Market Efficiency Update

Transmission Expansion Advisory Committee

February 8, 2018

Agenda

- Conclusion of 2017 Acceleration Analysis (2nd read)
- Conclusion of Market Efficiency Re-evaluation Efforts (2014/15 Window)
- 2016/17 RTEP Window Update
- 2018/19 RTEP Window Cycle

Conclusion of 2017 Acceleration Analysis

Acceleration Analysis (2nd read)

- PJM completed the acceleration analysis
  - 2018 (AS-IS) and 2022 (RTEP) set of economic input assumptions used to study impacts of approved RTEP reliability upgrades
  - Compared the board approved reliability upgrades with the congestion reductions between the AS-IS and the RTEP Base cases
  - Estimated economic impact of accelerating RTEP reliability upgrades
- RTEP B2766 was selected for acceleration from 2021 to 2020
  - Upgrade substation equipment at Conastone and Peach Bottom 500 kV stations to increase facility Normal/Emergency rating to 2826/3525 MVA. (b2766.1 - b2766.2)
  - Estimated annual congestion savings: $4.4 million
  - Acceleration cost: 0$

Conclusion of Market Efficiency Re-evaluation Efforts (2014/15 RTEP Window)

Re-evaluation of Market Efficiency Projects

- PJM presented at the September 2017 TEAC the results of the reevaluation process:
  - Applied to market efficiency projects approved during the 2014/15 RTEP Window
  - Analysis performed individually, one project at a time
  - All projects analyzed passed the B/C ratio threshold of 1.25

- PJM re-evaluated project 2014/15_1-9A, AP-South, (b2743.1-8, b2752.1-7), with the most recent Market Efficiency base case update (posted on 1/9/2018)
  - The updated B/C ratio is 1.32

- Updated B/C Ratios Re-evaluation table included in Appendix B

2016/2017 Long Term Window – BGE Group

BGE Group Analysis Status

- Reran all submitted proposals with the posted Final Update Base Case
  - Included Crane generator retirement along with corresponding reliability upgrade.
  - Updated the load forecast to reflect the 2018 PJM Load Forecast.

- Results similar to those previously presented at November 2017 TEAC
  - Conclusions remain unchanged
  - A number of proposals did not pass the B/C ratio threshold.
  - Some proposals did not fully address the congestion driver or introduced new significant congestion.
  - Updated B/C ratios included in Appendix A.

- Due to the significant decrease in the posted congestion drivers, upgrades are the most cost-effective solutions. (see next slide)

BGE Posted Congestion Drivers

- Congestion drivers decreased 65% compared to the start of the RTEP Window

BGE Congestion Drivers (posted November 2016)

Facility Name	AREA	2017 Market Congestion ($ Millions)	2021 Market Congestion ($ Millions)	2024 Market Congestion ($ Millions)	2027 Market Congestion ($ Millions)	Average 2021, 2024 ($ Millions)
GRACETON TO CONASTON 230kV	BGE	$ 51.80	$ 58.26	$ 72.10	$ 68.88	$ 65.18
BAGLEY TO GRACETON 230kV	BGE	$ 23.59	$ 33.01	$ 49.55	$ 59.57	$ 41.28
Total Target Congestion Driver		$ 75.39	$ 91.27	$ 121.65	$ 128.45	$ 106.46

BGE Congestion Drivers Latest Base Case (posted January 2018)

Facility Name	AREA	2017 Market Congestion ($ Millions)	2021 Market Congestion ($ Millions)	2024 Market Congestion ($ Millions)	2027 Market Congestion ($ Millions)	Average 2021, 2024 ($ Millions)
GRACETON TO CONASTON 230kV	BGE	$ 19.80	$ 13.55	$ 23.50	$ 17.33	$ 18.52
BAGLEY TO GRACETON 230kV	BGE	$ 36.88	$ 12.87	$ 24.17	$ 16.94	$ 18.52
Total Target Congestion Driver		$ 56.69	$ 26.42	$ 47.67	$ 34.28	$ 37.05

Decrease	$ (69.41)	-65%

Proposal 5E Analysis (BGE)

- B/C ratio of 8.16
  - 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
  - Bagley – Raphael 230 kV; Raphael – Northeast 230 kV
  - Glenarm – Windy Edge 115 kV
- Remaining shifted congestion is within acceptable levels
  - Congestion shifts < $1million/year (average 2021, 2024)

Proposal 5E Analysis (con't)

- Completed 5E Sensitivity Analysis
  - 5E Passes all PROMOD sensitivity scenarios

Base Case Name	In Service	Cost	B/C Ratio
5E Base Case	2021	$ 25.40	8.16
5E Sensitivity - Low Gas Forecast	2021	$ 25.40	17.45
5E Sensitivity - High Gas Forecast	2021	$ 25.40	2.42
5E Sensitivity - Low Load Forecast	2021	$ 25.40	6.95
5E Sensitivity - High Load Forecast	2021	$ 25.40	8.40
5E Sensitivity - No FSA Units	2021	$ 25.40	4.82

- Reliability Analysis has been completed and no reliability violation identified as a result of the 5E Market Efficiency proposal

- Cost/Constructability Analysis in-progress
  - Constructability review to be completed by the end of February (see next slide)

Proposal 5E Constructability Assessment

- PJM and BGE had discussions to understand the existing conditions and proposed project scope
- PJM is conducting full constructability review, which is expected to be completed by the end of February
- Project component constructability assessment
  - Graceton – Bagley – Raphael Rd 230 kV
    - Scope: Install bundled conductor along 20 mile double circuit 230 kV corridor
    - Rebuild completed in Feb 2017 was designed to support the second conductor
      - All hardware and insulators will be re-used

Proposal 5E Constructability Assessment (con't)

