Transmission Expansion Advisory Committee (TEAC)

Recommendations to the PJM Board

PJM Staff Whitepaper
July 2018

Executive Summary

On April 10, 2018, the PJM Board of Managers approved changes to the Regional Transmission Expansion Plan (RTEP), totaling $638.55 million, primarily to resolve baseline reliability criteria violations.

Since that time, PJM has identified additional baseline reliability criteria violations within the planning horizon as part of the 2018 RTEP. Transmission upgrades have been identified to resolve these reliability criteria violations. The increase in the RTEP costs associated with the upgrades required to resolve the new baseline reliability criteria violations is $636.57 million. In addition, a number of previously approved baseline projects have been canceled or their cost and scope have changed, resulting in a net decrease of $7.34 million. The net impact due to these baseline reliability changes is an increase in the RTEP of $629.23 million.

With these changes, the RTEP will include over $36,707 million of transmission additions and upgrades since the first plan was approved by the Board in 2000.

The additional baseline projects are summarized in the following paper and are presented for the Board Reliability Committee's consideration and for recommendation to the full Board for approval. At the July 2018 meeting, the PJM Board approved the updated RTEP as requested.

2018 Baseline Reliability Upgrades Changes and Additions

One aspect of the development of the Regional Transmission Expansion Plan is an evaluation of the "baseline" system, i.e., the transmission system without any of the generation interconnection requests included in the current planning cycle. This baseline analysis determines the compliance of the existing system with reliability criteria and standards. Transmission upgrades required to maintain a reliable system are identified and reviewed with stakeholders through the Transmission Expansion Advisory Committee (TEAC) and Subregional RTEP committees. The cost of transmission upgrades to mitigate such baseline reliability criteria violations is the responsibility of the PJM load customers.

Reliability Project Summary

A summary of the more significant baseline projects with estimated costs equal to or greater than $5 million is detailed below. A complete listing of all of the projects that were approved by the PJM Board along with their associated cost allocations is included in Attachment A and Attachment B to this white paper. The projects with estimated costs less than $5 million include transformer replacements, line reconductoring, breaker replacements, and upgrades to terminal equipment, which includes items such as relay and wavetrap replacements.

Mid-Atlantic Region System Upgrades

- Duquesne Transmission Zone
  - Construct new Elrama 138 kV substation (on existing property) and connect seven 138 kV lines to new substation. – Deactivation Driven – $16.6M
  - Reconductor Elrama to Wilson 138 kV line (4.8 miles). – Deactivation Driven – $5.3M
  - Run new conductor on existing tower to establish the new Dravosburg-Elrama circuit (10 miles). – Deactivation Driven – $6.7M

- Penelec Transmission Zone
  - Rebuild Glade to Warren 230 kV line with new conductor and substation terminal upgrades (11.5 miles). New conductor will be 1033 ACSS with an anticipated rating of 855 Normal/984 Emergency. Existing conductor is 1033 ACSR with a rating of 520 Normal/621 Emergency. – Deactivation Driven – $33.3 million

- PSE&G Transmission Zone
  - Construct a 230/69kV station at Maywood (PSEG needs to acquire new property). – PSEG TO Criteria – $87 million
  - Construct a 230/69/13kV station (on existing property)by tapping the Mercer-Kuser Rd 230 kV circuit– PSEG TO Criteria – $62 million

Western Region System Upgrades

- DEOK Transmission Zone
  - Rebuild the Tanner Creek-Miami Fort 345 kV line (3.4 miles) to achieve an anticipated capacity of 2390 MVA. (This upgrade is the DEOK portion of line, the AEP portion, b2831.1, was approved in February 2017) – Generator Deliverability – $7.2M

- ComEd Transmission Zone
  - Install a 120 MVAR 345 kV shunt inductor at Powerton to absorb reactive power. – Operational Performance – $9M
  - Rebuild the Schauff Road to Nelson tap 138 kV line (12.36 miles). – Generator Deliverability – $17M

- APS Transmission Zone
  - Replace four Yukon 500/138 kV transformers with three transformers with higher rating and reconfigure 500 kV bus. – Deactivation Driven – $55.6M
  - Construct new Route 51 substation (on existing property) and connect 10 138 kV lines to new substation. – Deactivation Driven – $26.2M
  - Construct a new Flint Run 500/138 kV substation (APS needs to acquire new property) tying into the Belmont-Harrison 500 kV line with two single circuits to Waldo Run 138 and Sherwood 138 kV line. – Generator Deliverability, N-1– $40.1M

Southern Region System Upgrades

- Dominion Transmission Zone
  - Rebuild the Bristers to Chancellor 500 kV line (21.6 miles). – Dominion End-of-Life Criteria – $64.65M
  - Rebuild the Ladysmith to Elmont 500 kV line (26.2 miles). – Dominion End-of-Life Criteria – $87M
  - Rebuild the Ladysmith to Chancellor 500 kV line (15.2 miles). – Dominion End-of-Life Criteria – $45.6M
  - Build a new switching station (Skippers) at the tap on the Carolina-Clubhouse 115 kV serving Brink delivery point (serves load to Mecklenburg co-op) with a 115 kV four breaker ring to split line #130 and terminate the newly split line into the new switching station. – Dominion TO Criteria – $8M
  - Install a second 230/115 kV transformer 1 mile north of Bremo and tie Bremo-Charlottesville 230 kV line and Bremo-Sherwood 115 kV together. – Deactivation Driven – $27M

In addition to the upgrades with estimated costs equal to or greater than $5 million, are 30 upgrades with a total cost of $45.5M that are also being recommended to the PJM Board for their consideration. These projects include breaker replacement, upgrades to transformer terminals, reconductoring of short segments of line and upgrades to relays.

Following is a more detailed description of the larger-scope upgrades that were approved by the PJM Board for their consideration. A description of the criteria driving the need for the upgrade, as well as the required in-service date, is provided.

Baseline Projects b3003 and b3004 – Maywood and Clinton Ave Substations in the PSEG Transmission Zone

