



Market Efficiency Update

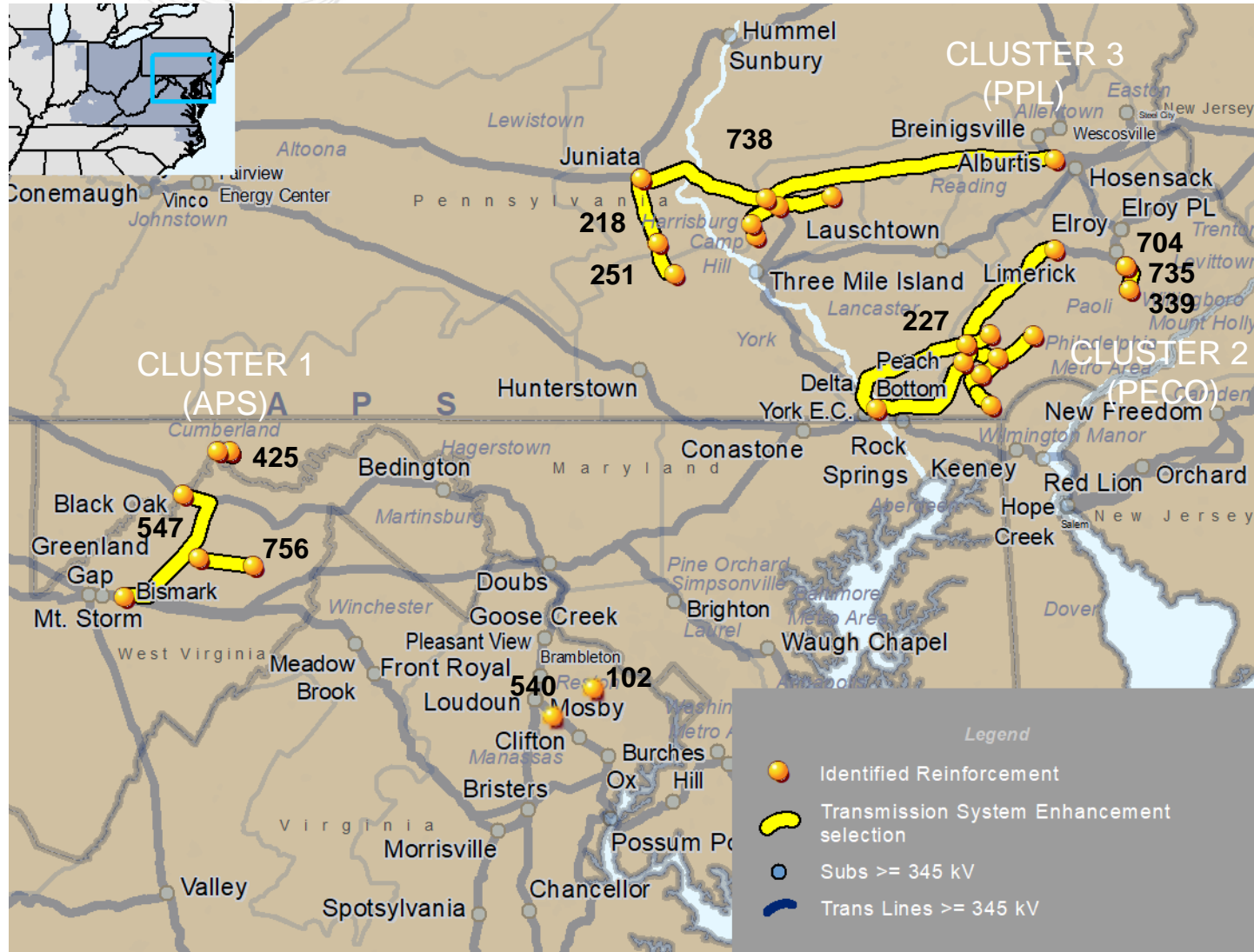
Nick Dumitriu
Principal Engineer, PJM Market Simulation
Transmission Expansion Advisory Committee
August 10, 2021

- 2020/21 Long-Term Window
 - Opened on January 11, 2021 and closed on May 11, 2021
 - 24 proposals received from 7 submitting entities (10 greenfield proposals, 14 upgrades)

- Window Analysis Status
 - Data Validation (completed)
 - N-1 Preliminary Reliability Analysis (completed)
 - Market Efficiency Analysis (in-progress)

- ME-5, Charlottesville to Proffit 230 kV (DOM)
 - Constraint posted as a reliability violation in the 2021 Window 1.
 - Proposals must be submitted to the 2021 Window 1 to be included in the reliability window evaluation.

Cluster Map



*Cluster 4 (DOM) not shown on the map

- Completed the PROMOD runs for the proposals in Cluster Nos. 1 (APS), 2 (PECO) and 3 (PPL)
 - Cluster 4 proposals will be evaluated in conjunction with the reliability window*
- Initial Performance Review – PJM evaluated whether or not the project proposal satisfied the benefit to cost ratio threshold of 1.25 and solved the required congestion driver.
- Initial Planning Level Cost Review – PJM reviewed the estimated project cost submitted by the project sponsor and any relevant cost containment mechanisms submitted.
- Initial Feasibility Review – PJM reviewed the overall proposed implementation plan to determine if the project, as proposed, can feasibly be constructed.

**Note: A number of proposals submitted for the congestion driver Charlottesville to Proffit Rd Del Pt 230 kV (DOM) as the main target also indicated potential congestion benefits for the Junction to French's Mill 138 kV (Cluster No. 1) and Cumberland to Juniata 230 kV (Cluster No. 3) drivers. PJM's preliminary analysis for these proposals found they have little to no impact on the congestion drivers from Cluster Nos. 1 and 3. Therefore, these proposals will not be considered further for inclusion in the Cluster Nos. 1 and 3 analyses.*

- All proposals passed a preliminary N-1 thermal violation screening.
 - Also used to determine list of flowgates to monitor.
- Calculated PJM benefits and determined preliminary B/C ratios.
 - B/C ratios were computed using the submitted in-service cost of components.
- A high level review of the plans identified in each of the five proposals did not reveal any other concerns at this stage of PJM’s review.
- PJM also completed an informational FSA Sensitivity scenario of the proposals.
 - Generation expansion plan that included additional generation, specifically, generators which were added as part of the FSA (Facility Study Agreement) sensitivity.
- Descriptions of submitted proposals included in Appendix A
- Publicly available redacted versions of the proposals can be found [here](#)

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2020/21 Long-Term Window Preliminary Results Cluster No. 1 (APS)

