Transmission Expansion Advisory Committee (TEAC) Recommendations to the PJM Board

PJM Staff Whitepaper
Dec. 2018

For Public Use

Executive Summary

On October 2, 2018, the PJM Board of Managers approved changes to the Regional Transmission Expansion Plan (RTEP), totaling $201.5 million, primarily to resolve baseline reliability criteria violations.

Since then, PJM has identified additional baseline reliability criteria violations and the transmission system enhancements needed to solve them, at an estimated cost of $183.6 million. In addition, three previously approved baseline projects have been canceled resulting in a net cost decrease of $17.5 million. This yields an overall RTEP net increase of $166.1 million.

PJM staff is recommending two interregional Targeted Market Efficiency Projects (TMEPs) with MISO - with a total estimated cost of $4.5 million and an estimated market efficiency benefit of $31.9 million. The two TMEP projects were found to meet all criteria for inclusion in the interregional market efficiency process, as developed by the PJM/MISO IPSAC in 2016.

PJM staff has also completed 187 new interconnection queue impact studies. 176 of those projects are generation interconnection requests, for a total of over 12,500 MW of capacity. Additionally, 250 projects have withdrawn their interconnection requests from the queue. 252 new network upgrades, are required for the interconnection of queued projects. The net impact of these associated RTEP changes is an increase of $1,135.9 million.

The total RTEP change for which PJM recommended Board approval is a net increase of $1,302 million. With these changes, the RTEP comprises $38,223.9 million of transmission enhancements since the first Board approvals in 2000.

The projects are summarized in the following paper and were brought for the Board Reliability Committee's consideration and for recommendation to the Board for approval.

December 2018 Baseline Reliability Recommendations

A key dimension of PJM's RTEP process is baseline reliability evaluation, necessary before subsequent interconnection requests can be analyzed. Baseline analysis identifies system violations to reliability criteria and standards. PJM then develops transmission system enhancements to solve identified violations and reviews them with stakeholders through the Transmission Expansion Advisory Committee (TEAC) and Subregional RTEP committees prior to recommendation to the Board. Baseline reliability transmission enhancement costs are allocated to PJM load.

Baseline Reliability Projects Summary

A summary of baseline projects with estimated costs equal to or greater than $5 million is provided below. A complete listing of all recommended projects and their associated cost allocations is included in Attachment A (for allocation to a single zone) and Attachment B (for allocation to multiple zones). Projects with estimated costs less than $5 million typically include transformer replacements, line reconductoring, breaker replacements, and upgrades to terminal equipment, including relay and wave trap replacements.

Mid-Atlantic Region Transmission System Enhancements

- No baseline projects have been identified in PJM's Mid-Atlantic region with estimated costs equal to or greater than $5 million.

Western Region Transmission System Enhancements

- AEP Transmission Zone
  - Rebuild 15.4 miles of North Delphos - Rockhill 138 kV double circuit line - $24.5M
  - Rebuild Ravenswood-Racine Tap 69 kV line section (~15 miles) to 69 kV standards, utilizing 795 26/7 ACSR conductor; Rebuild existing Ripley-Ravenswood 69 kV circuit (~9 miles) to 69 kV standards, utilizing 795 26/7 ACSR conductor; associated terminal equipment work at Sarah Lane and South Buffalo - $68.1M

- ATSI Transmission Zone
  - Ottawa-Lakeview 138 kV Reconductor and Substation Upgrades - $20M

Southern Region Transmission System Enhancements

- Dominion Transmission Zone
  - Add a 2nd 500/230 kV 840 MVA transformer at Dominion's Ladysmith Substation – Dominion End-of-Life Criteria Violation - $ 23.4 million
  - Rebuild 230 kV Lines #2154 and #19 Waller-Skiffes Creek – Dominion End-of-Life Criteria Violation - $10 million

- Partial Rebuild of #265 and #200 230 kV lines and full rebuild of #2051 230 kV line – Dominion End-of-Life Criteria Violation - $11.5 million

In addition to the projects noted above with estimated costs equal to or greater than $5 million, PJM also recommended four projects totaling $26 million that include breaker replacements, line reconductoring and terminal equipment work.

Following is a more detailed description of the larger-scope projects PJM recommended to the Board. A description of the criteria driving the need for the project and the required in-service date are also provided.

Baseline Project b3036: North Delphos–Rockhill 138 kV Line Rebuild
AEP Transmission Zone

The Logtown–North Delphos 138 kV line – shown on **Map 1** – is overloaded for multiple contingencies in the winter generator deliverability and common mode outage analysis for multiple contingencies. The North Delphos area was originally a supplemental project (s1563.2: North Delphos-Rockhill 138 kV: Rebuild 15.4 miles of double circuit 138 kV line utilizing 1033 ACSR conductor), presented at the February and March 2018 TEAC meetings. Subsequently, reliability criteria violations were identified as described below that drove the change for this upgrade from a supplemental project to a baseline project.

Map 1: North Delphos-Rockhill Area Substations

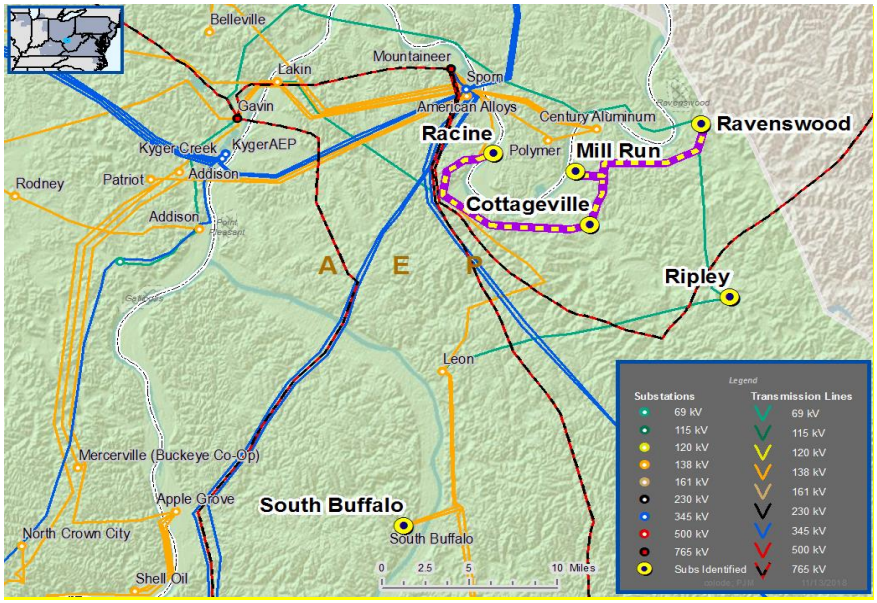
The recommended solution – Baseline Project b3036 – to address the Generator Deliverability and Common Mode Outage criteria violations is to convert existing supplemental project s1563.2 into a baseline project. Project s1563.2 comprises a North Delphos-Rockhill 138 kV rebuild with 15.4 miles of double circuit 138 kV line utilizing 1033 ACSR conductor. The estimated cost for this project is $24.5 million, and the required in-service date is December 2020. The local transmission owner, AEP, will be designated to complete this work.