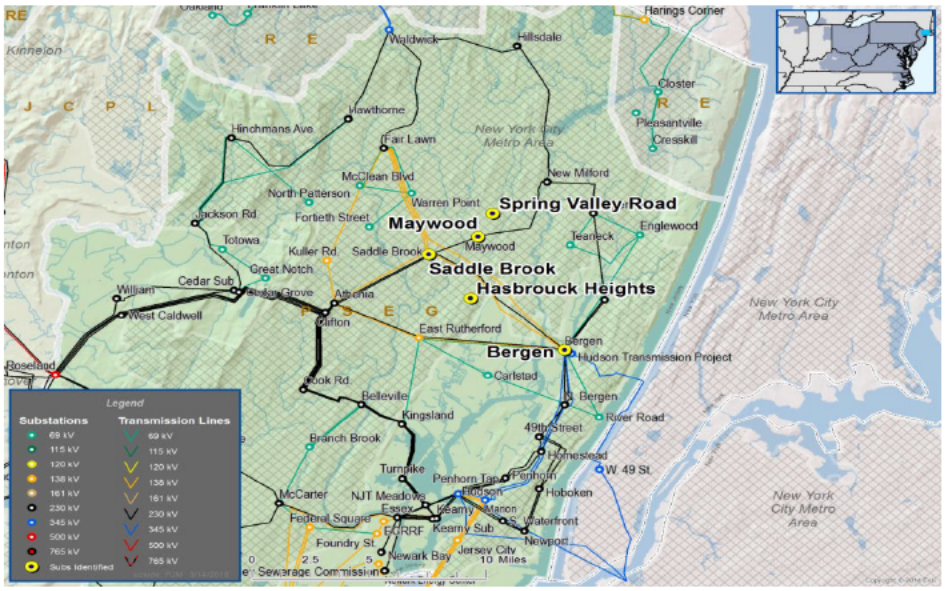
PSEG N-1-1 analysis in the areas of Maywood and Clinton results in the loss of supply to tens of thousands of customers and violates PSE&G FERC 715 filed transmission owner criteria. Section C of PSE&G TO criteria outlines acceptable load drop levels and durations. For N-1-1 analysis, PSE&G criteria consider any outage that result in load loss for greater than 24 hours to be a criteria violation. See Figure 1.

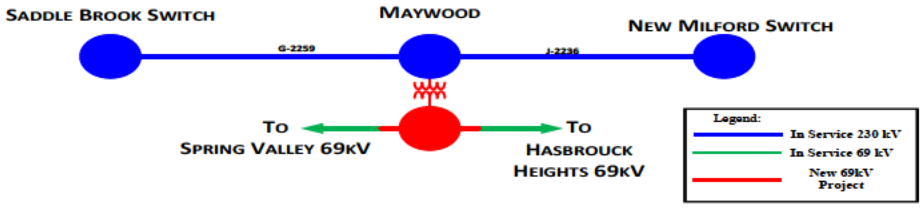
Maywood Substation is supplied by two underground 230 kV cables. Maywood supplies more than 25,000 customers with load in excess of 130 MVA. An N-1-1 event at the Maywood 230 kV substation would result in a complete loss of electric supply to the station for more than 24 hours, violating PSE&G criteria.

The South Trenton 69 kV network, as shown in Figure 2, is supplied by a 230/69 kV transformer at Trenton Switching Station and an underground 69 kV circuit between Lawrence Switching Station and Ewing. The South Trenton 69 kV network, which consists of Clinton Ave., Ewing, Hamilton and Liberty St., supplies over 15,000 customers with load in excess of 40 MVA. An N-1-1 event at these facilities would result in a complete loss of electric supply to the network for more than 24 hours, violating PSE&G criteria.

Additionally, Kuser Road 230 kV, located between Clinton Ave. and Trenton, currently supplies over 42,000 customers in the Trenton area. There has been a large increase in local loads due to increased development in this area. The load supplied exceeded 150 MVA during the summer of 2017 and is expected to grow in the local area. During the loss of a transformer at Kuser Road, there will be a ~9 percent overload on the remaining transformers.

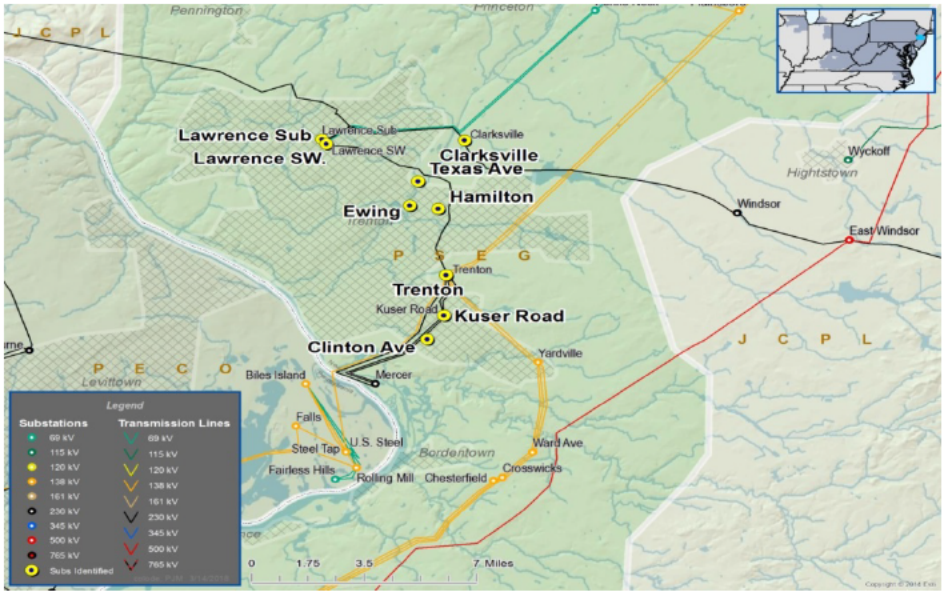
Figure 1. Area surrounding b3003

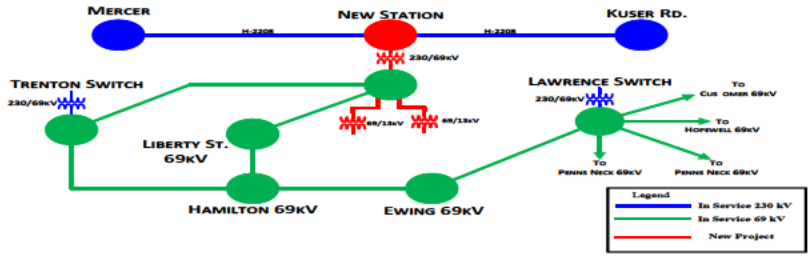




The recommended solution to address the Maywood N-1-1 PSEG criteria violations is to construct a new 230/69 kV substation at Maywood by extending the existing Maywood 230 kV station. This new portion will include one new 230/69 kV transformer along a 69 kV ring bus with 69 kV network lines connecting between Spring Valley Road, Hasbrouck Heights and Maywood. The estimated cost for this work is $87 million, and the required in-service date is June 2018. The local transmission owner, PSE&G, will be designated to complete this work.

Figure 2. Area surrounding b3004





The recommended solution to address the Trenton area N-1-1 and load growth PSEG criteria violations is to construct a new 230/69/13 kV substation on the existing 230 kV right-of-way at Clinton Ave. This new substation will expand the existing 69 kV ring bus at Clinton Ave. with two additional breakers tying into a 230 kV ring bus with a 230/69 kV transformer. Additionally, this station will include two 69/13 kV transformers and an 18 MVAR capacitor bank. The estimated cost for this work is $62 million, and the required in-service date is June 2018. The local transmission owner, PSE&G, will be designated to complete this work.

Baseline Projects b3019, 3020 and b3021 – End-of-life 500 kV line rebuilds in the Dominion Transmission Zone

Three 500 kV lines in the Dominion Transmission zone have been identified as violating the Dominion FERC 715 filed "End of Life Criteria." As part of Dominions end-of-life criteria, as documented in section C.2.9 of Dominion's transmission planning criteria, age, condition and tower weakening were all identified as issues with these lines. The lines were built in the 1960s using Cor-Ten lattice towers. They are part of Dominion's original 500 kV loop that begins at Mt. Storm and loops around their system back to Mt. Storm. These lines and the original 500 kV loop were reviewed independently by a 3rd party to validate conditions and confirm the facilities met the criteria defined in Section C.2.9.