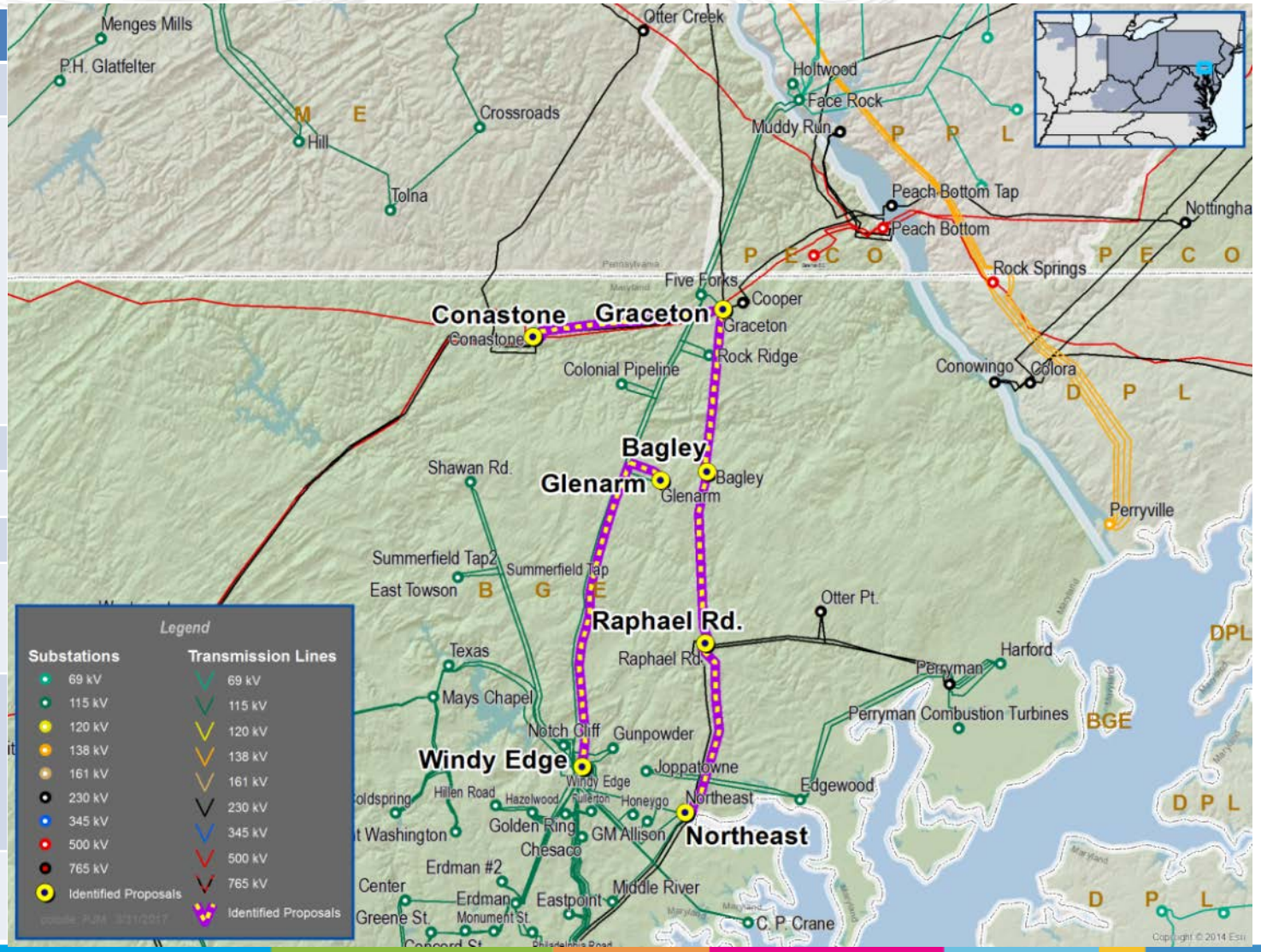
- Project component constructability assessment (con't)

  - Raphael Road – Northeast 230 kV line
    - Scope: Reconductor the 4 mile double 230kV circuit corridor
    - Equipment approximately 30 years old
    - Existing insulators and hardware to be replaced
    - Minor tower loading change with new conductor limits rebuild risk

  - Conastone – Graceton 230 kV line
    - Scope: Reconductor the 9 mile double 230kV circuit corridor
    - Existing insulators and hardware to be replaced
    - Proposed project cost included scope to rebuild 5 structures and reinforce remaining structures where required

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: To be recommended for approval at the next Board meeting.

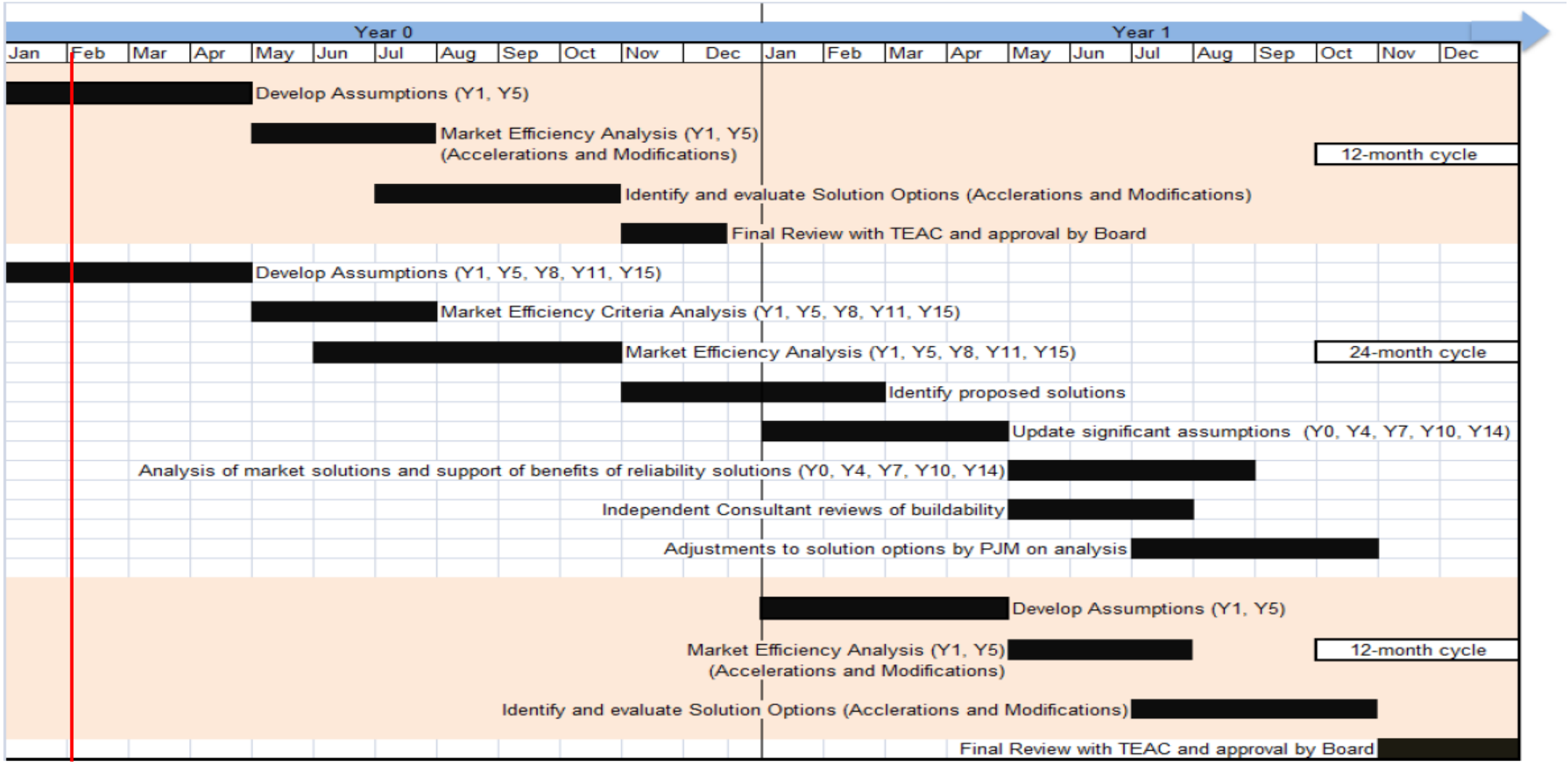


2016/17 RTEP Window Next Steps

- Pending constructability review, PJM will be recommending BGE's proposal 5E for approval at the April Board meeting.
- PJM will complete PPL Group analysis with 5E included in the base case
- PJM will present the final conclusions for the 2016/17 RTEP Window at the March TEAC

