



Transmission Expansion Advisory Committee Market Efficiency Update

September 10, 2015



Market Efficiency Long Term Proposal Window Update

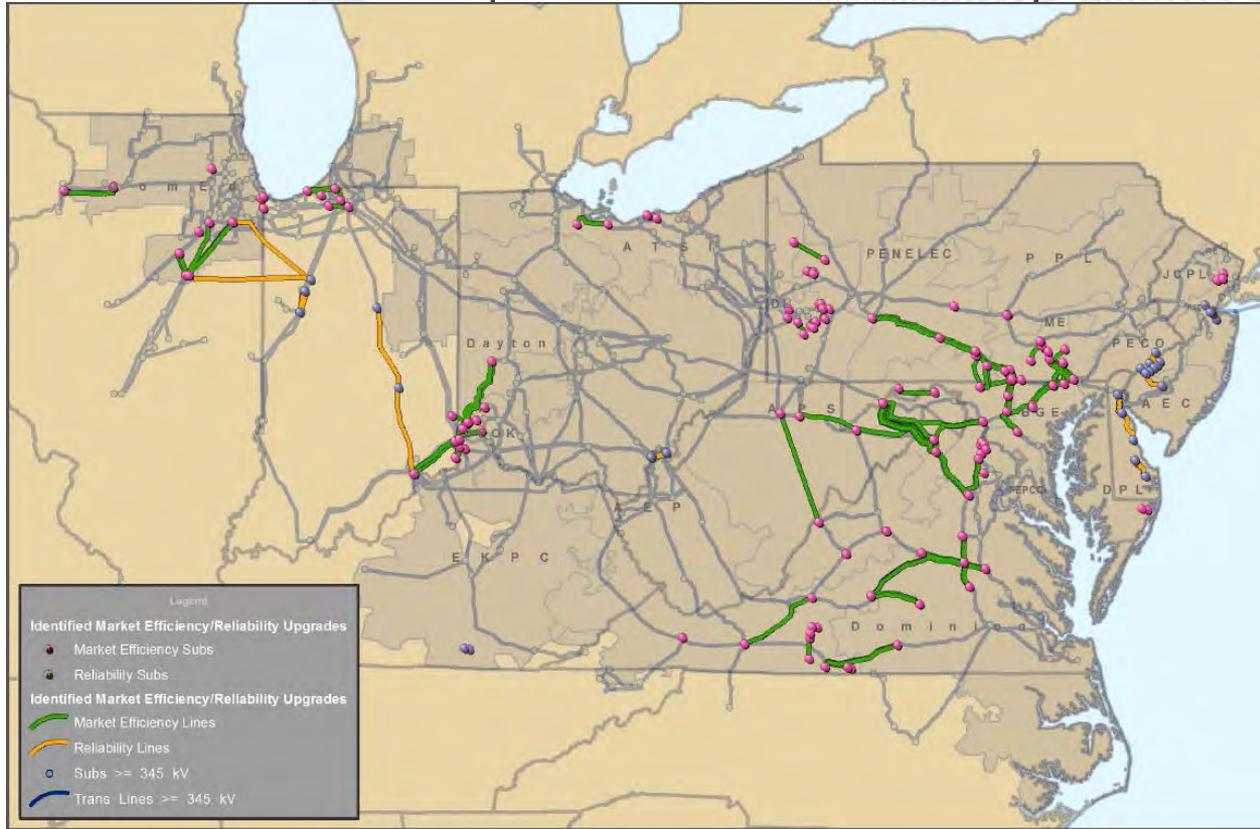
- **93 Market Efficiency Proposals**
 - 35 Transmission Owner Upgrades
 - Cost range of \$0.1M to \$68M
 - 58 Greenfield Projects
 - Cost range of \$9.2M to \$432.5M



2014/15 RTEP Long Term Proposal Window: Market Efficiency

AREA of Proposal	Number of proposals
AEP	2
APS	6
APSOUTH and/or AEP-DOM Area	41
ATSI	4
BGE/PPL	4
ComEd	15
DEOK	8
DPL	1
DUQ	4
PECO	5
PSEG	3
Grand Total	93

Proposed Market Efficiency / Reliability Upgrades



Objective of PJM Market Efficiency:

Operating Agreement : 1.5.7 (b) *Following PJM Board consideration of the assumptions, the Office of the Interconnection shall perform a market efficiency analysis to compare the costs and benefits of: (i) accelerating reliability-based enhancements or expansions already included in the Regional Transmission Plan that if accelerated also could relieve one or more economic constraints; (ii) modifying reliability-based enhancements or expansions already included in the Regional Transmission Plan that as modified would relieve one or more economic constraints; and (iii) adding new enhancements or expansions that could relieve one or more economic constraints, but for which no reliability-based need has been identified. Economic constraints include, but are not limited to, constraints that cause: (1) significant historical gross congestion; (2) pro-ration of Stage 1B ARR requests as described in section 7.4.2(c) of Schedule 1 of this Agreement; or (3) significant simulated congestion as forecasted in the market efficiency analysis. The timeline for the market efficiency analysis and comparison of the costs and benefits for items 1.5.7(b)(i-iii) is described in the PJM Manuals.*

1.5.7 (c) *The process for conducting the market efficiency analysis described in subsection (b) above shall include the following: (i) The Office of the Interconnection shall identify and provide to the Transmission Expansion Advisory Committee a list of economic constraints to be evaluated in the market efficiency analysis.*

Economic Justification for Market Efficiency

1.5.6 Development of the Recommended Regional Transmission Expansion Plan.

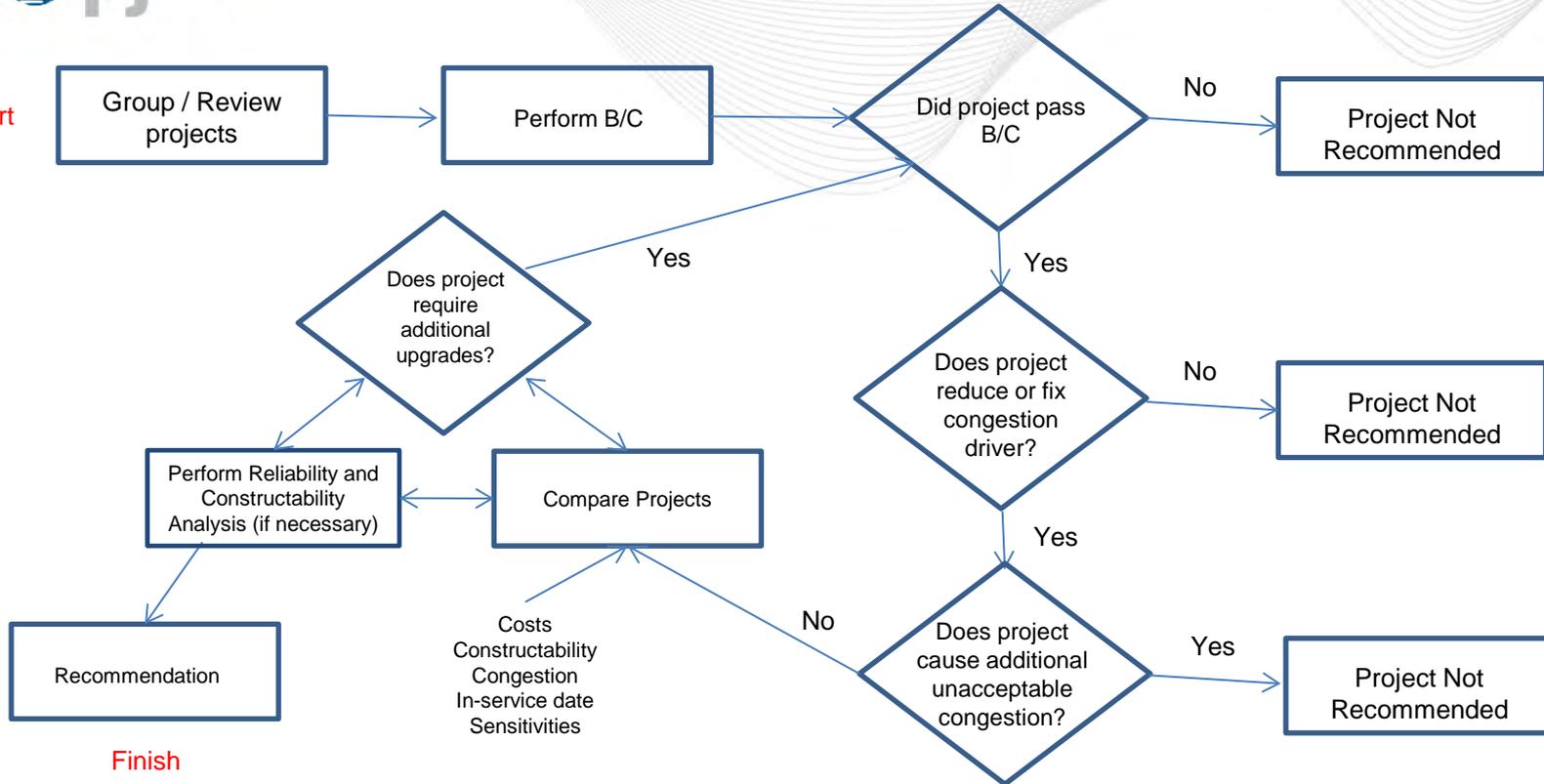
(h) The recommended plan shall identify enhancements and expansions that relieve transmission constraints and which, **in the judgment of the Office of the Interconnection, are economically justified.** Such economic expansions and enhancements shall be developed in accordance with the procedures, criteria and analyses described in Sections 1.5.7 and 1.5.8 of this Schedule 6.

Market Efficiency Projects Criteria

1. Project must reduce or relieve economic congestion on identified PJM constraints.
2. Project 's Benefit/Cost Ratio >1.25 .
 - Various scenario analysis may be performed
3. Project's that pass first or second criteria may be further compared if necessary to determine economic justification.
 - Project costs/In service date
 - Reliability/Constructability
 - Congestion
 - Load Payments
 - Production Costs
 - Additional Metrics as determined by PJM

Market Efficiency Project Benefits		
Production Cost	Net Load Payment	Hybrid: Production Cost/Net Load Payments
Represents a Societal Metric and measures benefits to all consumers and all producers regardless of who pays for upgrade	Represents a Participant/Rate Payer Metric and measures benefit to consumers. Inclusion of all zones represents benefit to all consumers and inclusion of only zones that benefit represent benefit only to consumers that benefit from upgrade.	Represents combination of Societal and Participant/Rate Payer Metric.
Calculated using actual generator costs and not LMP	Calculated using LMP Prices. Represents current method used for Lower Voltage projects	Represents current method used for Regional Projects
Includes Fuel, Variable O&M, and Emission costs	Includes Load Payments reduced by congestion credits	
Measured on system level and not zonal	Measured on Zonal level	Measured partially on system and zonal level

Start



Finish

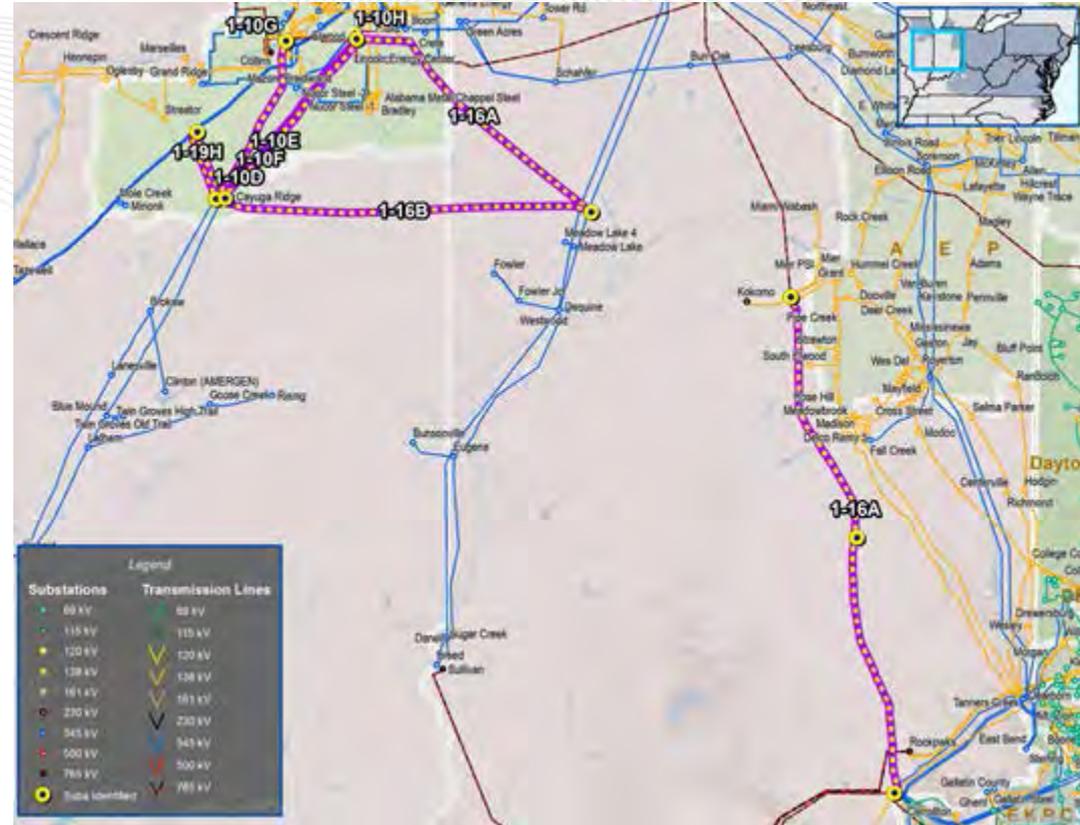
Project Recommendation Updates Groups 2 thru 19 (non AP-South/AEP-DOM Projects)



UNDER EVALUATION:

Group 2: COMED - Loretto to Wilton Center

- 9 Projects:
 - 1-10C,1-10D,1-10E,1-10F,1-10G,1-10H,1-16A,1-16B,1-19H
- Cost:
 - From \$11.5M to \$290M
- Constraints:
 - Loretto to Wilton CTR 345 kV
- 2018/2019 RPM BRA Results
 - COMED LDA binding with Loretto to Wilton CTR 345 kV as limiting CETL constraint

