Market Efficiency Update

Transmission Expansion Advisory Committee
March 8, 2018

Version 2
2016/17 Long Term Window

BGE Group Analysis Conclusion
PJM completed analysis for the BGE Group and selected proposal 5E

- 5E passes all PROMOD sensitivity scenarios
- Reliability Analysis has been completed and no reliability violation identified as a result of the 5E Market Efficiency proposal
- Cost/Constructability Analysis completed

PJM will be recommending BGE’s proposal 5E for approval at the April Board meeting.

- Highest among proposals submitted for the BGE constraints.
- Fully addresses target congestion driver Conastone – Graceton – Bagley 230 kV
- Addresses downstream congestion expected to be relieved on the 230 kV & 115 kV system
- Remaining shifted congestion is within acceptable levels
Trend for Net Load Benefits of Recommended Proposal 5E

201617_1-5E
Net Load Payment Benefit
Simulated Results are PJM Total Benefits for zones that get allocation

($ Million)


2031 Simulation
2031 Trend
Project ID: 201617_1-5E

Proposed by: BGE

Proposed Solution:
Reconductor the Conastone to Graceton 230kV lines. Upgrade substation equipment at Conastone. Add bundled conductors to the Graceton-Bagley-Raphael Road 230kV double circuit lines. Reconductor the Raphael Road to Northeast 230 kV double circuit lines. Upgrade substation equipment at Windy Edge substation.

kV Level: 115/230 kV

In-Service Cost ($M): $25.40  B/C: 8.16
PJM Cost Estimate ($M): $39.65  B/C: 5.23

In-Service Date: 2021

Target Zone: BGE

ME Constraints:
CONASTONE - GRACETON - BAGLEY 230 kV

Notes: To be recommended for approval at the April 2018 Board meeting.
PPL Group Analysis Results
• PJM completed the analysis for the PPL group using the latest posted Market Efficiency base case updated to include the solution selected for the BGE group

• Sensitivity Scenarios considered:
  – No FSA Scenario
  – High/Low Gas Price Forecast (+/- 20%)
  – Low Load Forecast (- 2%)

• Descriptions of submitted proposals included in Appendix B
SUSQ – HARW Congestion Driver Decrease

- Compared to the start of the 2016/17 Window, congestion driver decreased significantly
  - lower load forecast and changes in generation expansion.
- Most of the SUSQ-HARW congestion is driven by PPL FSA units:
  - Sunbury #2 (AA2-182), 977 MW
  - Good Spring Power CC, 337 MW (withdrew October 2017)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Market Congestion ($ Millions)</th>
<th>Notes</th>
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<tbody>
<tr>
<td>Initial Driver (posted November 2016)</td>
<td>$3.98</td>
<td>Facilities Recommended for Proposals Criteria: $1 million for 2021 and 2024</td>
</tr>
<tr>
<td>Base Case (vintage November 2017)</td>
<td>$2.94</td>
<td>45% congestion decrease compared to initial driver</td>
</tr>
<tr>
<td>No PPL FSA Sensitivity (vintage November 2017)</td>
<td>$1.34</td>
<td>80% congestion decrease compared to initial driver</td>
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<tr>
<td>Latest Posted Base Case + 5E</td>
<td>$2.46</td>
<td>56% congestion decrease compared to initial driver</td>
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<tr>
<td>Latest No FSA Sensitivity (5E included)</td>
<td>$1.41</td>
<td>79% congestion decrease compared to initial driver</td>
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</tbody>
</table>
• Congestion Driver
  – Both the reconductoring proposal 2A and the new Harwood - Trexler Run 230 kV line fully solve the SUSQ-HARW congestion driver.

• B/C Ratio
  – Significant decrease in B/C ratios compared to values posted at November 2017 TEAC
  – No proposal passes the 1.25 threshold when considering a PJM wide no FSA sensitivity scenario.