2018/2019 Long Term Window

2018/19 Market Efficiency Timeline

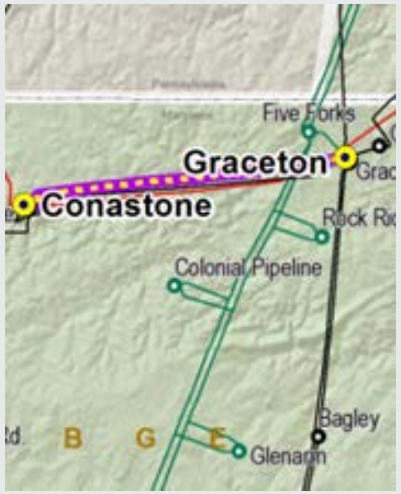
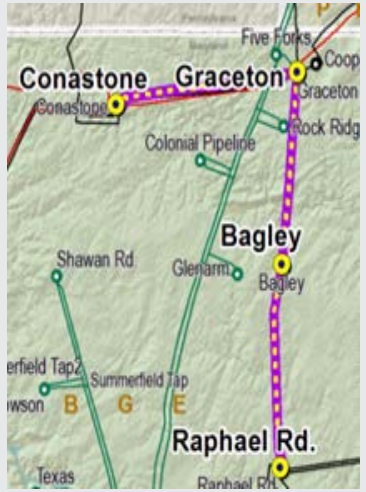
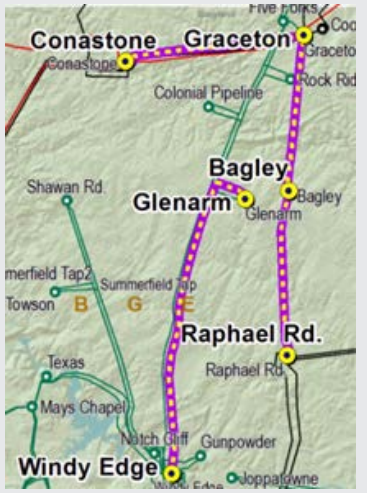


Next Steps

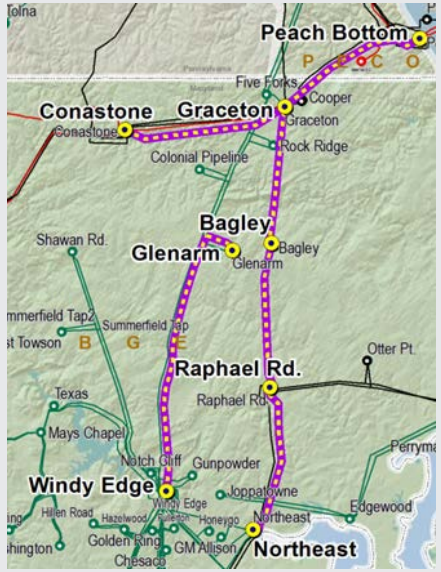
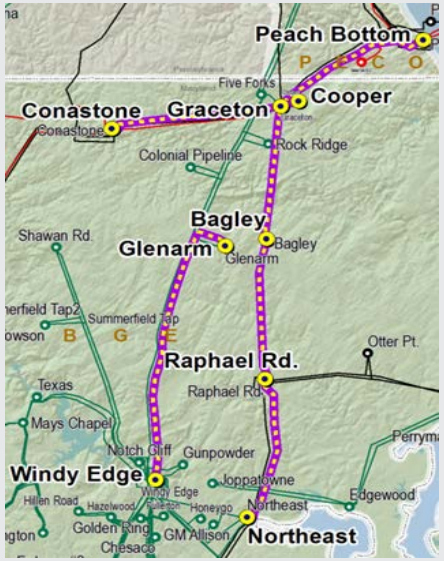
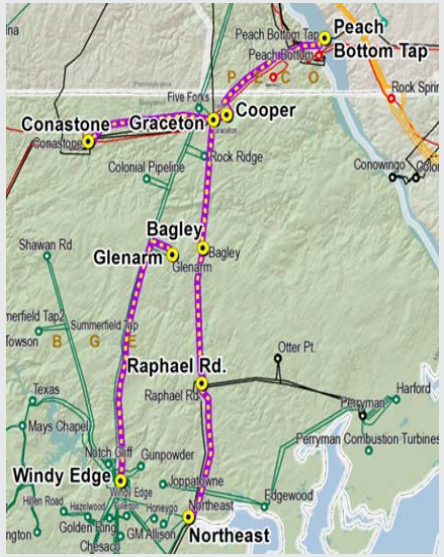
Step	Timeline
Develop Assumptions	February – May 2018
Build Base Case	June – July 2018
Identify Congestion Drivers	August – September 2018
Post Base Case and Congestion Drivers	October 2018
Proposal Window	November 2018 - February 2019
Analysis of Proposed Solutions	March - November 2019
Final TEAC Review and Board Approval	November - December 2019

