Market Efficiency 2014/15 Long Term Proposal
Window Update
Project 9A (Without Capacitors)

- Tap the Conemaugh - Hunterstown 500 kV line and build new 230 kV double circuit line between Rice and Ringgold.
- Build new 230 kV double circuit line between Furnace Run and Conastone.
- Rebuild of the Conastone - Northwest 230 kV line.
- Replace the Ringgold #3 and #4 transformers with 230/138 kV autotransformers
- Ringgold bus reconfiguration
- Reconductor of Ringgold-Catoctin 138 kV.
- Cost ($M): $340.6
- IS Date: 2020
- Recommendation at August PJM Board meeting
## Recommended Project Designated Entities

<table>
<thead>
<tr>
<th>Component Description</th>
<th>Designated Entity</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project 9A (Without Capacitors)</strong></td>
<td></td>
</tr>
<tr>
<td>Tap the Conemaugh - Hunterstown 500 kV line &amp; create new Rice 500 kV &amp; 230 kV stations. Install two 500/230 kV transformers.</td>
<td>Transource Energy, LLC</td>
</tr>
<tr>
<td>Build new 230 kV double circuit line between Rice and Ringgold.</td>
<td>Transource Energy, LLC</td>
</tr>
<tr>
<td>Tap the Peach Bottom – TMI 500 kV line &amp; create new Furnace Run 500 kV &amp; 230 kV stations. Install two 500/230 kV transformers.</td>
<td>Transource Energy, LLC</td>
</tr>
<tr>
<td>Build new 230 kV double circuit line between Furnace Run and Conastone.</td>
<td>Transource Energy, LLC</td>
</tr>
<tr>
<td>Rebuild the Conastone - Northwest 230 kV line.</td>
<td>Baltimore Gas &amp; Electric</td>
</tr>
<tr>
<td><strong>Additional Reliability Upgrades</strong></td>
<td></td>
</tr>
<tr>
<td>Replace the Ringgold #3 and #4 230/138 kV transformers.</td>
<td>Allegheny Power</td>
</tr>
<tr>
<td>Ringgold bus reconfiguration.</td>
<td>Allegheny Power</td>
</tr>
<tr>
<td>Rebuild/reconstructor the Ringgold-Catoctin 138 kV &amp; replace terminal equipment at both ends of the circuit.</td>
<td>Allegheny Power</td>
</tr>
</tbody>
</table>
Additional Analysis from ApSouth studies

• Additional sensitivity on project 9A using lower gas prices (-$2)
  – B/C ratio= 4.9
  – 9A project continues to provide significant ApSouth congestion savings.

• Additional incremental simulations conducted with project 9A included in base case
  – Competitive projects no longer passed B/C test
Market Efficiency 2016/17 Long Term Proposal
Window Update
2015 Historical Market Congestion

• Total market congestion for 2015 about $1385.3 million

• Top 20 congestion causing events account for about 53.4% of total congestion

• Future RTEP upgrades will help reduce congestion associated with most 2015 historical constraints
## 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>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conastone - Northwest</td>
<td>Line</td>
<td>BGE</td>
<td>$108.80</td>
<td>7.9%</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</td>
<td>Line</td>
<td>BGE</td>
<td>$107.90</td>
<td>7.8%</td>
<td>RTEP upgrades expected to reduce congestion (B0497, B1016, B1251).</td>
</tr>
<tr>
<td>3</td>
<td>5004/5005 Interface</td>
<td>Interface</td>
<td>500</td>
<td>$89.00</td>
<td>6.4%</td>
<td>West - East Transfers.</td>
</tr>
<tr>
<td>4</td>
<td>Bedington - Black Oak</td>
<td>Interface</td>
<td>500</td>
<td>$87.60</td>
<td>6.3%</td>
<td>West - East Transfers.; Future reactive upgrades expected to reduce congestion.</td>
</tr>
<tr>
<td>5</td>
<td>Cherry Valley TX</td>
<td>Flowgate</td>
<td>MISO</td>
<td>$79.60</td>
<td>5.7%</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</td>
<td>Interface</td>
<td>500</td>
<td>$56.20</td>
<td>4.1%</td>
<td>West - East Transfers; Future reactive upgrades expected to reduce congestion.</td>
</tr>
<tr>
<td>7</td>
<td>AEP - DOM</td>
<td>Interface</td>
<td>500</td>
<td>$52.40</td>
<td>3.8%</td>
<td>West - East Transfers; Future reactive upgrades expected to reduce congestion.</td>
</tr>
<tr>
<td>8</td>
<td>Joshua Falls</td>
<td>Transformer</td>
<td>AEP</td>
<td>$44.00</td>
<td>3.2%</td>
<td>Congestion is outage related (work on ESSEX-KEARNY, BERGEN-SADDLEBR).</td>
</tr>
<tr>
<td>9</td>
<td>Bergen - New Milford</td>
<td>Line</td>
<td>PSEG</td>
<td>($43.50)</td>
<td>-3.10%</td>
<td>Existing PSEG upgrades expected to alleviate future congestion.</td>
</tr>
<tr>
<td>10</td>
<td>Person - Halifax</td>
<td>Flowgate</td>
<td>MISO</td>
<td>$40.00</td>
<td>2.9%</td>
<td>Market to Market Congestion.</td>
</tr>
</tbody>
</table>

