Market Efficiency Update

Transmission Expansion Advisory Committee
June 13, 2019
Nick Dumitriu, Market Simulation
2018/19 Market Efficiency Window
• Posted sensitivity cases
  – FSA Sensitivity Scenario
    » includes units categorized as Facility Study Agreement (FSA) status
  – High and Low Load Sensitivity Scenarios
    » +/- 2% Load Forecast increase/decrease from the base case
  – High and Low Gas Price Forecast Sensitivity Scenarios
    » +/- 20% Henry Hub increase/decrease from the base case

• Posted FSA sensitivity congestion results
2018/19 Market Efficiency Window Analysis Status

- Data validation for all projects (completed)
- Preliminary N-1 contingency analysis for all proposals (completed)
- PROMOD modeling of proposals (in-progress)
  - Completed PROMOD models for all interregional proposals
  - Currently finalizing PROMOD models for Hunterstown-Lincoln proposals
- PROMOD simulations for the interregional proposals (completed)
  - Simulated years 2019, 2023, 2026, 2029
  - Both Base Case and FSA sensitivity
- Calculated PJM benefits and determined B/C ratios for interregional proposals
Preliminary Results for Interregional Proposals
## Interregional Proposals Summary

<table>
<thead>
<tr>
<th>Congestion Driver</th>
<th>Transmission Zone</th>
<th>Greenfield Proposals Count</th>
<th>Upgrade Proposals Count</th>
<th>Total Proposals Count</th>
<th>Cost Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosserman - Trail Creek 138 kV</td>
<td>AEP-MISOE</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>$14M - $266M</td>
</tr>
<tr>
<td>Marblehead XFMR</td>
<td>MISOC</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>$36M</td>
</tr>
<tr>
<td>Monroe 1&amp;2 - Wayne 345 kV</td>
<td>MISOE</td>
<td>-</td>
<td>3</td>
<td>3</td>
<td>$0.1M - $0.5M</td>
</tr>
</tbody>
</table>
Interregional Proposals Analysis

• Completed preliminary N-1 contingency analysis for all interregional proposals to determine flowgates to monitor

• Completed the PROMOD runs for the 10 interregional proposals received from 9 entities (including 1 joint proposal)
  – Projects were modeled using the submitted assumptions
  – Modeled Base Case and FSA sensitivity

• Calculated PJM benefits and determined preliminary B/C ratios for the interregional proposals
  – B/C ratios were computed using the submitted in-service cost of components (assumed full cost assigned to PJM)
  – MISO benefits were not included in B/C ratios

• Descriptions of submitted proposals included in Appendix A
## Bosserman-Trail Creek Proposals Preliminary Results

<table>
<thead>
<tr>
<th>Proposal ID</th>
<th>BT_481</th>
<th>BT_398</th>
<th>BT_436</th>
<th>BT_129</th>
<th>BT_249</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proposal Description</strong></td>
<td>Rebuild Michigan City-Trail Creek-Bosserman 138 kV (10.7mi) and reconductor Maple-LNG 138 kV (7.8 mi)</td>
<td>New Meadow Lake-Pike Creek 345kV line (63.4mi)</td>
<td>New Toto 345kV station</td>
<td>New Kuchar station and new Kutchar-Luchtman 138kV line (10.5mi)</td>
<td>50 MW 4-hour battery at Trail Creek 138 kV station</td>
</tr>
<tr>
<td><strong>Project Type</strong></td>
<td>Upgrade</td>
<td>Greenfield</td>
<td>Greenfield</td>
<td>Greenfield</td>
<td>Greenfield</td>
</tr>
<tr>
<td><strong>B/C Ratio Metric</strong></td>
<td>Lower Voltage</td>
<td>Lower Voltage</td>
<td>Lower Voltage</td>
<td>Lower Voltage</td>
<td>Lower Voltage</td>
</tr>
<tr>
<td><strong>In-Service Cost ($MM)</strong></td>
<td>$35.60</td>
<td>$266.44</td>
<td>$19.31</td>
<td>$27.62</td>
<td>$42.96</td>
</tr>
<tr>
<td><strong>Cost Containment</strong></td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>In-Service Year</strong></td>
<td>2023</td>
<td>2023</td>
<td>2023</td>
<td>2023</td>
<td>2023</td>
</tr>
<tr>
<td><strong>% Cong Driver Mitigated</strong></td>
<td>100%</td>
<td>52%</td>
<td>40%</td>
<td>100%</td>
<td>67%</td>
</tr>
<tr>
<td><strong>2023 Shifted Cong ($MM)</strong></td>
<td>-</td>
<td>-</td>
<td>$0.08</td>
<td>$0.52</td>
<td>$1.63</td>
</tr>
<tr>
<td><strong>Base Case B/C Ratio</strong></td>
<td>1.80</td>
<td>0.37</td>
<td>2.09</td>
<td>1.79</td>
<td>0.19</td>
</tr>
<tr>
<td><strong>FSA Sens. B/C Ratio</strong></td>
<td>3.55</td>
<td>0.53</td>
<td>4.01</td>
<td>4.00</td>
<td>1.56</td>
</tr>
</tbody>
</table>