The 21.6-mile-long 500 kV line between the Bristers and Chancellor substations in the Dominion transmission zone violate existing TO criteria. Reliability assessments continue to demonstrate that the removal of the Bristers-Chancellor 500 kV line from service adversely impacts system reliability. Previous generation additions in this area have been reduced in size due to system stability issues. Removal of the Bristers-Chancellor 500 kV line would only increase damping issues for existing generation in this area.

The 26.2-mile-long 500 kV line between the Ladysmith and Elmont substations in the Dominion transmission zone violate existing TO criteria. Reliability assessments continue to demonstrate that the removal of the Ladysmith-Elmont 500 kV line from service adversely impacts system reliability. Previous generation additions in this area have been reduced in size due to system stability issues. Removal of the Ladysmith-Elmont 500 kV line would only increase damping issues for existing generation in this area.

The 15.2-mile-long 500 kV line between the Ladysmith and Chancellor substations in the Dominion transmission zone violate existing TO criteria. Reliability assessments continue to demonstrate that the removal of the Ladysmith-Chancellor 500 kV line from service adversely impacts system reliability. Previous generation additions in this area have been reduced in size due to system stability issues. Removal of the Ladysmith-Chancellor 500 kV line would only increase damping issues for existing generation in this area.

These facilities have reached their end of life given their age and condition and need to be addressed under Dominion's FERC Form 715 transmission planning criteria.

Figure 3. Area surrounding b3019

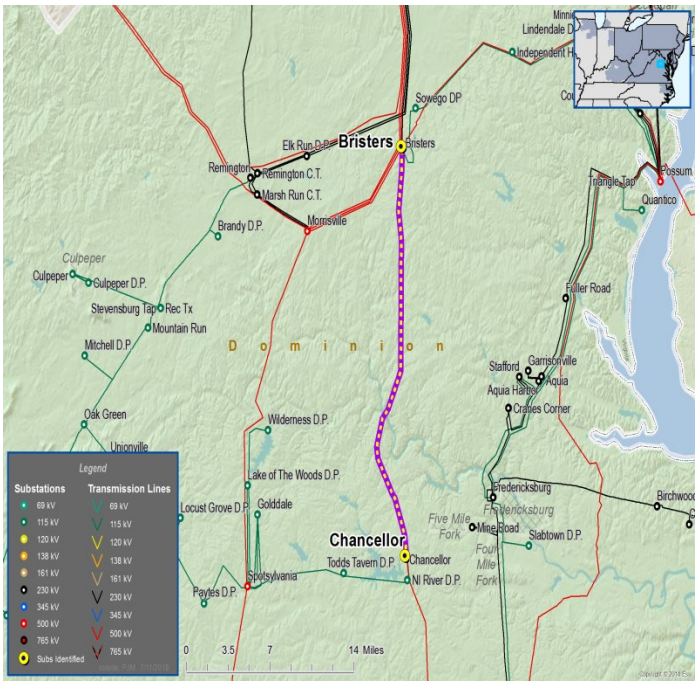


Figure 4. Area surrounding b3020

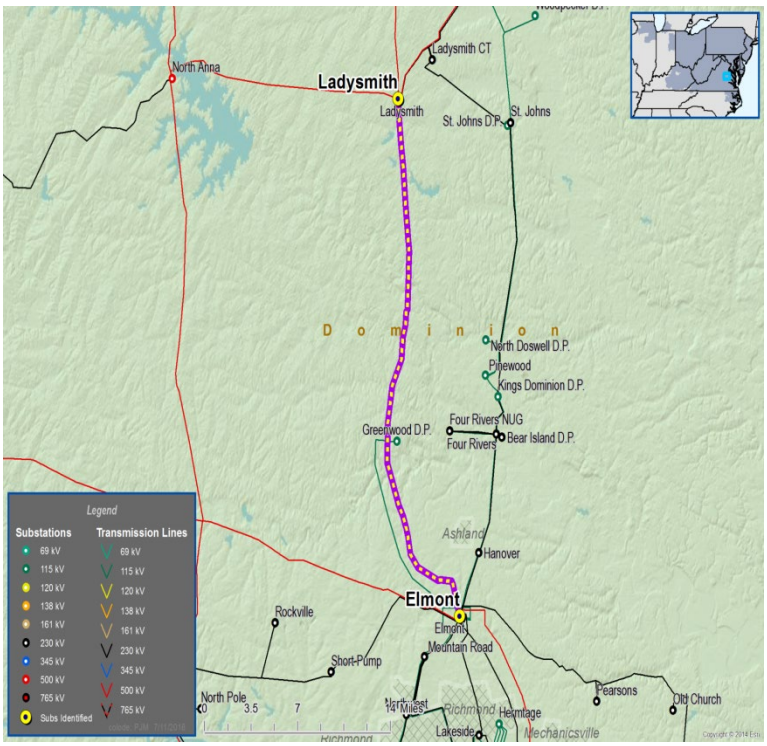
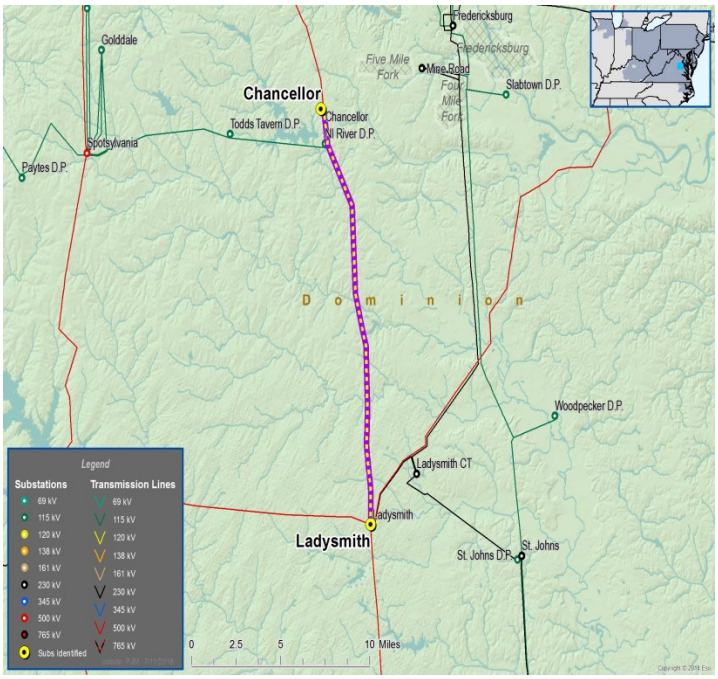


Figure 5. Area surrounding b3021



The recommended solution to address the Bristers to Chancellor 500 kV End of Life TO Criteria violation is to rebuild the 500 kV line (21.6 miles), increasing the ampacity from 3,364 to 5,000 amps. This rebuild will utilize the standard single circuit 500 kV tower design. The estimated cost for this work is $64.65 million, and the required in-service date is immediate. The local transmission owner, Dominion, will be designated to complete this work.

