Market Efficiency Update

Transmission Expansion Advisory Committee

January 11, 2018

Agenda

- Acceleration Analysis Results
- 2016/17 RTEP Window Status Update
- BGE Group Results

Acceleration Analysis

Acceleration Analysis

- Scope
  - Determine which reliability upgrades, if any, have an economic benefit if accelerated or modified.
- Study Years
  - 2018 and 2022 set of economic input assumptions used to study impacts of approved RTEP projects
- Process
  - Compare simulated market congestion for near term vs. future topology
  - Estimate economic impact of accelerating planned upgrades

Acceleration Analysis Status

- Finalized PROMOD modeling work for 2018 and 2022 AS-IS cases

- Completed PROMOD simulations
  - 2018 and 2022 study years with 2018 Topology (AS-IS Topology)
  - 2018 and 2022 study years with 2022 Topology (RTEP Topology)

- Compared the board approved reliability upgrades with the congestion reductions between the AS-IS and the RTEP Base cases.

Acceleration Analysis: 2018 Load, Generation and Economic Assumptions

Congestion Decreases Associated With Approved Reliability Projects - 2018 Study Year			2018 Study Year		
			2018 Topology	2022 Topology	Congestion Savings ($ Millions)
Constraint Name	AREA	TYPE	Year 2018 Congestion ($ Millions)	Year 2018 Congestion ($ Millions)	
05TANNER345-08M.FORT345	AEP/DEOK	LINE	$24.5	$0.0	$24.5
ROXBURY 138/115	PENELEC	XFMR	$3.4	$0.0	$3.4
27YORKANA230-BRIS230	ME/PPL	LINE	$4.0	$0.0	$4.0
CNASTONE500-PCHBTM1S500	PJM500	LINE	$74.3	$5.8	$68.5
NWEST230-CONASTON230	BGE	LINE	$8.3	$0.0	$8.3
SAHA34TP230-GRACETON230	PPL/BGE	LINE	$13.0	$0.0	$13.0
PCHBTM 500/230	PECO	XFMR	$11.5	$0.0	$11.5

Upgrade Associated with Congestion Reduction	ISD
RTEP B2831: Upgrade the Tanner Creek - Miami Fort 345 kV circuit.	2021
RTEP B2743:Build new 230 kV double circuit line between Rice and Ringgold 230 kV	2020
RTEP B2691:Reconductor three spans limiting Brunner Island - Yorkana 230 kV line	In Service
RTEP B2766: Upgrade substation equipment at Conastone & Peachbottom 500 kV	2021
RTEP B2752.7:Reconductor/Rebuild the two Conastone - Northwest 230 kV lines and upgrade terminal equipment	2020
RTEP B2690:Reconductor two spans of the Graceton - Safe Harbor 230 kV transmission line. Includes termination point upgrades	2018
RTEP B2694:Increase ratings of Peach Bottom 500/230 kV transformer	2019

Note: For a particular flowgate, the congestion savings for the 2018 study year are calculated as the difference in simulated congestion between the PROMOD case with AS-IS topology and the PROMOD case with the RTEP topology.

Acceleration Analysis: 2022 Load, Generation and Economic Assumptions

Congestion Decreases Associated With Approved Reliability Projects - 2022 Study Year			2022 Study year		
			2018 Topology	2022 Topology	Congestion Savings ($ Millions)
Constraint Name	AREA	TYPE	Year 2022 Congestion ($ Millions)	Year 2022 Congestion ($ Millions)	
05TANNER345-08M.FORT345	AEP/DEOK	LINE	$5.2	$0.0	$5.2
ROXBURY 138/115	PENELEC	XFMR	$9.3	$0.0	$9.3
27YORKANA230-BRIS230	ME/PPL	LINE	$7.3	$0.0	$7.3
CNASTONE500-PCHBTM1S500	PJM500	LINE	$4.4	$0.0	$4.4
NWEST230-CONASTON230	BGE	LINE	$2.4	$0.0	$2.4
SAHA34TP230-GRACETON230	PPL/BGE	LINE	$3.4	$0.0	$3.4
PCHBTM 500/230	PECO	XFMR	$60.0	$0.0	$60.0