Baseline Project b3040: Ravenswood–Racine Tap 69 kV Line
AEP Transmission Zone

In the 2022 RTEP Summer Case, the Racine–Ravenswood 69 kV circuit - shown on **Map 2 -** is overloaded under N-1-1 conditions for the loss of the Gavin–Meigs 69 kV circuit and the loss of the Leon–Ripley 138 kV circuit. Additionally, the Ravenswood–Ripley 69 kV circuit is overloaded under N-1-1 conditions including the loss of the Leon–Sporn 138 kV circuit and the Amos–South Buffalo 138 kV circuit. Under both N-1-1 scenarios above there are also low voltage violations at Mill Run, Ravenswood, Ripley, Leon and South Buffalo.

In addition to PJM regional reliability criteria violations, AEP Transmission Owner Criteria violations were also identified. AEP FERC No. 715 Transmission Owner Criteria include requirements to evaluate the equipment materials, condition, performance, and risk. The Ravenswood–Ripley 69 kV circuit (~9.31 mi) currently has 98 open conditions on 47 out of 69 structures, much of it condition issues on wood construction dating to the 1950s. The Racine–Ravenswood 69 kV circuit (~23.41 mi) currently has 269 open conditions on 100 out of 195 structures much of it also due to condition issues on wood construction dating the 1950s and 1960s. From 2014-2016 the line has experienced 23 momentary and 3 permanent outages resulting in 1.3 million customer minutes of interruption. In addition, line switches have become prone to mis-alignment with each operation. As a result, an existing two-way switch at Cottageville substation will be replaced. Otherwise it will limit the new conductor's thermal capability.

Map 2: Ravenswood – Racine Tap Area



Recommended solution – Baseline Project b3040 – to address the N-1-1 overloads and equipment criteria:

- Rebuild Ravenswood–Racine Tap 69 kV line section (~15 miles) to 69 kV standards (b3040.1) - $39.2 M
- Rebuild existing Ripley–Ravenswood 69 kV circuit (~9 miles) (b3040.2) - $23.6 M

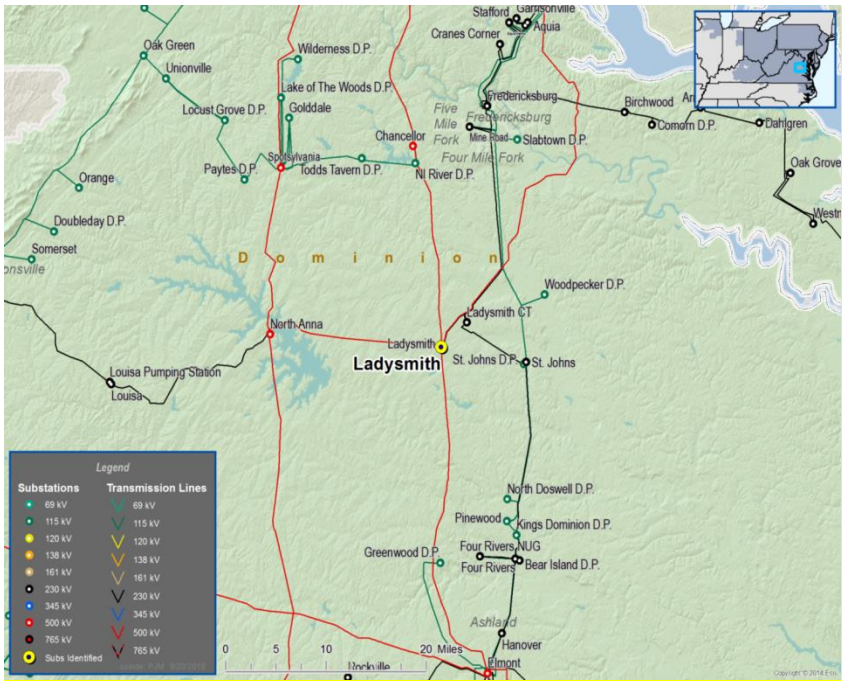
- Install a new 3-way phase over phase switch to replace the retired switch at Cottageville. (b3040.3) - $1.0 M
- Install new 138/12 kV 20 MVA XFR at Polymer to transfer load from Mill Run Station to help address overload on the 69 kV network. (b3040.4) - $3.5 M
- Retire Mill Run Station (b3040.5) - $0M
- Install 28.8 MVAr Cap Bank at South Buffalo (b3040.6) - $0.8 M

This project is estimated to cost $68.1 million. The local transmission owner, AEP, will be designated to complete this work.

Baseline Project b3027: Ladysmith 500/230 kV Transformer
Dominion Transmission Zone

PJM has identified a generation deliverability violation on the Ladysmith 500/230 kV Transformer #1 – shown on **Map 3** - for summer 2023. Additionally, PJM and Dominion have identified a stability issue in the Ladysmith and Four Rivers areas of Dominion under an N-1 contingency using Dominion's FERC No. 715 stability criteria. The Ladysmith 500kV breakers "H1T575", "H1T581", and "568T574" are over-dutied as a result of the work to address these violations.

Map 3: Ladysmith 500 kV Area



The recommended solution – Baseline Project b3027 – to address the generation deliverability, stability and short circuit violations is to add a 2nd 500/230 kV 840 MVA transformer at Dominion's Ladysmith Substation, re-conductor Ladysmith-Ladysmith CT Substations to increase the line rating from 1047 MVA to 1225 MVA, replace the Ladysmith 500kV 40kA breaker "H1T581" with a 50kA breaker; and update the nameplate for Ladysmith 500kV breaker "H1T575" and "H2T568" from 40kA to 50kA

This project is estimated to cost $23.43 million. The local transmission owner, Dominion, will be designated to complete this work.

Changes to Previously Approved Projects

PJM is cancelling three AEP projects:

- Baseline projects b1470.1 (Build a new 138 kV double circuit off the Kanawha–Baileysville #2 138 kV circuit to Skin Fork Station) and b1470.2 (Install a new 138/46 kV transformer at Skin Fork), totaling $17.1 million. With the inclusion of b2611 (New 138/46 kV station near Skin Fork and other components; Construct 3.2 miles of 1033 ACSR double circuit from new Station to cut into Sundial - Baileysville 138 kV line), b1470.1 and b1470.2 are no longer needed.
- Project b2790 (Install a 3 MVAR cap bank at Caldwell 34.5 kV substation) is recommended for cancelation due to updated modeling data that corrected several branch impendences in the area. With the updated modeling data, b2790 is no longer needed.

These changes yield a net RTEP decrease of $17.5 million.

Review by the Transmission Expansion Advisory Committee (TEAC)

Project needs and recommended solutions as discussed in this report were reviewed with stakeholders throughout 2018, most recently at the October 2018 TEAC and Subregional RTEP Committee meetings. Written comments were requested to be submitted to PJM to communicate any concerns with project recommendations. No comments have been received as of this white paper publication date.

Cost Allocation

Cost allocations for recommended projects are shown Attachment A (for allocation to a single zone) and Attachment B (for allocation to multiple zones).

Cost allocations 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 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 No. 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 was requested to endorse the new baseline reliability projects and associated cost allocations and recommend to the full Board approval of the projects in this white paper to be included in PJM's RTEP. The baseline projects will be incorporated into the published RTEP after approval by the PJM Board. The RTEP will be published on PJM's website.