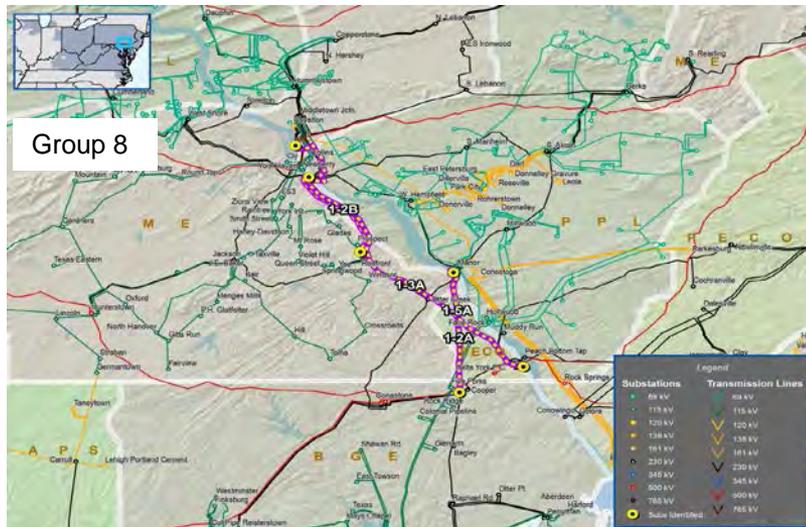
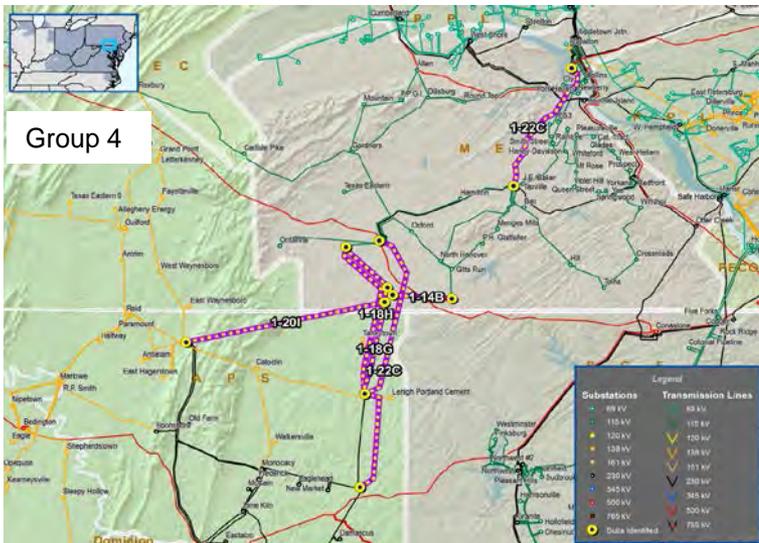


Project ID	Upgrade/ Greenfield	Cost (\$M)	Target Zone	kV Level	ME Constraints Identified	Evaluation Type	B/C Ratio Base	B/C Ratio 2015 Sens.	Status
201415_1-10D	Upgrade	11.50	ComEd	345	Lorreto to Wilton CTR 345 kV	Lower Voltage	1.79	1.14	Not Recommended
201415_1-10F	Upgrade	14.00	ComEd	345	Lorreto to Wilton CTR 345 kV	Lower Voltage	1.38	0.79	Not Recommended
201415_1-16A	Greenfield	240.00	AEP/CE/NIPS	345	None Specified	Lower Voltage	0.04	N/A	Not Recommended
201415_1-16B	Greenfield	290.00	AEP/CE/NIPS	345	Lorreto to Wilton CTR 345 kV	Regional	0.14	N/A	Not Recommended
201415_1-10C	Greenfield	37.80	ComEd	345	Lorreto to Wilton CTR 345 kV	Lower Voltage	1.63	0.73	Not Recommended
201415_1-19H	Greenfield	42.90	ComEd	345	Lorreto to Wilton CTR 345 kV	Lower Voltage	1.16	0.9	Not Recommended
201415_1-10E	Upgrade	17.40	ComEd	345	Lorreto to Wilton CTR 345 kV	Lower Voltage	1.17	0.93	Not Recommended
201415_1-10G	Upgrade	19.90	ComEd	345	Lorreto to Wilton CTR 345 kV	Lower Voltage	1.02	0.81	Not Recommended
201415_1-10H	Upgrade	25.90	ComEd	345	Lorreto to Wilton CTR 345 kV	Lower Voltage	0.78	0.62	Not Recommended

Projects will be evaluated to determine RPM Benefits

Groups 4 and 8: APS/METED/PPL

- 9 Projects: 1-14B, 1-18G, 1-18H, 1-20I, 1-22C, 1-2A, 1-2B, 1-3A, 1-5A
- Cost: From \$1.1M to \$107M
- Constraints: Brunner Island to Yorkana 230 kV, Safe Harbor to Graceton 230 kV, Taneytown to Carroll 138 kV



Project ID	Upgrade/ Greenfield	Cost (\$M)	Target Zone	kV Level	ME Constraints Identified	Evaluation Type	B/C Ratio Base	B/C Ratio 2015 Sens.	Status	Comments
201415_1-18G	Upgrade	5.20	APS/Meted	138	Taneytown to Carroll 138 kV	Lower Voltage	55.74	90.14	Recommended	Low Cost and Removes Congestion Driver
201415_1-14B	Greenfield	21.11	Meted	115	Taneytown to Carroll 138 kV	Lower Voltage	11.68	23.14	Not Recommended	Removes Congestion Driver
201415_1-18H	Upgrade	58.00	APS/Meted	138	Taneytown to Carroll 138 kV	Lower Voltage	4.97	5.62	Not Recommended	Removes Congestion Driver
201415_1-20I	Greenfield	70.80	APS/Dominion	138	Taneytown to Carroll 138 kV Brunner Island to Yorkana 230 kV Safe Harbor to Graceton 230 kV	Lower Voltage	2.63	5.36	Not Recommended	Removes Congestion Driver
201415_1-22C	Greenfield	107.20	APS/Meted	230	Taneytown to Carroll 138 kV	Lower Voltage	34.66	34.21	Not Recommended	Removes Congestion Driver: Increases RTO Congestion

Project ID	Upgrade/ Greenfield	Cost (\$M)	Target Zone	kV Level	ME Constraints Identified	Evaluation Type	B/C Ratio 2015 Sens.	Status
201415_1-2A	Upgrade	1.10	PPL/BGE	230	Safe Harbor to Graceton 230 kV	Lower Voltage	14.42	Recommended
201415_1-2B	Upgrade	3.10	PPL/Meted	230	Brunner Island to Yorkana 230 kV	Lower Voltage	22.16	Recommended
201415_1-3A	Upgrade	40.20	PPL/Meted	500	Brunner Island to Yorkana 230 kV	Lower Voltage	1.85	Not Recommended
201415_1-5A	Upgrade	5.60	BGE/PPL	230	Safe Harbor to Graceton 230 kV	Lower Voltage	0.63	Not Recommended

Project ID: 201415_1-18G

Proposed by: FirstEnergy

Proposed Solution: Upgrade terminal equipment on the Lincoln - Carroll 115/138kV path.

kV Level: 138

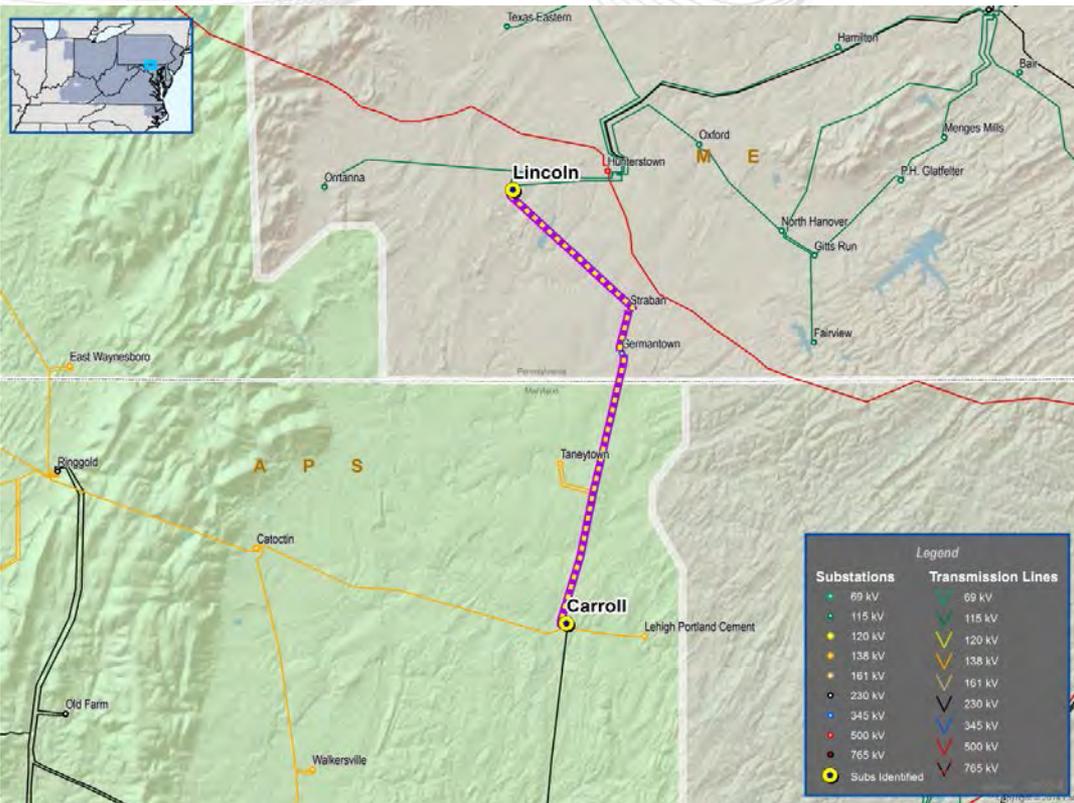
Cost (\$M): 5.2

IS Date: 2019

Target Zone: APS/Meted

ME Constraints: Taneytown to Carroll 138 kV

Notes: **Recommended**



Project ID: 201415_1-2A

Proposed by: PPL

Proposed Solution: Reconductor two spans of the Graceton-Safe Harbor 230kV transmission line.

Includes termination point upgrades

kV Level: 230

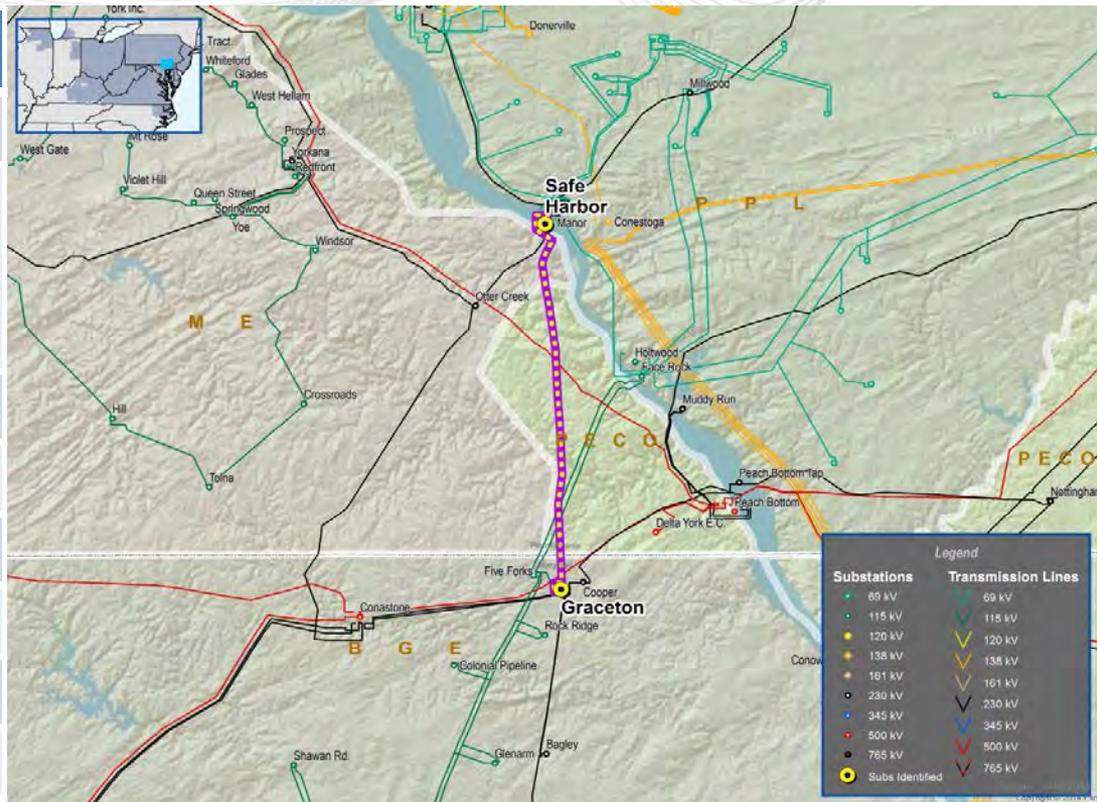
Cost (\$M): 1.1

IS Date: 2019

Target Zone: PPL/BGE

ME Constraints: Safe Harbor to Graceton 230 kV

Notes: **Recommended**



Project ID: 201415_1-2B

Proposed by: PPL

Proposed Solution: Reconductor three spans limiting the Brunner Island - Yorkana 230kV line, add 2 breakers to Brunner Island Switchyard, upgrade associated terminal equipment