- List of Flowgates

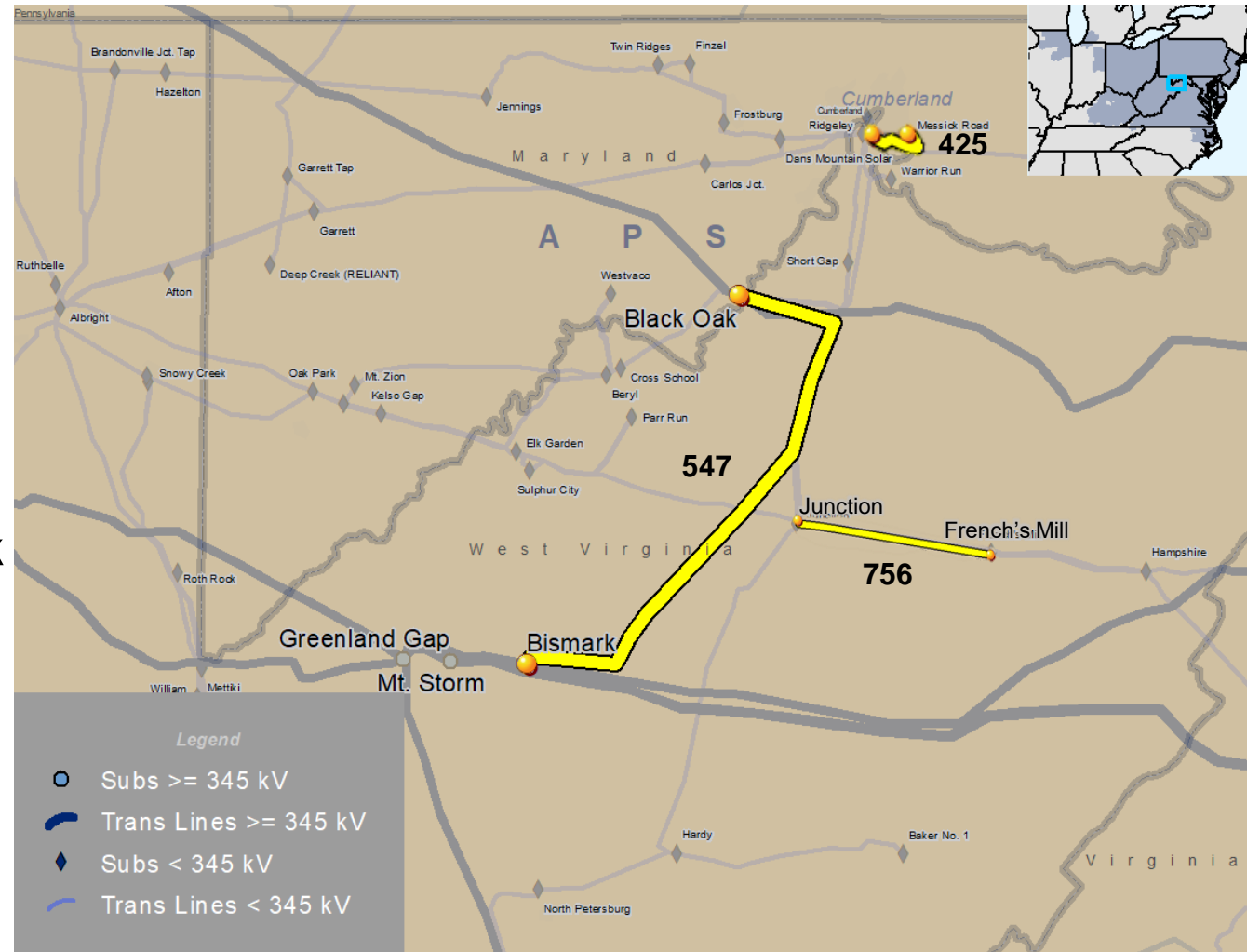
Flowgate ID	Description	Voltage Level	Driver
ME-3	French's Mill to Junction	138 kV	Congestion Relief - Economic

- List of Proposals Submitted

Proposal ID#	Project Type	Project Description	Estimated Total In-Service Construction Cost (\$, millions)	Cost Capping Provisions (Y/N)
102	Upgrade	Reston 230kV Capacitor	\$1.89	N
425	Upgrade	French's Mill-Junction 138kV Terminal Upgrades and Messick Rd-Ridgeley 138kV Line Reconductor	\$11.99	N
540	Upgrade	Bull Run 230kV Capacitor	\$5.73	N
547	Greenfield	Black Oak-Bismark 500kV Line	\$128.75	Y
756	Upgrade	French's Mill-Junction 138kV Terminal Upgrades	\$0.77	N

Cluster No. 1 (APS) - Map

- 102*: Capacitor bank at Reston 230 kV substation
- 425: Replace terminal equipment on the French's Mill-Junction 138 kV line. Reconductor Messick Road-Ridgeley 138 kV line.
- 540*: Capacitor bank at Bull Run 230 kV substation
- 547: Build 500 kV transmission line connecting Black Oak Substation and Bismark Substation.
- 756: Replace terminal equipment on the French's Mill-Junction 138 kV line.



* Proposals 102 and 540, capacitor banks at Reston and Bull Run 230 kV, are not show on the map

Cluster No. 1 (APS) - Initial Review Conclusions

- Impacts on the congestion driver
 - Proposal No. 756 solves the identified congestion driver, however congestion is shifted to the Messick Rd-Ridgeley 138 kV circuit.
 - Proposal No. 425 solves the identified congestion driver and also upgrades the conductor limited Messick Rd-Ridgeley 138 kV circuit to address the shifted congestion.
 - The Proposals Nos. 102 and 540 have little to no impact on the congestion driver ME-3. Therefore these capacitor proposals will not be considered as stand-alone solutions for Cluster No. 1.

- B/C ratios
 - Proposal Nos. 425 and 756 both exceed the benefit to cost ratio threshold of 1.25.
 - Proposal No. 547 fails to meet the benefit to cost ratio threshold of 1.25.

- Proposal No. 425 appears to be the most efficient or cost effective solution in Cluster No. 1.
 - PJM performed preliminary reliability analysis on Proposal No. 425 and no reliability violations were identified.

Cluster No. 1 (APS) - Preliminary B/C Ratios

Proposal ID	102	425	540	547	756
Proposal Description	Reston 230kV Capacitor	756 Upgrades + Reconductor Messick Rd-Ridgeley	Bull Run 230kV Capacitor	Black Oak to Bismark 500kV Line	French's Mill - Junction Upgrades
Project Type	Upgrade	Upgrade	Upgrade	Greenfield	Upgrade
B/C Ratio Metric	Lower Voltage	Lower Voltage	Lower Voltage	Regional	Lower Voltage
In-Service Cost (\$MM)*	\$1.89	\$11.99	\$5.73	\$128.75	\$0.77
Cost Containment*	No	No	No	Yes	No
In-Service Year	2022	2025	2023	2025	2022
% Cong Driver Mitigated	0%	100%	0%	100%	100%
Shifted Cong	N/A	Shifts congestion to Bla-Bed Interface	N/A	Shifts congestion to Bla-Bed Interface	Shifts congestion to Messick Rd-Ridgeley, Bla-Bed Interface
Base Case B/C Ratio	N/A	13.64	N/A	0.74	189.91
FSA Sens. B/C Ratio	N/A	22.62	N/A	1.12	327.83

* Note: Costs under review by PJM

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2020/21 Long-Term Window Preliminary Results Cluster No. 2 (PECO)

- List of Flowgates

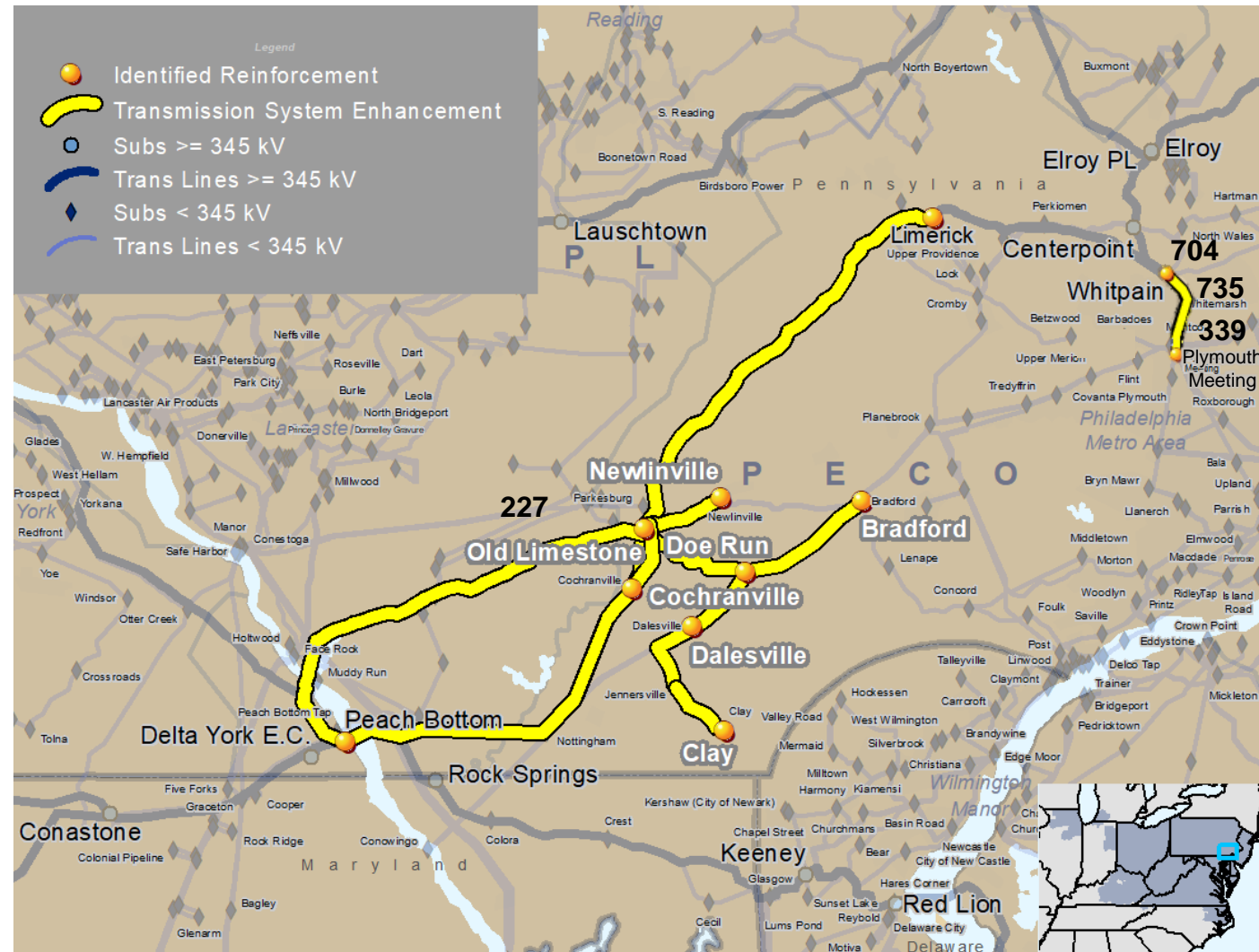
Flowgate ID	Description	Voltage Level	Driver
ME-6	Plymouth Meeting to Whitpain	230 kV	Congestion Relief - Economic