*Note: Costs under review by PJM*
Marblehead Transformer Proposals Preliminary Results

<table>
<thead>
<tr>
<th>Proposal ID</th>
<th>MH_322</th>
<th>MH_506</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Type</td>
<td>Upgrade</td>
<td>Greenfield</td>
</tr>
<tr>
<td>B/C Ratio Metric</td>
<td>Lower Voltage</td>
<td>Lower Voltage</td>
</tr>
<tr>
<td>In-Service Cost ($M)*</td>
<td>$35.95</td>
<td>$36.02</td>
</tr>
<tr>
<td>Cost Containment</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>In-Service Year</td>
<td>2023</td>
<td>2023</td>
</tr>
<tr>
<td>% Cong Driver Mitigated</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>2023 Shifted Cong ($MM)</td>
<td>$0.42</td>
<td>$0.45</td>
</tr>
<tr>
<td>Base Case B/C Ratio*</td>
<td>1.32</td>
<td>1.85</td>
</tr>
<tr>
<td>FSA Sens. B/C Ratio*</td>
<td>0.12</td>
<td>0.22</td>
</tr>
</tbody>
</table>

* Note: Costs under review by PJM
## Monroe-Wayne Proposals Preliminary Results

<table>
<thead>
<tr>
<th>Proposal ID</th>
<th>Proposal Description</th>
<th>Project Type</th>
<th>B/C Ratio Metric</th>
<th>In-Service Cost ($M)</th>
<th>Cost Containment</th>
<th>In-Service Year</th>
<th>% Cong Driver Mitigated*</th>
<th>2023 Shifted Cong ($MM)*</th>
<th>Base Case B/C Ratio</th>
<th>FSA Sens. B/C Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>MW_782</td>
<td>Upgrade Monroe-Wayne 345 kV line rating by replacing switches at the 345kV Wayne station.</td>
<td>Upgrade</td>
<td>Lower Voltage</td>
<td>$0.46</td>
<td>No</td>
<td>2023</td>
<td>100%*</td>
<td>All congestion shifted to parallel line</td>
<td>81.39</td>
<td>36.38</td>
</tr>
<tr>
<td>MW_078</td>
<td>Modify the Monroe-Wayne 345 kV line impedance to significantly reduce line flows.</td>
<td>Upgrade</td>
<td>Lower Voltage</td>
<td>$0.10</td>
<td>No</td>
<td>2023</td>
<td>100%*</td>
<td>All congestion shifted to parallel line</td>
<td>0</td>
<td>147.63</td>
</tr>
<tr>
<td>MW_775</td>
<td>Reconfigure the Monroe-Coventry 345 kV line that runs adjacent to the Monroe-Wayne line on common structures.</td>
<td>Upgrade</td>
<td>Lower Voltage</td>
<td>$0.10</td>
<td>No</td>
<td>2023</td>
<td>100%*</td>
<td>All congestion shifted to parallel line</td>
<td>0</td>
<td>15.98</td>
</tr>
</tbody>
</table>

* 100% Congestion shifts from Monroe-Wayne 345 kV to Monroe-Brownstone 345 kV

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* 100% Congestion shifts from Monroe-Wayne 345 kV to Monroe-Brownstone 345 kV

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Map
All three proposals shifted congestion from Monroe – Wayne 345 kV to parallel Monroe - Brownstone 345 kV constraint.

Because of the congestion shift, none of the proposals received significantly decreased the total congestion around the Monroe bus.

Table below shows congestion around the Monroe bus (base case and each proposal, simulated year 2023).
Next Steps

- **Interregional Analysis**
  - Coordination with MISO on interregional proposal B/C ratios
    - B/C ratios including both PJM and MISO benefits will be presented at the next IPSAC meeting
  - Complete Load and Gas Price sensitivities for interregional proposals
  - Reliability Analysis for interregional proposals
  - RPM Check for Bosserman – Trail-Creek projects
  - Cost Constructability Analysis for interregional proposals

- **Start analysis of Hunterstown-Lincoln proposals**
Appendix A
2018/19 Long Term Window
Individual Proposal Descriptions
Project ID: 201819_BT_129

Proposed Solution:

kV Level: 138 kV
In-Service Cost ($M): $27.62
In-Service Year: 2023
Target Zone: AEP/MISOE
ME Constraints: Bosserman - Trail Creek 138kV
Notes:
## Project ID: 201819_BT_249

**Proposed Solution:**
Build a 50 MW 4-hour Warnke Battery Energy Storage System (BESS) to be connected to Trail Creek 138 kV station. Upgrade Trail Creek 138 kV station (less than 1mi).