kV Level: 230

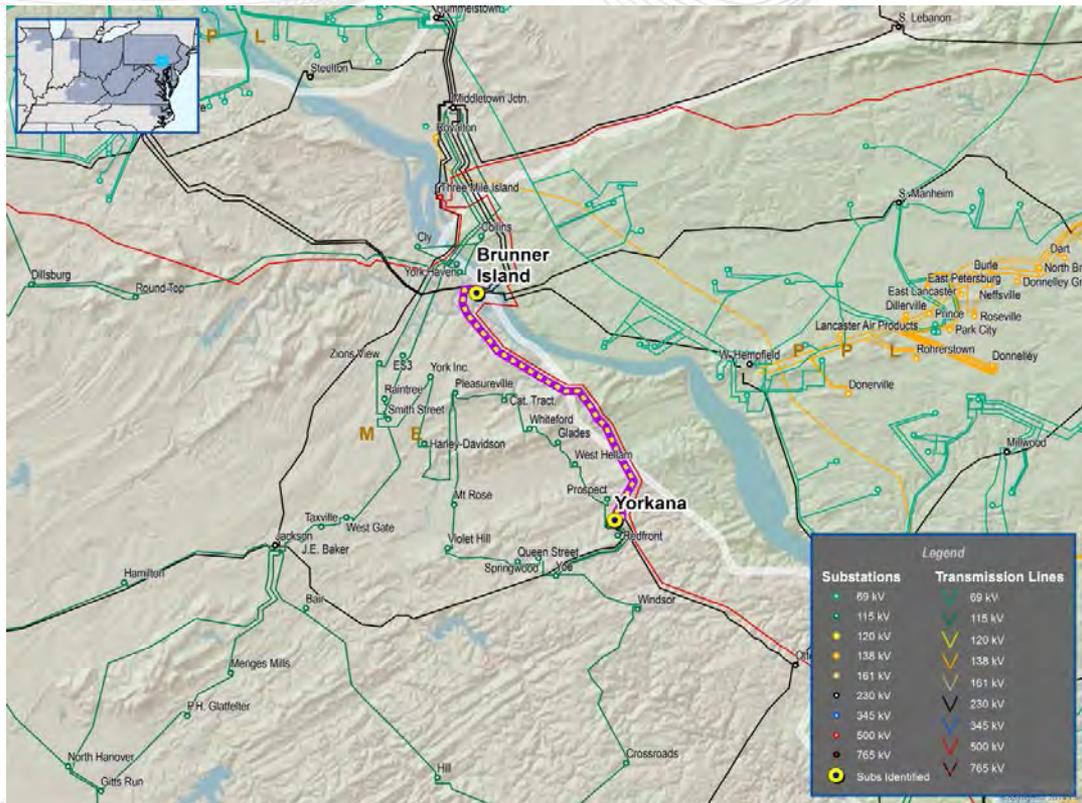
Cost (\$M): 3.1

IS Date: 2019

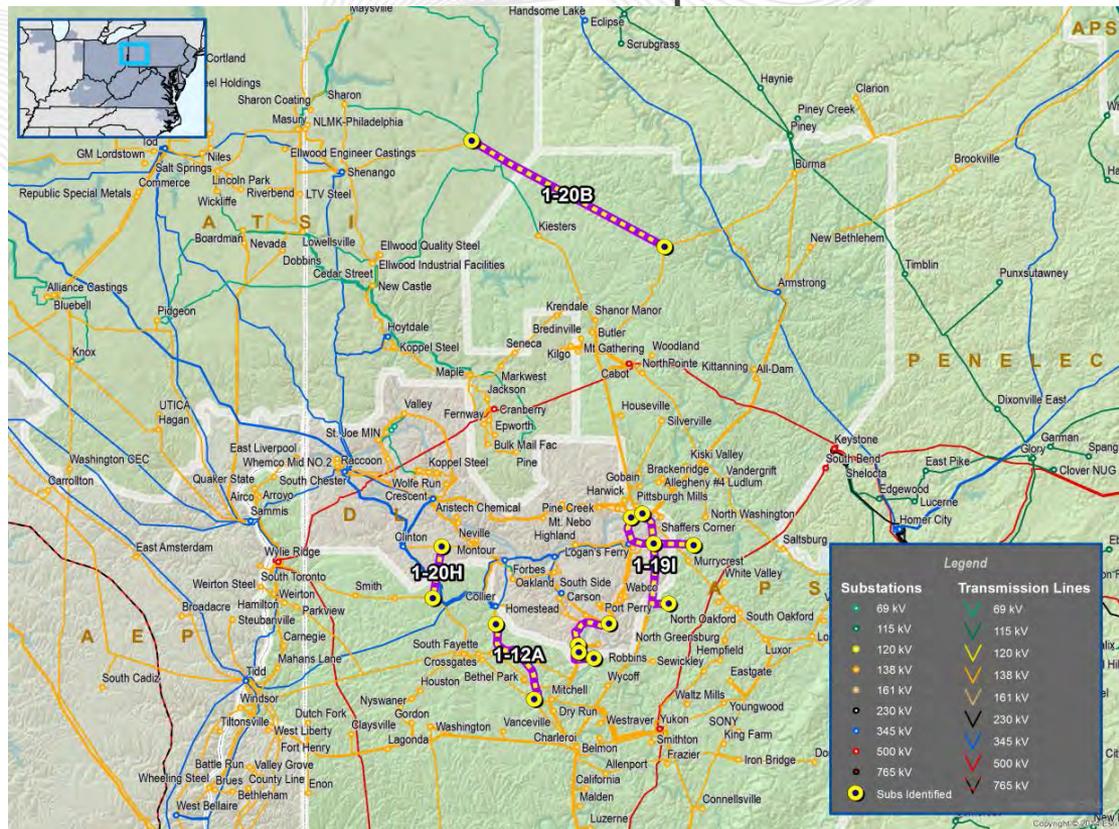
Target Zone: PPL/Meted

ME Constraints: Brunner Island to Yorkana 230 kV

Notes: **Recommended**



- 4 Projects:
 - 1-12A, 1-19I, 1-20B
1-20H
- Cost:
 - From \$1M to \$64M
- Constraints:
 - Dravosburg to West Mifflin 138 kV
 - Krendale to Shanor Manor 138 kV
 - Woodville to 15USAP 138 kV



Project ID	Upgrade/ Greenfield	Cost (\$M)	In Service date	Target Zone	kV Level	B/C Ratio 2015 Sens.	Total PJM Congestion Delta (\$millions) (2019 + 2022)	Comments	Status
201415_1-12A	Upgrade	11.18	2018	DUQ	138	1.98	-10	Removes DUQ congestion	Recommended
201415_1-19I	Greenfield	9.20	2020	APS/DUQ	138	48.5	10.9	Residual congestion remains on congestion drivers. Required new monitored events.	Not Recommended
201415_1-19I with Cheswick- Springdale 138 kV Line Closed	Greenfield	9.20	2020	APS/DUQ	138	41.61	7.6	Removes DUQ congestion drivers. Required new monitored events.	Not Recommended
201415_1-20B	Greenfield	70.98	2019	APS/DUQ	138	3.33	-1.9	Residual congestion remains on congestion drivers.	Not Recommended
201415_1-20H	Greenfield	14.40	2020	APS/DUQ	138	0.93	Failed B/C	Failed B/C	Not Recommended

* Dravosburg to West Mifflin 138 kV actual congestion in 2015 through June was approximately \$12 million

- Projects 12A and 19I both eliminate DUQ congestion and posted congestion drivers
- Project 19I creates additional congestion and reliability violations
 - Fix for new congestion drivers require full line reconductoring.
 - Reliability review identified thermal violations on Cabot-Lawson 138 kV facility for various contingencies.
- Project 20B does not eliminate the congestion drivers

Constraint	Delta in Congestion (\$ millions)					
	12A		19I		20B**	
	2019	2022	2019	2022	2019	2022
50045005 L/O RCKSPG-KEENY	\$1.00		\$3.90	\$6.60	-\$11.30	-\$11.50
AP SOUTH L/O BED-BLA	\$3.10		\$7.00	\$6.10	-\$6.30	-\$8.10
15RENTON to Springdale 138 kV*			\$5.60	\$5.60		
Cheswick to 15RENTON 138 kV*			\$5.00	\$4.50		
Woodville to 15USAP 138 kV	-\$2.30	-\$3.70	-\$2.30	-\$3.70	-\$1.10	-\$1.00
Dravosburg to West Mifflin 138 kV	-\$9.60	-\$5.70	-\$9.60	-\$5.70	-\$7.50	-\$4.50
AEP-DOM L/O BED-BLA			\$1.30		-\$0.40	-\$0.90
Shenango to McDowell 138 kV					\$33.60	\$35.90

*New Congestion driver created by proposed 19I upgrade

**Reliability analysis not performed; Congestion remains on driver

Project ID: 201415_1-12A

Proposed by: Duquesne Light

Proposed Solution: Reconductor approximately 7 miles of the Woodville-Peters (Z-117) 138kV circuit, reconfigure the West Mifflin-USS Clairton (Z-15) 138kV circuit to establish the Dravosburg-USS Clairton (Z-14) 138kV circuit and the West Mifflin-Wilson (Z-15) 138kV circuit

kV Level: 138

Cost (\$M): 11.184

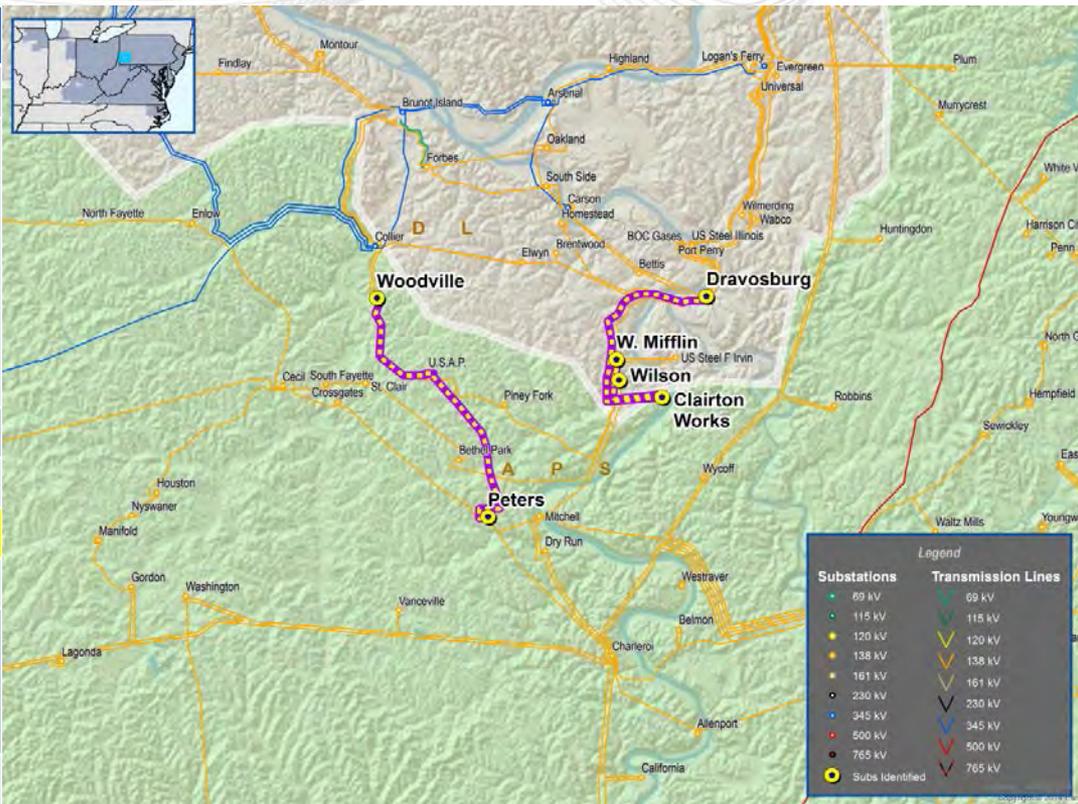
IS Date: 2018

Target Zone: DUQ

ME Constraints: Dravosburg to West Mifflin 138 kV
Woodville to 15USAP 138 kV

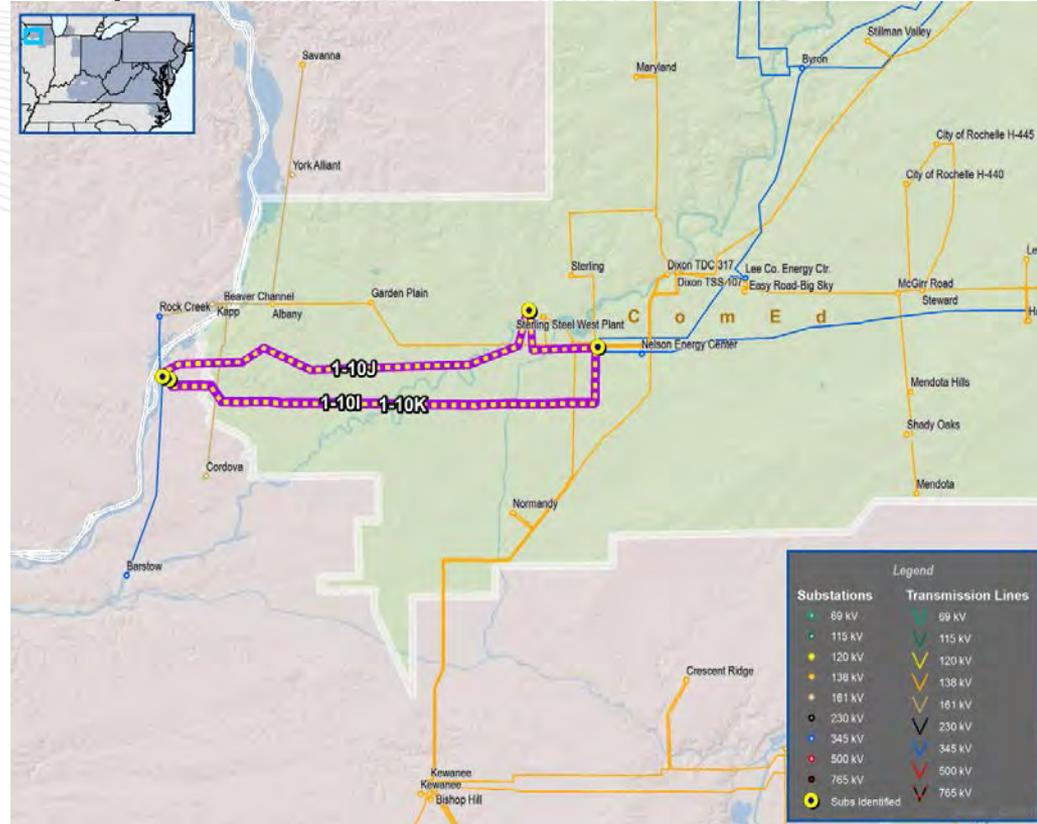
Notes: Reduces overall PJM congestion.

Recommended



Group 9: COMED - Cordova to Nelson

- 3 Projects:
 - 1-10I, 1-10J, 1-10K
- Cost:
 - \$2M to \$25M
- Constraints:
 - Cordova to Nelson 345 kV



Project ID	Upgrade/ Greenfield	Cost (\$M)	Target Zone	kV Level	ME Constraints Identified	Evaluation Type	B/C Ratio 2015 Sens.	Status	Comments
201415_1-10I	Upgrade	2.00	ComEd	345	Cordova to Nelson 345 kV	Lower Voltage			Already in service
201415_1-10K	Upgrade	15.50	ComEd	345	Cordova to Nelson 345 kV	Lower Voltage	1.18	Not Recommended	Failed B/C
201415_1-10J	Upgrade	24.60	ComEd	345	Cordova to Nelson 345 kV	Lower Voltage	1.94	Recommended	Passes B/C and Removes congestion driver