Appendix A
BGE Group Updated Results

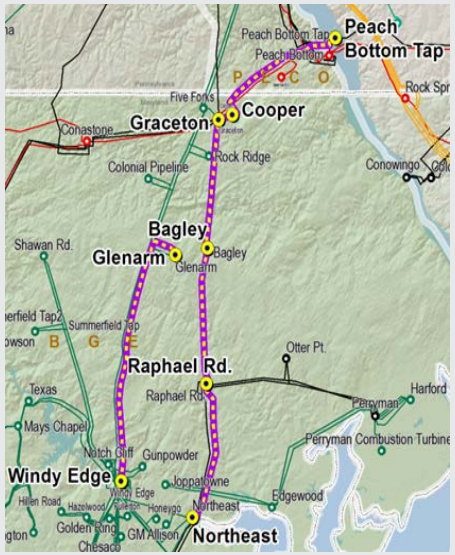
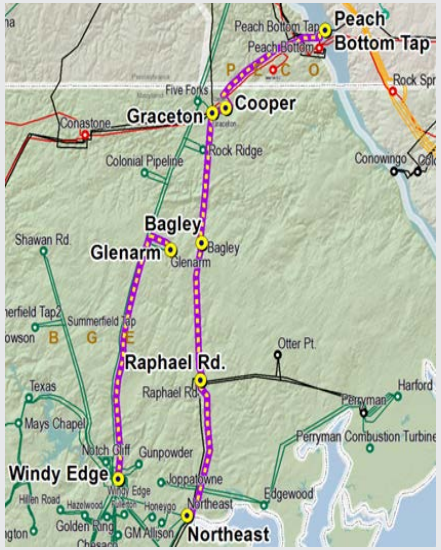
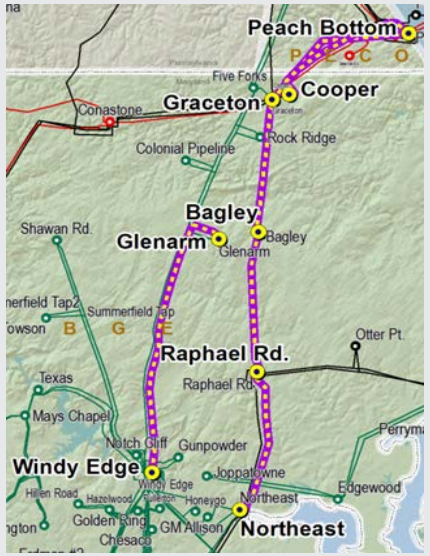
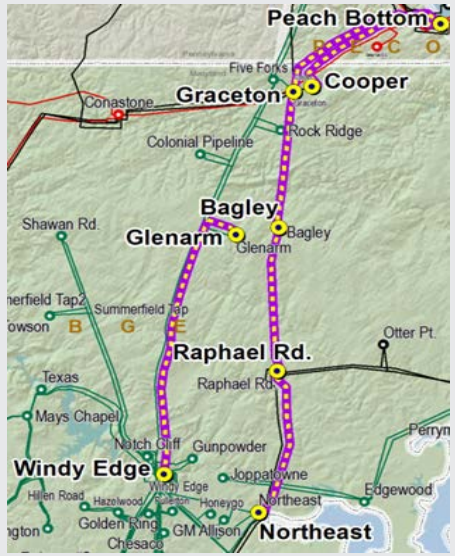
BGE (5 proposals)

Proposal	5A	5B	5C	5D	5E
In-Service cost ($M)	$ 5.97	$ 14.20	$ 20.30	$ 20.40	$ 25.40
In-service Year	2020	2021	2021	2021	2021
B/C Ratio	11.99	6.38	8.15	8.16	8.16
Fully Solves Target Congestion	No	No	Yes	Yes	Yes
Creates other BGE/PECO Congestion	No	Yes	Yes	Yes	See Slide 10
Map					

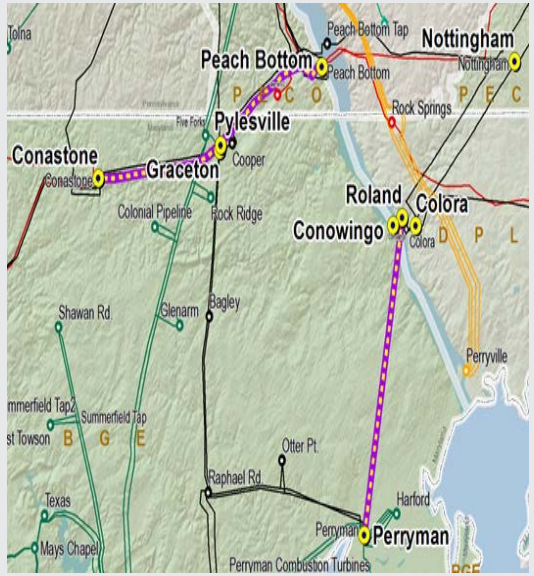
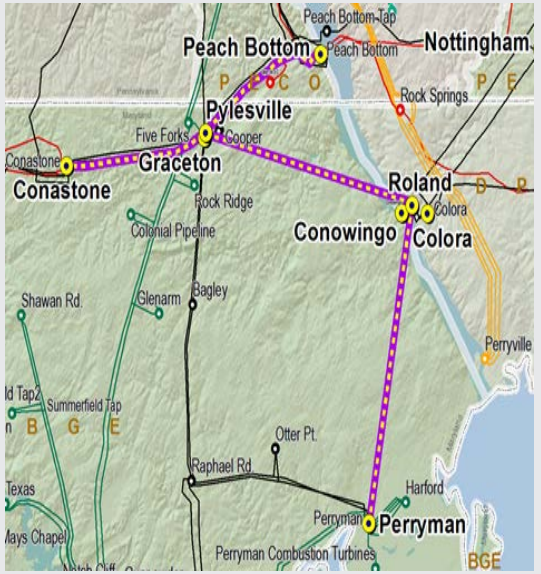
PECO BGE (4 proposals)

Proposal	6F	6G	6L	6M
In-Service cost ($M)	$ 49.20	$ 56.00	$ 41.70	$ 65.49
In-service Year	2021	2021	2021	2021
B/C Ratio	4.05	3.67	5.23	3.28
Fully Solves Target Congestion	Yes	Yes	Yes	Yes
Creates other BGE/PECO Congestion	Yes	Yes	Yes	Yes
Map				

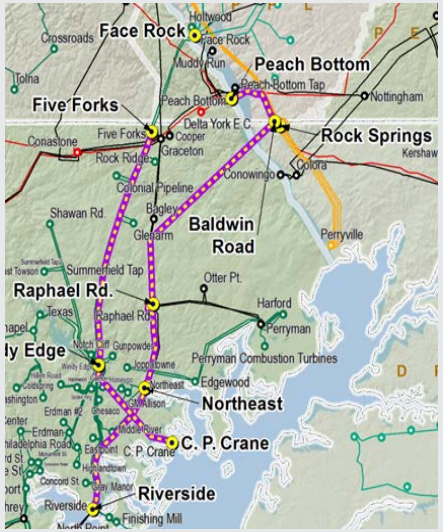
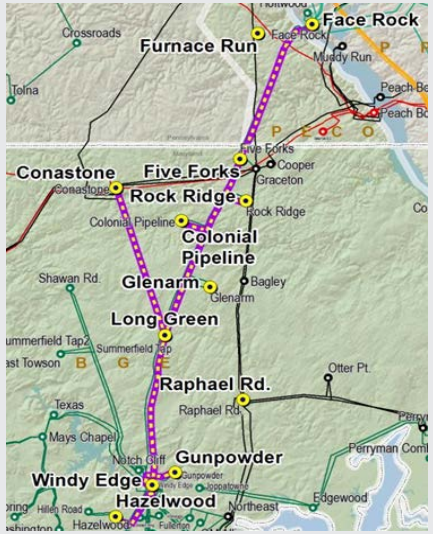
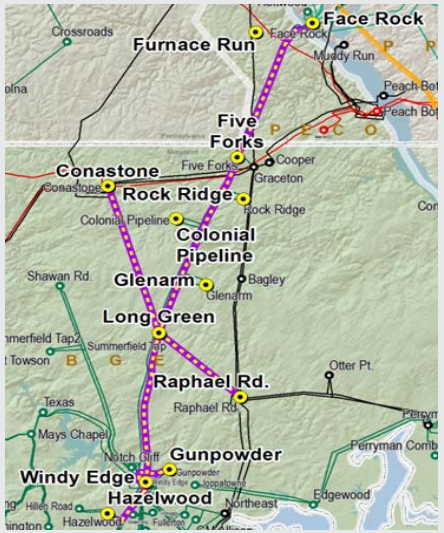
PECO (4 proposals)