<table>
<thead>
<tr>
<th>Proposal Description</th>
<th>Company</th>
<th>ID</th>
<th>Proposal Cost ($ million)</th>
<th>New B/C Ratios (Base Case with 5E)</th>
<th>Old B/C Ratios (presented Nov 2017 TEAC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reconductor Susquehanna - Harwood 230 kV</td>
<td>PPL</td>
<td>2A</td>
<td>13.13</td>
<td>0.24</td>
<td>1.74</td>
</tr>
<tr>
<td>New Siegfried 500/230 kV transformer</td>
<td>PPL</td>
<td>2C</td>
<td>18.32</td>
<td>0.51</td>
<td>0.83</td>
</tr>
<tr>
<td>New Harwood - Trexler Run 230 kV line</td>
<td>NTD</td>
<td>18Q</td>
<td>33.70</td>
<td>1.73</td>
<td>2.70</td>
</tr>
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</table>

* No FSA Sensitivity scenario removed all FSA units from PJM.

** No PPL FSA Sensitivity scenario removed FSA units in PPL.
• Base Case includes monitoring of PPL Wescosville supplemental project (s0864).
• s0864 supplemental project changes operations around Wescosville transformer:
  – New Wescosville 230/138 kV transformer is projected to be operated as normally closed
  – Removes the current Wescosville 230/69 kV #2 transformer (currently operated as normally open)
• The new configuration creates a new flow path
  – from Wescosville 500 kV bus, down through Wescosville 500/138 kV transformer, back up through Wescosville 138/230 kV transformer, toward Hosensack 230 kV bus.
• The new configuration changes congestion pattern
  – Susquehanna – Harwood congestion driver is significantly diminished
  – New congestion pattern around Wescosville 500/138 kV transformer
Analysis Conclusions

• **B/C ratios decreased**
  – In the latest analysis, the B/C ratios for all proposals significantly decreased.

• **Impact of FSA Units**
  – Significant part of the congestion driver is FSA driven.
  – The B/C ratios for all proposals are failing when FSA units are excluded from the base case

• **Congestion Pattern**
  – SUSQ-HARW congestion driver decreased significantly from the initially posted values.
  – Moreover, the SUSQ-HARW congestion driver disappears with the Wescosville 230/138 kV supplemental project closed and a new congestion pattern is introduced.
  – The new congestion pattern was not evident prior to opening of the window.

• **PJM is currently not recommending any proposals in the PPL area.**
2016/17 RTEP Window Conclusions

• PJM will be recommending BGE’s proposal 5E for approval at the April Board meeting.

• PJM is not currently recommending any proposals in the PPL area for the 2016/17 Market Efficiency Long Term window.
2018/19 RTEP Long Term Window
### 2018/19 Market Efficiency Timeline

<table>
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<tr>
<th>Year 0</th>
<th>Year 1</th>
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<td>Jan</td>
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**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**

**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**

**12-month cycle**

**24-month cycle**
<table>
<thead>
<tr>
<th>Step</th>
<th>Timeline</th>
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<tbody>
<tr>
<td>Develop Assumptions</td>
<td>March – May 2018</td>
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<tr>
<td>Build Base Case</td>
<td>June – July 2018</td>
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<tr>
<td>Identify Congestion Drivers</td>
<td>August – September 2018</td>
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<tr>
<td>Post Base Case and Congestion Drivers</td>
<td>October 2018</td>
</tr>
<tr>
<td>Proposal Window</td>
<td>November 2018 - February 2019</td>
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<tr>
<td>Analysis of Proposed Solutions</td>
<td>March - November 2019</td>
</tr>
<tr>
<td>Final TEAC Review and Board Approval</td>
<td>November - December 2019</td>
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Appendix A

PPL Group Proposals
Project ID: 201617_1-2A

Proposed by: PPL

Proposed Solution:
Reconductor the Susquehanna - Harwood and Susquehanna-Sugarloaf-Harwood 230 kV DCT lines and replace a limited number of structures as necessary to accommodate the heavier conductor.

Kv Level: 230 kV

In-Service Cost ($M): $13.13

In-Service Date: 2021

Target Zone: PPL

ME Constraints:
SUSQUEHANNA - HARWOOD 230 kV

Notes:
• This is an upgrade.
• Due to different conductor size, 2A has higher ratings than 2B
• This project is not currently recommended.
Reconductor the Susquehanna - Harwood and Susquehanna-Sugarloaf-Harwood 230 kV DCT lines and replace a limited number of structures as necessary to accommodate the heavier conductor.