Attachment A - Reliability Project Single Zone Allocations

Upgrade ID	Description	Cost Estimate ($M)	Trans Owner	Cost Responsibility	Required IS Date
b2943	Perform a LIDAR study on the Clifty Creek - Dearborn 345 kV line to increase the Summer Emergency rating above 1023MVA).	$0.17	OVEC	OVEC	6/1/2018
b3027.1	Add a 2nd 500/230 kV 840 MVA transformer at Dominion's Ladysmith Substation	$20.00	Dominion	Dominion	6/1/2021
b3027.2	Re-conductor Line #2089 between Ladysmith and Ladysmith CT Substations to increase the line rating from 1047 MVA to 1225 MVA.	$2.40	Dominion	Dominion	6/1/2021
B3027.3	Replace the Ladysmith 500kV breaker "H1T581" with 50kA breaker	$0.52	Dominion	Dominion	6/1/2021
B3027.4	Update the nameplate for Ladysmith 500kV breaker "H1T575" to be 50kA breaker	$0.52	Dominion	Dominion	6/1/2021
B3027.5	Update the nameplate for Ladysmith 500kV breaker "568T574" (will be renumbered as "H2T568") to be 50kA breaker	$0.00	Dominion	Dominion	6/1/2021
b3032	Greenfield-NASA 138 kV Terminal Upgrades: NASA Substation, Greenfield exit: Revise CT tap on Breaker B22 and adjust line relay settings; Greenfield	$0.10	ATSI	ATSI	12/1/2023

	Substation, NASA exit: Revise CT tap on Breaker B1 and adjust line relay settings; replace 336.4 ACSR line drop with 1033.5 AL.				
b3033	Ottawa-Lakeview 138 kV Reconductor and Substation Upgrades	$20.00	ATSI	ATSI	12/1/2023
b3034	Lakeview-Greenfield 138 kV Reconductor and Substation Upgrades	$2.40	ATSI	ATSI	12/1/2023
B3036	Rebuild 15.4 miles of double circuit North Delphos - Rockhill 138 kV line	$24.50	AEP	AEP	12/1/2023
b3037	Upgrades at the Natrium substation	$1.10	AEP	AEP	6/1/2023
b3038	Reconductor the Capitol Hill - Coco 138 kV line section	$3.80	AEP	AEP	12/1/2023
b3039	Line Swaps at Muskingum 138 kV Station	$0.10	AEP	AEP	12/1/2023
b3040.1	Rebuild Ravenswood - Racine Tap 69 kV line section (~15 miles) to 69 kV standards, utilizing 795 26/7 ACSR conductor	$39.20	AEP	AEP	6/1/2022
b3040.2	Rebuild existing Ripley - Ravenswood 69 kV circuit (~9 miles) to 69 kV standards, utilizing 795 26/7 ACSR conductor	$23.60	AEP	AEP	6/1/2022
b3040.3	Install new 3-way phase over phase switch at Sarah Lane station to replace the retired switch at Cottageville.	$1.00	AEP	AEP	6/1/2022
b3040.4	Install new 138/12 kV 20 MVA transformer at Polymer station to transfer load from Mill	$3.50	AEP	AEP	6/1/2022

	Run Station to help address overload on the 69 kV network.				
b3040.5	Retire Mill Run station.	$0.00	AEP	AEP	6/1/2022
b3040.6	Install 28.8 MVAr Cap Bank at South Buffalo station.	$0.80	AEP	AEP	6/1/2022
b3041	Peach Bottom - Furnace Run 500kV Terminal Equipment	$3.50	PECO	PECO	6/1/2021
b3042	Replace substation conductor at Raritan River 230 kV substation on the Kilmer line terminal	$0.05	JCPL	JCPL	6/1/2023
b3043	Install one 115 kV 36 MVAR capacitor at West Fall 115 kV substation	$0.90	PENELEC	PENELEC	6/1/2023
b3044	Increase the MOT of the double circuit Cooper-Somerset 69kV line 266.8 MCM conductor from 212°F to 266°F	$0.35	EKPC	EKPC	6/1/2020
b3045	Increase the MOT of Liberty Church Tap-Bacon Creek Tap 69kV line 266.8 MCM conductor from 212°F to 266°F	$0.25	EKPC	EKPC	6/1/2020
b3046	Increase the MOT of Summer Shade-JB Galloway Jct. 69kV line 266.8 MCM conductor to from 167°F to 212°F.	$0.75	EKPC	EKPC	6/1/2020
b3047	Upgrade the existing 4/0 CU line jumpers with double 500 MCM CU associated with the Green Co-KU Green Co 69 KV line section. Also, replace the existing 600 A disconnect switches with 1200 A associated with the Green Co 161/69 KV transformer	$0.25	EKPC	EKPC	6/1/2020

b3048	Replace 138 kV breakers 937, 941 and 945 at TODHunter station	$1.90	DEOK	DEOK	12/31/2020
b3049	Replace 345kV breaker at Joliet Substation	$4.00	ComEd	ComEd	6/1/2020
b3050	Install redundant relay to Port Union 138 kV Bus#2	$0.37	DEOK	DEOK	6/1/2023
b3051.1	Ronceverte Cap Bank and Terminal Upgrades	$0.72	APS	APS	6/1/2018
b3051.2	Adjust CT tap ratio at Ronceverte 138 kV	$0.01	AEP	AEP	6/1/2018
B3052	Install a 138 kV capacitor (29.7 MVAR effective) at West Winchester 138 kV.	$1.01	APS	APS	6/1/2018
B3056	Partial Rebuild 230 kV Line #2113 Waller to Lightfoot	$4.00	Dominion	Dominion	6/1/2018
B3057	Rebuild 230 kV Lines #2154 and #19 Waller to Skiffes Creek	$10.00	Dominion	Dominion	6/1/2018
B3058	Partial Rebuild of 230 kV Lines #265, #200 and #2051 Rebuild	$11.50	Dominion	Dominion	6/1/2018

Attachment B - Reliability Project Multi-Zone Allocations

Upgrade ID	Description	Cost Estimate ($M)	Trans Owner	Cost Responsibility	Required IS Date
B3053	Upgrade terminal equipment on Gibson - Petersburg 345kV	$4.30	MISO	AEP (4.79%) / ATSI (0.22%) / COMED (1.45%) / DAYTON (0.05%) / DL (0.01%) / ME (0.02%) / PECO (0.10%) / PENELEC (0.11%) / PPL (0.05%) / PSEG (0.20%) / MISO (93.00%)	10/29/2018

Attachment C – Interconnection Queue Projects

Queue Position	Path Name	Request Type	TO
Y3-092	Erie West 345kV	Merch. Trans.	PENELEC
AD2-084	Cardiff 230kV	Merch. Trans.	AEC

Queue Position	Path Name	Request Type	MWs
AC1-056	PJM-AMIL	Long-Term Firm	100
AC1-126	PJM-CPLE	Long-Term Firm	25
AC1-127	PJM-CPLE	Long-Term Firm	25
AC1-128	PJM-CPLE	Long-Term Firm	25
AC1-129	PJM-CPLE	Long-Term Firm	25
AC1-131	PJM-CPLE	Long-Term Firm	50
AC1-132	PJM-CPLE	Long-Term Firm	50
AC1-133	PJM-CPLE	Long-Term Firm	100
AD1-021	PJM-LindenVFT	Long-Term Firm	330