*Data from 2015 Market Analytics State of Market Report*
### 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>
</thead>
<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>
</tr>
<tr>
<td>12</td>
<td>East</td>
<td>Interface</td>
<td>500</td>
<td>$22.60</td>
<td>1.6%</td>
<td>West - East Transfers.</td>
</tr>
<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>
</tr>
<tr>
<td>14</td>
<td>Glenarm - Windy Edge</td>
<td>Line</td>
<td>BGE</td>
<td>$20.50</td>
<td>1.5%</td>
<td></td>
</tr>
<tr>
<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>
</tr>
<tr>
<td>16</td>
<td>Mahans Lane - Tidd</td>
<td>Line</td>
<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>
</tr>
<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>
</tr>
<tr>
<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>
</tr>
<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>
</tr>
<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>
</tr>
</tbody>
</table>

**Top 20** $739.70  
**Total Congestion** $1,385.3

*Data from 2015 Market Monitor*  
PJM TEAC 06/09/2016
Emission Price Assumptions – CO2

CO2 Emission Price Assumptions

- RGGI CO2
- National CO2
Emission Price Assumptions – SO2

SO₂ Emission Price Assumptions

$/Ton

CSAPR Group 1 SO₂
Emission Price Assumptions – NOx

NOx Emission Price Assumptions

- $/Ton
- 2016 to 2030

CSAPR Annual NOx
CSAPR Seasonal NOx (May - Sep)
2016 PJM Peak Load and Energy Forecast

<table>
<thead>
<tr>
<th>Load</th>
<th>2017</th>
<th>2021</th>
<th>2024</th>
<th>2027</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak (MW)</td>
<td>154,149</td>
<td>157,358</td>
<td>159,991</td>
<td>162,988</td>
<td>167,469</td>
</tr>
<tr>
<td>Energy (GWh)</td>
<td>821,812</td>
<td>843,262</td>
<td>862,838</td>
<td>879,605</td>
<td>906,168</td>
</tr>
</tbody>
</table>

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.
Model zonal demand resources consistent with Table B-7 of the 2016 Load Forecast Report.

### 2016 PJM Demand Resource Forecast

<table>
<thead>
<tr>
<th>Demand Resource (MW)</th>
<th>2017</th>
<th>2021</th>
<th>2024</th>
<th>2027</th>
<th>2031</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8,883</td>
<td>3,424</td>
<td>3,478</td>
<td>3,543</td>
<td>3,651</td>
</tr>
</tbody>
</table>
Future Generation

PJM Market Efficiency Reserve Margin

Note: Includes existing and projected PJM internal capacity based on PJM generation queue information. Model informed by 2021 RTEP machines list.
Carrying Charge Rate and Discount Rate

- Discount rate and levelized carrying charge rate developed using information contained in TO Formula Rate sheets (Attachment H) [1]

- Discount rate based on weighted average after-tax embedded cost of capital
  
  Discount rate = 7.4%

- Levelized annual carrying charge rate based on weighted average net plant carrying charge levelized over an assumed 45 year life of project

  Levelized Annual Carrying Charge Rate = 15.3%

Market Efficiency Data Posting

- Market Efficiency Web Page located at

- PJM will post Market Efficiency Case Files for all study years
  - Access requires CEII confirmation (PJM and MISO)
  - Access requires Vendor (Ventyx) confirmation
  - No confidential data provided or used in analysis (i.e. actual bid data)
  - XML Format

- Reference Files
  - Input Assumptions Summary
  - Updated Modeling Document will provide details of setup and modeling methods
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)
- Final Review with TEAC and approval by Board

Year 1
- 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)
- 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

- **Long Term proposal window:** November 2016 - February 2017
- **Analysis of proposed solutions:** March 2017 - November 2017
- **Determination of Final projects:** December 2017
Next Steps

Finalize Market Efficiency Inputs: June
Market Efficiency Preliminary Results: July
Post Market Efficiency Base Scenarios: July
Stakeholder feedback on model: August-September
PJM review for acceleration candidates: August-October
Proposal window opens: November
Questions?

Email: RTEP@pjm.com