**kV Level:** 230 kV

**In-Service Cost ($M):** $13.01

**In-Service Date:** 2021

**Target Zone:** PPL

**ME Constraints:**

SUSQUEHANNA - HARWOOD 230 kV

**Notes:**

- This is an upgrade.
- Due to different conductor size, 2B has lower ratings than 2A
- This project is not currently recommended.
Project ID: 201617_1-2C

Proposed by: PPL

Proposed Solution:
Tap the Susquehanna - Wescosville 500 kV line at Siegfried. Expand Siegfried to include a 500/230 kV substation.

kV Level: 230/500 kV
In-Service Cost ($M): $18.32
In-Service Date: 2021
Target Zone: PPL

ME Constraints:
SUSQUEHANNA - HARWOOD 230 kV

Notes:
• This is an upgrade of Siegfried station
• This project is not currently recommended.
**Proposed by:** Nextera

**Proposed Solution:** Greenfield
Tap the Susquehanna - Wescosville 500 kV line near Siegfried and build a new 500/230 kV substation (Spring Hill). Tie Spring Hill 230 kV into the existing Siegfried 230 kV substation.

- **kV Level:** 230/500 kV
- **In-Service Cost ($M):** $33.8
- **In-Service Date:** 2021
- **Target Zone:** PPL

**ME Constraints:**
SUSQUEHANNA - HARWOOD 230 kV

**Notes:**
- This is a greenfield project
- This project is not currently recommended.
Project ID: 201617_1-18G

Proposed by: Northeast Transmission Development

Proposed Solution: Greenfield
Tap the Susquehanna - Wescosville 500 kV line near Siegfried and build a new 500/230 kV substation (Fells Creek). Tie the Fells Creek 230 kV into the existing Siegfried 230 kV substation.

<table>
<thead>
<tr>
<th>kV Level: 230/500 kV</th>
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<tbody>
<tr>
<td>In-Service Cost ($M): $32.9</td>
</tr>
<tr>
<td>In-Service Date: 2021</td>
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<tr>
<td>Target Zone: PPL</td>
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</table>

ME Constraints:
SUSQUEHANNA - HARWOOD 230 kV

Notes:
- This is a greenfield project
- This project is not currently recommended.
<table>
<thead>
<tr>
<th>Project ID: 201617_1-18Q</th>
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<tbody>
<tr>
<td>Proposed by: Northeast Transmission Development</td>
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</table>

**Proposed Solution: Greenfield**

Tap the Catawissa - Frackville 230 kV line and build a new 230 kV switchyard (Trexler Run). Build a new Harwood - Trexler Run 230 kV line.

**kV Level:** 230 kV  
**In-Service Cost ($M):** $33.7  
**In-Service Date:** 2021  
**Target Zone:** PPL  
**ME Constraints:**  
SUSQUEHANNA - HARWOOD 230 kV

**Notes:**
- This is a greenfield project
- This project is not currently recommended.
Appendix B – PPL Supplemental Project
Wescosville Transformer 230/138 kV
PPL Transmission Zone (presented at TEAC 04/09/2015)

- S0864 Supplemental Upgrade Scope Change:
- Old Scope: Rebuild approximately 10 miles of the Hosensack-Wescosville 230 kV line to 500 kV and upgrade Wescosville 500-138 kV Substation.
  - New Scope:
    - Build approximately 6 miles 500 kV 2nd circuit on the existing Alburtis – Breinigsville.
    - Reconfigure the Wescosville 500 kV station to double breaker arrangement.
    - Install a new Wescosville 230/138 kV transformer.
- Estimated Project Cost: $ 58.4 M
- Projected IS Date: 12/31/2017

Note: New Projected IS Date is 3/1/2019
Revision History

- V1 – 3/05/2018 – Original Version Posted to PJM.com
- V2 – 3/20/2018 – Slide 5 updated with independent cost estimate and adjusted B/C ratio for project 5E reflecting the information which was presented at the March 8, 2018 meeting