Final Market Efficiency 2016/17 Base Case</td>
<td>End of October</td>
</tr>
<tr>
<td>Post Required Documentation</td>
<td>End of October</td>
</tr>
<tr>
<td>Proposal Window opens</td>
<td>November 1</td>
</tr>
<tr>
<td>PJM Review for Acceleration Candidates</td>
<td>November-December</td>
</tr>
</tbody>
</table>
Questions?

Email: RTEP@pjm.com
Appendix A

Market Efficiency Data Posting
Market Efficiency Data Posting

• Market Efficiency Web Page located at

• Market Efficiency Case Files (first draft posted on 09/14/2016)
  – Access requires CEII access approval (execute PJM CEII NDA and fill out PJM CEII Request Form)
    • Note: the access request must indicate “2016/17 RTEP Proposal Window”
  – Access requires Vendor (ABB) approval that the requester is a licensee of PROMOD confirmation
  – Access requires MISO CEII approval with access confirmed by PJM
  – No confidential data provided or used in analysis (i.e. actual bid data)
  – XML Format

• Posted Reference Files
  – Steps to run Model Document
  – Input Assumptions Summary

• Market Efficiency Questions
  – Please send to the RTEP e-mail distribution (rtep@pjm.com) with “Market Efficiency” in the subject line header
Appendix B

2015 Historical Congestion
<table>
<thead>
<tr>
<th>Rank</th>
<th>Constraint</th>
<th>Type</th>
<th>Location</th>
<th>Approximate total Market Congestion ($)</th>
<th>% of Total Congestion</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conastone - Northwest Line</td>
<td>BGE</td>
<td>$108.80</td>
<td>7.9%</td>
<td></td>
<td>RTEP upgrades expected to reduce congestion (B0497, B1016, B1251). Partial congestion is outage related (work on BAGLEY-GRACETON).</td>
</tr>
<tr>
<td>2</td>
<td>Bagley - Graceton Line</td>
<td>BGE</td>
<td>$107.90</td>
<td>7.8%</td>
<td></td>
<td>RTEP upgrades expected to reduce congestion (B0497, B1016, B1251).</td>
</tr>
<tr>
<td>3</td>
<td>5004/5005 Interface Interface</td>
<td>500</td>
<td>$89.00</td>
<td>6.4%</td>
<td></td>
<td>West - East Transfers.</td>
</tr>
<tr>
<td>4</td>
<td>Bedington - Black Oak Interface</td>
<td>500</td>
<td>$87.60</td>
<td>6.3%</td>
<td></td>
<td>West - East Transfers.; Future reactive upgrades expected to reduce congestion.</td>
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<tr>
<td>5</td>
<td>Cherry Valley TX Flowgate</td>
<td>MISO</td>
<td>$79.60</td>
<td>5.7%</td>
<td></td>
<td>Market to Market Congestion. Partial congestion is outage related (work on 156 CHERRY 45TR81 CT).</td>
</tr>
<tr>
<td>6</td>
<td>AP South Interface</td>
<td>500</td>
<td>$56.20</td>
<td>4.1%</td>
<td></td>
<td>West - East Transfers; Future reactive upgrades expected to reduce congestion.</td>
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<td>7</td>
<td>AEP - DOM Interface</td>
<td>500</td>
<td>$52.40</td>
<td>3.8%</td>
<td></td>
<td>West - East Transfers; Future reactive upgrades expected to reduce congestion.</td>
</tr>
<tr>
<td>8</td>
<td>Joshua Falls Transformer</td>
<td>AEP</td>
<td>$44.00</td>
<td>3.2%</td>
<td></td>
<td>Congestion is outage related (work on ESSEX-KEARNY, BERGEN-SADDLEBR).</td>
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<tr>
<td>9</td>
<td>Bergen - New Milford Line</td>
<td>PSEG</td>
<td>($43.50)</td>
<td>-3.10%</td>
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<td>Existing PSEG upgrades expected to alleviate future congestion.</td>
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<td>10</td>
<td>Person - Halifax Flowgate</td>
<td>MISO</td>
<td>$40.00</td>
<td>2.9%</td>
<td></td>
<td>Market to Market Congestion.</td>
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*Data from 2015 Market Analytics State of Market Report

PJM TEAC 10/25/2016
## 2015 Historical Market Congestion – Top 20 Congestion Causing Constraints

<table>
<thead>
<tr>
<th>Rank</th>
<th>Constraint</th>
<th>Type</th>
<th>Location</th>
<th>Approximate total Market Congestion ($)</th>
<th>% of Total Congestion</th>
<th>Comment</th>
</tr>
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<tbody>
<tr>
<td>11</td>
<td>Maywood - Saddlebrook</td>
<td>Line</td>
<td>PSEG</td>
<td>($23.40)</td>
<td>-1.70%</td>
<td>Congestion is outage related (work on BERGEN-SADDLEBR). Existing PSEG upgrades expected to alleviate future congestion.</td>
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<tr>
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<td>East</td>
<td>Interface</td>
<td>500</td>
<td>$22.60</td>
<td>1.6%</td>
<td>West - East Transfers.</td>
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<tr>
<td>13</td>
<td>Easton</td>
<td>Transformer</td>
<td>DPL</td>
<td>$21.90</td>
<td>1.6%</td>
<td>Congestion is outage related (work on IBCORN-PRICE).</td>
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<tr>
<td>14</td>
<td>Glenarm - Windy Edge</td>
<td>Line</td>
<td>BGE</td>
<td>$20.50</td>
<td>1.5%</td>
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<td>15</td>
<td>Oak Grove - Galesburg</td>
<td>Flowgate</td>
<td>MISO</td>
<td>$19.70</td>
<td>1.4%</td>
<td>Market to Market Congestion.</td>
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<td>16</td>
<td>Mahans Lane - Tidd</td>
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<td>AEP</td>
<td>$19.60</td>
<td>1.4%</td>
<td>Partial congestion is outage related (work on COLLIER-TIDD). RTEP upgrade expected to reduce future congestion (b2445).</td>
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<tr>
<td>17</td>
<td>East Danville - Banister</td>
<td>Line</td>
<td>AEP</td>
<td>$19.10</td>
<td>1.4%</td>
<td>RTEP upgrade expected to reduce congestion (b2375).</td>
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<td>18</td>
<td>49th Street - Hoboken</td>
<td>Line</td>
<td>PSEG</td>
<td>($18.80)</td>
<td>-1.40%</td>
<td>Congestion is outage related (work on ESSEX-KEARNY, BERGEN-SADDLEBR). Existing PSEG upgrades expected to alleviate future congestion.</td>
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<tr>
<td>19</td>
<td>BCPEP</td>
<td>Interface</td>
<td>Pepco</td>
<td>$18.40</td>
<td>1.3%</td>
<td>RTEP upgrades expected to reduce future congestion (B2443, B2443.3).</td>
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<tr>
<td>20</td>
<td>Braidwood - East Frankfort</td>
<td>Line</td>
<td>ComEd</td>
<td>$18.10</td>
<td>1.3%</td>
<td>Market to Market Congestion. Partial congestion is outage related (work on CHERRY 45TR81 CT).</td>
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</table>

**Total Congestion** $1,385.3

*Data from 2015 Market Monitor*