The recommended solution to address the Ladysmith to Elmont 500 kV End of Life TO Criteria violation is to rebuild the 500 kV line (26.2 miles), increasing the ampacity from 3,364 to 5,000 amps. This rebuild will utilize the "5-2" tower design, with the new 500 kV circuit overbuild strung above a future 230 kV underbuilt line. The estimated cost for this work is $87 million, and the required in-service date is immediate. The local transmission owner, Dominion, will be designated to complete this work.

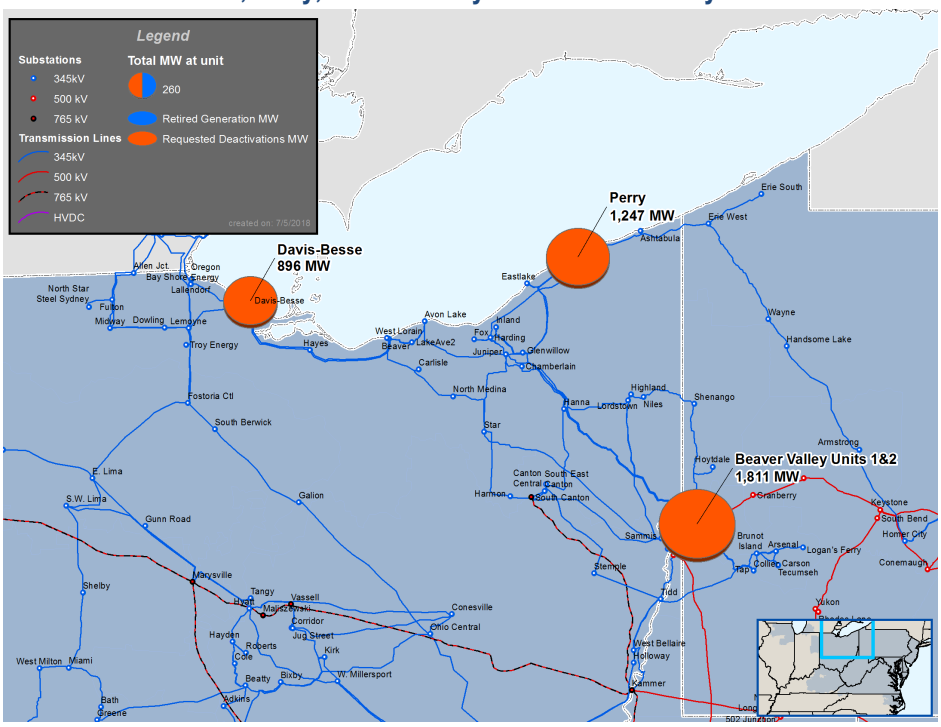
The recommended solution to address the Ladysmith to Chancellor 500 kV End of Life TO Criteria violation is to rebuild the 500 kV line (15.2 miles), increasing the ampacity from 3,364 to 5,000 amps. This rebuild will utilize the standard single circuit 500 kV tower design. The estimated cost for this work is $45.6 million, and the required in-service date is immediate. The local transmission owner, Dominion, will be designated to complete this work.

Baseline Projects b2966.1, b3005, b3006, b3007.1, b3007.2, b3008, b3009, b3010, b3011, b3012, b3013, b3013, b3015, b3016, b3017, b3024 – Deactivation Analysis – Davis Besse, Perry, Beaver Valley 1 and Beaver Valley 2

On March 28, 2018, PJM received the following generator deactivation notices from First Energy Nuclear:

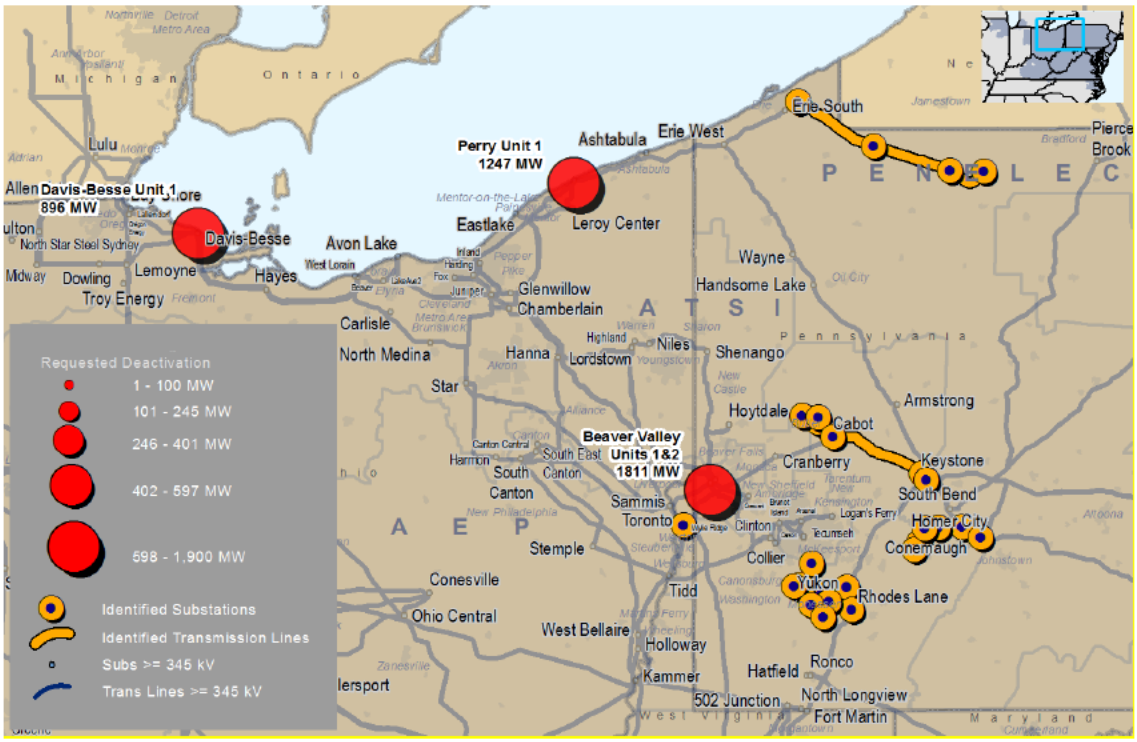
- Davis Besse Nuclear Unit 1 (ATSI) – 896 MW CIRs – Deactivation Date = May 31, 2020
- Beaver Valley Nuclear Unit 1 (DUQ) – 909 MW CIRs – Deactivation Date = May 31, 2021
- Beaver Valley Nuclear Unit 2 (DUQ) – 902 MW CIRs – Deactivation Date = October 31, 2021
- Perry Nuclear Unit 1 (ATSI) – 1247 MW CIRs – Deactivation Date = May 31, 2021

Figure 6. Davis Besse, Perry, Beaver Valley 1 and Beaver Valley



Analysis was performed to identify the impacts of the retiring generators, and determine what system enhancements need to be performed in order for the units to retire as requested, without adverse impacts to the transmission system. Reliability criteria violations, all within the AEP, APS, Duquense and Penelec transmission zones, identified as part of deactivation studies performed for the retiring FE nuclear units included Generator Deliverability violations in the Shanor Manor, Yukon, Seward, Keywood and Charleroi areas of the 138 kV network and Cabot, Keystone and Yukon areas of the 500 kV network. Additionally, a cluster of violations was identified along the APS/Duquesne border in the area of Mitchell, Westraver and Smithton.