Transmission Owner	Queue Position	Fuel Type	MW Capacity (FTIR/FTWR)	MW Energy (nFTIR/nFTWR)
ATSI	Z1-035	Wind	2.34	18
PSEG	Z1-116	Natural Gas	671	675
PSEG	Z2-002	Natural Gas	54	61
AEC	Z2-083	Natural Gas	74	74
PENELEC	AA1-111	Natural Gas	463	463
AEP	AA2-070	Hydro	34	34
PENELEC	AA2-133	Natural Gas	19.9	19.9
AEP	AB1-058	Coal	11	11
PENELEC	AB1-092	Natural Gas	17	41
AEP	AB1-109	Coal	36	36
Dayton	AB1-169	Natural Gas	1100	1150
Dominion	AB2-022	Solar	13	20
AEP	AB2-028	Wind	26	200
APS	AB2-041	Wind	3.7	19.4
AEP	AB2-083	Solar	27.2	40
AEP	AB2-085	Solar	54.4	80
AEP	AB2-141	Natural Gas	388.6	394
AEP	AB2-170	Solar	49.4	130
PECO	AB2-175	Nuclear	44	44

ComEd	AB2-191	Wind	8.4	20
AEP	AC1-001	Solar	54.4	80
APS	AC1-003	Natural Gas	80	80
APS	AC1-021	Natural Gas	0	110
JCPL	AC1-029	Natural Gas	20	20
Dominion	AC1-034	Solar	42.75	75
MAIT	AC1-035	Natural Gas	30	30
Dominion	AC1-036	Solar	5.7	15
AEP	AC1-038	Natural Gas	13	13
AEP	AC1-040	Solar	57	150
Dominion	AC1-042	Solar	15.96	42
Dominion	AC1-043	Solar	38	100
AEP	AC1-044	Natural Gas	550	550
ME	AC1-048	Solar	13.3	35
DPL	AC1-049	Solar	1.5	4
DPL	AC1-050	Solar	1.9	5
AEP	AC1-051	Wind	7.8	60
Dominion	AC1-054	Solar	44.5	65
APS	AC1-055	Natural Gas	30	30
Dominion	AC1-065	Solar	19	50
Dayton	AC1-068	Solar	34	49.9
Dayton	AC1-069	Solar	34	49.9
PPL	AC1-071	Wind	8.74	67.25
AEP	AC1-072	Natural Gas	20	20
APS	AC1-073	Wind; Storage	5.8	16.3
EKPC	AC1-074	Solar	56	80
Dominion	AC1-075	Solar	38.3	60
Dominion	AC1-076	Solar	23.8	62.5
ATSI	AC1-078	Solar	66	176
Dominion	AC1-080	Solar	12.8	20
AEP	AC1-082	Solar	29	48
AEP	AC1-083	Solar	38	100
Dayton	AC1-085	Solar	152	400
Dominion	AC1-086	Solar	123.7	180
PPL	AC1-087	Solar	3.8	10
AEP	AC1-089	Solar	57	150
DPL	AC1-095	Solar	3.8	9.9
Dominion	AC1-098	Solar	37.6	60
Dominion	AC1-099	Solar	12.6	20
AEP	AC1-101	Solar	19	50

AEP	AC1-102	Solar	19	50
AEP	AC1-103	Natural Gas	1026	1050
Dominion	AC1-105	Solar	34.5	51
Dominion	AC1-107	Natural Gas	1600	1600
PENELEC	AC1-108	Natural Gas	100	50
Dominion	AC1-120	Solar	39.6	60
Dominion	AC1-121	Solar	13.6	20
AEP	AC1-122	Solar	40.7	60
AEP	AC1-123	Solar	13.7	20
Dominion	AC1-134	Natural Gas	50	0
APS	AC1-140	Coal	10	10
Dominion	AC1-143	Solar	41.2	60
Dominion	AC1-145	Solar	19	50
PPL	AC1-151	Solar	7.6	20
AEP	AC1-152	Natural Gas	50	50
Dominion	AC1-158	Solar	347.5	500
Dominion	AC1-159	Natural Gas	369.1	250.1
Dominion	AC1-161	Solar	168.2	240
Dominion	AC1-162	Solar	168.9	240
Dominion	AC1-164	Solar	220.8	320
Dayton	AC1-165	Solar	33.6	49.9
Dayton	AC1-166	Solar	33.6	49.9
AEP	AC1-167	Solar	33.6	49.9
AEP	AC1-173	Wind	9.9	75.9
AEP	AC1-174	Solar	38	100
AEP	AC1-175	Solar	38	100
AEP	AC1-176	Wind	7.6	58.7
DPL	AC1-177	Biomass	4	4
ATSI	AC1-181	Natural Gas	5	5
DEOK	AC1-182	Coal	20	20
ComEd	AC1-185	Natural Gas	48	48
AEP	AC1-188	Solar	46.6	70
Dominion	AC1-189	Solar	53.4	80
DPL	AC1-190	Solar	35	50
Dominion	AC1-191	Solar	53.4	80
AEP	AC1-194	Solar	47.5	125
ComEd	AC1-204	Natural Gas	1115.9	1200.9
Dominion	AC1-208	Solar	55.4	80
PECO	AC1-209	Solar	12.4	18
Dayton	AC1-212	Storage	1.9	19.9

DPL	AC1-213	Solar	3.2	5.3
Dominion	AC1-216	Solar	54.8	97.9
Dominion	AC1-221	Solar	14.6	29.2
Dominion	AC1-222	Solar	22.9	44.7
DPL	AC1-229	Solar	3.8	10
PSEG	AC2-009	Solar; Storage	0.1	0.59
Dominion	AC2-012	Solar	57	150
AEP	AC2-015	Solar	53.55	117
ODEC	AC2-018	Natural Gas	8	60
APS	AC2-021	Hydro	15	15
DPL	AC2-023	Solar	26.5	45.8
AEP	AC2-029	Solar	26.6	70
AEP	AC2-035	Solar	29.4	49
AEP	AC2-043	Solar	20	50
AEP	AC2-045	Solar	3.8	10
AEC	AC2-050	Solar	3.8	10
ME	AC2-053	Solar	7.6	20
DEOK	AC2-066	Solar	28.5	75
Dayton	AC2-067	Solar	18.9	49.9
Dayton	AC2-068	Solar	7.6	20
Dominion	AC2-070	Solar	9.2	13
Dominion	AC2-071	Solar	13.3	20
Dominion	AC2-072	Solar	13.3	20
Dominion	AC2-073	Solar	13.3	20
Dominion	AC2-074	Solar	10.4	15.65
EKPC	AC2-075	Solar	13.3	20
PENELEC	AC2-077	Natural Gas	20	20
Dominion	AC2-078	Solar	22.8	60
Dominion	AC2-079	Solar	32.3	85
AEP	AC2-080	Wind	26	200
DEOK	AC2-088	Solar	38.4	70
AEP	AC2-089	Solar	8.8	18.2
PPL	AC2-092	Natural Gas	65	55
Dominion	AC2-100	Solar	33.6	50
SMECO	AC2-101	Solar	12.35	32.5
Dominion	AC2-102	Solar	30.4	80
Dominion	AC2-107	Solar	68.1	100
Dominion	AC2-110	Solar	7.6	20
Dominion	AC2-112	Solar	103.1	150
Dominion	AC2-113	Solar	13.3	20