Project ID: 201415_1-10J

Proposed by: ComEd

Proposed Solution: Replace station equipment at three stations and upgrade conductor rating of three lines by re-conductoring and mitigating sag limitations. NOTE: Component 1 of this project (s0704) is scheduled to complete on March 13, 2015

kV Level: 345

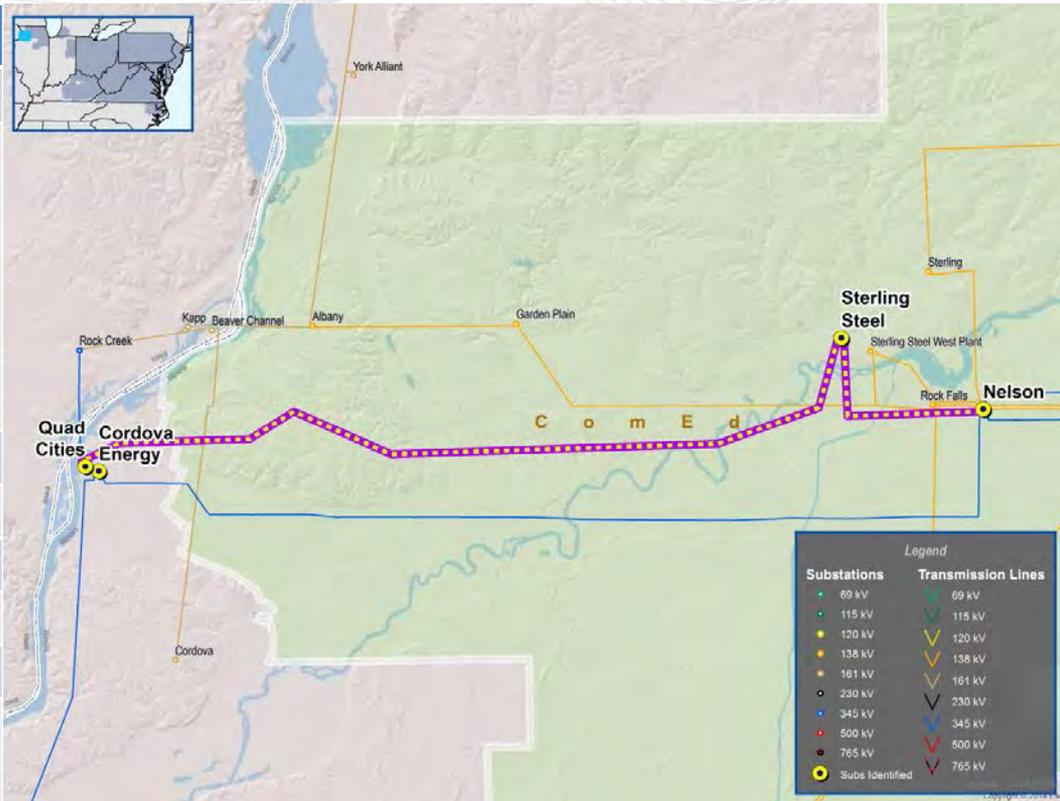
Cost (\$M): 24.6

IS Date: 2019

Target Zone: ComEd

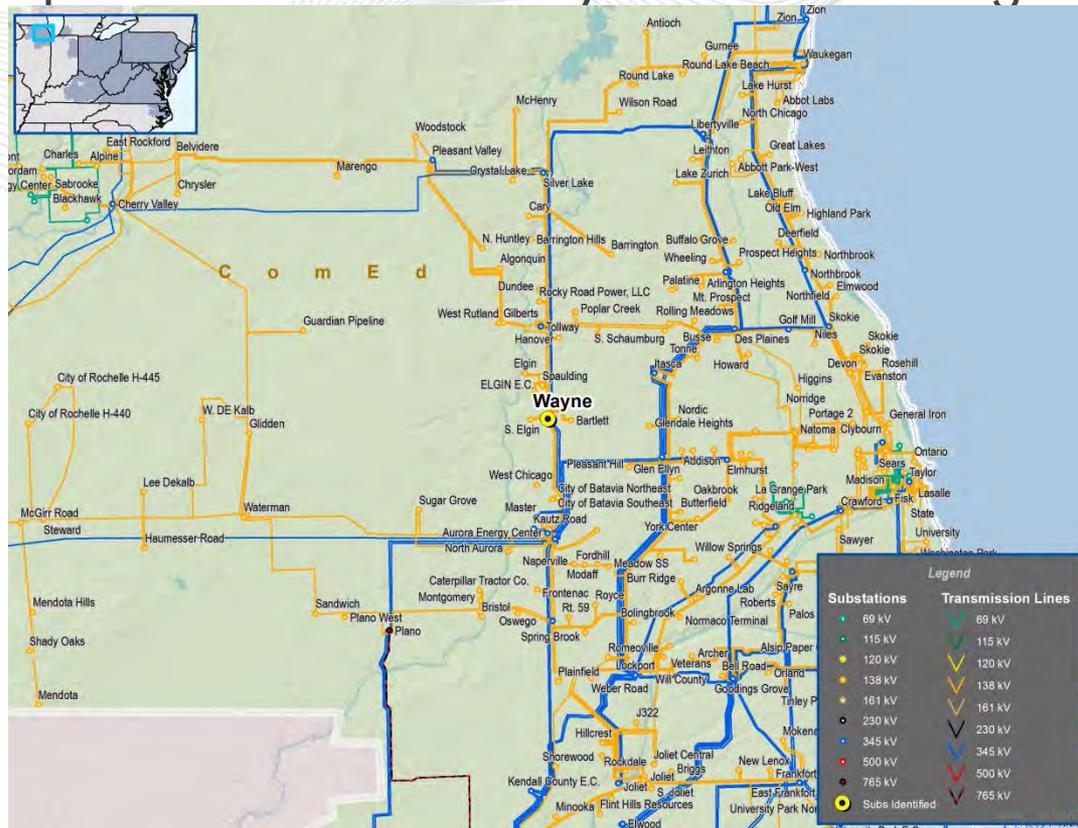
ME Constraints: Cordova to Nelson 345 kV

Notes: **Recommended**



Group 10: COMED - Wayne to South Elgin

- 1 Project:
 - 1-10B
- Cost:
 - \$0.1M
- Constraints:
 - Wayne to South Elgin
 - 138 kV



Project ID	Upgrade/ Greenfield	Cost (\$M)	Target Zone	kV Level	ME Constraints Identified	Evaluation Type	B/C Ratio Base	B/C Ratio 2015 Sens.	Status
201415_1-10B	Upgrade	0.10	ComEd	138	Wayne to South Elgin 138 kV	Lower Voltage	7.23	6.43	Recommended

Project ID: 201415_1-10B

Proposed by: ComEd

Proposed Solution: Replace L7815 B phase line trap at Wayne substation

kV Level: 138

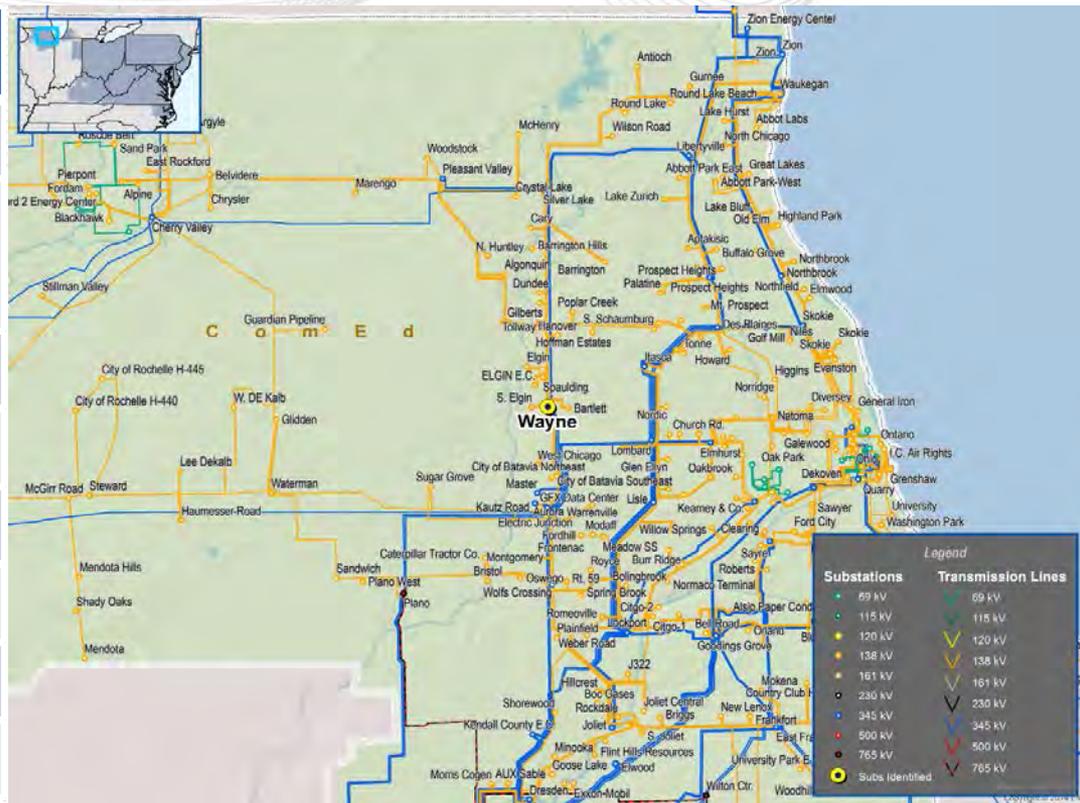
Cost (\$M): 0.1

IS Date: 2019

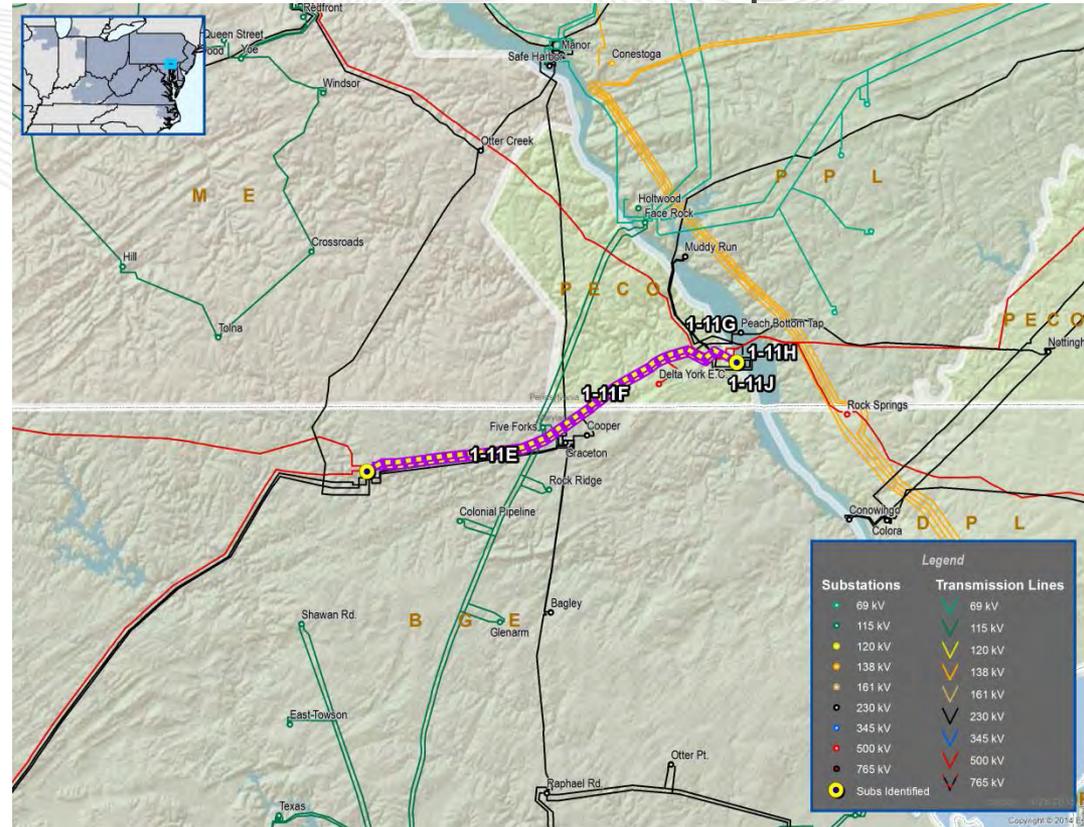
Target Zone: ComEd

ME Constraints: Wayne to South Elgin 138 kV

Notes: **Recommended**



- 5 Projects:
 - 1-11E, 1-11F, 1-11G, 1-11H, 1-11I
- Cost:
 - From \$0.2M to \$21M
- Constraints:
 - Peach Bottom 500 kV
 - Peach Bottom to Conastone 500 kV



Project ID	Upgrade/ Greenfield	Cost (\$M)	Target Zone	kV Level	ME Constraints Identified	Evaluation Type	B/C Ratio 2015 Sens.	Comments	Status
201415_1-11G	Upgrade	0.20	PECO	230	Peach Bottom 500 kV	Lower Voltage	72.97	Partially removes congestion driver	Not Recommended
201415_1-11E	Upgrade	1.80	PECO	500	Peach Bottom to Conastone 500 kV	Regional	0.24	Failed B/C	Not Recommended
201415_1-11F	Upgrade	8.70	PECO	500	Peach Bottom to Conastone 500 kV	Regional	0.18	Failed B/C	Not Recommended
201415_1-11H	Upgrade	9.70	PECO	230	Peach Bottom 500 kV	Lower Voltage	3.03	Removes Congestion Driver	Recommended
201415_1-11I	Upgrade	21.10	PECO	230	Peach Bottom 500 kV	Lower Voltage	3.07	Removes Congestion Driver	Not Recommended

Project ID: 201415_1-11H

Proposed by: PECO

Proposed Solution: Increase ratings of Peach Bottom 500-230 kV transformer to 1479 MVA normal / 1839 MVA emergency