Figure 7. Violations Identified by Deactivation Studies



With reliability analysis complete, PJM determined that the following new and existing baselines resolve identified impacts. As a result, these units can retire as scheduled. Operational flexibility can be used to bridge any delays with the transmission upgrades.

The following existing approved baseline upgrades are recommended for scope modification to address identified reliability violations driven by the deactivation of these four First Energy nuclear units, the accelerations include 4 line upgrade projects for a total of approximately $24 million and 3 terminal equipment enhancements for a total cost of $1.5 million.

Figure 8 Deactivation-driven scope accelerations

			Original		Scope Change	
Baseline Upgrade ID	Description	TO Zone	Cost ($M)	In-Service Date	Cost ($M)	In-Service Date
b2938	Perform a sag mitigation on the Broadford-Wolf Hills 138kV circuit to allow the line to operate to a higher maximum temperature	AEP	2.6	6/1/2022	N/A	6/1/2021
b2965	Reconductor the Charleroi-Allenport 138 kV line with 954 ACSR conductor; replace breaker risers at Charleroi and Allenport	APS	7.5	6/1/2022	N/A	6/1/2020

b2966.1	Reconductor the Yukon-Smithton-Shepler Hill Jct 138 kV line and replace terminal equipment as necessary to achieve required rating	APS	6.2	6/1/2022	6.7	6/1/2020
b2967	Convert the existing six-wire Butler-Shanor Manor-Krendale 138 kV line into two separate 138 kV lines. New lines will be Butler-Keisters and Butler-Shanor Manor-Krendale 138 kV	APS	6.96	6/1/2022	N/A	6/1/2020
b2951.1	Upgrade Florence 115 kV line terminal equipment at Seward SS	Penelec	0.5	6/1/2022	N/A	6/1/2020
b2951.2	Replace Blairsville East/Seward 115 kV line tuner, coax, line relaying and carrier set at Shelocta SS	Penelec	0.5	6/1/2022	N/A	6/1/2020
b2951.3	Replace Seward/Shelocta 115 kV line CVT, tuner, coax and line relaying at Blairsville East SS	Penelec	0.5	6/1/2022	N/A	6/1/2020

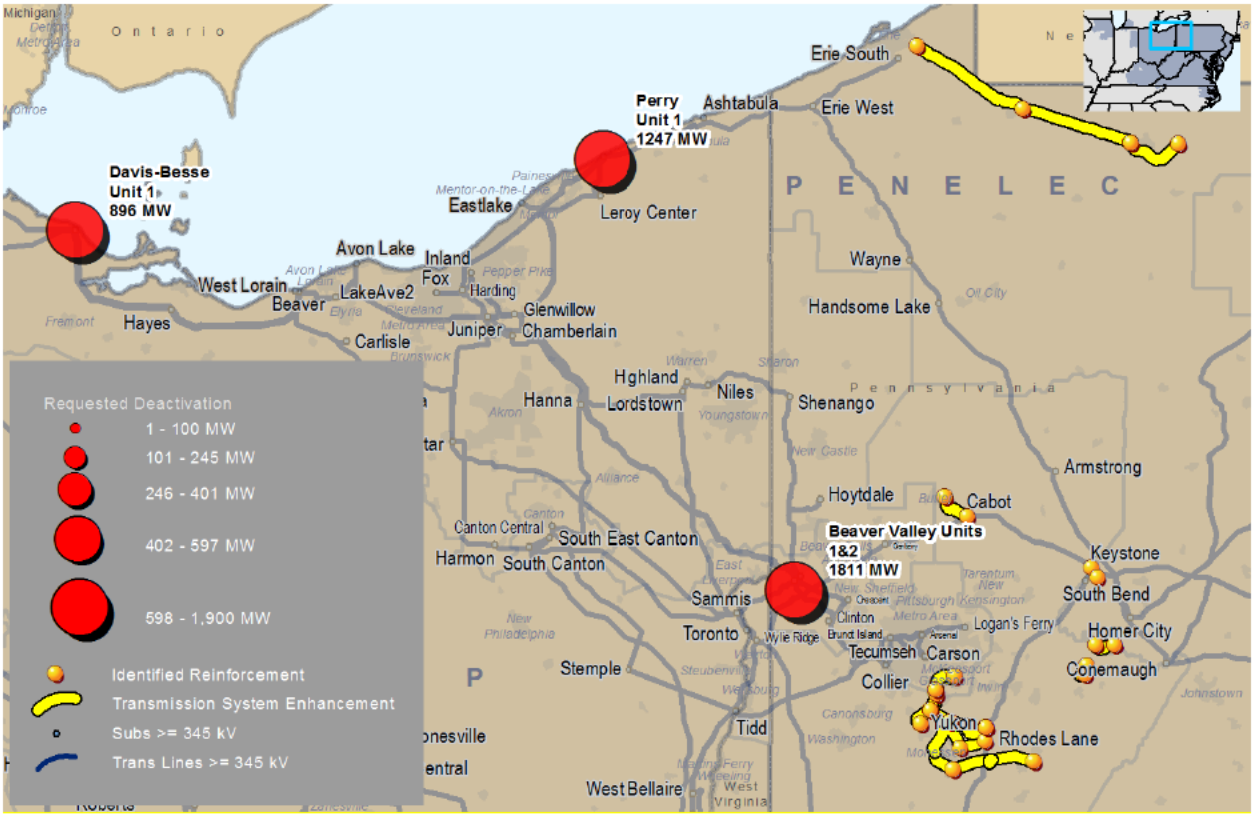
The following new baseline upgrades are recommended for inclusion in the RTEP to address identified reliability violations driven by the deactivation of these four First Energy nuclear units, the new projects include 14 line upgrade projects for a total of $77 million; 2 new substations for a total of $43 million; 2 transformer replacement for $60 million and 12 terminal equipment enhancements for a total cost of $2.5 million.