- List of Proposals Submitted

Proposal ID#	Project Type	Project Description	Estimated Total In-Service Construction Cost (\$, millions)	Cost Capping Provisions (Y/N)
227	Greenfield	Old Limestone-Doe Run 500/230kV Project	\$73.51	Y
399	Upgrade	Plymouth Meeting-Whitpain 230kV Terminal Upgrades and SmartWires	\$8.42	N
704	Upgrade	Plymouth Meeting-Whitpain 230kV Terminal Upgrades	\$0.62	N
735	Upgrade	Plymouth Meeting-Whitpain 230kV Line Reconductor	\$14.98	N

Cluster No. 2 (PECO) - Map

- 227: Interconnect the Peach Bottom - Limerick 500kV and Cochranville - Newlinville 230kV lines via a new Old Limestone 500/230 kV substation. Build new 230 kV Doe Run substation and interconnect Daleville - Bradford and Clay Tap - Bradford 230kV lines. Construct a new 230 kV line from Old Limestone to Doe Run.
- 339: Install Smart Wires device in series with the 220-13 and 220-14 Whitpain-Plymouth 230 kV lines and upgrade terminal equipment at Whitpain and Plymouth substations.
- 704: Upgrade terminal equipment at Whitpain and Plymouth substations.
- 735: Reconductor the 220-13 and 220-14 Whitpain-Plymouth 230 kV lines.



Cluster No. 2 (PECO) - Initial Review Conclusions

- Impacts on the congestion driver
 - All proposals addressed the congestion driver by significantly decreasing the congestion on flowgate ME-6.
 - In all four proposals there is no significant shift of congestion.
- B/C ratios
 - Proposal Nos. 399, 704, and 735 all exceed the benefit to cost ratio threshold of 1.25.
 - Proposal No. 227 fails to meet the benefit to cost ratio threshold of 1.25.
- Proposal No. 704 appears to be the more efficient or cost effective solution in Cluster No. 2.
 - PJM performed preliminary reliability analysis on Proposal No. 704 and no reliability violations were identified.

Cluster No. 2 (PECO) - Preliminary B/C Ratios

Proposal ID	227	399	704	735
Proposal Description	Old Limestone - Doe Run 500/230kV Project	Plymouth-Whitpain 220-13, 220-14 Terminal Upgrades and SmartWires	Plymouth-Whitpain 220-13, 220-14 Terminal Upgrades	Rebuild Plymouth-Whitpain 220-13, 220-14
Project Type	Greenfield	Upgrade	Upgrade	Upgrade
B/C Ratio Metric	Lower Voltage	Lower Voltage	Lower Voltage	Lower Voltage
In-Service Cost (\$MM)*	\$73.51	\$8.42	\$0.62	\$14.98
Cost Containment	Yes	No	No	No
In-Service Year	2025	2025	2025	2025
% Cong Driver Mitigated	99.81%	100%	97.82%	100%
Shifted Cong	No significant shift	No significant shift	No significant shift	No significant shift
Base Case B/C Ratio*	0.84	6.18	77.06	2.60
FSA Sens. B/C Ratio*	0.93	2.40	20.48	0.47

* Note: Costs under review by PJM

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2020/21 Long-Term Window Preliminary Results Cluster No. 3 (PPL)

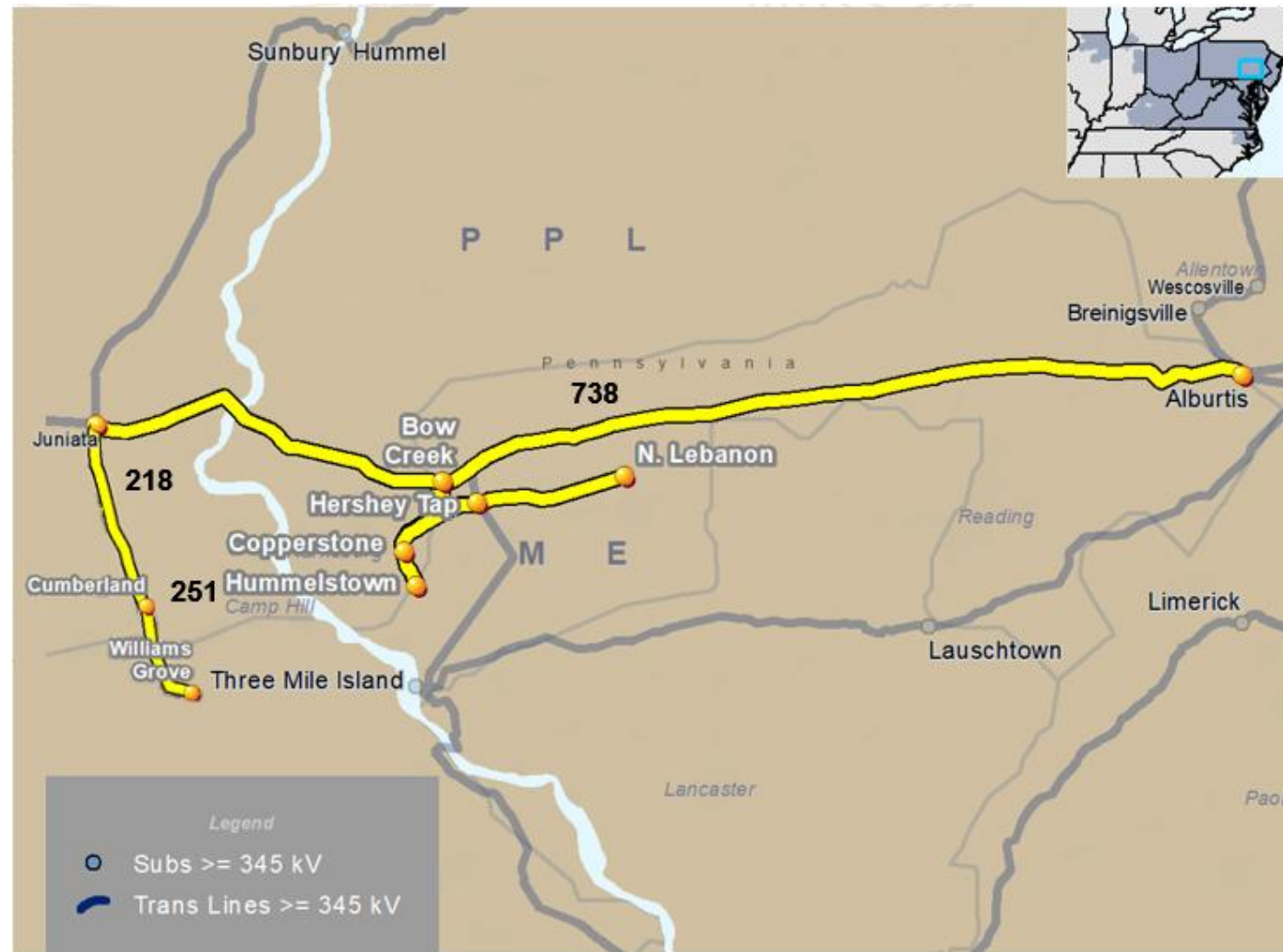
- List of Flowgates

Flowgate ID	Description	Voltage Level	Driver
ME-7	Juniata to Cumberland	230 kV	Congestion Relief - Economic

- List of Proposals Submitted

Proposal ID#	Project Type	Project Description	Estimated Total In-Service Construction Cost (\$, millions)	Cost Capping Provisions (Y/N)
102	Upgrade	Reston 230kV Capacitor	\$1.89	N
218	Upgrade	Juniata-Cumberland 230kV Line Reconductor	\$9.00	Y
251	Upgrade	Juniata - Cumberland 230kV Line Rebuild to double circuit and Cumberland-Williams Grove 230kV Line Reconductor	\$49.05	N
540	Upgrade	Bull Run 230kV Capacitor	\$5.73	N
738	Greenfield	Bow Creek 500/230kV Project	\$55.05	Y

- 102*: Capacitor bank at Reston 230 kV substation
- 218: Reconductor the Juniata - Cumberland 230 kV line.
- 251: Rebuild the existing single circuit Juniata - Cumberland 230 kV section to double circuit. Upgrade the Cumberland to Wil. Grove 230 kV line.
- 540*: Capacitor bank at Bull Run 230 kV substation
- 738: Build new 500/230 kV Bow Creek tap substation on the Juniata – Alburtis 500kV line. Interconnect North Hershey - Hummelstown and North Lebanon – Copperstone 230kV lines to the Bow Creek substation.