SMECO	AC2-120	Solar	10.45	27.5
PENELEC	AC2-122	Solar	19	50
AEP	AC2-123	Solar	44.6	75
Dominion	AC2-133	Natural Gas	20	20
Dominion	AC2-137	Solar	11.4	18.8
Dominion	AC2-138	Solar	4.8	10.8
Dominion	AC2-141	Solar	168.2	240
APS	AC2-142	Natural Gas	129.7	129.7
Dominion	AC2-161	Solar	13.2	20
Dominion	AC2-162	Solar	13.2	20
PPL	AC2-170	Solar	3	0
AEP	AC2-172	Natural Gas	12	17
AEP	AC2-176	Wind	16.9	150
DPL	AC2-186	Solar	3.8	10
DPL	AC2-187	Solar	7.6	20
DPL	AC2-188	Solar	7.6	20
ATSI	AC2-195	Solar	62.1	99.96
Dominion	AC2-196	Solar	10	16.7
JCPL	AD1-028	Natural Gas	0	0.2
Dominion	AD1-048	Solar	13.3	20
PSEG	AD1-053	Solar	0	3
PSEG	AD1-054	Solar	0	1.5
JCPL	AD1-059	Natural Gas	14.9	0
APS	AD1-060	Solar	5.7	15
ComEd	AD1-062	Storage	0	1
Dominion	AD1-063	Solar	9	15
PSEG	AD1-071	Solar	0.99	2.6
Dominion	AD1-084	Hydro	5.5	5.5
PENELEC	AD1-108	Natural Gas	1.5	1.5
PENELEC	AD1-109	Natural Gas	1.1	1.1
PENELEC	AD1-110	Natural Gas	1.5	1.5
DL	AD1-135	Solar	3.15	8.3
DEOK	AD1-136	Solar	5.4	10
PENELEC	AD1-142	Natural Gas	1.1	1.1
Dominion	AD1-144	Solar	9.7	15
Dominion	AD1-156	Solar	11.82	19.7
Dominion	AD1-157	Solar	9	15

Attachment D – Interconnection Network Upgrades

Upgrade ID	Description	Cost Estimate ($, Millions)	Required In-Service Date
n5696	Modify Relay and Control in association with TSS98 Nevada construction	0.258	3/1/2019
n5697	Modify Relay and Control in association with TSS98 Nevada construction	0.258	3/1/2019
n5698	Install Fiber work associated with TSS98 Nevada construction	3.456	3/1/2019
n5960	Relay Modification Work to accommodate the AA1-077 uprate	0.0384	1/31/2019
n5739	Replace the existing breaker and wave trap at East Towanda 115 kV sub, and replacing the wave trap at the North Meshoppen 115kV Sub	0.2428	3/30/2021
n5740	Stability Reinforcement for AA1-111: Install a 230-345kV transformer between the proposed AA1-111 interconnection swichyard and the NYSEG Q496 interconnection switchyard	12.5726	3/30/2021
n5905	Glen Falls-McAlpin 138 kV Line – Replace Tower #87 w/ one (1) steel pole, single circuit, dead-end structure	0.3	6/1/2020
n5906	Glen Falls-Waldo Run/Glen Falls -Fairview 138kV lines – Replace Tower #1 w/ two (2) steel pole, single circuit, tangent structures	0.35	6/1/2020
n5516	Oversight for splicing, terminating, and testing fiber for Direct Transfer Trip (DTT) at the AA2-133 Point of Interconnection	0.11	5/31/2019
n5488	Perform a sag study on the W4-004 - Madison 138 kV line.	0.09	12/31/2017

n5909	Z-70 Elwyn breaker at Dravosburg 138 kV substation from a 50 kA breaker to a 63 kA breaker. Time estimate is 8-12 months.	0.4	6/1/2021
n5573	AEP shall review and revise line protection settings at the Meadow Lake 345 kV switching station.	0.04	12/31/2018
n5476	Build a three breaker ring bus at Harts Mill substation	4.7214	11/15/2020
n5477	Install power Line Carrier communication at Hathaway - Tarboro line #80 and 55	0.8108	11/15/2020
n5478	Install Transmission structure at Heartsease DP - Anaconda line # 80, to loop line #80 into and out of Harts Mill substation	1.0388	11/15/2020
n5496	Modify transfer trip equipment at Thelma and Lakeview 230 kV substations	0.12	11/1/2020
n5475	transfer trip equipment at Carolina, Clubhouse, and Emporia substations	0.14703	3/31/2018
n5528	Install a new T-Line Cut in at the Desoto-Fall Creek 345 kV	2.2	10/31/2018
n5529	Install 345 kV Revenue Metering at the new AB2-028 switching station	0.25	10/31/2018
n5530	Install line protection and controls at the new 345 kV switching station.	0.3	10/31/2018
n5624	Install new transmission structures, as well as 2 switches and one wave trap at the new AB2-040 substation	1.44	5/1/2020
n5625	Upgrade protection and communication to allow for interconnection of the AB2-040 generating facilities	0.91	5/1/2020
n5482	Reconductor 0.14 miles of conductor to 550MVA for line # 259 between Chesterfield and Basin	0.25	3/31/2021
n5483	Replace wave trap at Elmont	0.7	3/31/2021

	and Ladysmith substations		
n5484	Replace circuit breaker number 210512 with 50kA breaker	0.3	3/31/2021
n5644	Install two breakers and new connection point at Chesapeake substation	1.44	3/31/2021
n5645	Raise four 115 kV lines outside of the Chesapeake substation and replace a 230 kV line span	5.413	3/31/2021
n5646	Install protection and communication equipment to support queue AB2-051 at Greenwich and Yadlkin 230 kV substations	0.096	3/31/2021
n5719	Queue AB2-059 switching station: Build new three (3) CB ring switchyard	5.263	6/20/2018
n5720	Hathaway-Harts Mill 115 kV Transmission Line termination into AB2-059 Interconnection Yard	2.9337	6/20/2018
n5721	Modify remote relaying at Hathaway Substation	0.0644	6/20/2018
n5722	Modify remote relaying at the Harts Mill Substation	0.0361	6/20/2018
n5715	Queue AB2-060 switching station: Build new three (3) CB ring switchyard	4.7757	6/1/2020
n5716	Chase City-Gary 115 kV Transmission Line termination into AB2-060 Interconnection Yard	1.6825	6/1/2020
n5717	Chase City Substation: Remote relaying modifications	0.1659	6/1/2020
n5718	Lunenburg Substation: Remote relaying modifications	0.0588	6/1/2020
n5651	Install new transmission structures, as well as 2 switches and one wave trap at the new AB2-040 substation	1.663	7/1/2020
n5652	Upgrade protection and communication equipment to allow for interconnection of the AB2-062 generating facilities	0.142	7/1/2020

n5714	Modify Chickahominy - Elmont 500kV line #557 and Chesterfield - Lanexa 115kV line #92 to be relocated near Chickahominy substation	2.55	9/30/2022
n5664	Install transmission structure to loop line #36 into Queue AB2-077 / 078 / 079 switching station	1.482	12/15/2020
n5665	Build three breaker ring bus at AB2-077 / 078 / 079 switching station	5.175	12/15/2020
n5666	Upgrade protection and communication for interconnection of Queue AB2-077 / 078 / 079	0.98	12/15/2020
n5491	System Protection Work on the Beechwood - Palmer Springs 115 kV line, to accommodate AB2-089	0.095	6/1/2018
n5492	Install transmission Structure in-line with the Beechwood - Palmer Springs 115 kV line transmission line to allow the proposed interconnection station to be interconnected to the transmission system	0.5	6/1/2018
n5493	Attachment Facilities work to accommodate AB2-089 including: Construct one span of attachment line between the generation substation and the new AB2-089 Switching Substation, Establish new 115kV AB2-089 switching substation and install all metering and associated protection equipment at the generation substation.	3.05	6/1/2018