Figure 9 Deactivation driven new baseline upgrades

Baseline Upgrade ID	Description	Zone	Cost ($M)	Required In-Service Date
b3005	Reconductor 3.1 mile 556 ACSR portion of Cabot to Butler 138 kV with 556 ACSS and upgrade terminal equipment. 3.1 miles of line will be reconductored for this project. The total length of the line is 7.75 miles.	AP	4.5	6/1/2021
b3006	Replace four Yukon 500/138 kV transformers with three transformers with higher rating and reconfigure 500 kV bus	AP	55.56	6/1/2021
b3007.1	Reconductor the Blairsville East to Social Hall 138 kV line and upgrade terminal equipment – AP portion, 4.8 miles total. The new conductor will be 636 ACSS, replacing the existing 636 ACSR conductor. At Social Hall, meters, relays, a bus conductor, a wavetrap, circuit breaker and disconnects will be replaced.	AP	3.135	6/1/2021
b3007.2	Reconductor the Blairsville East to Social Hall 138 kV line and upgrade terminal equipment – PENELEC portion, 4.8 miles total. The new conductor will be 636 ACSS, replacing the existing 636 ACSR conductor. At Blairsville East, the wave trap and breaker disconnects will be replaced.	PENELEC	3.135	6/1/2021
b3008	Upgrade Blairsville East 138/115 kV transformer terminals. This project is an upgrade to the tap of the Seward-Shelocta 115 kV line into Blairsville substation. The project will replace the circuit breaker and adjust relay settings.	PENELEC	0.32	6/1/2021
b3009	Upgrade Blairsville East 115 kV terminal equipment. Replace 115 kV circuit breaker and disconnects.	PENELEC	0.26	6/1/2021
b3010	Replace terminal equipment at Keystone and Cabot 500 kV buses. At Keystone, bus tubing and conductor, a wavetrap, and meter will be replaced. At Cabot, a wavetrap and bus conductor will be replaced.	AP	0.28	6/1/2021
b3011.1	Construct new Route 51 substation and connect 10 138 kV lines to new substation	AP	26.202	6/1/2021
b3011.2	Upgrade terminal equipment at Yukon to increase rating on Yukon to Charleroi #2 138 kV line (New Yukon to Route 51 #4 138 kV line)	AP	0.0592	6/1/2021
b3011.3	Upgrade terminal equipment at Yukon to increase rating on Yukon to Route 51 #1 138 kV line	AP	0.2937	6/1/2021
b3011.4	Upgrade terminal equipment at Yukon to increase rating on Yukon to Route 51 #2 138 kV line	AP	0.0592	6/1/2021
b3011.5	Upgrade terminal equipment at Yukon to increase rating on Yukon to Route 51 #3 138 kV line	AP	0.2937	6/1/2021

b3011.6	Upgrade remote end relays for Yukon-Allenport-Iron Bridge 138 kV line	AP	0.71	6/1/2021
b3012.1	Construct new ties from FE's new substation to new DL substation – AP portion(DL portion=b3012.2). The estimated line length is approximately 4.7 miles; however, this length is subject to change based on the final route of the line. Approximately 1.7 miles could potentially be constructed by using the existing double circuit towers on the Wycoff tap. The line is planned to use two 954 ACSS conductors per phase.	AP	4.6	6/1/2021
b3012.2	Construct new ties from new AP substation to new DL substation - DL portion (AP portion=b3012.2)	DL	4.6	6/1/2021
b3013	Reconductor Vasco Tap to Edgewater Tap 138 kV line. 4.4 miles. The new conductor will be 336 ACSS replacing the existing 336 ACSR conductor.	AP	4.99	6/1/2021
b3014	Replace the existing Shelocta 230/115 kV transformer and construct a 230 kV ring bus	PENELEC	4.77	6/1/2021
b3015.1	Construct new Elrama 138 kV substation and connect seven 138 kV lines to new substation	DL	16.6	6/1/2021
b3015.2	Reconductor Elrama to Wilson 138 kV line. 4.8 miles	DL	5.3	6/1/2021
b3015.3	Reconductor Dravosburg to West Mifflin 138 kV line. 3 miles	DL	1.7	6/1/2021
b3015.4	Run new conductor on existing tower to establish the new Dravosburg-Elrama (Z-75) circuit. 10 miles	DL	6.7	6/1/2021
b3015.5	Reconductor Elrama to Mitchell 138 kV line – DL portion. 4.2 miles total. 2x795 ACSS/TW 20/7	DL	1.75	6/1/2021
b3015.6	Reconductor Elrama to Mitchell 138 kV line – AP portion. 4.2 miles total. 2x795 ACSS/TW 20/7	AP	1.75	6/1/2021
b3015.7	Reconductor Wilson to West Mifflin 138 kV line. 2 miles. 795ACSS/TW 20/7	DL	1.7	6/1/2021
b3016	Upgrade terminal equipment at Corry East 115 kV to increase rating of Four Mile to Corry East 115 kV line. Replace bus conductor.	PENELEC	0.05	6/1/2021
b3017.1	Rebuild Glade to Warren 230 kV line with hi-temp conductor and substation terminal upgrades. 11.53 miles. New conductor will be 1033 ACSS. Existing conductor is 1033 ACSR.	PENELEC	33.3	6/1/2021
b3017.2	Glade substation terminal upgrades. Replace bus conductor, wave traps and relaying.	PENELEC	0.05	6/1/2021
b3017.3	Warren substation terminal upgrades. Replace bus conductor, wave traps and relaying.	PENELEC	0.05	6/1/2021
b3024	Upgrade terminal equipment at Corry East 115 kV to increase rating of Warren to Corry East 115 kV line. Replace bus conductor.	PENELEC	0.05	6/1/2021

Figure 10. Deactivation driven upgrades



The recommended solutions to address the deactivations of Davis Besse, Perry, Beaver Valley 1 and Beaver Valley 2 are identified in the tables above. The local transmission owners, APS, Duquesne and Penelec, as shown above, will be designated to complete this work.

Changes to Previously Approved Projects

Three projects, totaling $16.85 million, are being canceled as they are no longer needed to satisfy reliability criteria. Two of these projects are in the ATSI transmission zone and are no longer required for reliability due to updated as built data from a previously approved project on the same lines. One of these projects is in the EKPC transmission zone and is no longer needed as changing system conditions and corresponding analysis have shown that the violation is no longer valid.

Additionally, four projects have had increases in scope based on coordination with transmission owners. Two projects in Dominion required additional breaker replacements based on short circuit analysis of previously approved baseline projects. One project in APS/Dominion required the relocation of a piece of terminal equipment within an existing substation to allow for the installation of a new motor operated switch being installed as part of a previously approved baseline upgrade. One project in DEOK requires additional

scope as upon inspection of the existing line, engineers determined that five structures, which were planned for re-use, needed to be replaced. A complete rebuild of this circuit (six structures total) will provide additional margin at minimal incremental cost. The total increase in scope resulting from these four projects is $9.51 million.

The net change to the RTEP to incorporate all of these changes is decrease of $7.34 million.

Review by the Transmission Expansion Advisory Committee (TEAC)

The need for the projects noted in this report was reviewed with stakeholders at several meetings throughout 2018, most recently at the June 2018 TEAC and Subregional RTEP Committee meetings. Written comments were requested to be submitted to PJM to communicate any concerns with the recommendations. As of the writing of this report, there have been no comments received on the projects presented to the TEAC.

Cost Allocation

Preliminary cost allocations for the projects being recommended are shown in Attachment A and Attachment B. Attachment A shows the projects with cost allocations to a single zone. Attachment B shows the projects with cost allocations to multiple zones.