* Proposals 102 and 540, capacitor banks at Reston and Bull Run 230 kV, are not show on the map

Cluster No. 3 (PPL) - Initial Review Conclusions

- Impacts on the congestion driver
 - Proposal Nos. 218 and 251 completely address the identified congestion driver.
 - Proposal No. 738 significantly addresses the identified congestion driver, however some congestion remains.
 - In Proposal Nos. 218, 251, and 738 there was no significant shift of congestion.
 - The Proposal Nos. 102 and 540 have little to no impact on the congestion driver ME-7. Therefore these capacitor proposals will not be considered as stand-alone solutions for Cluster No. 3.

- B/C ratios
 - Proposal Nos. 218, 251, and 738 all exceed the benefit to cost ratio threshold of 1.25.
 - Proposal No. 218 yielded a robust benefit to cost ratio that far exceeds all other proposals.


- Proposal No. 218 appears to be the more efficient or cost effective solution in Cluster No. 3.
 - PJM performed preliminary reliability analysis on Proposal No. 218 and no reliability violations were identified.

Cluster No. 3 (PPL) - Preliminary B/C Ratios

Proposal ID	102	218	251	540	738
Proposal Description	Reston 230kV Capacitor	Juniata - Cumberland 230 kV Line Reconductor	Juniata - Cumberland 230 kV Line Rebuild to double circuit, Reconductor Cumberland-Williams Grove	Bull Run 230kV Capacitor	Bow Creek 500/230kV Project
Project Type	Upgrade	Upgrade	Upgrade	Upgrade	Greenfield
B/C Ratio Metric	Lower Voltage	Lower Voltage	Lower Voltage	Lower Voltage	Lower Voltage
In-Service Cost (\$M)	\$1.89	\$9.00	\$49.05	\$5.73	\$55.05
Cost Containment	No	Yes	No	No	Yes
In-Service Year	2022	2023	2024	2023	2025
% Cong Driver Mitigated*	0%	100%	100%	0%	95.85%
Shifted Cong	N/A	No significant shift	No significant shift	N/A	No significant shift
Base Case B/C Ratio	N/A	13.61	2.88	N/A	2.71
FSA Sens. B/C Ratio	N/A	21.01	3.40	N/A	2.60

* Note: Costs under review by PJM

- PJM anticipates a retool of the Market Efficiency case that will be used to conduct a final review of all proposals.
- Complete Load and Gas Price sensitivities for all proposals
- Cost / Constructability Analysis
- PJM intends to share the results of the final review with stakeholders at the December TEAC. After which a final recommendation will be made to the PJM Board for review and approval.

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Appendix A

2020/21 Long Term Window

Individual Proposal Descriptions

Project ID: 202021_425

Proposed Solution:
 Replace terminal equipment on the French's Mill-Junction 138 kV line. Reconductor existing line segments on the Messick Road-Ridgeley 138 kV line. Replace the remote end equipment for the Messick Road-Ridgeley 138 kV line.

Project Type: Upgrade

kV Level: 138 kV

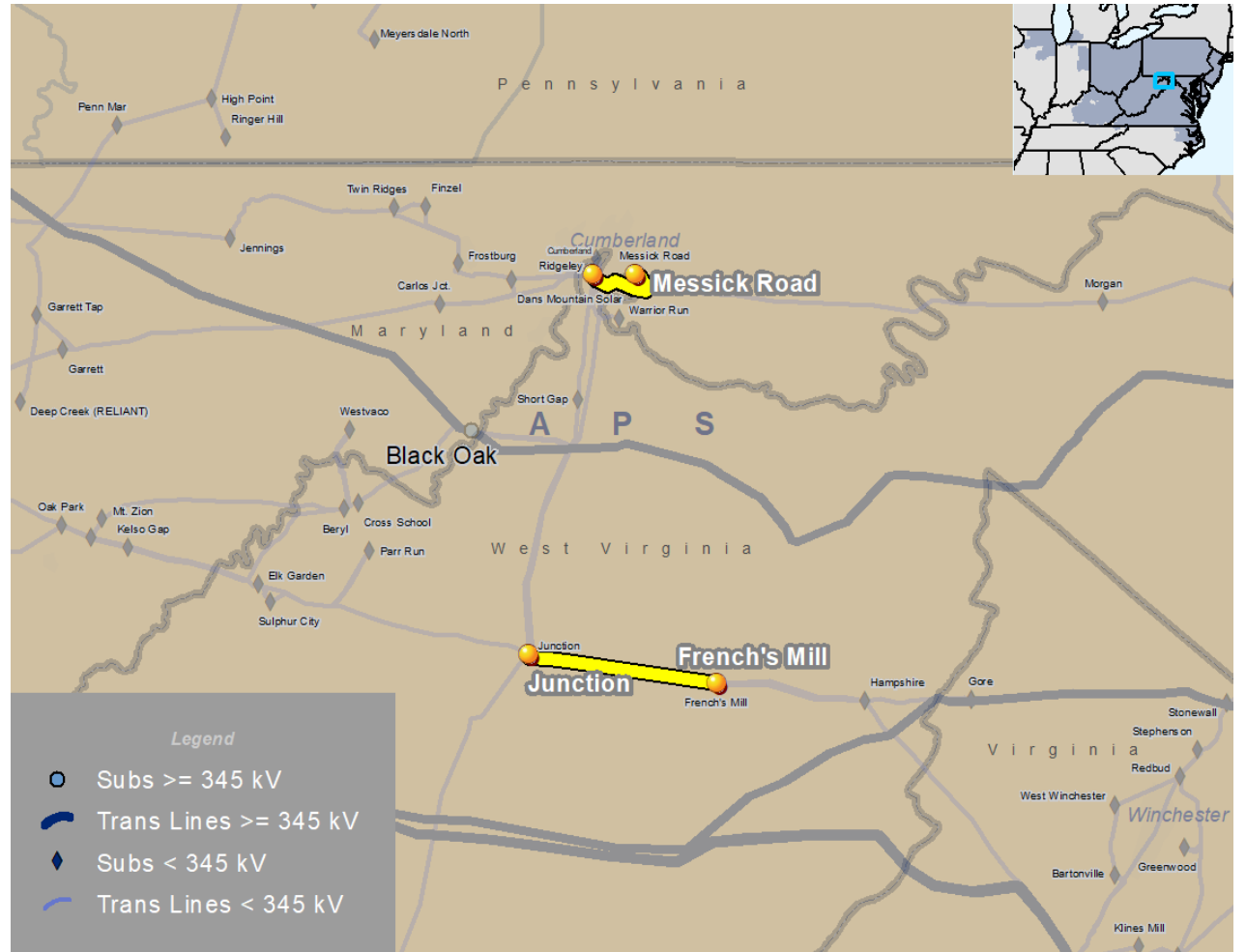
In-Service Cost (\$M): \$11.99

In-Service Year: 2025

Target Zone: APS

ME Constraints:
 Junction to French's Mill 138 kV

Notes:



Project ID: 202021_540

Proposed Solution:
Install 356 MVAR capacitor at Bull Run 230 kV substation

Project Type: Upgrade

kV Level: 230 kV

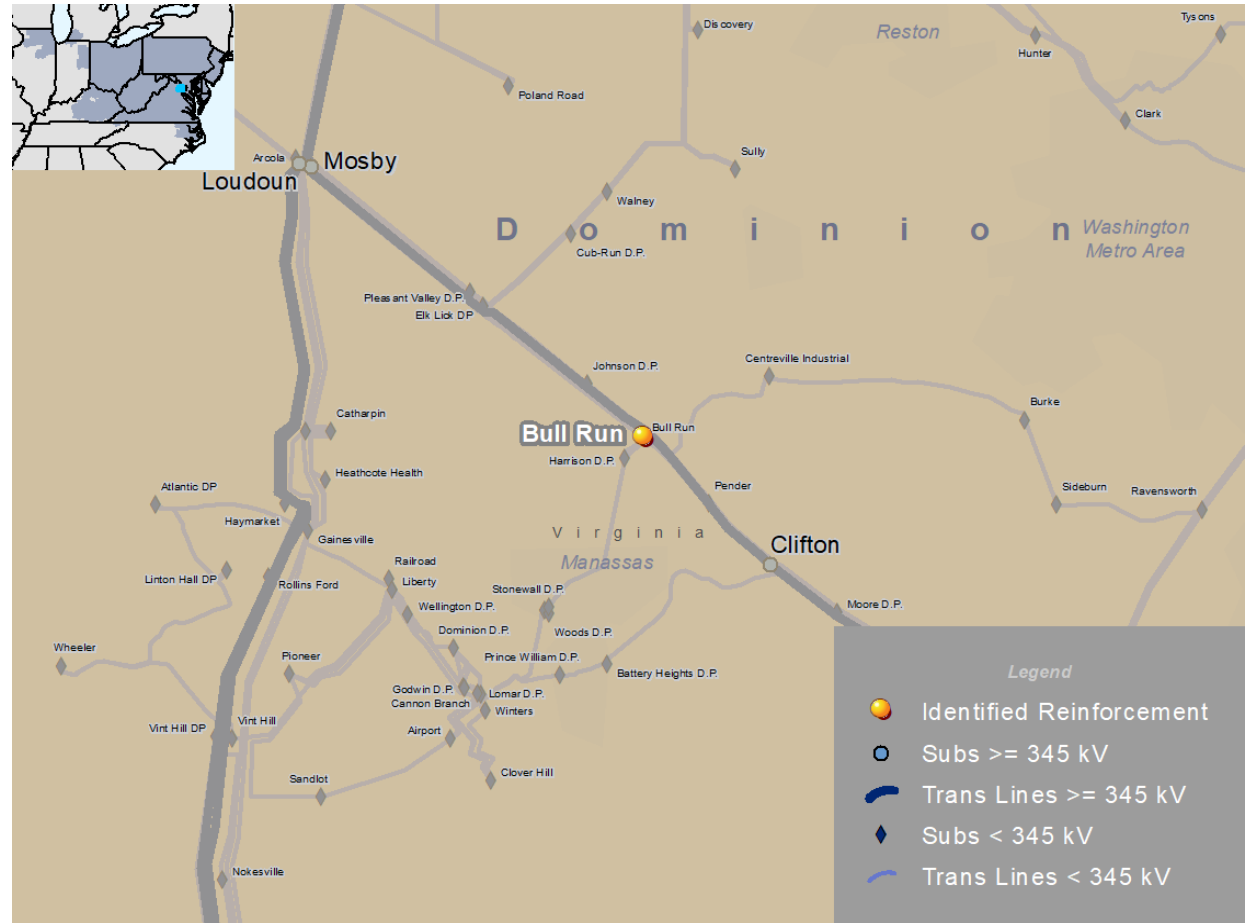
In-Service Cost (\$M): \$5.73

In-Service Year: 2023

Target Zone: APS, PPL

ME Constraints:
Junction to French's Mill 138 kV,
Cumberland to Juniata 230 kV

Notes:



Project ID: 202021_756

Proposed Solution:
 Replace terminal equipment on the French's Mill-Junction 138 kV line.

Project Type: Upgrade

kV Level: 138 kV

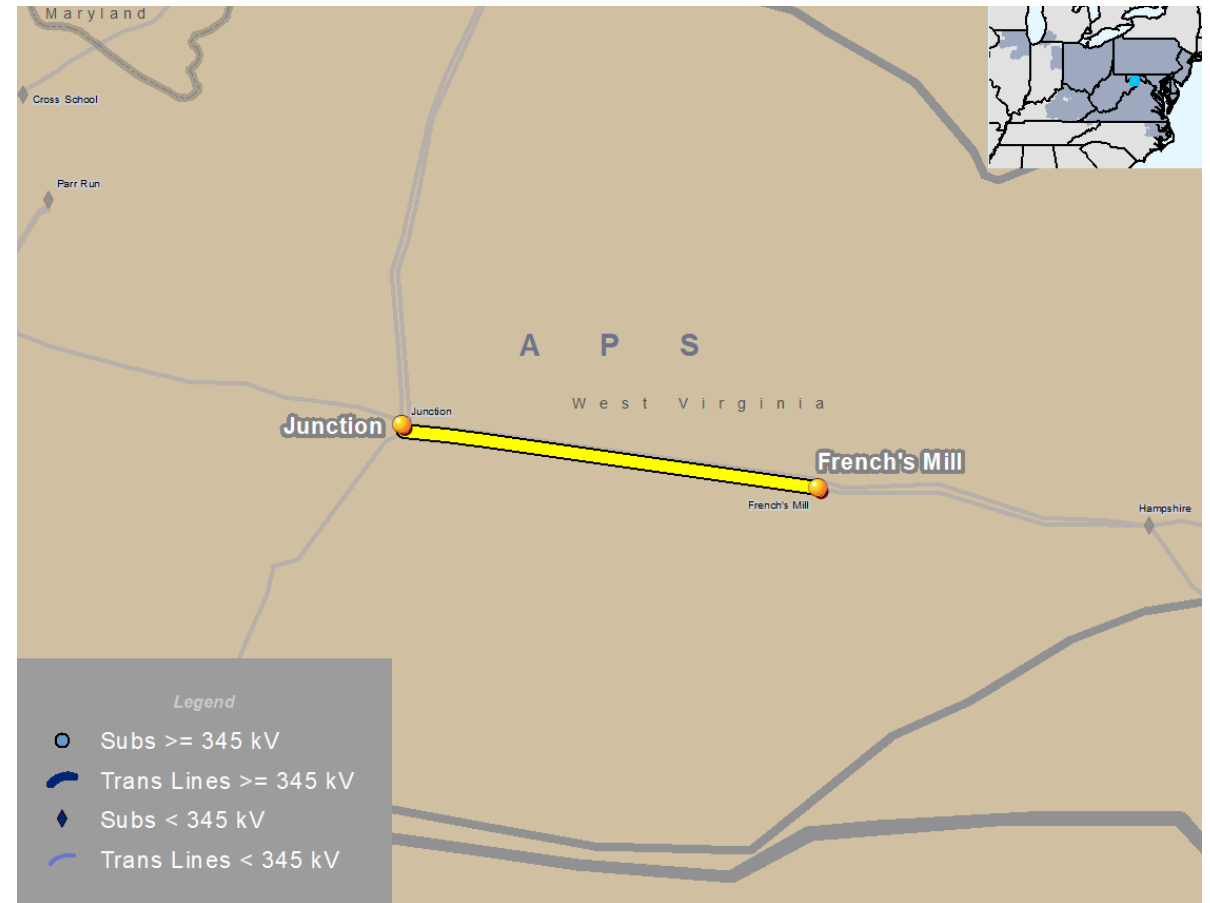
In-Service Cost (\$M): \$0.77

In-Service Year: 2022

Target Zone: APS

ME Constraints:
 Junction to French's Mill 138 kV

Notes:



Project ID: 202021_547

Proposed Solution:

The Black Oak - Bismark 500kV Transmission Project will include a new 500kV Transmission Line connecting to new line positions at Black Oak Substation and Bismark Substation.