- **kV Level:** 138 kV
- **In-Service Cost ($M):** $45.40
- **In-Service Year:** 2022
- **Target Zone:** AEP/MISOE
- **ME Constraints:** Bosserman - Trail Creek 138kV
- **Notes:**

![Map Image](image_url)
**Project ID: 201819_BT_398**

**Proposed Solution:**
Establish a new 345 kV Pike Creek station near the intersection of the 345 kV Bloom-Davis Creek and the 345 kV Burnham-Davis Creek lines. Build a new Meadow Lake-Pike Creek 345kV line (63.4mi). Upgrade Meadow Lake 345 kV station.

**kV Level:** 345 kV

**In-Service Cost ($M):** $266.44

**In-Service Year:** 2023

**Target Zone:** AEP/MISOE

**ME Constraints:**
Bosserman - Trail Creek 138kV

**Notes:**

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**Legend**
- Identified Reinforcement
- Transmission System Enhancement
- Subs >= 345 kV
- Trans Lines >= 345 kV

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**Map:**
- Diagram showing the proposed project locations and connections.
**Project ID: 201819_BT_436**

**Proposed Solution:**
Build a new Toto 345kV station, interconnecting the existing Olive-Reynolds #1, Olive-Reynolds #2, and Schafer-Burr Oak 345kV transmission lines with a new 345kV switching station (less than 1mi).

**kV Level:** 345 kV
**In-Service Cost ($M):** $19.31
**In-Service Year:** 2023
**Target Zone:** AEP/MISOE
**ME Constraints:** Bosserman - Trail Creek 138kV
**Notes:**

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![Map of Toto 345kV Station](image)
**Project ID: 201819_BT_481**

**Proposed Solution:**
Rebuild Michigan City-Trail Creek-Bosserman 138 kV circuits (10.7mi). Reconductor Maple-LNG 138 kV circuit (7.8mi). Upgrade Michigan City, Trail Creek, Maple and LNG terminals.

- **kV Level:** 138 kV
- **In-Service Cost ($M):** $35.60
- **In-Service Year:** 2023
- **Target Zone:** AEP/MISOE
- **ME Constraints:**
  - Bosserman - Trail Creek 138kV

**Notes:**
Project ID: 201819_MH_322

Proposed Solution:
Rebuild Palmyra-Marblehead 161 kV as a 345 kV/161 kV double circuit line, and Marblehead-Herleman 138 kV as a 345 kV/138 kV double circuit line (12mi). Upgrade Herleman substation. Construct a 345 kV ring bus at the Palmyra substation.

kV Level: 345 kV

In-Service Cost ($M): $35.95

In-Service Year: 2023

Target Zone: MISOC

ME Constraints:
Marblehead Transformer

Notes:

![Map showing the proposed solution]
**Project ID: 201819_MH_506**

**Proposed Solution:**
Rebuild Palmyra-Marblehead 161 kV as a 345 kV/161 kV double circuit line, and Marblehead-Herleman 138 kV as a 345 kV/138 kV double circuit line (15mi). Construct Maywood-Palmyra 345 kV line. Upgrade Herleman and Maywood substations.

**kV Level:** 345 kV

**In-Service Cost ($M):** $36.02

**In-Service Year:** 2023

**Target Zone:** MISOC

**ME Constraints:**
Marblehead Transformer

**Notes:**

![Map of project locations]
<table>
<thead>
<tr>
<th>Project ID: 201819_MW_078</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Proposed Solution:</strong></td>
</tr>
<tr>
<td>Modify the Monroe-Wayne 345 kV line impedance to significantly reduce line flows.</td>
</tr>
<tr>
<td><strong>kV Level:</strong> 345 kV</td>
</tr>
<tr>
<td><strong>In-Service Cost ($M):</strong> $0.10</td>
</tr>
<tr>
<td><strong>In-Service Year:</strong> 2023</td>
</tr>
<tr>
<td><strong>Target Zone:</strong> MISOE</td>
</tr>
<tr>
<td><strong>ME Constraints:</strong> Monroe 1&amp;2 - Wayne 345 kV</td>
</tr>
<tr>
<td><strong>Notes:</strong></td>
</tr>
</tbody>
</table>
Project ID: 201819_MW_775

Proposed Solution:
Reconfigure the Monroe-Coventry 345 kV line that runs adjacent to the Monroe-Wayne line on common structures.

kV Level: 345 kV
In-Service Cost ($M): $0.10
In-Service Year: 2023
Target Zone: MISOE
ME Constraints:
Monroe 1&2 - Wayne 345 kV
Notes:
Project ID: 201819_MW_782

Proposed Solution:
Upgrade Monroe-Wayne 345 kV line rating by replacing switches at the 345kV Wayne station.

kV Level: 345 kV
In-Service Cost ($M): $0.46
In-Service Year: 2023
Target Zone: MISOE
ME Constraints:
Monroe 1&2 - Wayne 345 kV
Notes:
Revision History

6/10/2019 – V1 – Original version posted to pjm.com
6/12/2019 – V2 – Added Cost Containment information to slides 8, 9 and 10.
   Corrected the cost of BT_129 on slide 8.