Cost allocations for the projects were calculated in accordance with the Schedule 12 of the Open Access Transmission Tariff (OATT). Baseline reliability project allocations are calculated using a distribution factor methodology that allocates the cost to the load zones that contribute to the loading on the new facility. Baseline projects required exclusively to address local transmission owner FERC Form 715 planning criteria are allocated to the local transmission owner zone. The allocations will be filed at the FERC 30 days following approval by the Board.

Board Approval

The PJM Board Reliability Committee endorsed the new baseline reliability projects and associated cost allocations, and recommend to the Board, approval of the baseline upgrades to the 2018 RTEP. The PJM Board of Managers approved all recommended changes to the RTEP.

Reliability Project Single Zone Allocations

Upgrade ID	Description	Cost Estimate ($M)	Trans Owner	Cost Responsibility	Required IS Date
b2747.1	Relocate the FirstEnergy Pratts 138 kV terminal CVTs at Gordonsville substation to allow for the installation of a new motor operated switch being installed by Dominion.	$0.11	AP	AP	6/1/2018
b2831.2	Rebuild the Tanner Creek – Miami Fort 345kV line (DEOK portion) to achieve a capacity of 2390 MVA.	$11.10	DEOK	DEOK	6/1/2018
b2951.1	Upgrade Florence 115kV line terminal equipment at Seward SS	$0.60	PENELEC	PENELEC	6/1/2020
b2951.2	Replace Blairsville East/Seward 115kV line tuner, coax, line relaying and carrier set at Shelocta SS	$0.20	PENELEC	PENELEC	6/1/2020
b2951.3	Replace Seward/Shelocta 115kV line CVT, tuner, coax, and line relaying at Blairsville East SS	$0.30	PENELEC	PENELEC	6/1/2020
b2962.1	Replace the Beaumeade 230kV breaker "274T2081" with 63kA breaker	$0.30	Dominion	Dominion	6/1/2022
b2962.2	Replace the NIVO 230kV breaker "2116T2130" with 63kA breaker	$0.30	Dominion	Dominion	6/1/2022

Upgrade ID	Description	Cost Estimate ($M)	Trans Owner	Cost Responsibility	Required IS Date
b2965	Reconductor the Charleroi –Allenport 138KV Line with 954 ACSR Conductor, Replace Breaker Risers at Charleroi and Allenport	$7.50	APS	APS	6/1/2020
b2966	Reconductor the Yukon - Smithton - Shepler Hill Jct 138 kV Line with 795 ACSS Conductor, Replace Line Disconnect Switch at Yukon	$6.20	APS	APS	6/1/2022
b2966.1	Reconductor the Yukon - Smithton - Shepler Hill Jct 138 kV line and replace terminal equipment as necessary to achieve required rating	$0.50	APS	APS	6/1/2020
b2989	Install a second 230 -115 kV Transformer (224 MVA) approximately 1 mile north of Bremo and tie 230 kV Line #2028(Bremo – Charlottesville) and 115 kV Line #91 (Bremo-Sherwood) together. A three breaker 230 kV ring bus will split Line #2028 into two lines and Line #91 will also be split into two lines with a new three breaker 115 kV ring bus. Install a temporary 230-115 kV transformer at Bremo substation for the	$27.00	Dominion	Dominion	6/1/2018

Upgrade ID	Description	Cost Estimate ($M)	Trans Owner	Cost Responsibility	Required IS Date
	interim until the new substation is complete.				
b2990	Chesterfield to Basin 230 kV line - Replace 0.14 miles of 1109 ACAR with a conductor which will increase the line rating to approximately 706 MVA	$0.35	Dominion	Dominion	6/1/2018
b2991	Chaparral to Locks 230 kV line - Replace breaker lead	$0.10	Dominion	Dominion	6/1/2018
b2993	Rebuild the Torrey – South Gambrinus Switch – Gambrinus Road 69kV line section (1.3 miles) with 1033 ACSR 'Curlew' conductor and steel poles.	$2.80	AEP	AEP	6/1/2018
b2994	Acquire land and build a new switching station (Skippers) at the tap serving Brink DP with a 115kV four breaker ring to split line #130 and terminate the end points.	$8.00	Dominion	Dominion	5/1/2020
b2995	Remove Davis Creek RAS	$0.10	ComEd	ComEd	12/31/2018
b2996	Construct a new Flint Run 500-138 kV substation as a 4-breaker ring bus	$40.10	APS	APS	6/1/2019
b2997	Remove University Park North RAS	$0.10	ComEd	ComEd	12/31/2018

Upgrade ID	Description	Cost Estimate ($M)	Trans Owner	Cost Responsibility	Required IS Date
b2998	Install a 120 Mvar 345kV shunt inductor at Powerton (the 345kV yard already contains an empty bus position on the ring we only need a switching breaker for the inductor)	$9.00	ComEd	ComEd	6/1/2021
b2999	Rebuild the 12.36 mile Schauff Road to Nelson tap 138kV line L15508.	17.00	ComEd	ComEd	11/1/2019
b3000	Replace South Canton 138kV breaker 'N' with an 80kA breaker	$1.00	AEP	AEP	6/1/2020
b3001	Replace South Canton 138kV breaker 'N1' with an 80kA breaker	$1.00	AEP	AEP	6/1/2020
b3002	Replace South Canton 138kV breaker 'N2' with an 80kA breaker	$1.00	AEP	AEP	6/1/2020
b3003	Construct a 230/69kV station at Maywood	$87.00	PSEG	PSEG	6/1/2018
b3003.1	Purchase properties at Maywood to accommodate new construction	$0.00	PSEG	PSEG	6/1/2018
b3003.2	Extend Maywood 230kV bus and install one (1) 230kV breaker	$0.00	PSEG	PSEG	6/1/2018
b3003.3	Install one (1) 230/69kV transformer at Maywood	$0.00	PSEG	PSEG	6/1/2018
b3003.4	Install Maywood 69kV ring bus	$0.00	PSEG	PSEG	6/1/2018

Upgrade ID	Description	Cost Estimate ($M)	Trans Owner	Cost Responsibility	Required IS Date
b3003.5	Construct a 69kV network between Spring Valley Road, Hasbrouck Heights, and Maywood	$0.00	PSEG	PSEG	6/1/2018
b3004	Construct a 230/69/13kV station by tapping the Mercer - Kuser Rd 230kV circuit	$62.00	PSEG	PSEG	6/1/2018
b3004.1	Install a new Clinton 230kV ring bus with one (1) 230/69kV transformer Mercer - Kuser Rd 230kV circuit	$0.00	PSEG	PSEG	6/1/2018
b3004.2	Expand existing 69kV ring bus at Clinton Ave with two (2) additional 69kV breakers.	$0.00	PSEG	PSEG	6/1/2018
b3004.3	Install two (2) 69/13kV transformers at Clinton Ave	$0.00	PSEG	PSEG	6/1/2018
b3004.4	Install 18 MVAR capacitor bank at Clinton Ave 69 kV	$0.00	PSEG	PSEG	6/1/2018
b3005	Reconductor 3.1 mile 556 ACSR portion of Cabot to Butler 138 kV with 556 ACSS and upgrade terminal equipment. 3.1 miles of line will be reconductored for this project. The total length of the line is 7.75 miles.	$4.50	AP	AP	6/1/2021