Upgrade Associated with Congestion Reduction	ISD
RTEP B2831: Upgrade the Tanner Creek - Miami Fort 345 kV circuit.	2021
RTEP B2743:Build new 230 kV double circuit line between Rice and Ringgold 230 kV	2020
RTEP B2691:Reconductor three spans limiting Brunner Island - Yorkana 230 kV line	In Service
RTEP B2766: Upgrade substation equipment at Conastone & Peachbottom 500 kV	2021
RTEP B2752.7:Reconductor/Rebuild the two Conastone - Northwest 230 kV lines and upgrade terminal equipment on both ends	2020
RTEP B2690:Reconductor two spans of the Graceton - Safe Harbor 230 kV transmission line. Includes termination point upgrades	2018
RTEP B2694:Increase ratings of Peach Bottom 500/230 kV transformer	2019

Note: For a particular flowgate, the congestion savings for the 2022 study year are calculated as the difference in simulated congestion between the PROMOD case with AS-IS topology and the PROMOD case with the RTEP topology.

Acceleration Analysis: Results

- RTEP B2766 was selected for acceleration from 2021 to 2020
  - Upgrade substation equipment at Conastone & Peach Bottom 500 kV
  - Estimated annual congestion savings: $4.4 million
  - Acceleration cost: 0$

- No other reliability upgrades were selected for acceleration*
  - did not provide significant congestion benefits in the acceleration analysis, or
  - ISD is in near future, or
  - project scope too large to accelerate