n5649	Complete all required upgrades to the Chase City 115/34.5kV substation to accommodate AB2-090 including: - Install an 84MVA 115-34.5kV transformer and a high side circuit switcher off of the 115kV bus # 4 - Install a new distribution breaker and distribution bay including necessary circuit protection equipment on the new feeder - Install accompanying load-break disconnects and a 4800kVAR capacitor bank on the new bus. - Install bus PTs, station service and IC panel to support the interconnection.	4.8753	12/31/2020
n5650	Complete all work required to overbuild the existing circuit #920 with new 477AL 34.5kV circuit from Chase City Substation, approximately 2.2 miles to the Point of Interconnection on IC's property.	1.1838	12/31/2020
n5304.1	Replace the Kammer wavetrap (2000 A) on the Kammer - George Washington 138 kV line	0.212	2/15/2020
n5560	Kammer-Ormet #1 138kV T-Line modifications	0.8869	2/15/2020
n5561	Kammer-Ormet #2 138kV T-Line modifications	0.6705	2/15/2020
n5562	Install Fiber-Optic Transition Cable at Hannibal 138 kV substation	0.0601	2/15/2020
n5563	Hannibal to IPP Fiber Interconnection installation	0.0425	2/15/2020
n5614	Build a three breaker ring at the new AB2-134 substation	6.573	12/31/2019
n5615	Install transmission structure to loop line #212 into and out of new AB2-134 substation	1.784	12/31/2019

n5616	Upgrade relay protection and communication to allow for interconnection of the AB2-134 generating facilities	0.113	12/31/2019
n5557	Expand the George Washington 138 kV GIS Substation	2	4/1/2019
n5558	Install 138 kV Revenue Metering at the George Washington substation	0.25	4/1/2019
n5559	Install line protection and controls at the newly configured George Washington 138 kV GIS substation.	0.25	4/1/2019
n5623	Install System Protection at the North Anna, South Anna, and Louisa Pumping Stations to accommodate the AB2-158 Interconnection	0.0812	10/1/2018
n5620	Build a three breaker ring at the new AB2-169 substation	5.448	12/31/2019
n5621	Install Transmission structure to loop line #189 into and out of new AB2-169 substation	1.337	12/31/2019
n5622	Upgrade protection and communication to allow for interconnection of the AB2-169 generating facilities	0.208	12/31/2019
n5497	Build a new AB2-174 switching station	5.5	11/1/2020
n5498	Install a dead end construction at the new AB2-174 switching station	0.8	11/1/2020
n5499	Replace transfer trip equipment at the Carolina and Clubhouse 115 kV substations	0.12	11/1/2020
n5500	Install a new transformer at the Clubhouse substation	9	11/1/2020
n5647	Review the relay settings and update record drawings at Mendota Hills 138 kV substation	0.02	3/1/2019
n5512	Adjust relay settings at the Delano 138 kV substation	0.05	1/1/2019
n5513	Upgrade the 138 kV revenue meter if the installed meter for the AB2-083 is not adequate for	0.1	1/1/2019

	the additional generation.		
n5553	Expand Rockport 345 kV Substation	3	12/31/2020
n5554	Install 345 kV Revenue Metering at the expanded Rockport substation	0.35	12/31/2020
n5555	Install line protection and controls at the expanded Rockport 345 kV substation	0.5	12/31/2020
n5556	Upgrade line protection and control settings at the Rockport 765 kV substation to coordinate with the expanded Rockport 345 kV substation	0.05	12/31/2020
n5494	Upgrade 765 kV Revenue Metering at the new 765 kV switching station	0.2	6/1/2020
n5495	Adjust relay settings at the New 765 kV Switching Station	0.1	6/1/2020
n5667	Install breaker, disconnect switches, CVT's and installation of relays/controls, and install fiber interface for new AC1-048 & AC2-053 fiber or OPGW. Fiber Work - Install in-sub fiber runs.	1.18	12/31/2020
n5567	Build New 69 kV Switching Station	2	12/31/2017
n5568	Construct Greenwich-South Greenwich 69 kV T-Line Cut In	0.75	12/31/2017
n5569	Construct Willard-Greenwich 69 kV T-Line Work	0.25	12/31/2017
n5570	Construct Carrothers-Willard 69 kV T-Line Work	0.25	12/31/2017
n5571	Install 69 kV Revenue Metering at the new AC1-051 substation	0.15	12/31/2017
n5572	Expand Willard 69 kV Substation	1	12/31/2017
n5892	Atlanta 69 kV Substation: Install new 69 kV ring bus including 3 circuit breakers, metering, protection and control, and SCADA upgrades	1.5	12/1/2019

n5933	Replace a full tension takeoff structure and upgrade the conductor leaving Adkins sub on the Adkins-Beatty 345 kV line.	0.4	12/1/2019
n5893	Atlanta 69 kV Substation: Expand 69 kV ring bus with an additional circuit breaker bay, metering, protection and control, and SCADA upgrades	0.83	12/1/2019
n5900	Construct one (1) new standard four bay BAAH 230kV switchyard	14.919	12/14/2018
n5901	Relay work at Lackawanna Substation	0.204	12/14/2018
n5902	Relay work at Paupack Substation	0.204	12/14/2018
n5924	All work associated with break and cut-in of the Lackawanna - Paupack 230kV line to interconnect the new AC1-071 BAAH substation with the transmission system	4.5	12/14/2018
n5958	Adjust Remote Relay and Metering Settings at the Leadsville 138 kV substations.	0.0308	3/31/2018
n5929	Build 138kv switching station at Jacksonville Tap including associated transmission line work	3.2	6/1/2019
n5930	Adjust remote, relaying, and metering settings at Jacksonville 138kV Sub	0.05	6/1/2019
n5931	Adjust remote, relaying, and metering settings at Renaker 138kV Sub	0.05	6/1/2019
n5925	AC1-078 - Install a 138kV three breaker ring bus on the London-Beatty (AEP) line for interconnection with AC1-078.	4.89	12/31/2019
n5926	Loop the Beatty-London 138kV circuit into the proposed 3-breaker ring bus.	0.51	12/31/2019
n5927	London - Replace Beatty 138kV line relaying for new AC1-078 line.	0.27	12/31/2019

n5928	Beatty Road 138kV Substation (AEP): Remote end relay changes for AC1-078 Substation on the 138kV London Line	0.25	12/31/2019
n5939	Install Metering and associated protection equipment at the AC1-080 generation Substation	0.6	6/1/2018
n5940	Build 115 kV attachment line from the AC1-080 Switching Substation to the POI	0.5	6/1/2018
n5941	Build New AC1-080three breaker ring bus Switching Substation (interconnection substation)	5.6	6/1/2018
n5942	Install Transmission structure in line with Perth - Hickory Grove 115kV transmission line to allow the proposed AC1-080 interconnection switching station to be interconnected with the transmission system	1	6/1/2018
n5589	Build a new 69 kV Switching Station	3.5	5/1/2018
n5590	Install T-Line Cut In on the Ravenswood-Hemlock 69 kV line	0.7	5/1/2018
n5591	Install 69 kV Revenue Metering at the new AC1-082 substation	0.2	5/1/2018
n5592	Upgrade line protection and controls at the Ravenswood 69 kV substation to coordinate with the new 69 kV switching station.	0.2	5/1/2018
n5593	Upgrade line protection and controls at the Hemlock 69 kV substation to coordinate with the new 69 kV switching station.	0.2	5/1/2018
N5599	Build a New 138 kV AC1-083 Switching Station	5	6/1/2018
N5600	Construct Smith Mountain-Bearskin 138 kV T-Line Cut In	1	6/1/2018
N5601	Install 138 kV Revenue Metering at the new AC1-083	0.25	6/1/2018