Upgrade ID	Description	Cost Estimate ($M)	Trans Owner	Cost Responsibility	Required IS Date
b3007.1	Reconductor the Blairsville East to Social Hall 138 kV line and upgrade terminal equipment - AP portion. 4.8 miles total. The new conductor will be 636 ACSS replacing the existing 636 ACSR conductor. At Social Hall, meters, relays, bus conductor, a wavetrap, circuit breaker and disconnects will be replaced.	$3.14	AP	AP	6/1/2021
b3007.2	Reconductor the Blairsville East to Social Hall 138 kV line and upgrade terminal equipment - PENELEC portion. 4.8 miles total. The new conductor will be 636 ACSS replacing the existing 636 ACSR conductor. At Blairsville East, the wave trap and breaker disconnects will be replaced.	$3.14	PENELEC	PENELEC	6/1/2021
b3008	Upgrade Blairsville East 138/115 kV transformer terminals. This project is an upgrade to the tap of the Seward – Shelocta 115 kV line into Blairsville substation. The project will replace the circuit breaker and adjust relay settings.	$0.32	PENELEC	PENELEC	6/1/2021

Upgrade ID	Description	Cost Estimate ($M)	Trans Owner	Cost Responsibility	Required IS Date
b3009	Upgrade Blairsville East 115 kV terminal equipment. Replace 115 kV circuit breaker and disconnects.	$0.26	PENELEC	PENELEC	6/1/2021
b3010	Replace terminal equipment at Keystone and Cabot 500 kV buses. At Keystone, bus tubing and conductor, a wavetrap, and meter will be replaced. At Cabot, a wavetrap and bus conductor will be replaced.	$0.28	AP	AP	6/1/2021
b3011.1	Construct new Route 51 substation and connect 10 138 kV lines to new substation	$26.20	AP	DL (100%)	6/1/2021
b3011.2	Upgrade terminal equipment at Yukon to increase rating on Yukon to Charleroi #2 138 kV line (New Yukon to Route 51 #4 138 kV line)	$0.06	AP	DL (100%)	6/1/2021
b3011.3	Upgrade terminal equipment at Yukon to increase rating on Yukon to Route 51 #1 138 kV line	$0.29	AP	DL (100%)	6/1/2021
b3011.4	Upgrade terminal equipment at Yukon to increase rating on Yukon to Route 51 #2 138 kV line	$0.06	AP	DL (100%)	6/1/2021

Upgrade ID	Description	Cost Estimate ($M)	Trans Owner	Cost Responsibility	Required IS Date
b3011.5	Upgrade terminal equipment at Yukon to increase rating on Yukon to Route 51 #3 138 kV line	$0.29	AP	DL (100%)	6/1/2021
b3011.6	Upgrade remote end relays for Yukon – Allenport – Iron Bridge 138 kV line	$0.71	AP	DL (100%)	6/1/2021
b3012.1	Construct new ties from FE's new substation to DUQ's new substation - AP portion. The estimated line length is approximately 4.7 miles, however, this length is subject to change based on the final route of the line. Approximately 1.7 miles could potentially be constructed by using the existing double circuit towers on the Wycoff tap. The line is planned to use 2-954 ACSS conductors per phase.	$4.60	AP	DL (100%)	6/1/2021
b3012.2	Construct new ties from FE's new substation to DUQ's new substation - DL portion	$4.60	DL	DL (100%)	6/1/2021
b3013	Reconductor Vasco Tap to Edgewater Tap 138 kV line. 4.4 miles. The new conductor will be 336 ACSS replacing the existing 336 ACSR	$4.99	AP	AP	6/1/2021

Upgrade ID	Description	Cost Estimate ($M)	Trans Owner	Cost Responsibility	Required IS Date
	conductor.				
b3014	Replace the existing Shelocta 230/115 kV transformer and construct a 230 kV ring bus	$4.77	PENELEC	PENELEC	6/1/2021
b3015.1	Construct new Elrama 138 kV substation and connect 7 138 kV lines to new substation	$16.60	DL	DL	6/1/2021
b3015.2	Reconductor Elrama to Wilson 138 kV line. 4.8 miles	$5.30	DL	DL	6/1/2021
b3015.3	Reconductor Dravosburg to West Mifflin 138 kV line. 3 miles	$1.70	DL	DL	6/1/2021
b3015.4	Run new conductor on existing tower to establish the new Dravosburg-Elrama (Z-75) circuit. 10 miles	$6.70	DL	DL	6/1/2021
b3015.5	Reconductor Elrama to Mitchell 138 kV line - DL portion. 4.2 miles total. 2x795 ACSS/TW 20/7	$1.75	DL	DL	6/1/2021
b3015.6	Reconductor Elrama to Mitchell 138 kV line - AP portion. 4.2 miles total. 2x795 ACSS/TW 20/7	$1.75	AP	DL	6/1/2021
b3015.7	Reconductor Wilson to West Mifflin 138 kV line. 2 miles. 795ACSS/TW 20/7	$1.70	DL	DL	6/1/2021

Upgrade ID	Description	Cost Estimate ($M)	Trans Owner	Cost Responsibility	Required IS Date
b3016	Upgrade terminal equipment at Corry East 115 kV to increase rating of Four Mile to Corry East 115 kV line. Replace bus conductor.	$0.05	PENELEC	PENELEC	6/1/2021
b3019	Rebuild 500kV Line #552 Bristers to Chancellor – 21.6 miles long	$64.65	Dominion	Dominion	6/1/2018
b3020	Rebuild 500kV Line #574 Ladysmith to Elmont - 26.2 miles long	$87.00	Dominion	Dominion	6/1/2018
b3021	Rebuild 500kV Line #581 Ladysmith to Chancellor - 15.2 miles long	$45.60	Dominion	Dominion	6/1/2018
b3024	Upgrade terminal equipment at Corry East 115 kV to increase rating of Warren to Corry East 115 kV line. Replace bus conductor.	$0.05	PENELEC	PENELEC	6/1/2021

Reliability Project Multiple Zone Allocations

Upgrade ID	Description	Cost Estimate ($M)	Trans Owner	Cost Responsibility	Required IS Date
b3006	Replace four Yukon 500/138 kV transformers with three transformers with higher rating and reconfigure 500 kV bus	$55.56	AP	APS (52.84%) / DL (47.16%)	6/1/2021
b3017.1	Rebuild Glade to Warren 230 kV line with hi-temp conductor and substation terminal upgrades. 11.53 miles. New conductor will be 1033 ACSS. Existing conductor is 1033 ACSR.	$33.30	PENELEC	ATSI (61.74%) / PENELEC (38.26%)	6/1/2021
b3017.2	Glade substation terminal upgrades. Replace bus conductor, wave traps, and relaying.	$0.05	PENELEC	ATSI (61.74%) / PENELEC (38.26%)	6/1/2021
b3017.3	Warren substation terminal upgrades. Replace bus conductor, wave traps, and relaying.	$0.05	PENELEC	ATSI (61.61%) / PENELEC (38.39%)	6/1/2021