Project Type: Greenfield

kV Level: 500 kV

In-Service Cost (\$M): \$128.75

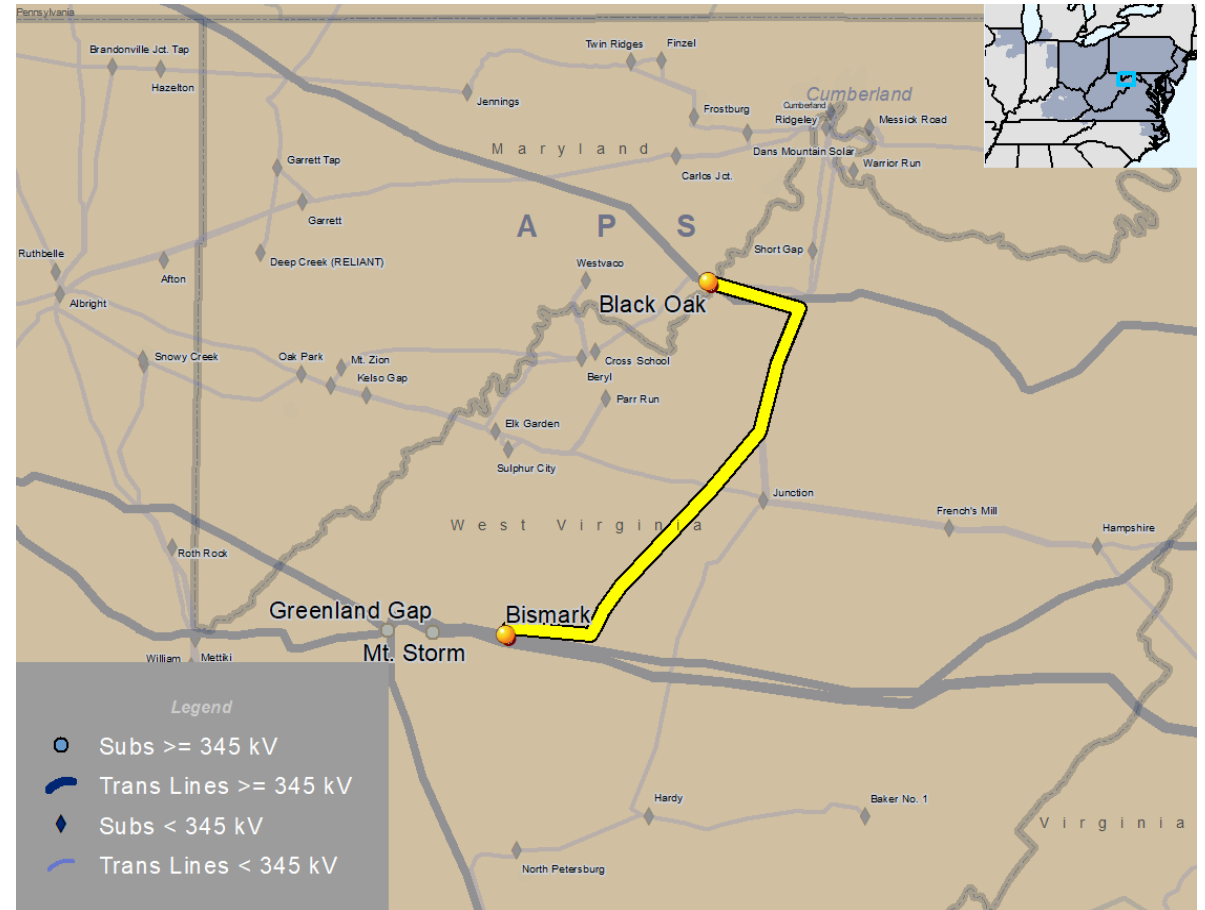
In-Service Year: 2025

Target Zone: APS

ME Constraints:

Junction to French's Mill 138 kV

Notes:



Project ID: 202021_227

Proposed Solution:

Interconnect the Peach Bottom - Limerick 500kV and Cochranville - Newlinville 230kV lines via a new Old Limestone 500/230 kV substation. Build new 230 kV Doe Run substation and interconnect Daleville - Bradford and Clay Tap - Bradford 230kV lines. Construct a new 230 kV line from Old Limestone to Doe Run.

Project Type: Greenfield

kV Level: 500 kV, 230 kV

In-Service Cost (\$M): \$73.51

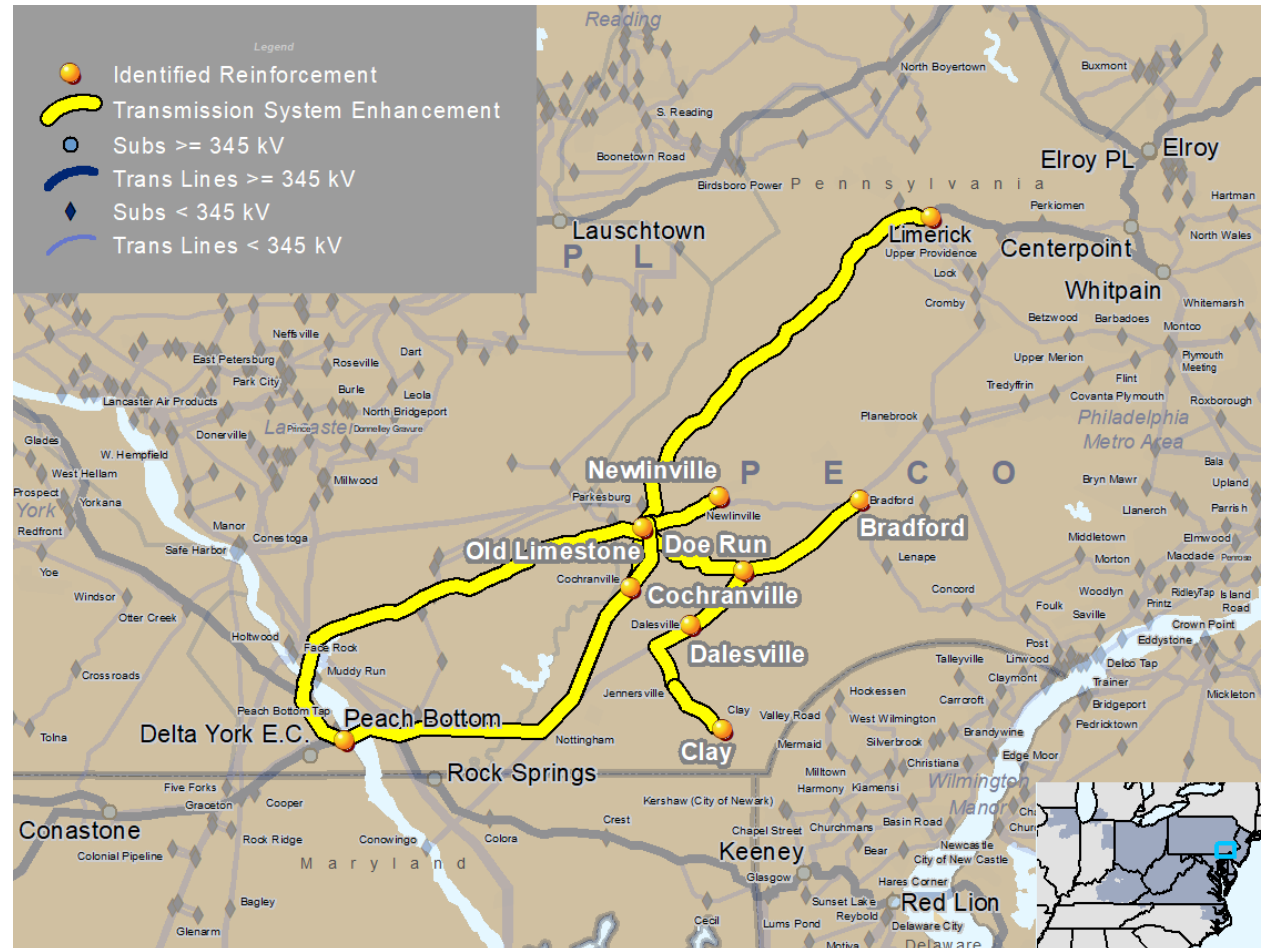
In-Service Year: 2025

Target Zone: PECO

ME Constraints:

Plymouth Meeting to Whitpain 230 kV

Notes:



Project ID: 202021_399

Proposed Solution:
 Install Smart Wires device in series with the 220-13 and 220-14 Whitpain-Plymouth 230 kV lines and replace station conductor and metering inside Whitpain and Plymouth substations.