Proposal	7H	7I	7J	7K
In-Service cost ($M)	$ 35.60	$ 59.80	$ 68.10	$ 191.40
In-service Year	2021	2021	2022	2022
B/C Ratio	5.57	3.90	3.56	1.10
Fully Solves Target Congestion	No	No	Yes	Yes
Creates other BGE/PECO Congestion	Yes	Yes	Yes	Yes
Map				

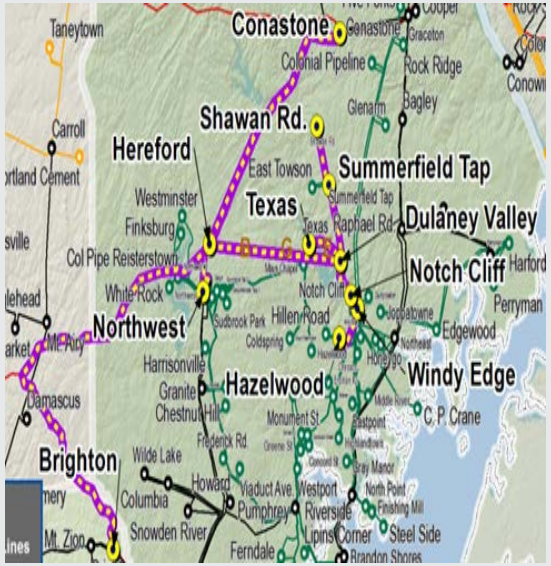
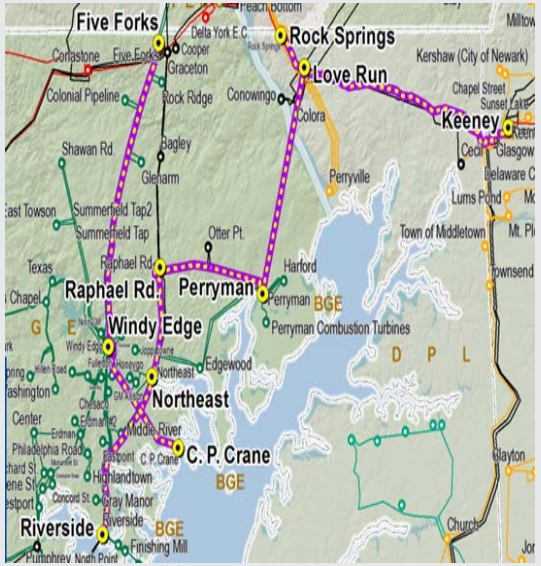
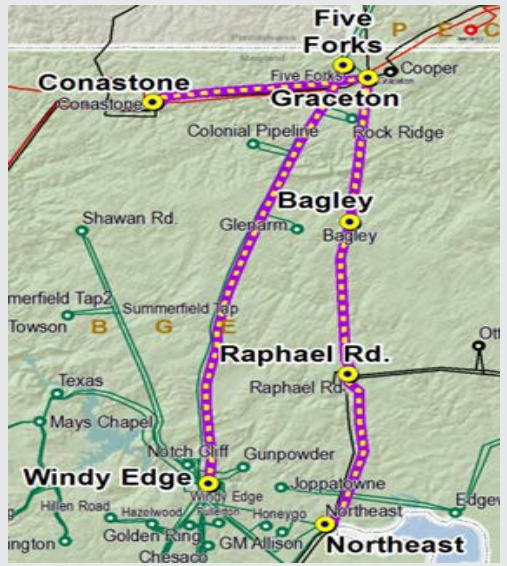
NEXTERA (3 proposals)

Proposal	10C	10D	10E
In-Service cost ($M)	$ 44.40	$ 93.50	$ 105.70
In-service Year	2021	2021	2021
B/C Ratio	2.50	1.22	0.48
Fully Solves Target Congestion	No	No	Yes
Creates other BGE/PECO Congestion	Yes	Yes	Yes
Map			

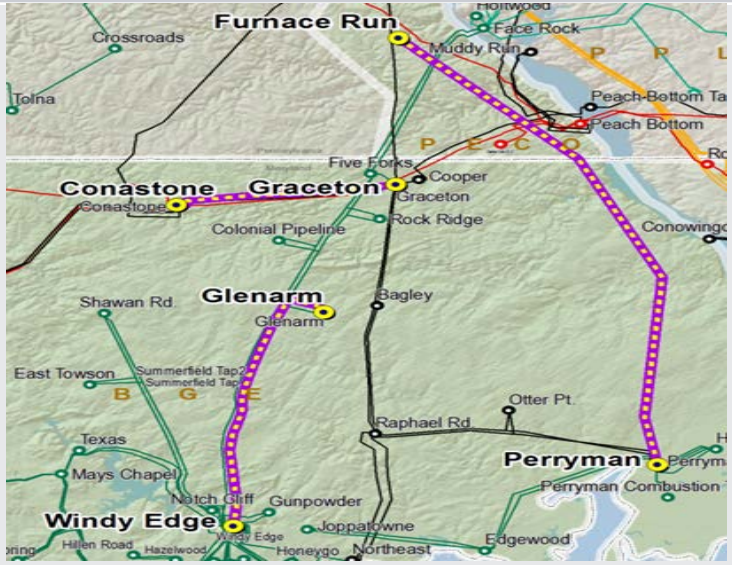
TRANSOURCE (7 proposals)

Proposal	13A	13B	13C	13D
In-Service cost ($M)	$ 457.80	$ 107.49	$ 169.27	$ 182.99
In-service Year	2024	2022	2022	2022
B/C Ratio	0.54	2.06	1.31	1.16
Fully Solves Target Congestion	Yes	No	No	No
Creates other BGE/PECO Congestion	No	Yes	Yes	Yes
Map				