**Update will be provided if any of facilities may be accelerated.*

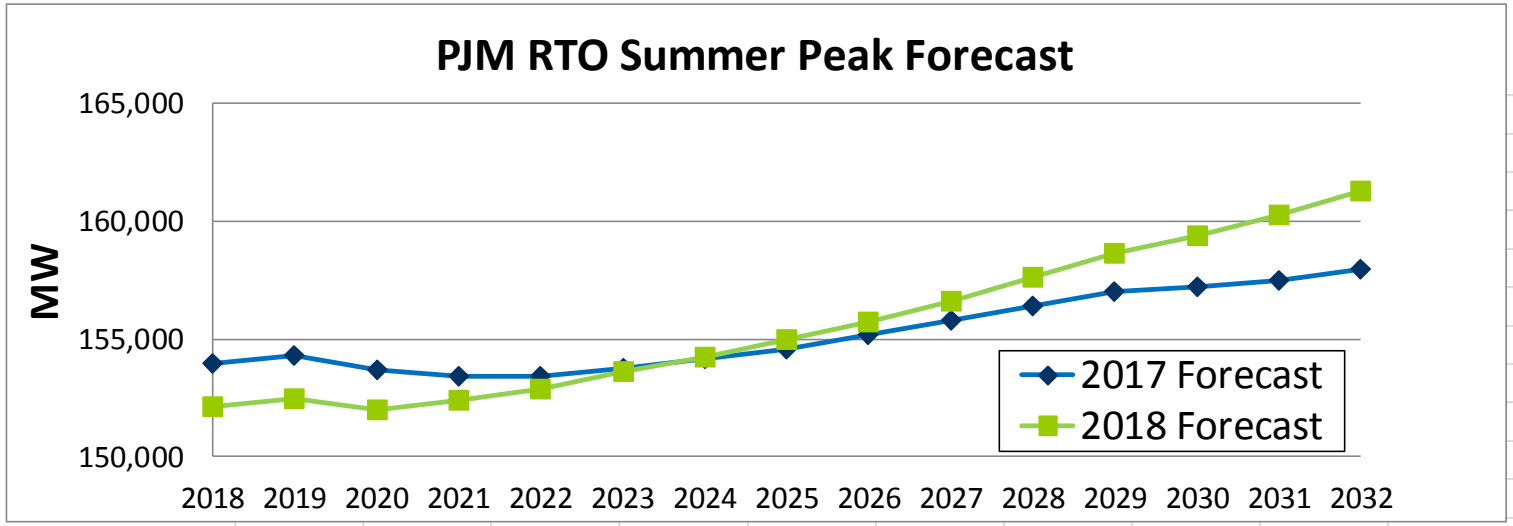
2016-2017 Long Term Window

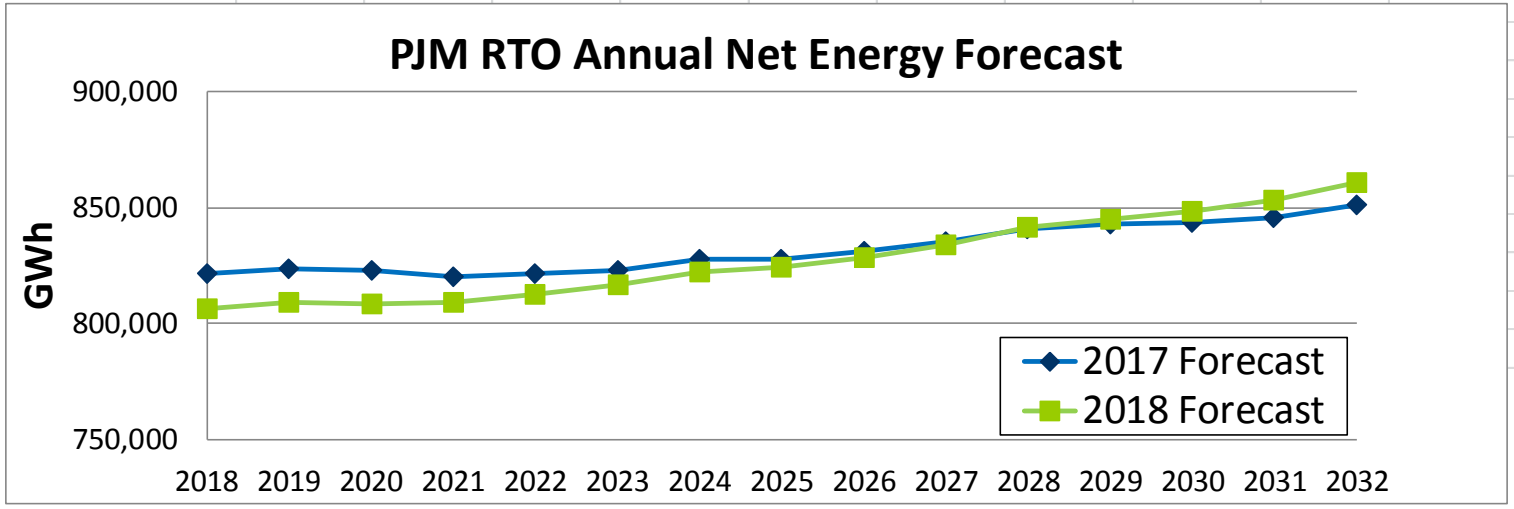
2016-2017 Window

- Posted Final Update Market Efficiency Base Case
  - Included Crane generator retirement along with corresponding reliability upgrade
  - Updated the load forecast to reflect the 2018 PJM Load Forecast.
  - Added constraint to balance PJM-NY PARs (matching the RTEP planning model).
  - Added BGE flowgates resulted from contingency analysis across all BGE proposals

- Analysis Status
  - RPM Projects analysis (completed)
  - Interregional Projects analysis (completed)
  - Reactive Proposals Group (completed)
  - PPL projects analysis (90% completed)
  - BGE projects (90% completed)
  - Due to lack of congestion on the project targeted constraint, none of the other proposals were considered for further analysis.
- Target determination of recommended projects: Feb 2018

2018 Load Forecast Update





BGE Group Results

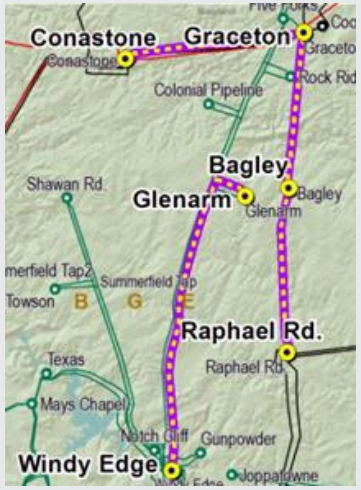
BGE Group Analysis Status

- Results were presented at November 2017 TEAC*
  - More than half of the proposals did not pass the B/C ratio threshold
  - Some proposals did not fully address the congestion driver or shifted congestion downstream.
  - The highest B/C ratios were achieved by the upgrade proposals.

- http://www.pjm.com/-/media/committees-groups/committees/teac/20171109/20171109-teac-market-efficiency-update.ashx

- Based on results presented at November 2017 TEAC, PJM focused the analysis on the BGE upgrades 5D and 5E (see next slide)
  - Used updated base case posted on January 2018.
  - Projects modeled using the submitted assumptions
  - B/C ratios computed using the submitted in-service cost of components

Comparative Analysis 5D vs 5E

Proposal	5D	5E
In-Service cost ($M)	$ 20.40	$ 25.40
In-service Year	2021	2021
B/C Ratio	8.2	8.1
Fully Solves Target Congestion	Yes	Yes
Creates Other BGE Congestion	Yes (NEAST – RAPHAEL)	No
Map		