Project Type: Upgrade

kV Level: 230 kV

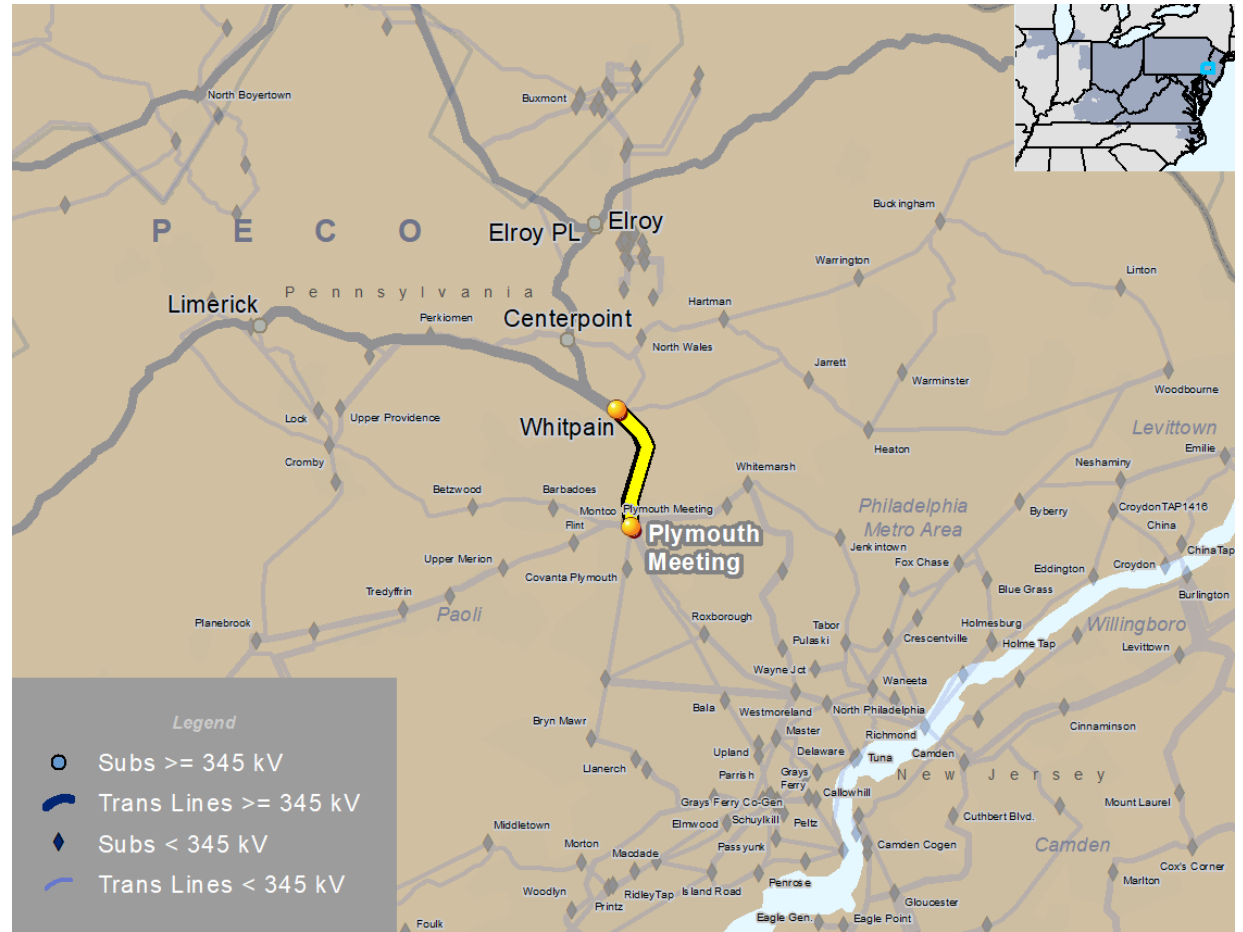
In-Service Cost (\$M): \$8.42

In-Service Year: 2025

Target Zone: PECO

ME Constraints:
 Plymouth Meeting to Whitpain 230 kV

Notes:



Project ID: 202021_704

Proposed Solution:
 Replace station conductor and metering inside Whitpain and Plymouth substations.

Project Type: Upgrade

kV Level: 230 kV

In-Service Cost (\$M): \$0.62

In-Service Year: 2025

Target Zone: PECO

ME Constraints:
 Plymouth Meeting to Whitpain 230 kV

Notes:



Project ID: 202021_735

Proposed Solution:
 Reconductor the 220-13 and 220-14 Whitpain-Plymouth 230 kV lines.

Project Type: Upgrade

kV Level: 230 kV

In-Service Cost (\$M): \$14.98

In-Service Year: 2025

Target Zone: PECO

ME Constraints:
 Plymouth Meeting to Whitpain 230 kV

Notes:



Project ID: 202021_218

Proposed Solution:
Reconductor the Juniata - Cumberland 230kV line.

Project Type: Upgrade

kV Level: 230 kV

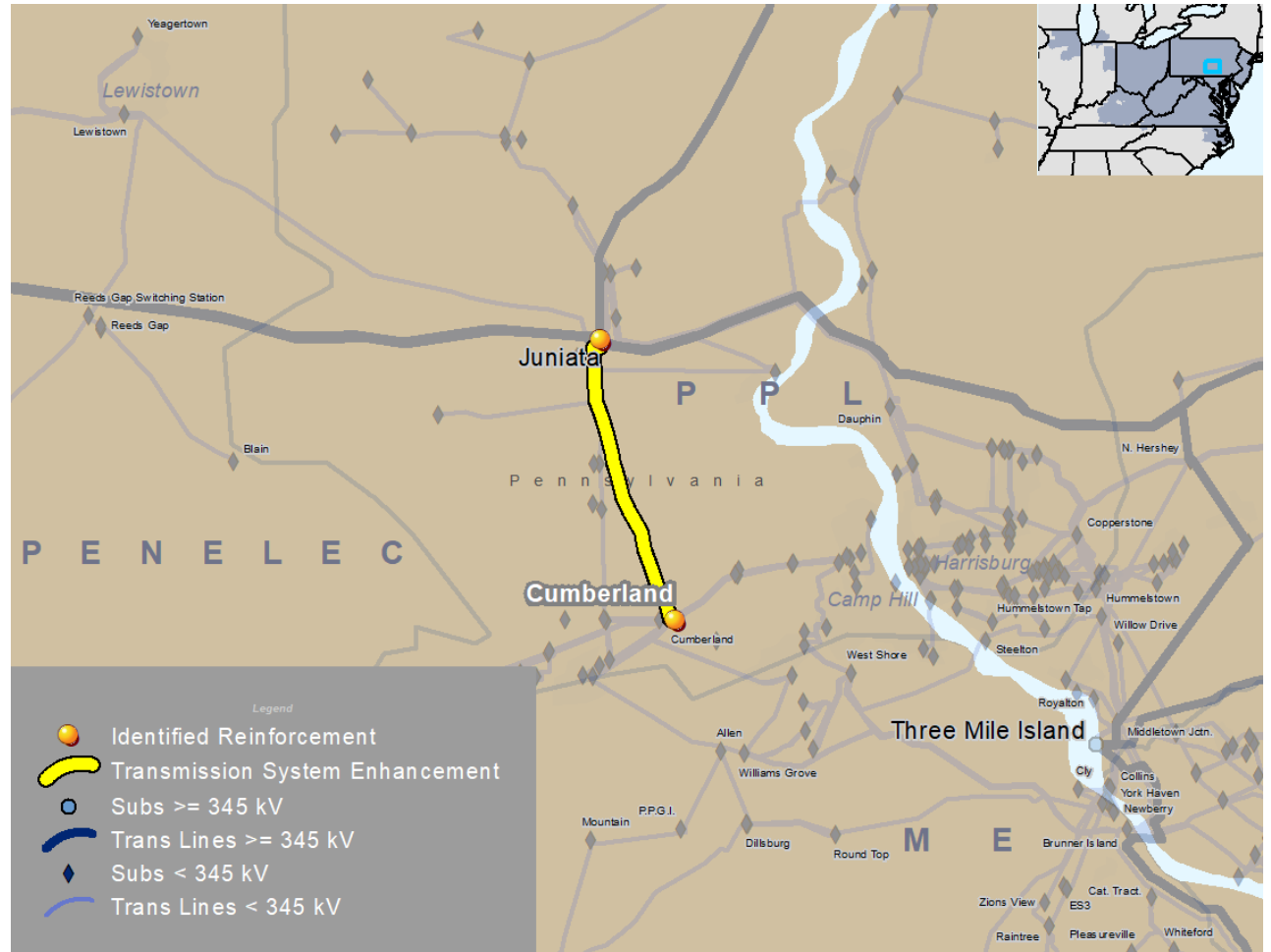
In-Service Cost (\$M): \$9.00

In-Service Year: 2023

Target Zone: PPL

ME Constraints:
Cumberland to Juniata 230 kV

Notes:



Project ID: 202021_251

Proposed Solution:
 Rebuild the existing single circuit Juniata -Cumberland 230 kV tower section to double circuit. Add a second circuit to the existing Juniata - Cumberland tower section that is presently already built for double circuit. Reconductor the Cumberland to Williams Grove 230 kV line.