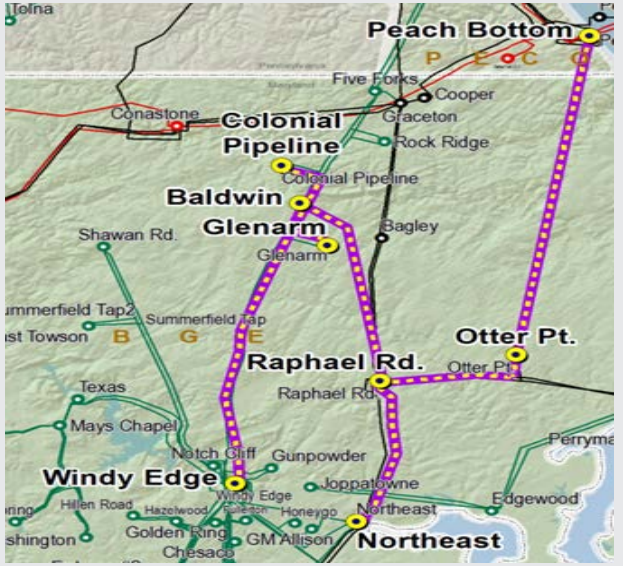
TRANSOURCE (continue)

Proposal	13E	13F	13G
In-Service cost ($M)	$ 179.22	$ 483.21	$ 192.07
In-service Year	2022	2024	2022
B/C Ratio	1.23	0.58	0.86
Fully Solves Target Congestion	No	Yes	No
Creates other BGE/PECO Congestion	No	No	No
Map			

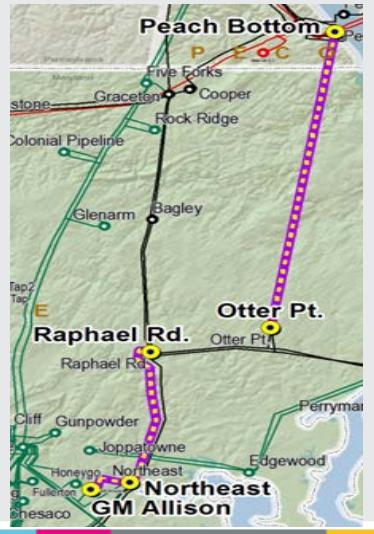
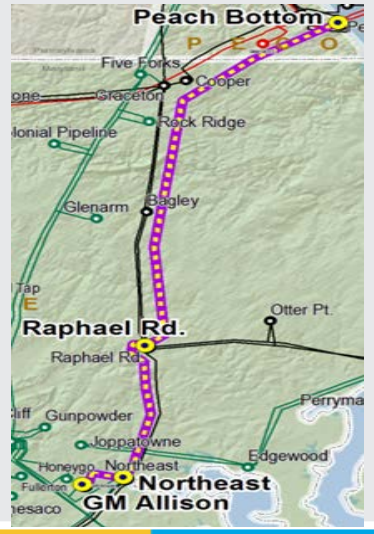
ATC (1 proposal)

Proposal	14A
In-Service cost ($M)	$ 114.80
In-service Year	2023
B/C Ratio	1.17
Fully Solves Target Congestion	Yes
Creates other BGE/PECO Congestion	Yes
Map	

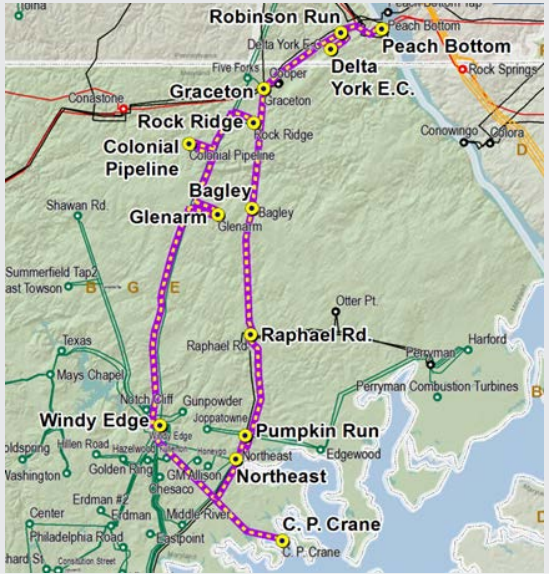
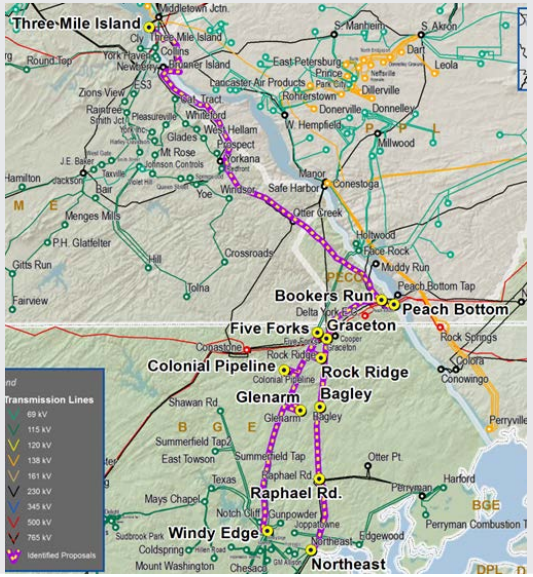
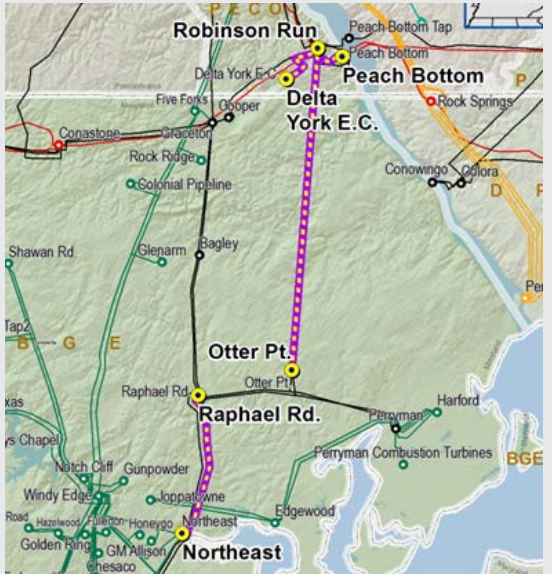
PPL ATXI EAST (2 proposals)

Proposal	15A	15B
In-Service cost ($M)	$ 138.50	$ 178.30
In-service Year	2022	2022
B/C Ratio	1.75	1.91
Fully Solves Target Congestion	Yes	Yes
Creates other BGE/PECO Congestion	Yes	No
Map		