kV Level: 230

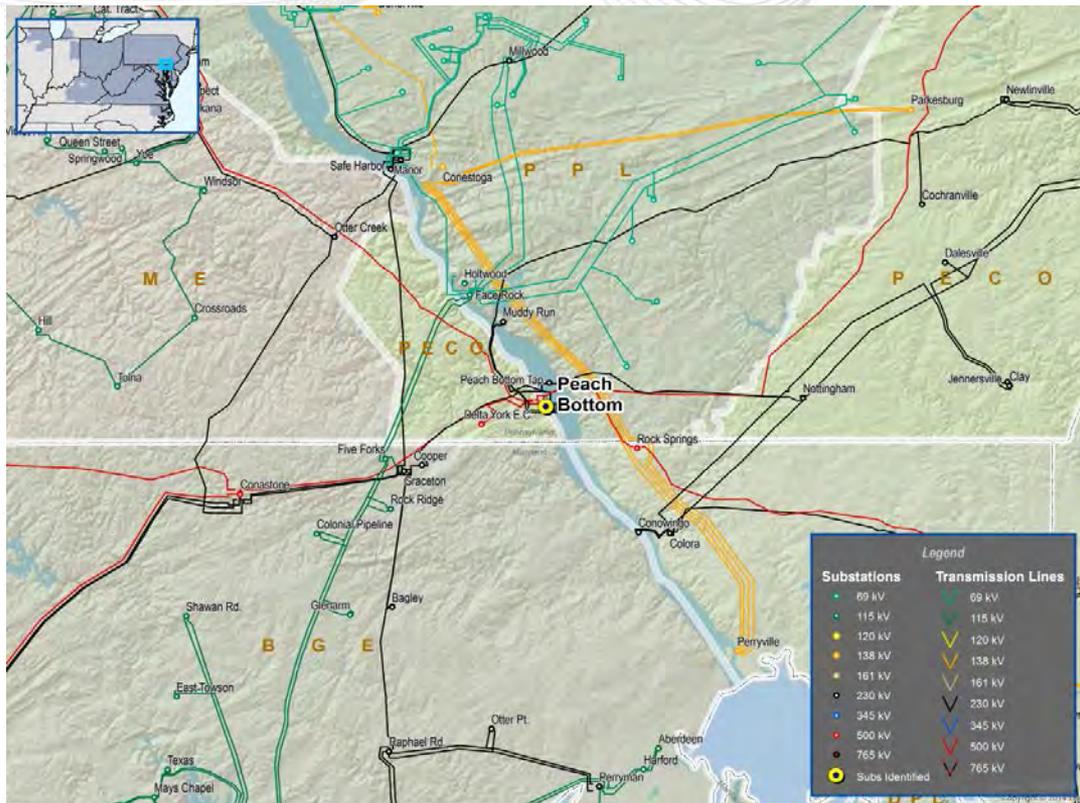
Cost (\$M): 9.7

IS Date: 2019

Target Zone: PECO

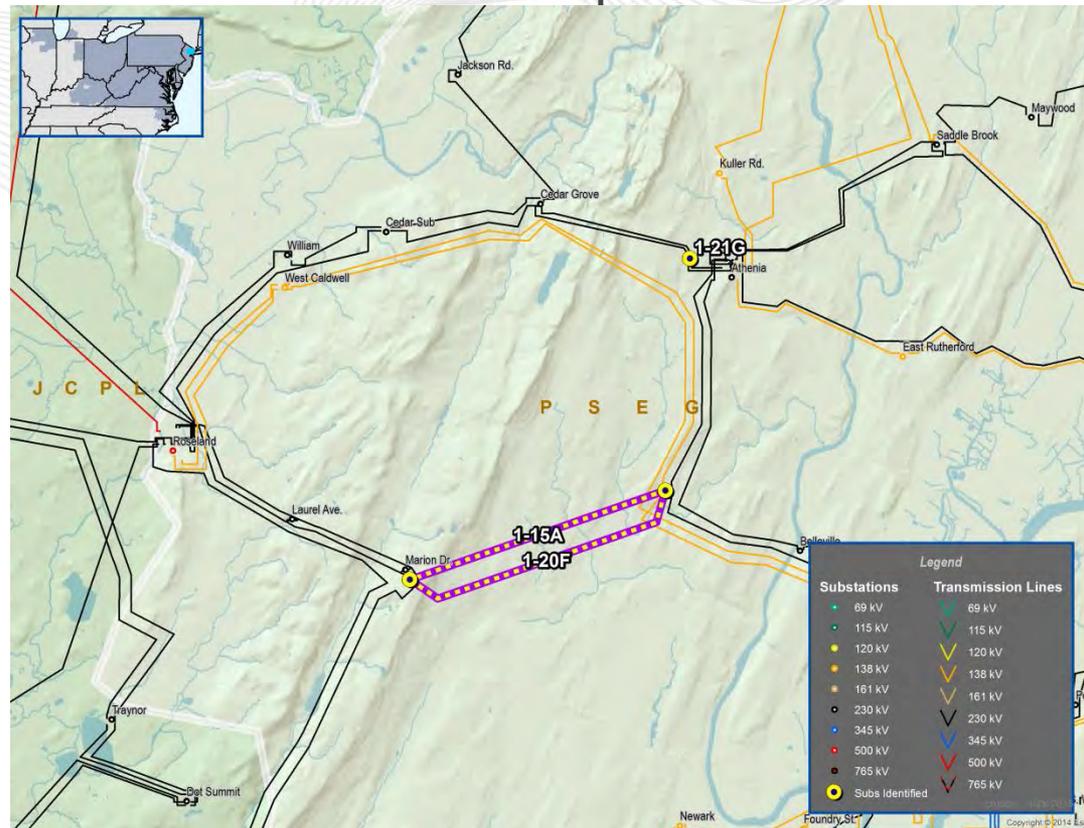
ME Constraints: Peach Bottom 500 kV

Notes: **Recommended**



- 3 Projects:
 - 1-15A, 1-20F, 1-21G
- Cost:
 - From \$2.8M to \$125M
- Constraints:
 - Roseland-Cedar Grove-Clifton 230 kV corridor
- Note:
 - PS and PS North not binding in BRA and therefore driver is removed

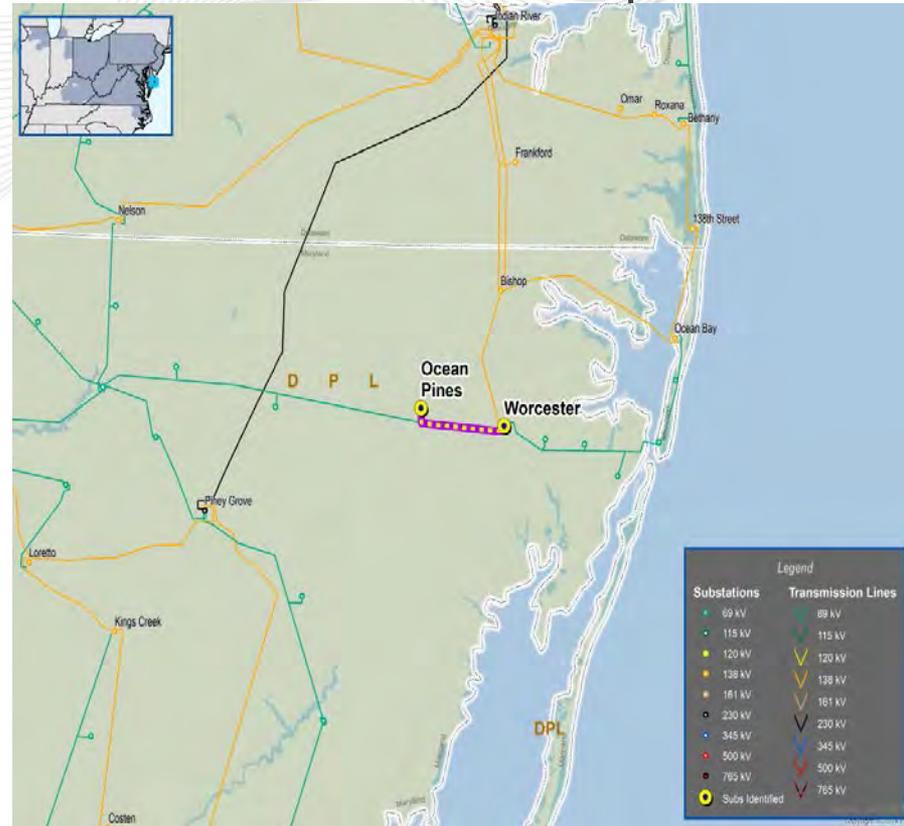
No upgrade necessary





- 1 Project:
 - 1-13E
- Cost:
 - \$2.4M
- Constraints:
 - Worcester to Ocean Pines 69 kV

Group 14: DPL



Project ID	Upgrade/ Greenfield	Cost (\$M)	Target Zone	kV Level	ME Constraints Identified	Evaluation Type	B/C Ratio Base	B/C Ratio 2015 Sens.	Status
201415_1-13E	Upgrade	2.40	DPL	69	Worcester to Ocean Pines 69 kV	Lower Voltage	82.68	65.30	Recommended

Project ID: 201415_1-13E

Proposed by: PHI

Proposed Solution: Rebuild Worcester - Ocean Pine 60 kV ckt 1 to 1400A capability summer emergency

kV Level: 69

Cost (\$M): 2.4

IS Date: 2016

Target Zone: DPL

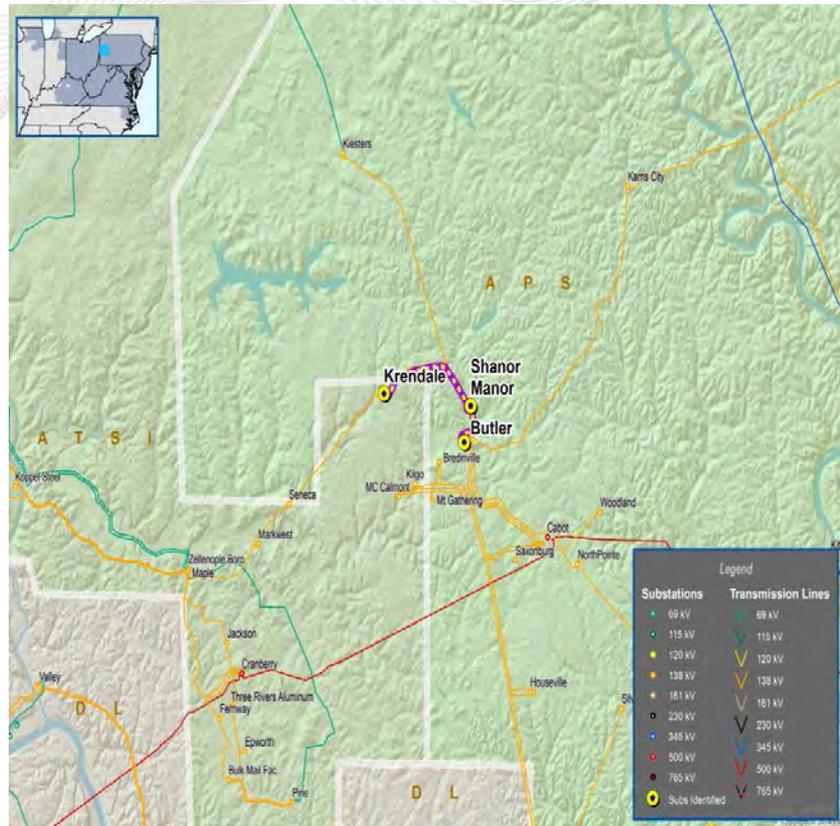
ME Constraints: Worcester to Ocean Pines (I) 69 kV

Notes: **Recommended**



Group 15: APS/ATSI - Krendale to Shanor Manor

- 1 Project:
 - 1-18I
- Cost:
 - \$0.6M
- Constraints:
 - Krendale to Shanor Manor 138 kV



Project ID	Upgrade/ Greenfield	Cost (\$M)	Target Zone	kV Level	ME Constraints Identified	Evaluation Type	B/C Ratio Base	B/C Ratio 2015 Sens.	Status
201415_1-18I	Upgrade	0.60	APS/ATSI	138	Krendale to Shanor Manor 138 kV	Lower Voltage	35.81	123.39	Recommended

Project ID: 201415_1-181

Proposed by: FirstEnergy

Proposed Solution: Upgrade 138 kV substation equipment at Butler, Shanor Manor, and Krendale substations. New rating of the line will be 353 MVA summer normal and 422 MVA summer emergency

kV Level: 138

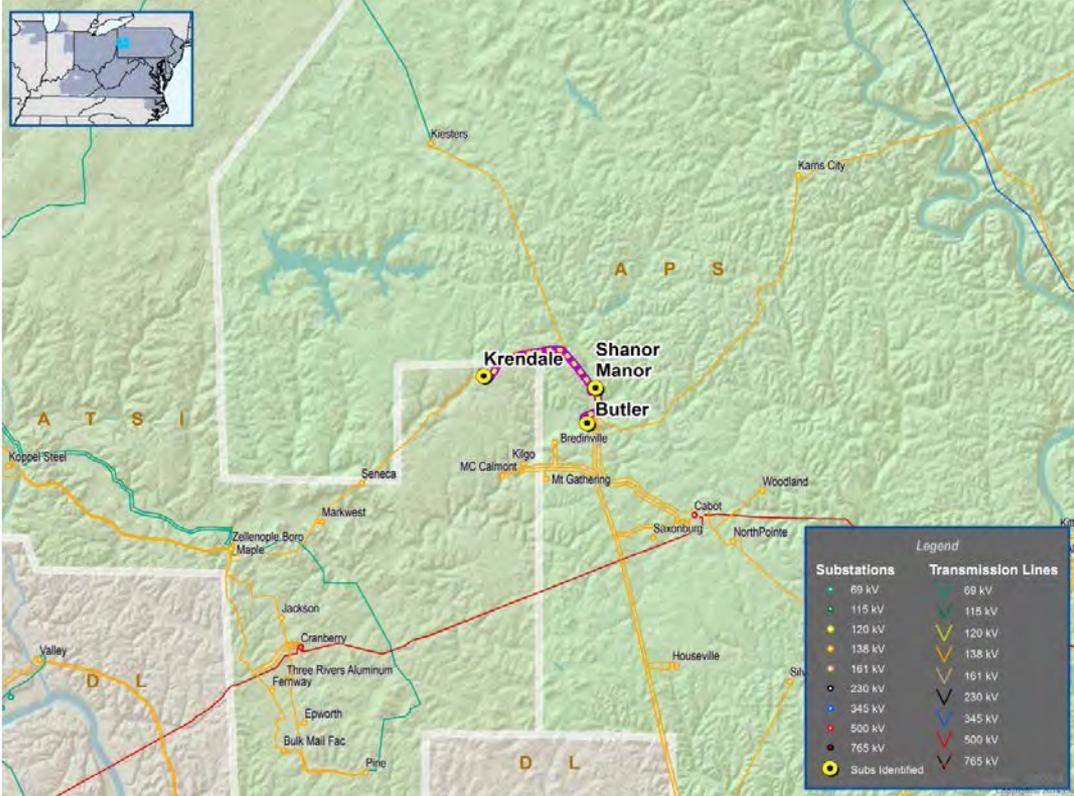
Cost (\$M): 0.6

IS Date: 2019

Target Zone: APS/ATSI

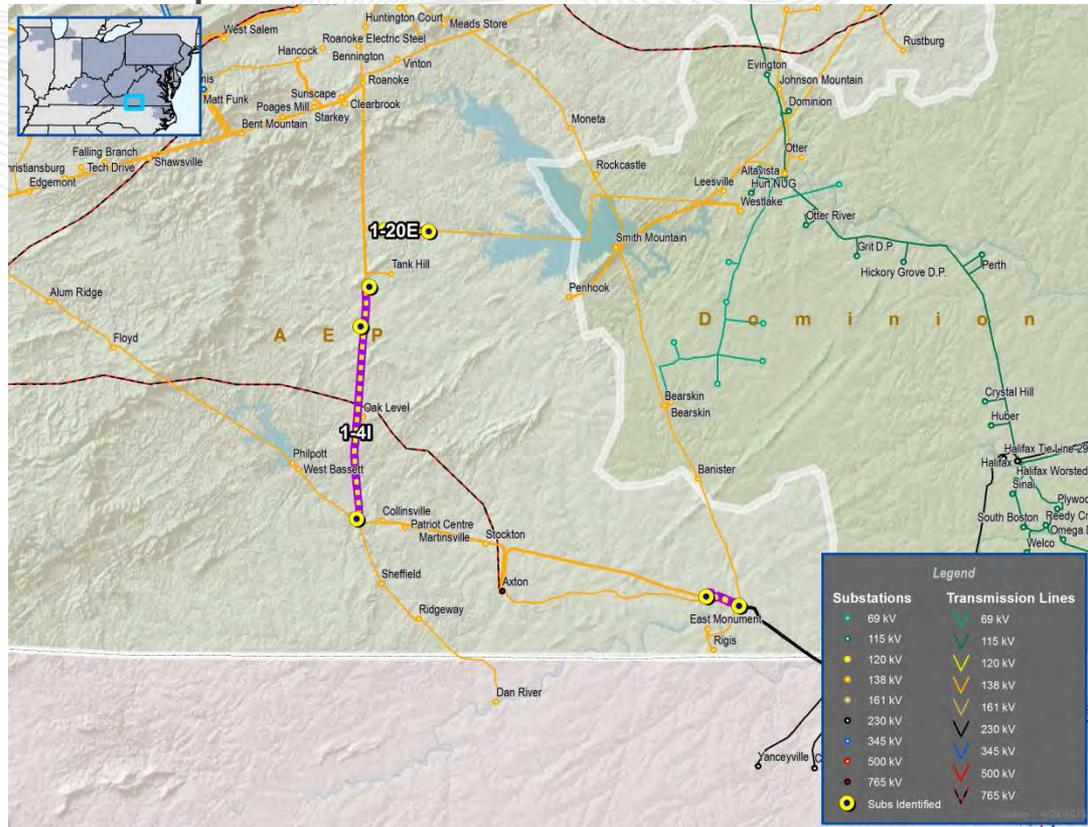
ME Constraints: Krendale to Shanor Manor 138 kV

Notes: Recommended



Group 18: AEP - Fieldale to Thornton

- 2 Projects:
 - 1-4I, 1-20E
- Cost:
 - From \$0.8M to \$19M
- Constraints:
 - Danville to East Danville
138 kV
 - Fieldale to Thornton 138 kV