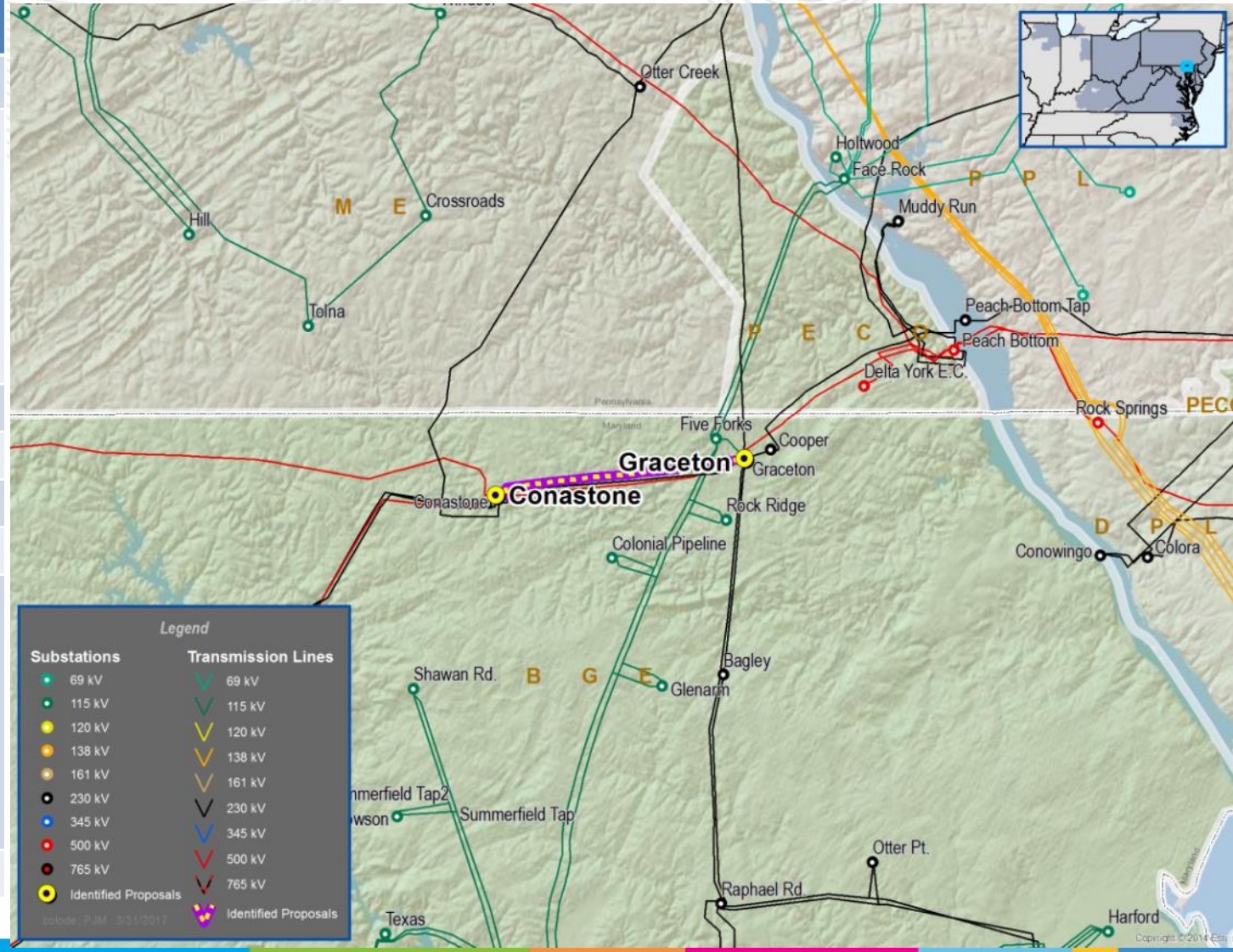
BGE Group Next Steps

- PJM intends to recommend BGE's proposal 5E for board approval.
  - 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.
- PJM will include BGE's proposal 5E in the base case and will determine if other proposals provide additional benefits when added incrementally to 5E.
- Other steps
  - Finalize Cost/Constructability Analysis
  - Finalize Reliability Analysis
  - Run sensitivities on gas and load forecast
- Final results to be presented at the next TEAC meeting