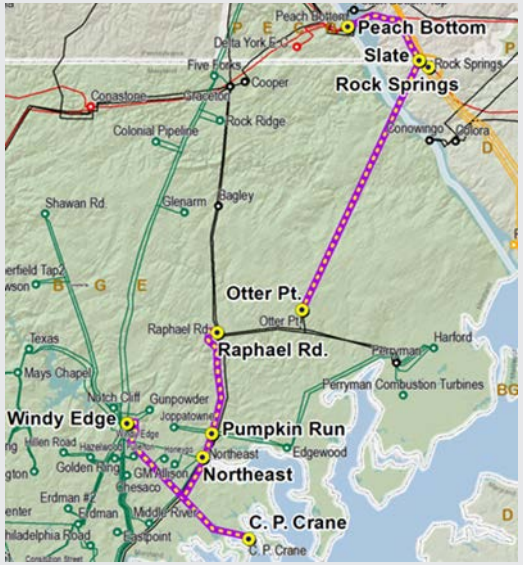
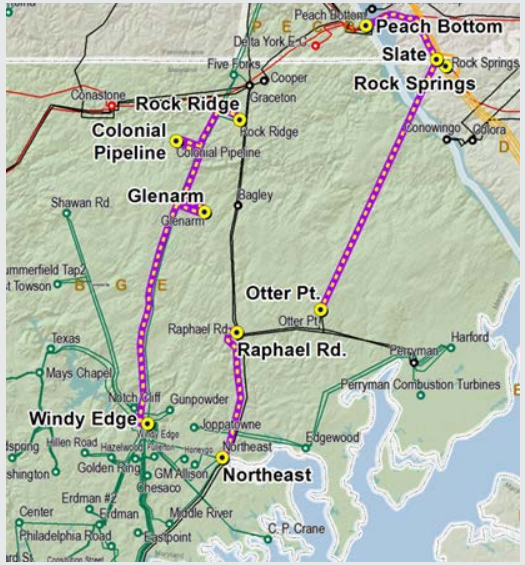
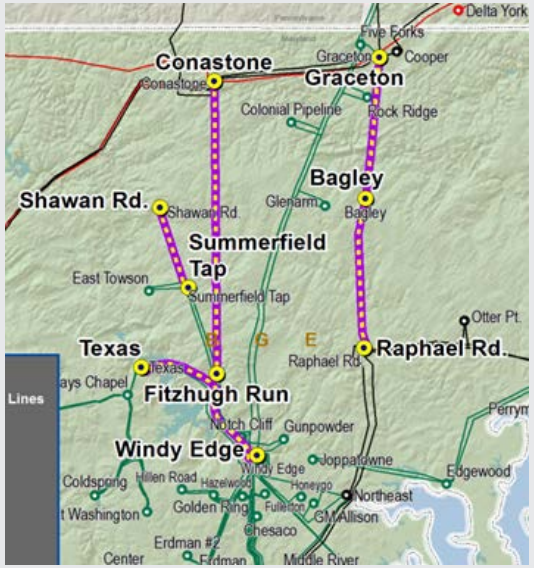
PSEG (5 proposals)

Proposal	16A	16B	16C	16D	16E
In-Service cost ($M)	$ 70.50	$ 92.20	$ 87.20	$ 105.10	$ 109.30
In-service Year	2021	2021	2021	2021	2021
B/C Ratio	3.03	2.34	1.77	1.82	2.67
Fully Solves Target Congestion	No	No	No	No	No
Creates other BGE/PECO Congestion	Yes	Yes	Yes	No	No
Map					

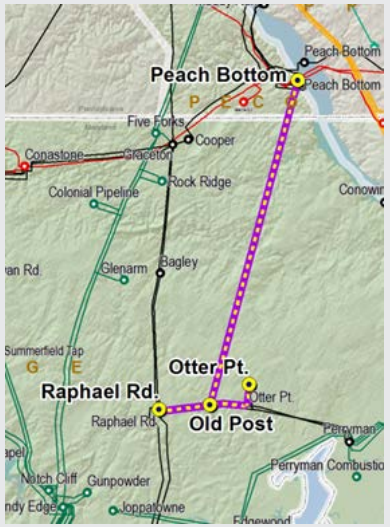
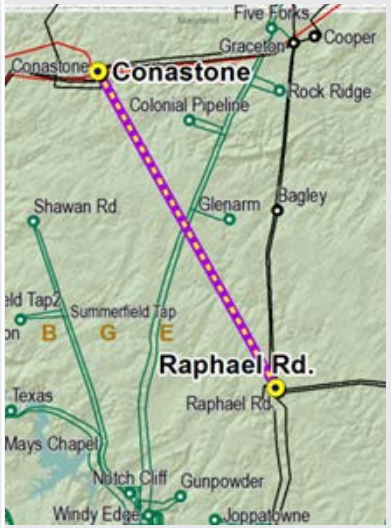
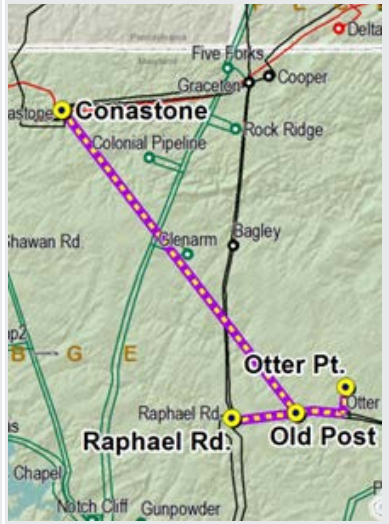
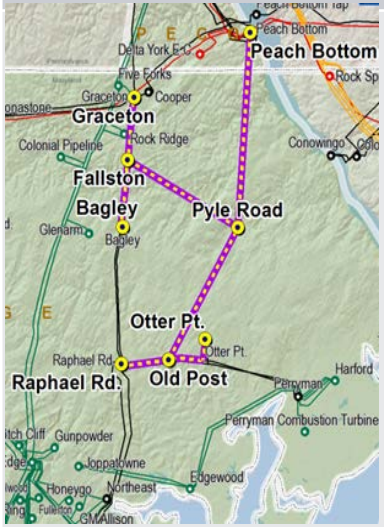
Northeast Transmission Development (6 proposals)

Proposal	18A	18B	18C
In-Service cost ($M)	$ 126.20	$ 132.80	$ 149.90
In-service Year	2021	2021	2021
B/C Ratio	2.23	2.26	1.83
Fully Solves Target Congestion	Yes	Yes	Yes
Creates other BGE/PECO Congestion	No	No	No
Map			