Project ID	Upgrade/ Greenfield	Cost (\$M)	Target Zone	kV Level	Evaluation Type	B/C Ratio 2015 Sens.	Comments	Status
201415_1-4I	Upgrade	0.75	AEP	138	Lower Voltage	101.19	Removes Congestion Driver	Recommended
201415_1-20E	Greenfield	19.00	AEP	138	Lower Voltage	2.67	Removes Congestion Driver	Not Recommended

Project ID: 201415_1-41

Proposed by: AEP

Proposed Solution: Operate the Fieldale - Thornton - Franklin overhead at maximum operating temperature. Replace terminal equipment at Danville and East Danville substations.

kV Level: 138

Cost (\$M): 0.75

IS Date: 2019

Target Zone: AEP

ME Constraints: Fieldale to Thornton 138 kV

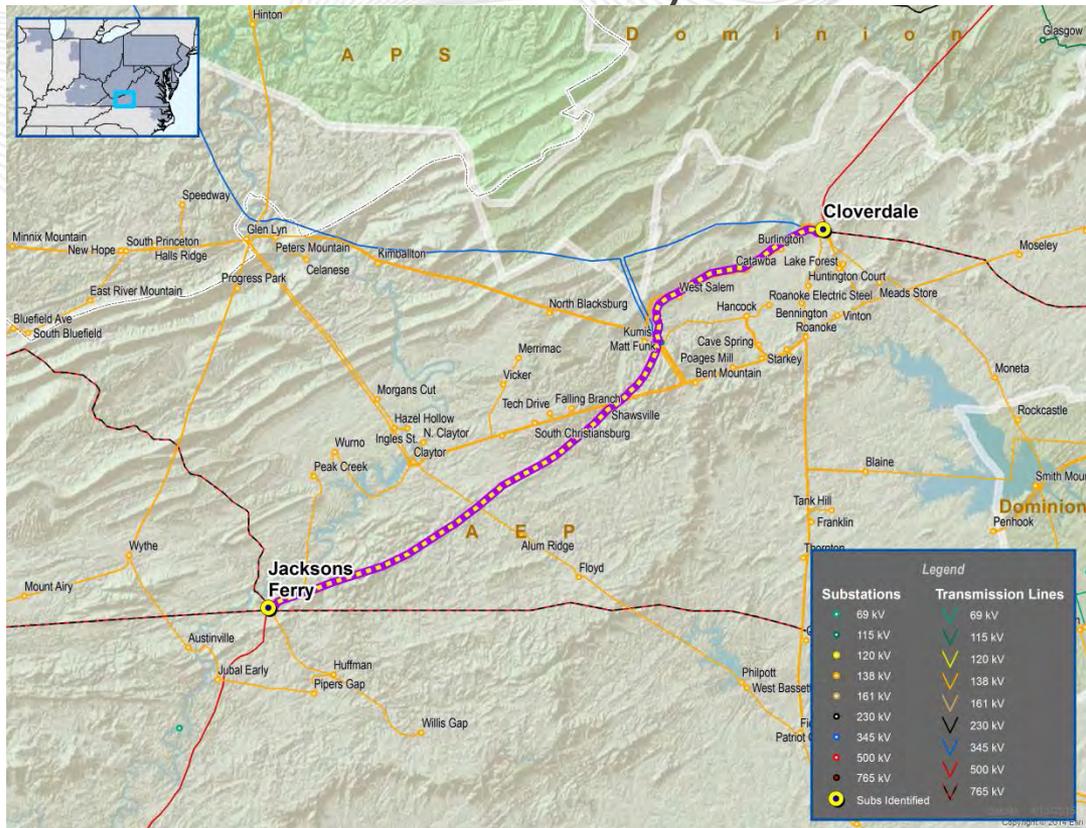
Danville to East Danville 138 kV

Notes: Recommended



Group 19: AEP – Jackson’s Ferry to Cloverdale

- 1 Project:
 - 1-4J
- Cost:
 - \$0.5M
- Constraints:
 - Jackson’s Ferry to Cloverdale 765 KV



Project ID	Upgrade/ Greenfield	Cost (\$M)	Target Zone	kV Level	ME Constraints Identified	Evaluation Type	B/C Ratio Base	B/C Ratio 2015 Sens.	Status
201415_1-4J	Upgrade	0.50	AEP	765	Jacksons Ferry to Cloverdale 765 KV	Regional	15.81	61.98	Recommended

Group 19 Recommended Project: 1-4J

Project ID: 201415_1-4J

Proposed by: AEP

Proposed Solution: Replace relays at AEP's Cloverdale and Jackson's Ferry substation to improve the thermal capacity of Cloverdale - Jackson's Ferry 765 kV line

kV Level: 765

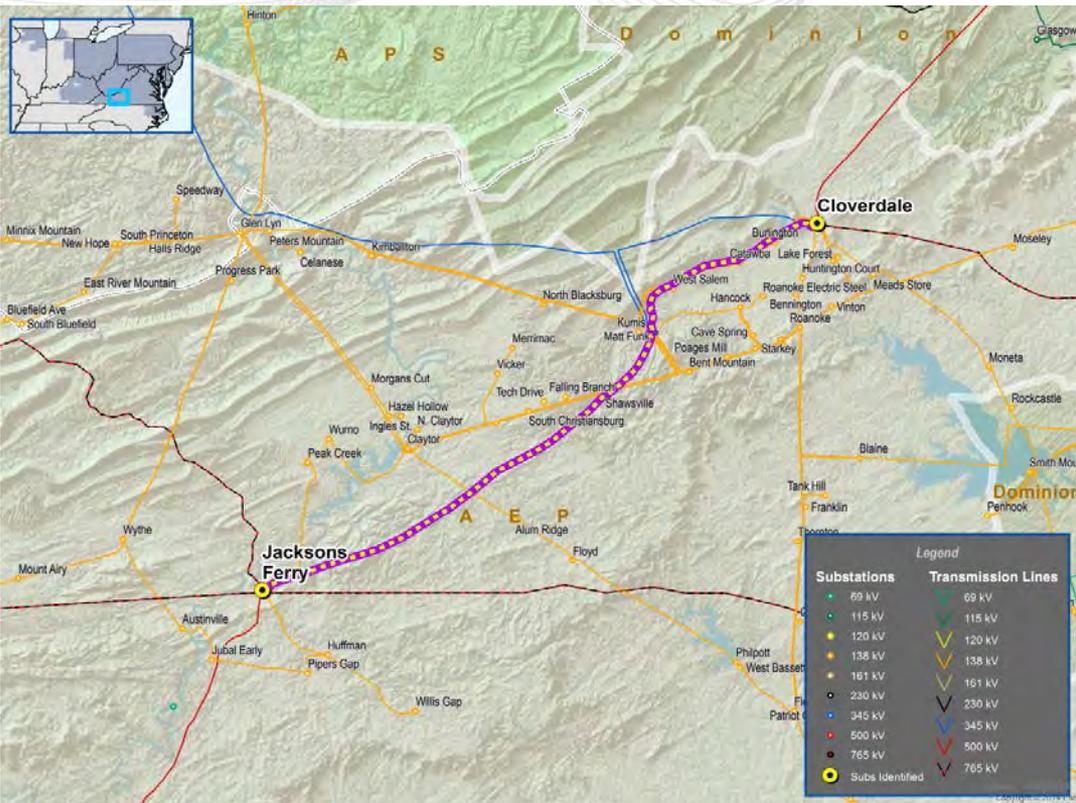
Cost (\$M): 0.5

IS Date: 2019

Target Zone: AEP

ME Constraints: Jackson's Ferry to Cloverdale 765 KV

Notes: **Recommended**





Summary: Recommended Projects from Groups 2 thru 19

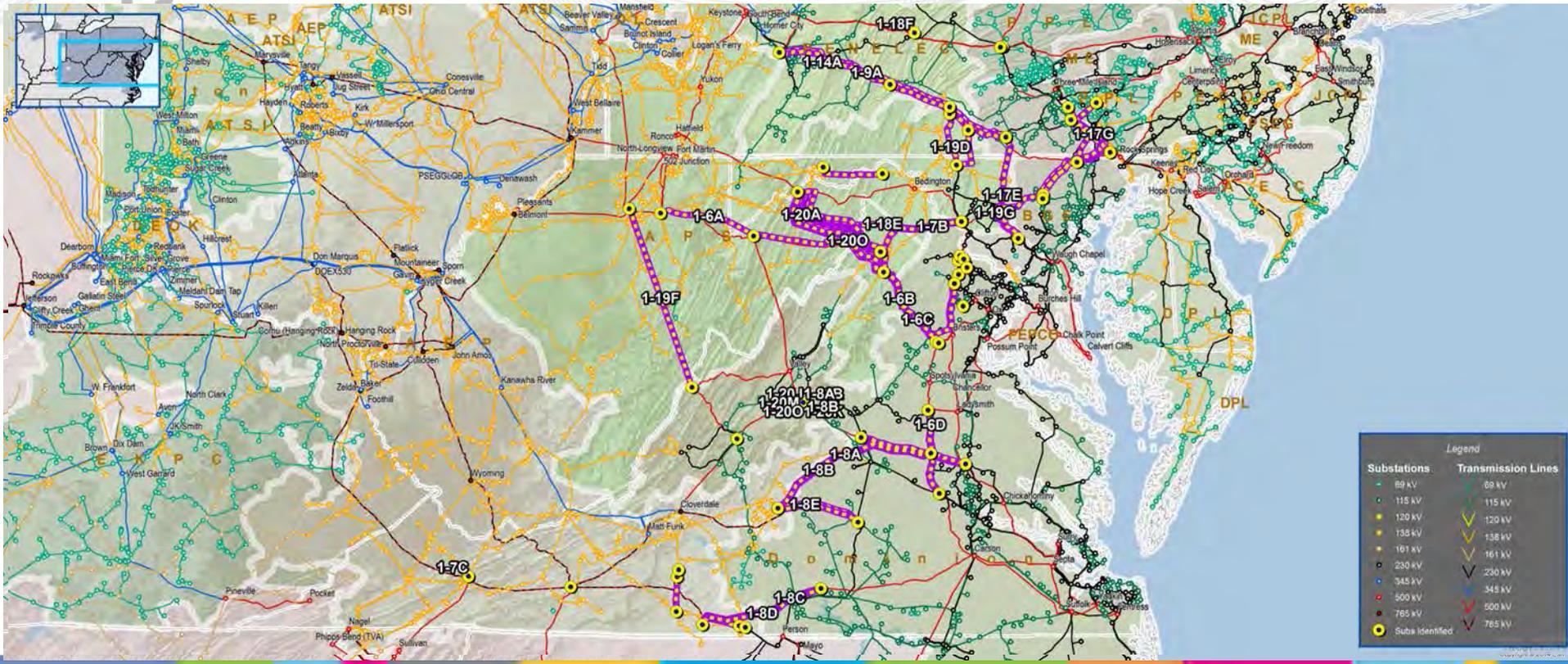
Group	Project ID	Area	Constraint	Cost (\$millions)	Type	In-service date	B/C 2014 Base	B/C 2015 Sensitivity	Does Project address congestion on Driver?
Group 4	201415_1-18G	APS	Taneytown to Carroll 138 kV	5.2	Upgrade	2019	55.7	90.1	Yes
Group 5	201415_1-12A	DUQ	Dravosburg to West Mifflin 138 kV	11.18	Upgrade	2018	5.8	2.0	Yes
Group 8	201415_1-2A	PPL - BGE	Safe Harbor to Graceton 230 kV	1.1	Upgrade	2019	4.3	14.4	Yes
Group 8	201415_1-2B	ME - PPL	Brunner Island to Yorkana 230 kV	3.1	Upgrade	2019	73.3	22.2	Yes
Group 9	201415_1-10J	COMED	Cordova to Nelson 345 kV	24.6	Upgrade	2019	1.7	1.9	Yes
Group 10	201415_1-10B	COMED	Wayne to South Elgin 138 kV	0.1	Upgrade	2019	7.2	6.4	Yes
Group 11	201415_1-11H	PECO	Peach Bottom 500 kV	9.7	Upgrade	2019	2.6	3.0	Yes
Group 14	201415_1-13E	DPL	Worcester to Ocean Pines (I) 69 kV	2.4	Upgrade	2019	82.7	65.3	Yes
Group 15	201415_1-18I	APS/ATSI	Krendale to Shanor Manor 138 kV	0.6	Upgrade	2019	35.8	123.4	Yes
Group 18	201415_1-4I	AEP	Fieldale to Thornton 138 kV	0.75	Upgrade	2019	114.2	101.2	Yes
Group 19	201415_1-4J	AEP	Jacksons Ferry to Cloverdale 765 kV	0.5	Upgrade	2019	15.8	62.0	Yes

Total Cost 59.23

Summary: Projects from Groups 2 thru 19

- Simulations were conducted to measure impact of all recommended projects from groups 2 thru 19 simultaneously.
 - B/C Ratio = 15.6 with all upgrades included as one project
 - Total 2019 congestion reduction was \$50 million
 - Minor congestion increases on other facilities
 - Additional simulations were conducted to measure impact of B/C ratio of recommended projects with each group 1 Apsouth/AEP-DOM project.
 - Recommended projects continue to pass B/C test with assumed inclusion of each group 1 project.
 - Reliability review has been completed for recommended projects and no additional violations were identified.
-
- Next Steps
 - Recommendation to PJM Board in October 2015*

Project Evaluations Group 1 (ApSouth/AEP-DOM Projects)



PJM results have been updated to reflect corrected model for inclusion of recommended Non ApSouth/AEP-Dom projects.