N5602	Install protection and controls at the new 138 kV switching station.	0.95	6/1/2018
N5603	Upgrade line protection and controls at the Smith Mountain 138 kV substation to coordinate with the new 138 kV switching station.	0.25	6/1/2018
n5692	AC1-085 Interconnection Switchyard Tie-In to Stuart-Clinton 345 kV Line	1.294179	6/21/2018
n5896	Install new 3 breaker ring interconnection switchyard for the AC1-085 project	6.05	6/1/2019
n5897	Upgrade Stuart 345 kV line relaying at Clinton Substation	0.1	6/1/2019
n5898	Upgrade Clinton 345 kV line relaying at Stuart Substation	0.1	6/1/2019
n5904	Modify Relay Settings at Hauto Substation	0.0256	6/1/2016
n5578	Install 138 kV Revenue Metering at the Wildcat substation	0.25	10/1/2019
n5579	Upgrade line protection and controls at the expanded Wildcat 138 kV substation.	0.25	10/1/2019
n5580	Upgrade line protection and controls at the Hillsboro 138 kV substation.	0.25	10/1/2019
n5581	Upgrade line protection and controls at the Kenton 138 kV substation.(This estimate needs to be confirmed by LGEE)	0.25	10/1/2019
n5582	To accommodate the interconnection at the Wildcat 138 kV substation, the Wildcat substation will have to be expanded requiring two (2) additional 138 kV circuit breakers to physically configure the substation in a breaker and half bus arrangement (see Figure 2). Installation of associated protection and control equipment, 138 kV line	3	10/1/2019

	risers, SCADA.		
n5594	Build a new 138 kV Switching Station	5	6/1/2018
n5595	Install T-Line Cut in at the Johns Creek-Excel 138 kV line	1	6/1/2018
n5596	Install 138 kV Revenue Metering at the new substation	0.3	6/1/2018
n5597	Upgrade line protection and controls at the Johns Creek 138 kV substation to coordinate with the new 138 kV switching station.	0.2	6/1/2018
n5598	Upgrade line protection and controls at the Inez 138 kV substation to coordinate with the new 138 kV switching station.	0.2	6/1/2018
n5540	Expand Nottingham 138 kV Substation	4.5	10/21/2020
n5541	Install 138 kV Revenue Metering at the expanded Nottingham 138kV substation	0.25	10/21/2020
n5542	Upgrade line protection and controls at the expanded Nottingham 138 kV substation.	0.4	10/21/2020
n5543	Upgrade line protection and control settings at the Freebyrd 138 kV remote-end substation.	0.25	10/21/2020
n5544	Upgrade line protection and control settings at the Yager 138 kV remote-end substation.	0.25	10/21/2020
n5545	Upgrade line protection and control settings at the Holloway 138 kV remote-end substation.	0.25	10/21/2020
n5546	Upgrade line protection and control settings at the Knox FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. PJM will have to coordinate this	0.25	10/21/2020

	upgrade with FE.		
n5547	Upgrade line protection and control settings at the Brookside FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. PJM will have to coordinate this upgrade with FE.	0.25	10/21/2020
n5548	Upgrade line protection and control settings at the Longview FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. PJM will have to coordinate this upgrade with FE.	0.25	10/21/2020
n5549	Upgrade line protection and control settings at the Harmon FE 138 kV substations to coordinate with the expanded Nottingham 138 kV substation. PJM will have to coordinate this upgrade with FE.	0.25	10/21/2020
n5943	Install Metering and associated protection equipment at the generation Substation	0.6	6/1/2019
n5944	Build 115 kV attachment line from the AC1-121 Switching Substation to the POI	0.5	6/1/2019
n5945	Build New AC1-121 three breaker ring bus Switching Substation (interconnection substation)	5.6	6/1/2019
n5946	Install Transmission structure in line with Mitchell-Mountain Run 115kV transmission line to allow the proposed interconnection switching station to be interconnected with the transmission system	0.6	6/1/2019
n5626	Build a New 138 kV AC1-122/123 Switching Station	5	6/1/2019

n5627	Construct Smith Mountain-Candlers Mountain 138 kV T-Line Cut In	1	6/1/2019
n5628	Install 138 kV Revenue Metering at the new AC1-122/123	0.25	6/1/2019
n5629	Install protection and controls at the new 138 kV switching station.	0.25	6/1/2019
n5630	Upgrade line protection and controls at the Smith Mountain 138 kV substation to coordinate with the new 138 kV switching station.	0.25	6/1/2019
n5631	Upgrade line protection and controls at the Opossum Creek 138 kV substation to coordinate with the new 138 kV switching station.	0.25	6/1/2019
n5947	North Longview 500 kV Substation: Adjust remote end relaying and metering settings.	0.0127	6/30/2018
n5963	Relay and Protection Work to accommodate the AC1-151 project	0.179	2/28/2019
n5964	Tap the Harwood - Berwick 69kV line and route line to the AC1-151 POI	0.96	2/28/2019
n5965	Provide and commission metering to be installed at Interconnection Customer substation	0.067	2/28/2019
n5966	Expand the ring bus by installing circuit breaker at Spotsylvania substation	3.5	5/1/2019
n5938	Wreck and rebuild the Waller – Lightfoot 230 KV line to a rating of 1047 MVA	15.2	1/1/2021
n5894	Atlanta 69 kV Substation: Expand 69 kV ring bus with an additional circuit breaker bay, metering, protection and control, and SCADA upgrades	0.83	12/1/2019

n5895	Atlanta 69 kV Substation: Expand 69 kV ring bus with an additional circuit breaker bay, metering, protection and control, and SCADA upgrades	0.83	12/1/2019
n5640	Expand Mark Center 69 kV Substation	0.7	12/1/2019
n5641	Install 69 kV Revenue Metering at Mark Center 69 kV Substation	0.2	12/1/2019
n5642	Upgrade line protection and controls at the expanded Mark Center 69 kV substation.	0.2	12/1/2019
n5648	Upgrade 138 kV Revenue Metering at Logtown 138 kV Substation	0.1	10/31/2019
n5653	Expand Losantville 345 kV Substation	3	11/30/2019
n5654	Install 138 kV Revenue Metering at the Losantville 345 kV substation	0.35	11/30/2019
n5655	Upgrade line protection and controls at the expanded Losantville 345 kV substation.	0.35	11/30/2019
n5656	Upgrade line protection and control settings at the Desoto 345 kV substation to coordinate with the expanded Losantville 345 kV substation.	0.05	11/30/2019
n5657	Upgrade line protection and control settings at the Tanners Creek 345 kV substation to coordinate with the expanded Losantville 345 kV substation.	0.05	11/30/2019
n5668	Construct a new 138 kV Switching Station	5	12/31/2019
n5669	Install Rio-Lick 138 kV T-Line Cut In	1	12/31/2019
n5670	Upgrade 138 kV Revenue Metering at the new AC1-188 switching station	0.25	12/31/2019
n5671	Upgrade line protection and controls at the Sporn 138 kV substation to coordinate with the new 138 kV switching station.	0.25	12/31/2019