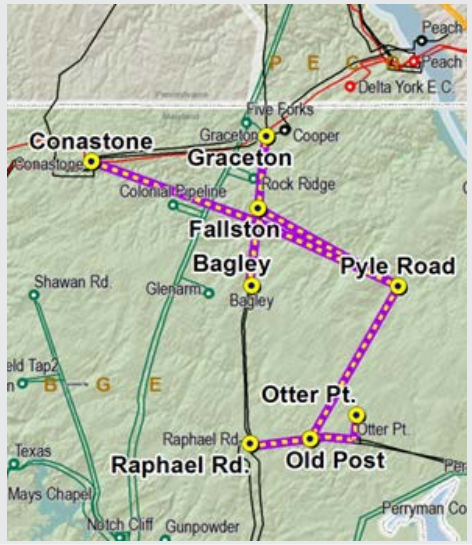
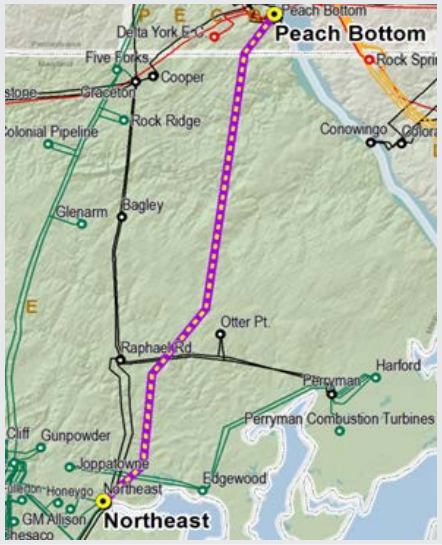
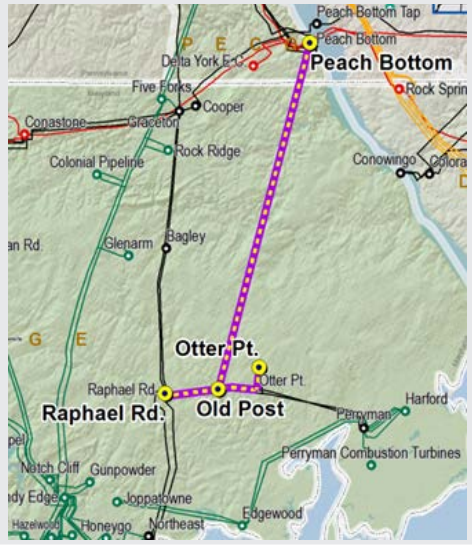
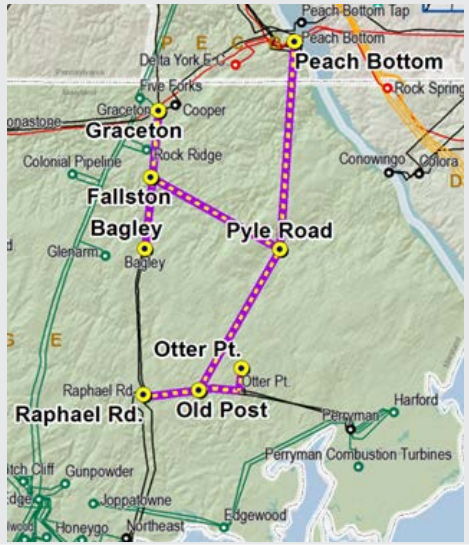
Northeast Transmission Development (continue)

Proposal	18D	18E	18F
In-Service cost ($M)	$ 166.00	$ 152.90	$ 95.30
In-service Year	2021	2021	2021
B/C Ratio	1.70	1.95	2.18
Fully Solves Target Congestion	Yes	Yes	No
Creates Other BGE Congestion	No	No	Yes
Map			

ITC (9 proposals)

Proposal	20A	20B	20C	20D	20E
In-Service cost ($M)	$ 73.60	$ 63.00	$ 135.80	$ 75.90	$ 132.20
In-service Year	2021	2021	2021	2021	2021
B/C Ratio	3.14	1.59	1.41	1.52	2.90
Fully Solves Target Congestion	Yes	Yes	No	No	No
Creates other BGE/PECO Congestion	Yes	Yes	Yes	Yes	Yes
Map					

ITC (continue)

Proposal	20F	20G	20H	20I
In-Service cost ($M)	$ 126.00	$ 151.50	$ 107.50	$ 165.70
In-service Year	2021	2021	2021	2021
B/C Ratio	0.65	1.30	3.51	2.71
Fully Solves Target Congestion	No	No	Yes	Yes
Creates Other BGE Congestion	Yes	Yes	Yes	Yes
Map				

Appendix B
BC Ratios Reevaluation Market Efficiency Projects (2014/15 RTEP Window)

Reevaluation Results (updated 02/2018)

PJM Window Project ID	Baseline#	Type	Area	Constraint	Cost ($mill)	In-Service Date	B/C 2014/15 Window	BC Reevaluation 2017
201415_1-2A	b2690	Upgrade	PPL/BGE	Safe Harbor to Graceton 230 kV	$ 1.10	2019	14.4	1.72
201415_1-2B	b2691	Upgrade	ME/PPL	Brunner Island to Yorkana 230 kV	$ 3.10	2019	22.2	2.84
201415_1-4I	b2697.1-2	Upgrade	AEP	Fieldale to Thornton 138 kV	$ 0.75	2019	101.2	9.47
201415_1-4J	b2698	Upgrade	AEP	Jacksons Ferry to Cloverdale 765 KV	$ 0.50	2019	62	46.18
201415_1-9A	b2743.1-8, b2752.1-7	Greenfield	APS/BGE	AP-South	$340.60	2020	2.48	1.32*
201415_1-10B	b2693	Upgrade	COMED	Wayne to South Elgin 138 kV	$ 0.10	2019	6.4	25.03
201415_1-10J	b2692.1-2	Upgrade	COMED	Cordova to Nelson 345 kV	$ 24.60	2019	1.9	1.59
201415_1-10D	b2728	Upgrade	COMED	Loretto-Wilton 345 kV (RPM)	$ 11.50	2017	64.5	In-service
201415_1-11H	b2694	Upgrade	PECO	Peach Bottom 500 kV	$ 9.70	2019	3	5.70
201415_1-12A	b2689.1-2	Upgrade	DUQ	Dravosburg to West Mifflin 138 kV	$ 11.18	2018	2	2.63
201415_1-13E	b2695	Upgrade	DPL	Worcester to Ocean Pines (I) 69 kV	$ 2.40	2019	65.3	10.14
201415_1-18G	b2688.1-3	Upgrade	APS	Taneytown to Carroll 138 kV	$ 5.20	2019	90.1	8.50
201415_1-18I	b2696	Upgrade	APS/ATSI	Krendale to Shanor Manor 138 kV	$ 0.60	2019	123.4	78.88
Optimal Caps	b2729	Upgrade	DOM	AP-South	$ 8.98	2019	15.4	2.16

Note: * B/C ratio calculated based on the Market Efficiency Base Case posted on 1/9/2018

Revision History

- Revision History
  - V1 – 2/5/2018 – Original Version Posted to PJM.com