Appendix A
BGE Proposed Upgrades 5A – 5E

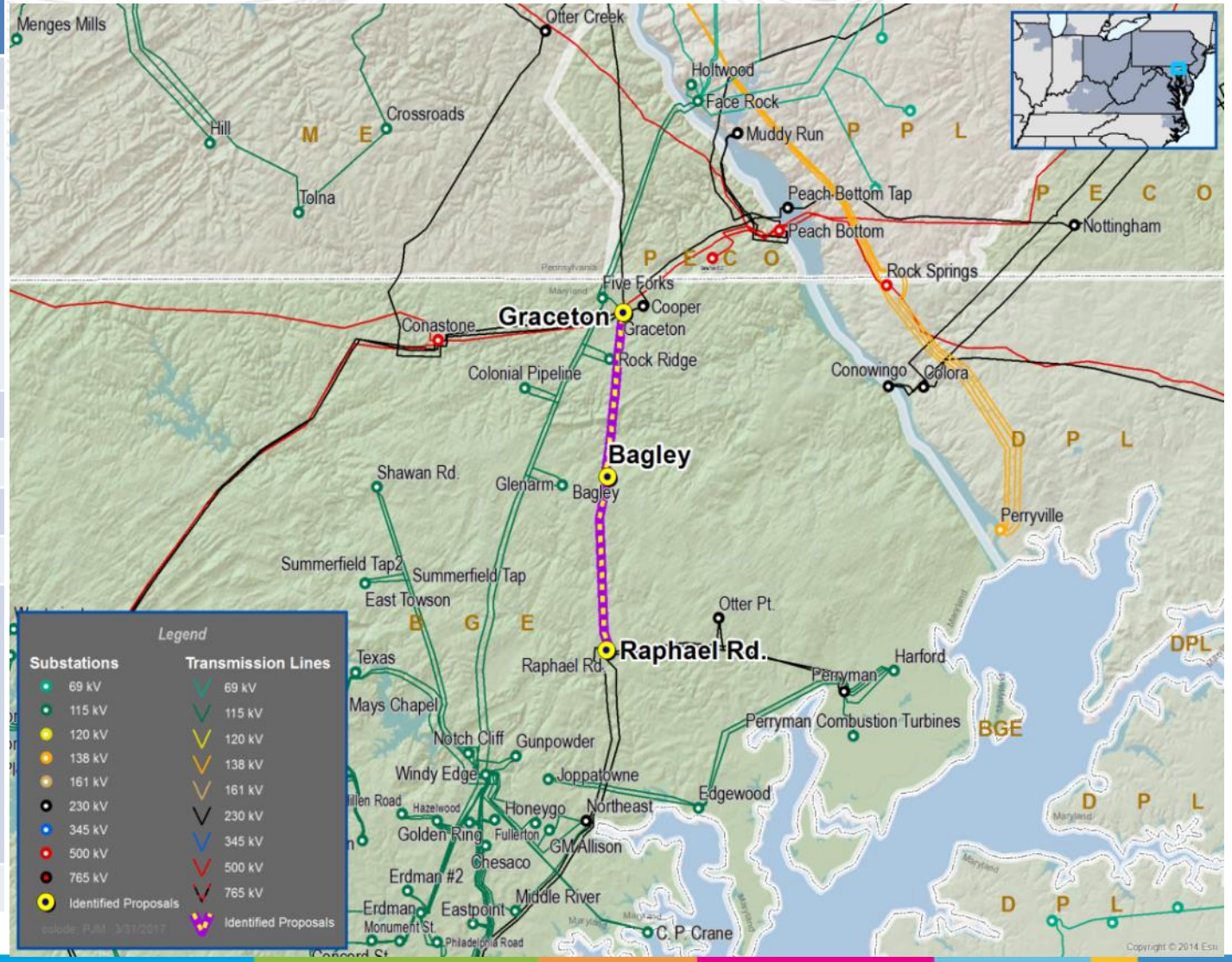
BGE 1-5A

Project ID: 201617_1-5A
Proposed by: BGE
Proposed Solution: Reconductor the Conastone to Graceton 230 kV lines. Upgrade substation equipment at Conastone.
kV Level: 230 kV
In-Service Cost ($M): $5.97
In-Service Date: 2020
Target Zone: BGE
ME Constraints: CONASTONE - GRACETON 230 kV
Notes:



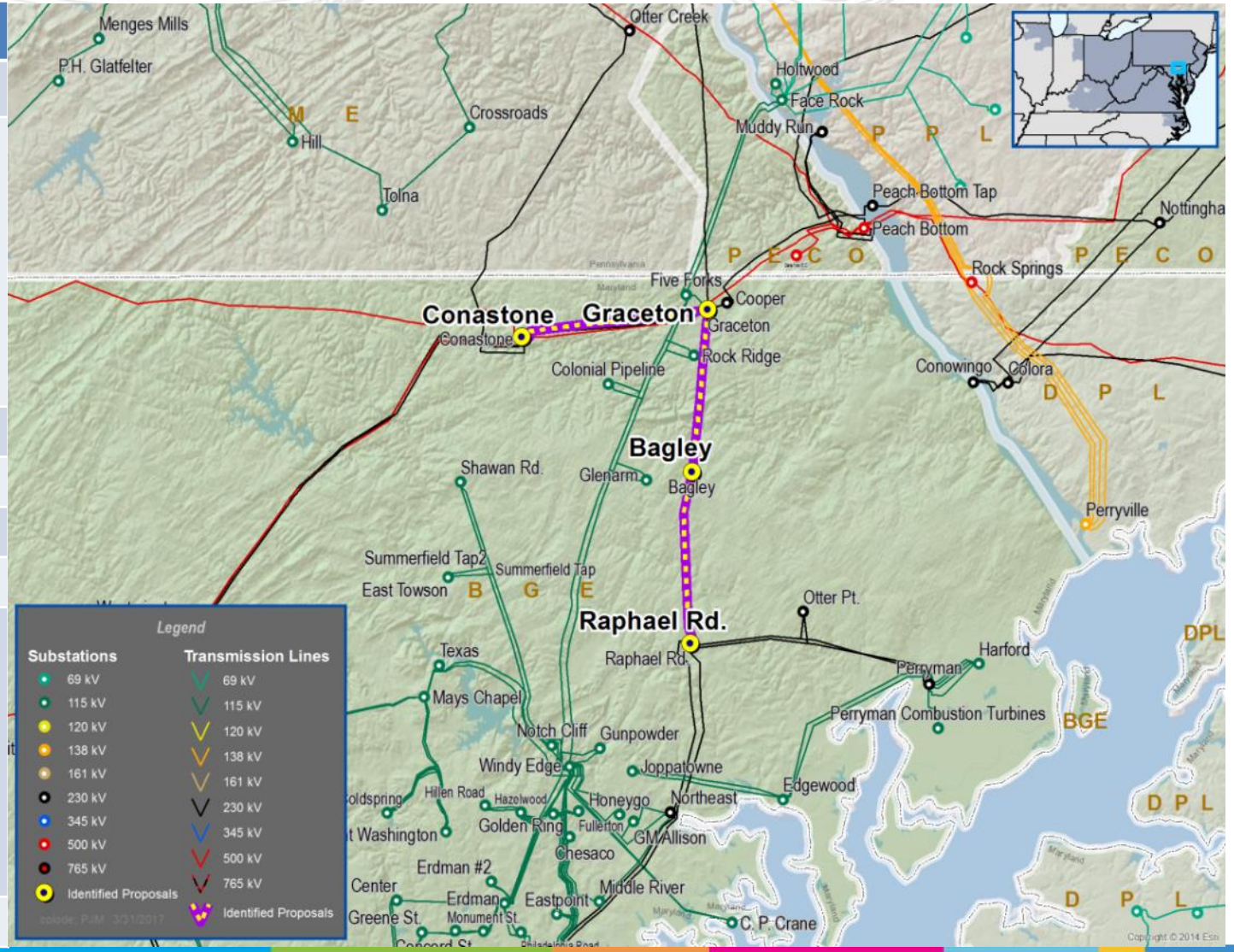
BGE 1-5B

Project ID: 201617_1-5B
Proposed by: BGE
Proposed Solution: Add bundled conductors to the Graceton-Bagley-Raphael Road 230 kV double circuit lines.
kV Level: 230 kV
In-Service Cost ($M): $14.20
In-Service Date: 2021
Target Zone: BGE
ME Constraints: GRACETON - BAGLEY 230 kV
Notes:



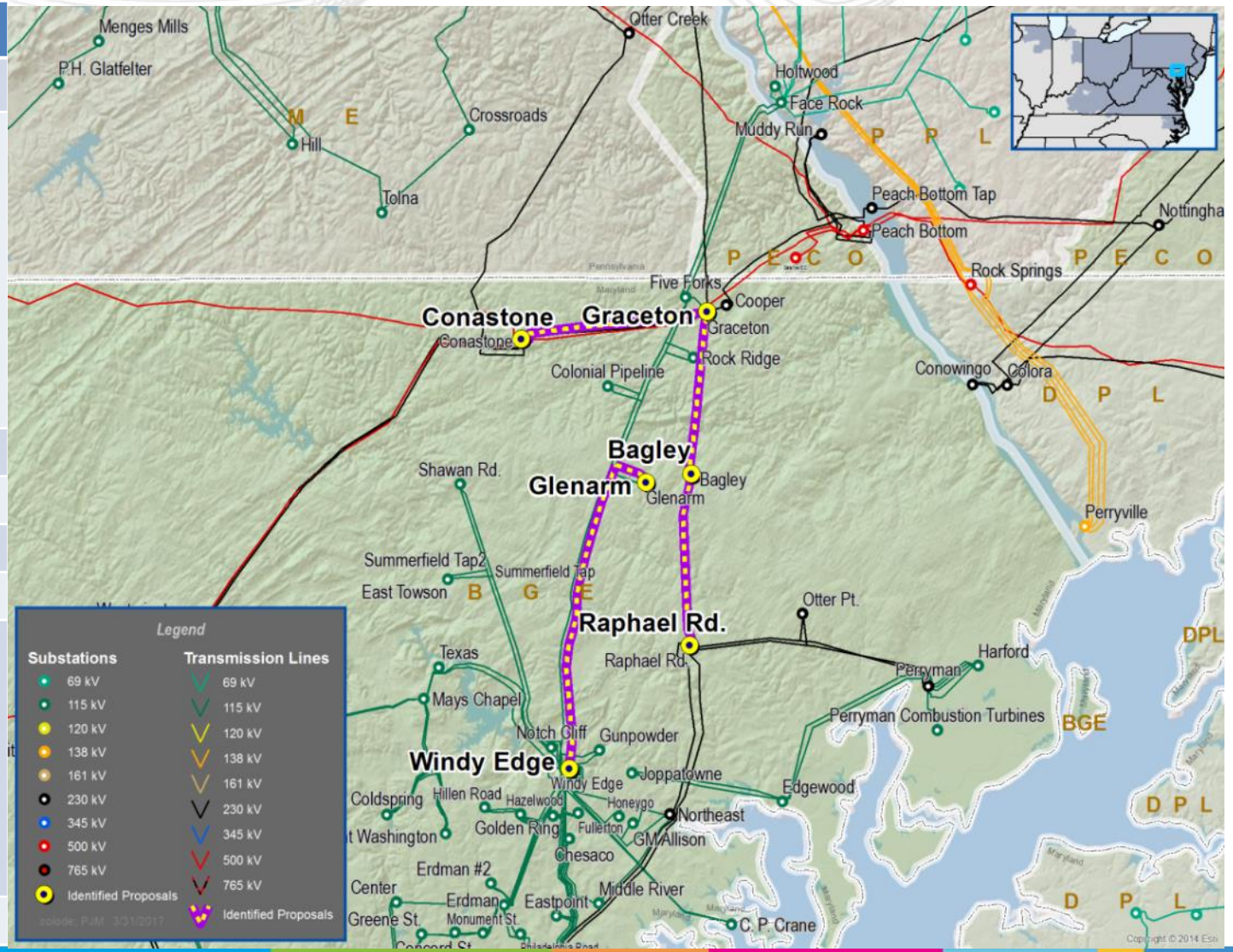
BGE 1-5C

Project ID: 201617_1-5C
Proposed by: BGE
Proposed Solution: Reconductor the Conastone to Graceton 230 kV lines. Upgrade substation equipment at Conastone. Add bundled conductors to the Graceton - Bagley-Raphael Road 230 kV double circuit lines.
kV Level: 230 kV
In-Service Cost ($M): $20.30
In-Service Date: 2021
Target Zone: BGE
ME Constraints: CONASTONE - GRACETON - BAGLEY 230 kV
Notes:



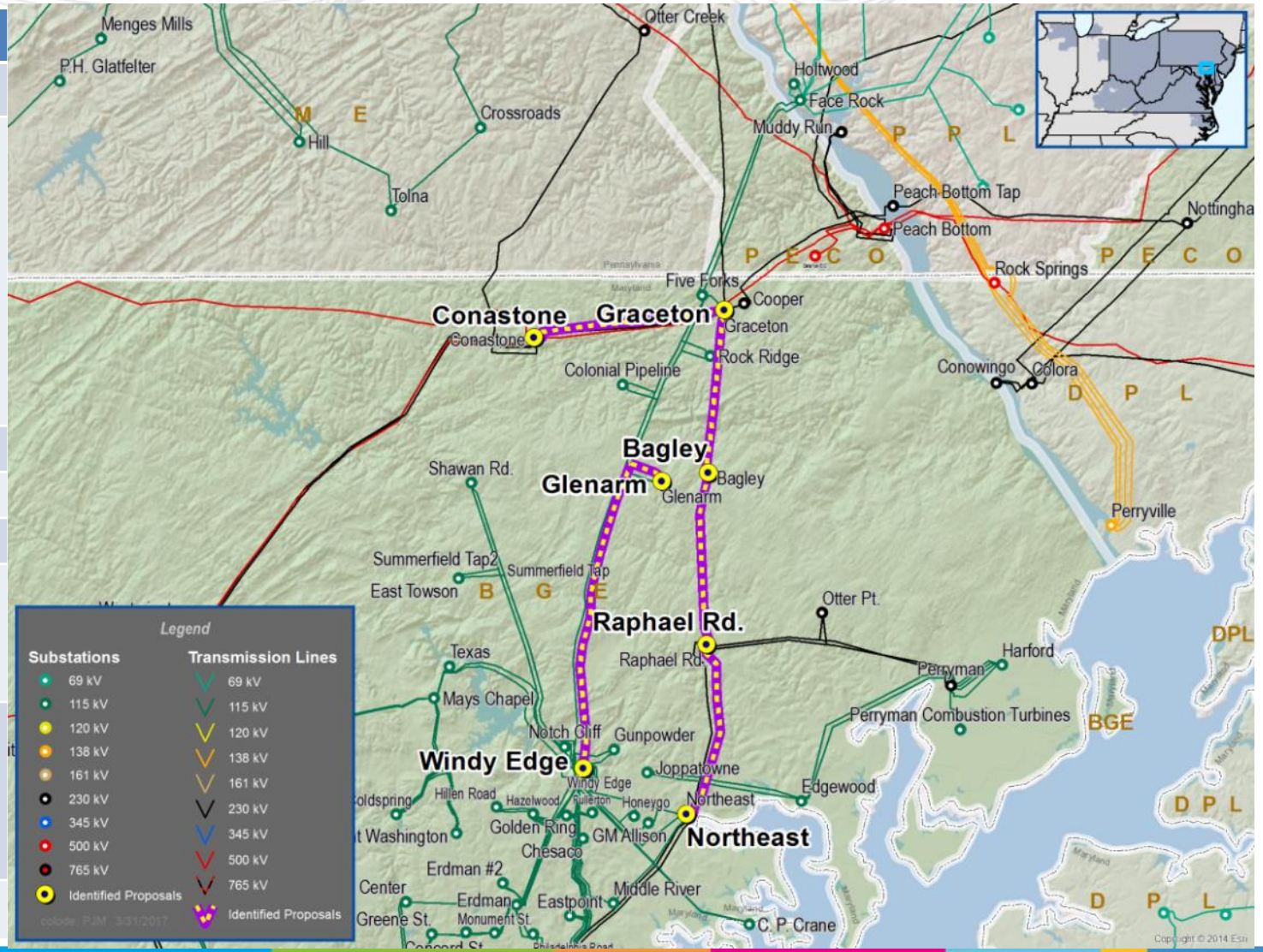
BGE 1-5D

Project ID: 201617_1-5D
Proposed by: BGE
Proposed Solution: Reconductor the Conastone to Graceton 230 kV lines. Upgrade substation equipment at Conastone. Add bundled conductors to the Graceton-Bagley-Raphael Road 230kV double circuit lines. Upgrade substation equipment at Windy Edge substation.
kV Level: 115/230 kV
In-Service Cost ($M): $20.40
In-Service Date: 2021
Target Zone: BGE
ME Constraints: CONASTONE - GRACETON - BAGLEY 230 kV
Notes:



BGE 1-5E

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
In-Service Date: 2021
Target Zone: BGE
ME Constraints: CONASTONE - GRACETON - BAGLEY 230 kV
Notes:



Revision History

- Revision History
  - V1 – 1/9/2018 – Original Version Posted to PJM.com
  - V2 -1/10/2018 – Slides 6, 7: corrected B2831 in-service date from 2018 to 2021