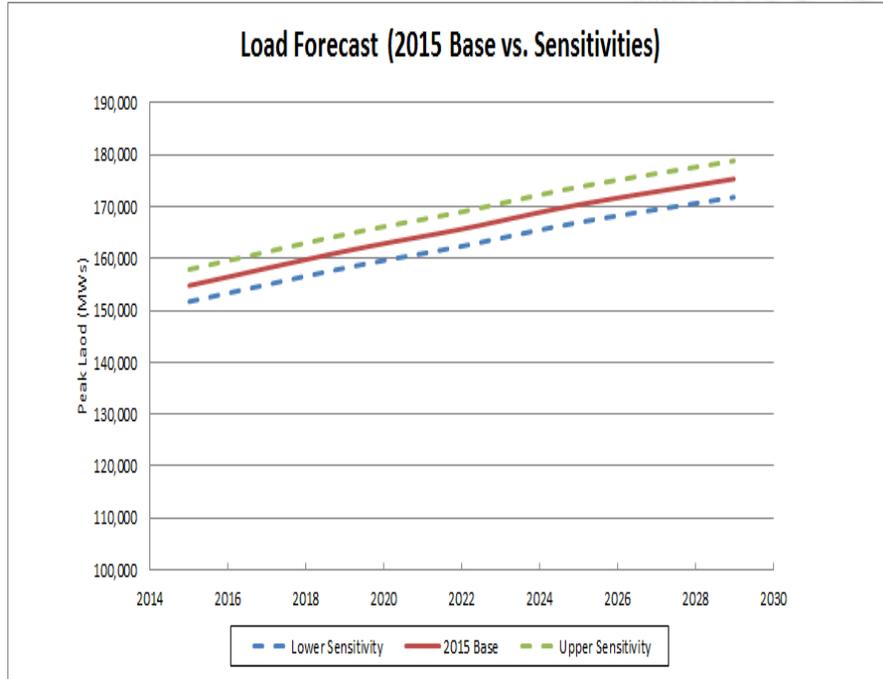
- 2015 B/C ratios not impacted
- B/C ratios with inclusion of recommended groups 2-19 projects have been updated
- Tier 1 finalist list updated

PJM sensitivity analysis conducted on all ApSouth projects that passed B/C test

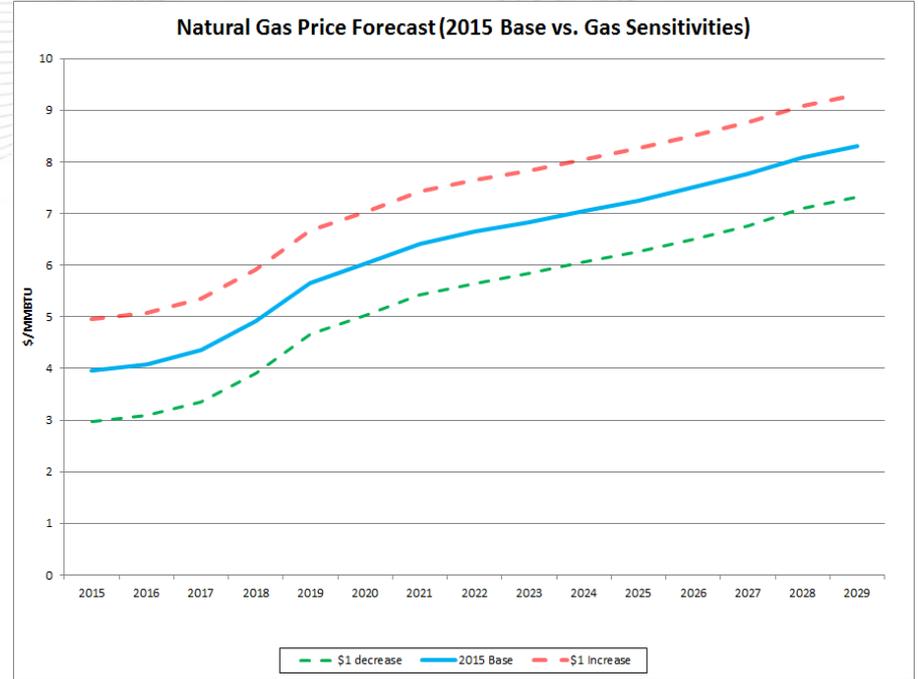
- Fuel Price Sensitivity included an increase and decrease of \$1/MMBtu
- Load Forecast Sensitivity included an increase and decrease of 2% of Load Forecast



Load Forecast Sensitivity



Gas Forecast Sensitivity



Group 1 Tier 1 Finalist Criteria:

- Project B/C > 1.25 using 2015 Sensitivity Case

and

- Project B/C > 1.25 when base case includes recommended projects from Groups 2-19 using 2015 Sensitivity Case.
 - Projects from groups 2-19 are lower cost upgrades.
 - Projects from Group 1 will not be substitutes for projects from groups 2-19.

and

- Project B/C > 1.25 with sensitivities on gas prices and load forecast

and

- Project reduces ApSouth and AEP-DOM congestion for combined 2019 and 2022 simulations.*

*Projects still considered if congestion increased by less than \$10 million

Project Name	Company	Cost	In-service Date	B/C 2015 Sensitivity	B/C with Recommended Groups 2-19 projects included	B/C Gas price increase sensitivity	B/C Gas price decrease sensitivity	B/C Load increase sensitivity	B/C Load decrease sensitivity	ApSouth Congestion Delta (\$ millions) (2019+2022)	AEP-DOM Congestion Delta (\$ millions) (2019+2022)	(Reference Only) Production Cost Delta (\$ millions) (2019+2022)	(Reference Only) Gross Load Payment Delta (\$ millions) (2019+2022)
201415_1-6B	Dominion	25.00	2019	2.37	1.94	1.48	1.82	2.02	1.97	-\$10.9	\$2.9	-\$15.6	\$16.7
201415_1-6C	Dominion	39.1	2019	4.07	4.64	4.05	3.46	5.05	4.60	-\$91.7	\$2.3	-\$25.9	-\$86.6
201415_1-6D	Dominion	42.70	2019	2.93	2.42	2.93	2.67	3.06	2.64	-\$52.6	\$2.5	-\$33.7	\$4.2
201415_1-9A	DOM High Voltage/Transource	300.7	2020	5.07	2.64	2.09	3.39	3.02	2.56	-\$134.0	-\$10.9	-\$67.1	-\$48.3
201415_1-14A	DATC	51.53	2019	3.73	1.76	1.35	2.13	2.19	1.72	-\$37.4	-\$0.2	-\$18.4	\$153.5
201415_1-19G	LSPower	48.60	2020	2.09	2.76	1.82	4.17	4.13	2.81	-\$7.9	\$8.0	-\$18.9	-\$2.2

Tier 1 finalists criteria: Projects with B/C>1.25 (all scenarios), ApSouth Congestion Delta<\$10 million, AEP-DOM Congestion Delta <\$10 million

*Negative represents a reduction as a result of the project

Next Steps

- Reviews costs and In-service dates
- Additional sensitivities
- Review project components
 - Partial project recommendations?
 - Hybrid/combination projects?
- Reliability/Constructability Review
- Reduce/Recommend Project(s)

Appendix A

Updated Group 1 Tier 1 Project Finalist (ApSouth/AEP-DOM Projects)

Project ID: 201415_1-6B

Proposed by: Dominion

Proposed Solution: Build one 500kV Thyristor Controlled Series Capacitors (TCSC) at Loudoun substation on the Loudoun - Meadowbrook line to reduce congestion on AP South and other PJM interfaces

kV Level: 500

Cost (\$M): 25

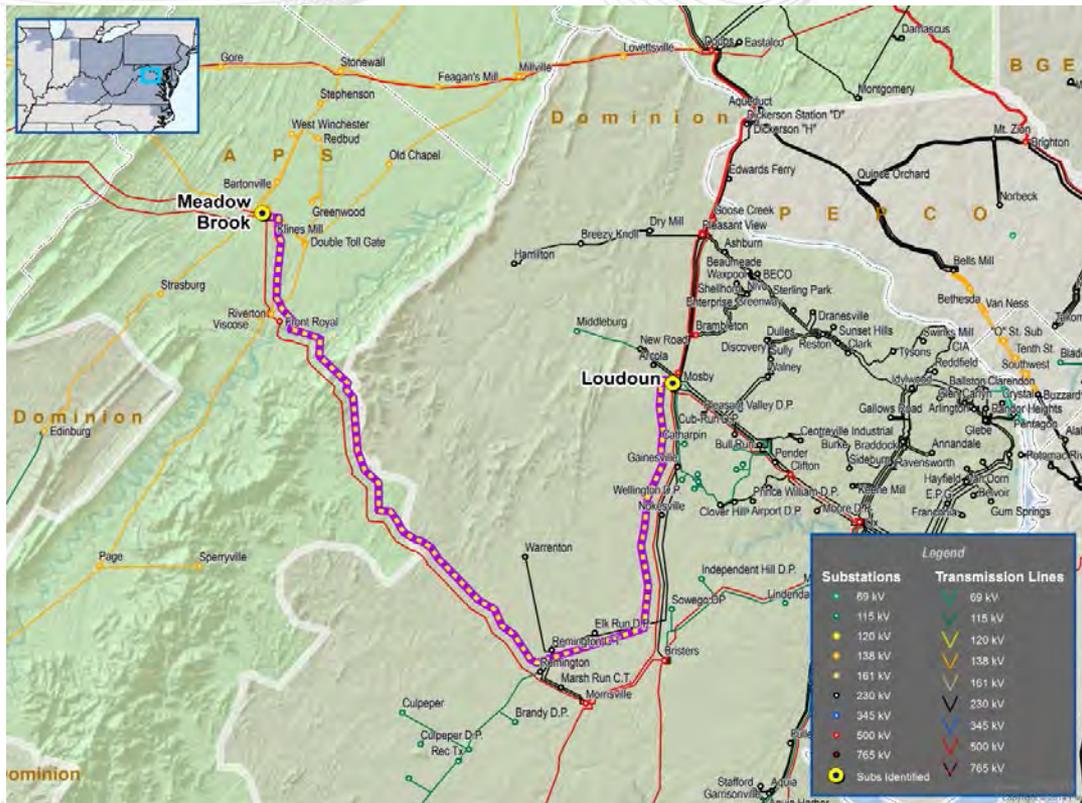
IS Date: 2019

Target Zone: Dominion

ME Constraints: AP SOUTH L/O BED-BLA

Other Interfaces

Notes:



Project ID: 201415_1-6C

Proposed by: Dominion

Proposed Solution: Build one 500kV Thyristor Controlled Series Capacitor (TCSC) at Loudoun substation on the Loudoun - Meadowbrook (535) line and build five (5) 230 kV capacitor banks at five (5) DVP substations to alleviate congestion on AP South and other PJM interfaces

kV Level: 500

Cost (\$M): 39.06

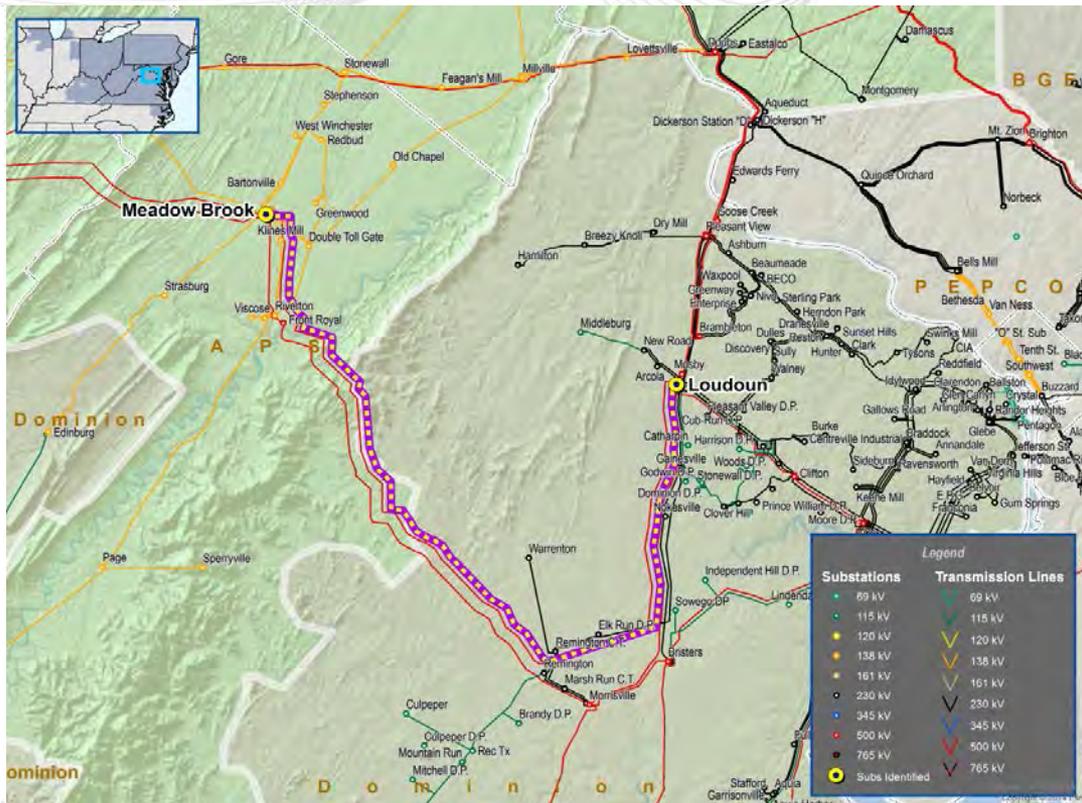
IS Date: 2019

Target Zone: Dominion

ME Constraints: AP SOUTH L/O BED-BLA

Other Interfaces

Notes:



Project ID: 201415_1-6D

Proposed by: Dominion

Proposed Solution: Build a new 500kV station (Palmyra) by connecting at the intersection of two (2) 500kV lines of North Anna - Midlothian 500kV line and Cunningham - Elmont 500kV line and build five (5) capacitor banks in DVP zone to alleviate AP South and AEP-DOM congestions

kV Level: 500

Cost (\$M): 42.7

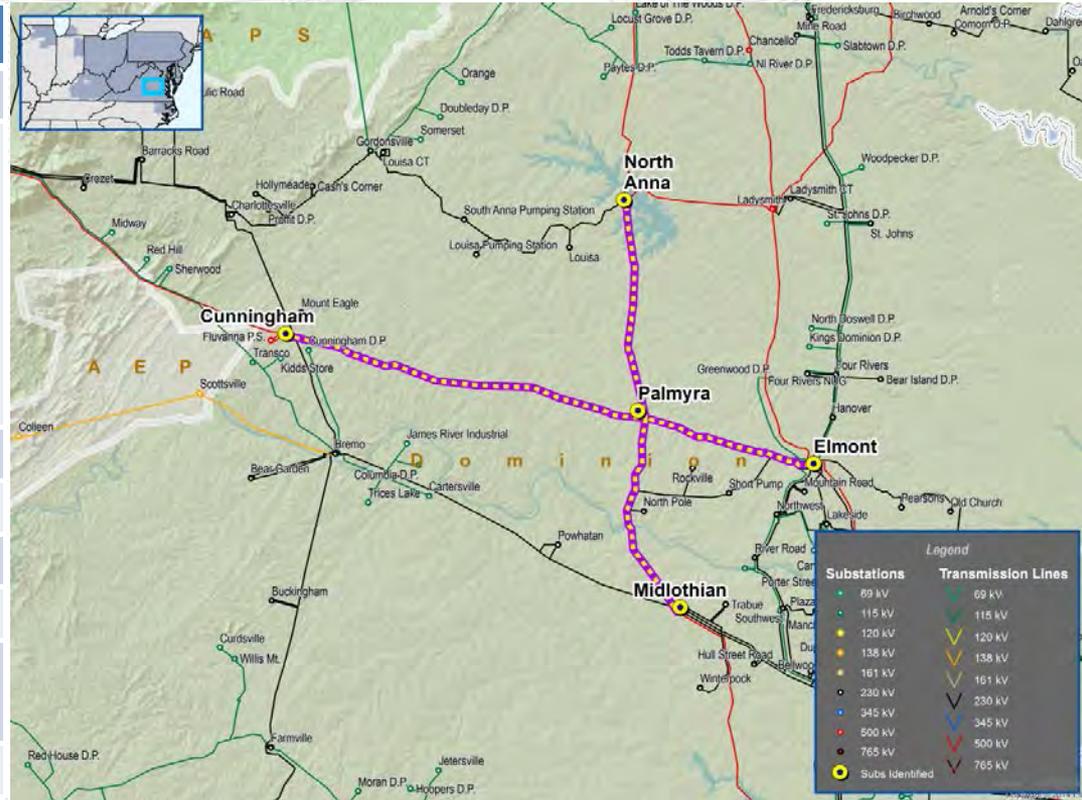
IS Date: 2019

Target Zone: Dominion

ME Constraints: AP SOUTH L/O BED-BLA

Other Interfaces

Notes:



Project ID: 1-9A

Proposed by: Dominion / Transource

Proposed Solution: 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. Add cap banks to Jackson's Ferry, Bradford, Lexington, Doms, Ashburn and Brambleton stations. Rebuild the Conastone - Northwest 230 kV line.

kV Level: 230

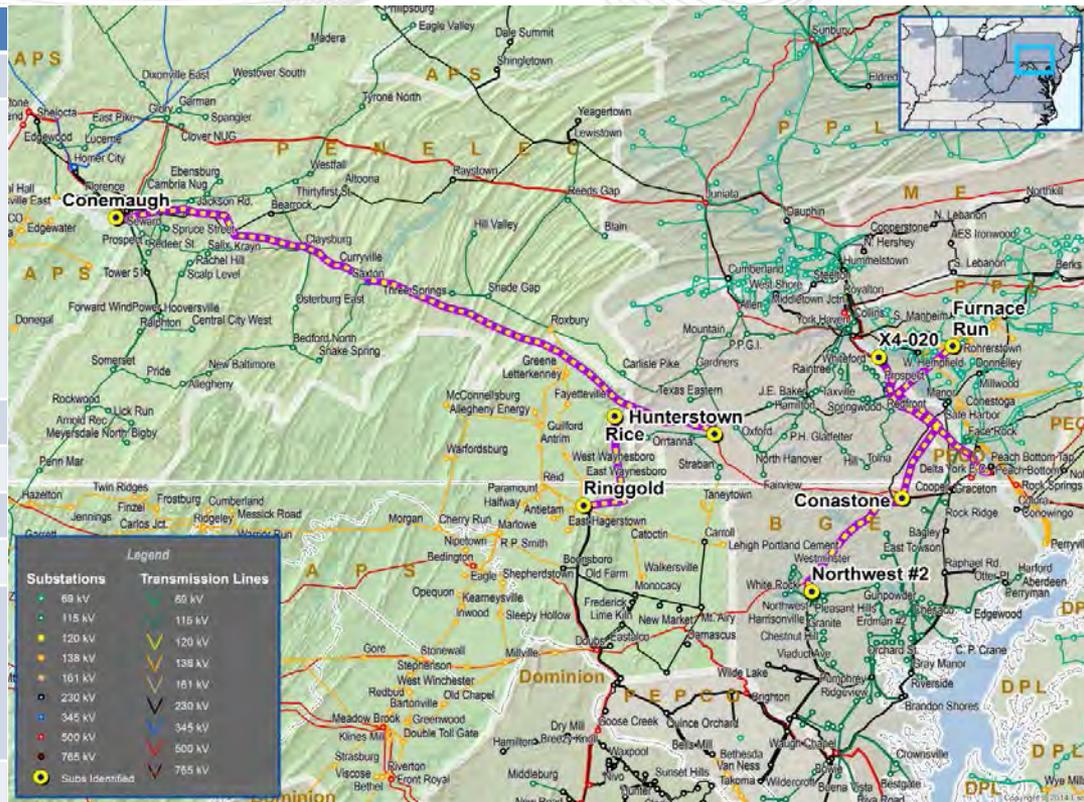
Cost (\$M): 269

IS Date: 2020

Target Zone: PECO/Dominion/AEP

ME Constraints: AP SOUTH L/O BED-BLA, Brunner Island to Yorkana 230 kV, Taneytown to Carroll 138 kV, Safe Harbor to Graceton 230 kV, Conastone to Northwest 230 kV

Notes:



Project ID: 201415_1-14A

Proposed by: DATC

Proposed Solution: A hybrid series capacitor and thyristor controlled series capacitor near the midpoint of Conemaugh to Hunterstown 500 kV line in southern Pennsylvania. Add a phase angle regulator on the Messick to Morgan 138 kV line and close the circuit in Maryland.

kV Level: 500

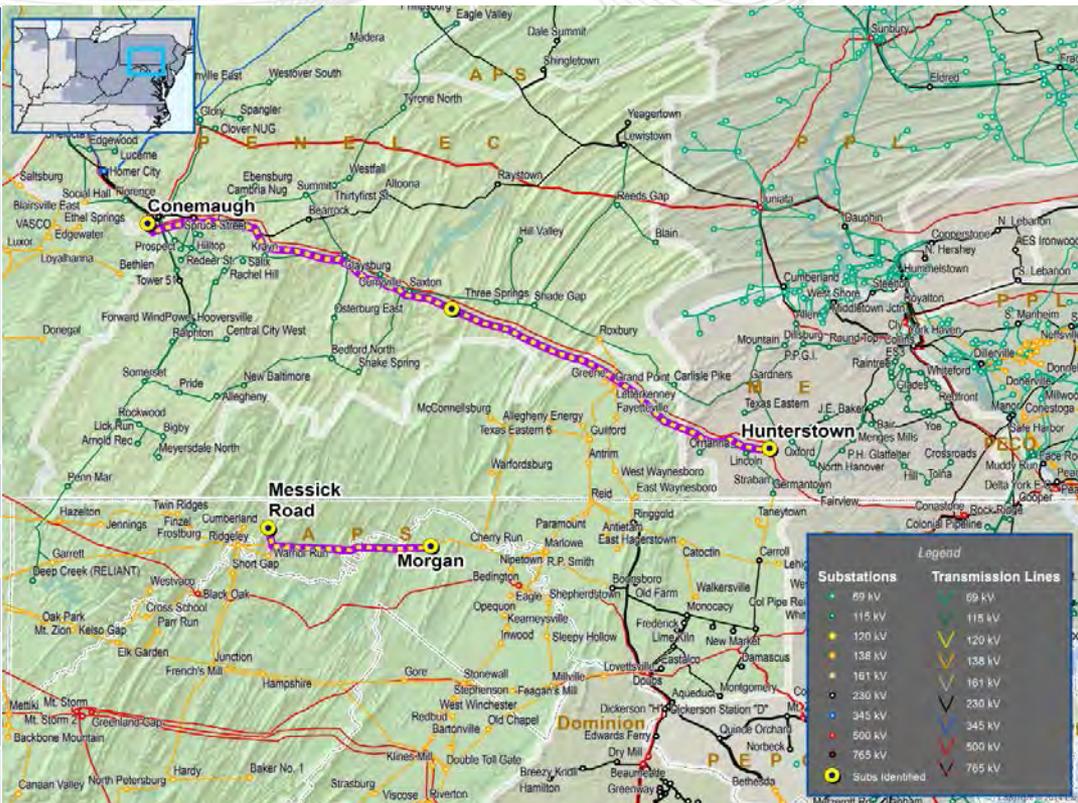
Cost (\$M): 47.14: 51.53(Escalated for 2019)

IS Date: 2019

Target Zone: PECO/Meted/APS

ME Constraints: AP SOUTH L/O BED-BLA

Notes:



Project ID: 201415_1-19G

Proposed by: Northeast Transmission Development

Proposed Solution: Build 500/230 kV Substation (Keyers Run) Interconnecting Conastone-Brighton 500 kV Line to Northwest 230 kV Substation.

kV Level: 230

Cost (\$M): 48.6

IS Date: 2020

Target Zone: Pepco/BGE

**ME Constraints: AP SOUTH L/O BED-BLA
L/O MTS-DOU**

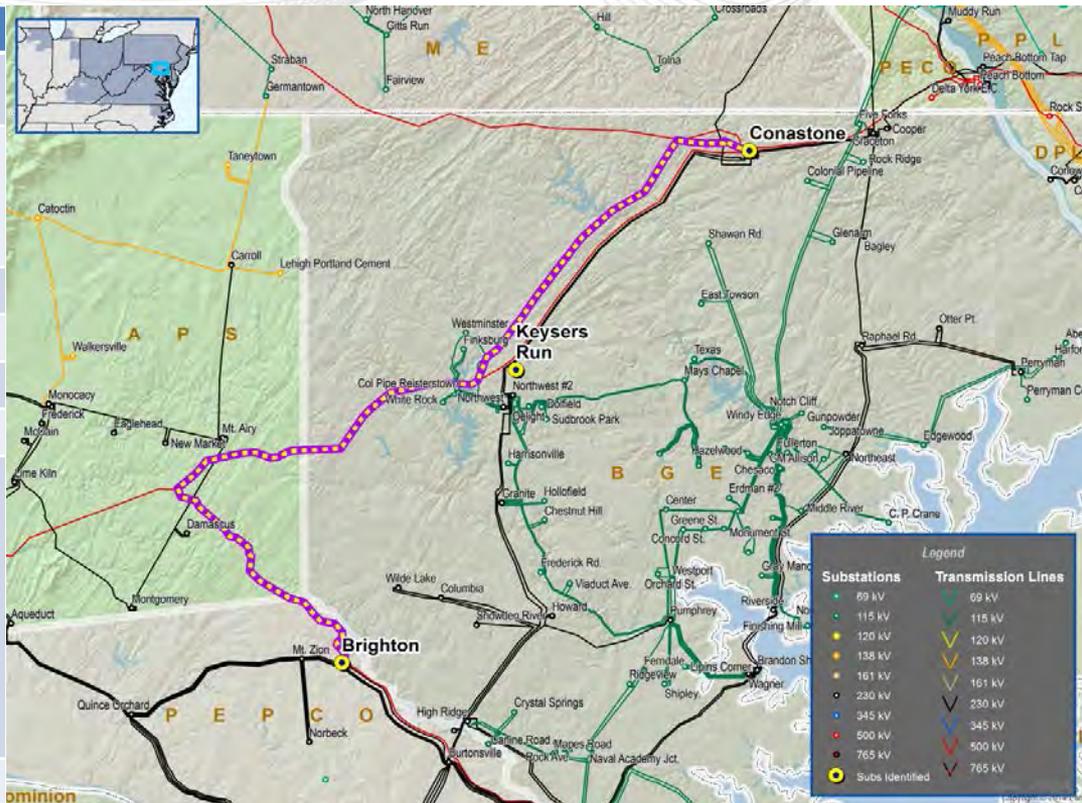
50045005 L/O RCKSPG-KEENY

Safe Harbor to Graceton 230 kV

Conastone to Northwest 230 kV

Peach Bottom 500 kV

Notes:



Appendix B

Detailed Group 1 Results

(ApSouth/AEP-DOM Projects)



Updated Group 1 Detailed Results

Project Name	Company	Cost	In-service Date	B/C 2015 Sensitivity	B/C with Recommended Groups 2-19 projects included	B/C Gas price increase sensitivity	B/C Gas price decrease sensitivity	B/C Load increase sensitivity	B/C Load decrease sensitivity	ApSouth Congestion Delta (\$ millions) (2019+2022)	AEP-DOM Congestion Delta (\$ millions) (2019+2022)
201415_1-6B	Dominion	25.00	2019	2.37	1.94	1.48	1.82	2.02	1.97	-\$10.9	\$2.9
201415_1-6C	Dominion	39.1	2019	4.07	4.64	4.05	3.46	5.05	4.60	-\$91.7	\$2.3
201415_1-6D	Dominion	42.70	2019	2.93	2.42	2.93	2.67	3.06	2.64	-\$52.6	\$2.5
201415_1-9A	DOM High Voltage/Transource	300.7	2020	5.07	2.64	2.09	3.39	3.02	2.56	-\$134.0	-\$10.9
201415_1-14A	DATC	51.53	2019	3.73	1.76	1.35	2.13	2.19	1.72	-\$37.4	-\$0.2
201415_1-19G	LSPower	48.60	2020	2.09	2.76	1.82	4.17	4.13	2.81	-\$7.9	\$8.0
201415_1-17A	Nextera	16.5	2019	3.96	3.64	1.89	3.84	5.34	4.83	-\$45.2	\$28.2
201415_1-17C	Nextera	15.7	2019	4.83	2.45	1.35	2.97	5.79	3.14	-\$42.5	\$20.8
201415_1-18E	FirstEnergy	66.0	2019	2.63	1.71	1.92	1.60	1.93	2.08	-\$65.8	\$13.0
201415_1-19B	LSPower	38.9	2020	11.34	4.07	2.68	2.82	4.08	3.47	-\$19.0	\$28.7
201415_1-19C	LSPower	41.90	2020	13.45	5.66	5.49	3.67	6.17	4.02	\$56.4	-\$6.0
201415_1-6A	Dominion	25.00	2019	3.48	3.22	3.86	0.86	3.90	4.26	N/A	N/A
201415_1-7A	Transource	155.36	2020	1.44	1.46	1.64	1.88	1.81	1.15	N/A	N/A
201415_1-7B	Transource	270.8	2021	1.37	1.11	0.71	1.10	1.08	1.08	N/A	N/A
201415_1-7C	Transource	240.0	2021	1.40	1.36	1.28	1.24	1.41	1.41	N/A	N/A
201415_1-17B	Nextera	41.00	2019	1.55	1.43	0.85	2.00	2.69	1.52	N/A	N/A
201415_1-17D	Nextera	36.4	2019	2.47	1.29	0.59	1.11	2.21	1.52	N/A	N/A
201415_1-17E	Nextera	297.0	2020	2.77	1.48	1.12	1.87	1.84	1.59	N/A	N/A
201415_1-18F	FirstEnergy	68.00	2019	2.62	1.13	1.60	1.34	1.55	0.92	N/A	N/A
201415_1-19D	LSPower	104.5	2020	8.19	1.50	1.09	1.84	2.23	1.71	N/A	N/A
201415_1-19F	LSPower	432.50	2023	1.29	1.19	1.16	2.71	1.16	1.26	N/A	N/A
201415_1-2C	PPL	33.95	2018	0.65	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-8A	Dominion/Transource	384.00	2020	0.56	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-8B	Dominion/Transource	293.00	2020	0.99	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-8C	Dominion/Transource	317.00	2020	0.41	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-8D	Dominion/Transource	222.00	2020	0.78	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-8E	Dominion/Transource	181.00	2019	0.88	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-8F	Dominion/Transource	193.00	2021	1.21	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-17F	Nextera	76.20	2019	0.90	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-17G	Nextera	86.30	2019	1.11	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-19E	LSPower	53.70	2020	0.79	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-20A	ITC	209.56	2020	0.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-20G	ITC	174.36	2020	0.21	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-20J	ITC	212.58	2020	0.32	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-20K	ITC	177.38	2020	0.40	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-20L	ITC	226.33	2020	0.17	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-20M	ITC	229.35	2020	0.45	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-20N	ITC	191.12	2020	0.71	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-20O	ITC	194.14	2020	0.66	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-22A	Ameren	46.6	2019	0.75	N/A	N/A	N/A	N/A	N/A	N/A	N/A
201415_1-22B	Ameren	46.6	2019	0.75	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Tier 1 finalists criteria: Projects with B/C>1.25 (all scenarios), ApSouth Congestion Delta<\$10 million, AEP-DOM Congestion Delta <\$10 million

*Negative represents a reduction as a result of the project

Questions?

Email: RTEP@pjm.com

- Revision History
 - V1: Original version distributed to the PJM TEAC - 9/10/2015
 - V2: Slide #21, added congestion delta for project 20B to the table “Delta in Congestion”