Project Type: Upgrade

kV Level: 230 kV

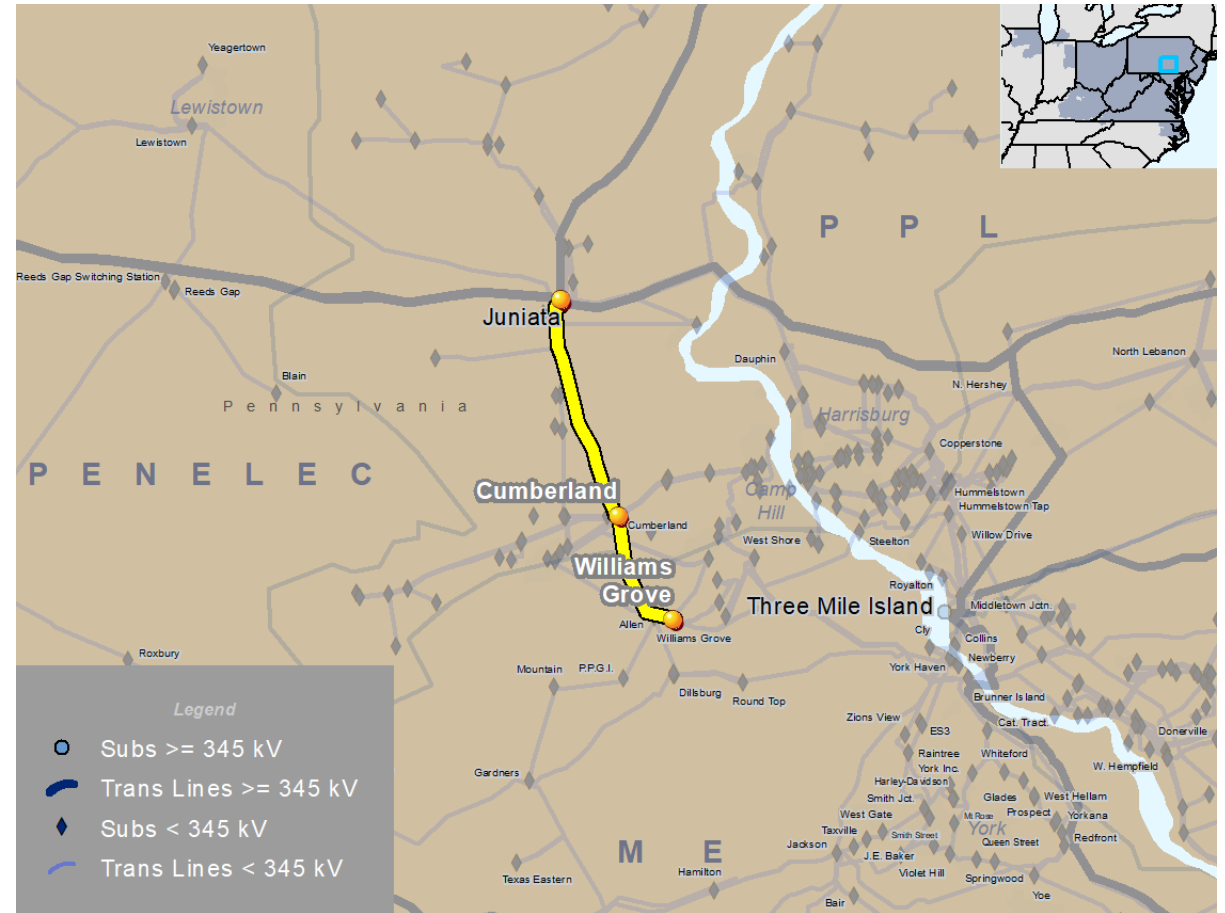
In-Service Cost (\$M): \$49.05

In-Service Year: 2024

Target Zone: PPL

ME Constraints:
 Cumberland to Juniata 230 kV

Notes:



Project ID: 202021_738

Proposed Solution:
 Build new 500/230 kV Bow Creek tap substation on the Juniata – Alburdis 500kV line. Interconnect North Hershey - Hummelstown and North Lebanon – Copperstone 230kV lines to the Bow Creek substation.

Project Type: Greenfield

kV Level: 500 kV, 230 kV

In-Service Cost (\$M): \$55.05

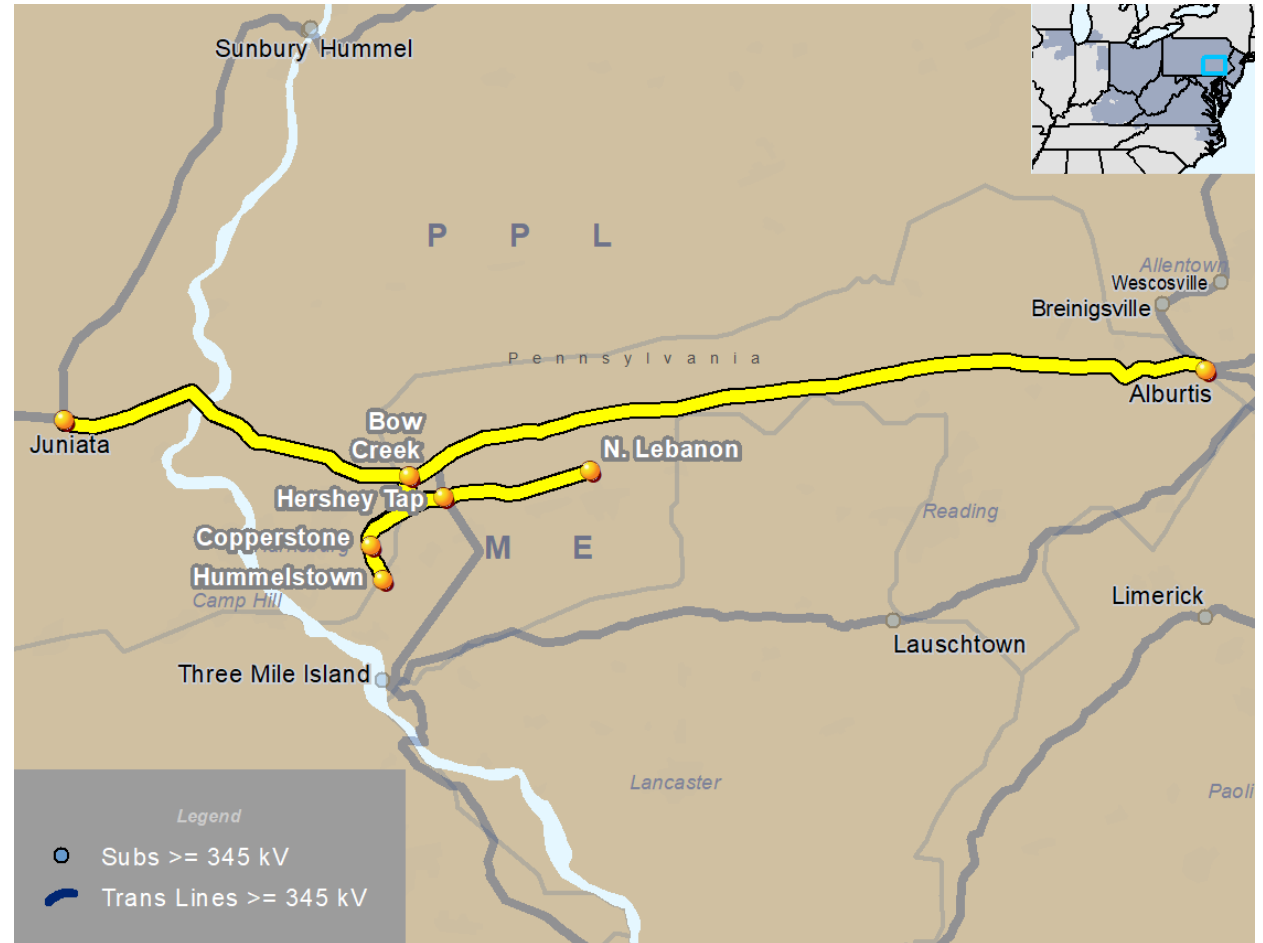
In-Service Year: 2025

Target Zone: PPL

ME Constraints:

Cumberland to Juniata 230 kV

Notes:



- V1 – 08/05/2021 – Original slides posted