n5672	Upgrade line protection and controls at the Lick 138 kV substation to coordinate with the new 138 kV switching station.	0.25	12/31/2019
n5673	Upgrade line protection and controls at the Addison 138 kV substation to coordinate with the new 138 kV switching station.	0.25	12/31/2019
n5674	Expand the Elk 138 kV Substation	5	12/31/2018
n5675	Elk-Poston 138 kV circuit Cut Into Elk substation	0.5	12/31/2018
n5676	Install 138 kV Revenue Metering at Elk substation	0.25	12/31/2018
n5677	Upgrade line protection and controls at the Poston 138 kV substation to coordinate with the expanded Elk 138 kV substation.	0.25	12/31/2018
n5678	Upgrade line protection and controls at the Corwin 138 kV substation to coordinate with the expanded Elk 138 kV substation.	0.25	12/31/2018
n4057	Perform a sag study on the Upnor - Olive 345 kV line	0.26	6/1/2016
n5915	Reconductor the Elwood - Goodings Grove 'B' 345 kV line, upgrade the station conductor at both line terminals, and upgrade the line circuit breaker at Goodings Grove.	23	6/1/2022
n5916	Reconductor the Elwood - Goodings Grove 'R' 345 kV line, upgrade the station conductor at both line terminals, and upgrade the line circuit breaker at Goodings Grove.	23	6/1/2022
n5917	Reconductor the E Frankfort - Crete 345 kV line.	10	6/1/2022
n5918	Upgrade station conductor on the Kendall - Lockport 'B' 345 kV line.	0.9	6/1/2022

n5606	Line #2018 Chesapeake-Greenwich 230 kV:wreck and rebuild the line of 11 miles to increase its line rating to 1047 MVA (normal), 1047 MVA (emergency), and 1204 MVA (load dump). It is estimated to cost $26,500,000 and 30-36 months to engineer, permit, and construct. A Va CPCN is required.	26.5	12/31/2019
n5699	Build a new 138 kV Switching Station with required Protection and Controls	5.95	12/31/2019
n5700	Construct Howard - Chatfield 138 kV T-Line Cut In	1	12/31/2019
n5701	Install 138 kV Revenue Metering at the new AC2-015 substation	0.25	12/31/2019
n5702	Upgrade line protection and controls at the Chatfield 138 kV substation to coordinate with the new 138 kV switching station.	0.25	12/31/2019
n5703	Upgrade line protection and controls at the Howard 138 kV substation to coordinate with the new 138 kV switching station.	0.25	12/31/2019
n5704	Upgrade line protection and controls at the Melmore 138 kV substation to coordinate with the new 138 kV switching station.	0.25	12/31/2019
n5705	Install one 138 kV Circuit Breaker at the Circleville 138 kV Substation	1.5	12/31/2019
n5706	Install 138 kV Revenue Metering at Circleville 138 kV substation	0.25	12/31/2019
n5707	Upgrade line protection and controls at the Circleville 138 kV substation.	0.25	12/31/2019
n5708	Build a new 69 kV Switching Station with Protection and Controls	4.35	6/1/2019
n5709	Construct Lick-Firebrick 69 kV T-Line Cut In	0.7	6/1/2019

n5710	Install 69 kV Revenue Metering	0.2	6/1/2019
n5711	Upgrade line protection and controls at the Lick 69 kV substation to coordinate with the new 69 kV switching station	0.2	6/1/2019
n5712	Upgrade line protection and controls at the Firebrick 69 kV substation to coordinate with the new 69 kV switching station.	0.2	6/1/2019
n5730	Build a new 138 kV Switching Station	5.95	12/15/2018
n5731	Construct West Millersport-South Baltimore 138 kV T-Line Cut In	1	12/15/2018
n5732	Install 138 kV Revenue Metering at the new AC2-043 substation	0.25	12/15/2018
n5733	Upgrade line protection and controls at the West Millersport 138 kV substation.	0.25	12/15/2018
n5734	Upgrade line protection and control settings at the South Baltimore 138 kV substation.	0.25	12/15/2018
n5518	Tap the Camden-Crystal 69 kV line section and install a three-way phase switch to interconnect the AC2-067 Project. (One switch covering the generator lead line is considered an Attachment Facility).	0.064	7/1/2019
n5519	Tap the Camden-Crystal 69 kV line section and install a three-way phase switch to interconnect the AC2-067 project. (Two network switches of the three-way switch are considered Non-Direct Connection Facilities).	0.128	7/1/2019
n5520	Modify protection system at Crystal Substation	0.1	7/1/2019
n5521	Modify protection system at Hutchings Substation	0.1	7/1/2019
n5735	Build a new 345 kV Switching Station	9.25	12/31/2019

n5736	Construct Olive – Reynolds (NIPSCO) 345 kV T-Line Cut In	1.2	12/31/2019
n5737	Install 345 kV Revenue Metering at new AC2-080 substation	0.35	12/31/2019
n5738	Upgrade line protection and controls at the Olive 345 kV substation.	0.35	12/31/2019
n5643	Relay Modification Work to Accommodate AC2-092	0.0256	6/1/2021
n5612	Line #153 AC1-076 Tap – Paytes DP 115 kV: wreck and rebuild the line of 3 miles to increase its line rating to 262 MVA (normal), 287 MVA (emergency), and 349 MVA (load dump). It is estimated to cost $6,500,000 and 24-36 months to engineer, permit and construct. A Va CPCN is required.	6.5	6/30/2019
n5613	4ALTVSTA-05OTTER 138 kV line (AEP upgrade) – Rebuild/Reconductor 0.9 miles conductor section. Estimated Cost: $1.8 Million. New ratings after work is completed:• SN: 257MVA • SE: 360MVA • WN: 325MVA • WE: 404MVA	1.8	10/1/2019
n5742	Expand Jacksons Ferry 138 kV Substation	1.5	12/31/2021
n5743	Install 138 kV Revenue Metering at Jackson Ferry	0.25	12/31/2021
n5744	Upgrade line protection and controls at the Jacksons Ferry 138kV substation	0.25	12/31/2021
n5968	Install one 138 kV Circuit Breaker at the Jay 138 kV Substation and associated equipment, including upgrades to line protection and controls.	1.25	10/1/2020
n5552	Reconductor the AB2-131 Tap - Galion 138 kV line and replace	8.8063	12/31/2020

	substation conductor at Galion.		
n5575	Construct AD1-060 Line Tap, Install 2 34.5 kV Line Switches, Install Single 34.5 kV Tap Switch, and Provide Revenue Metering Package	0.0625	9/1/2021
n5576	Adjust Remote End Relay Settings at Milnor and Mercersburg Substations	0.0127	9/1/2021
n5312.3	Replace the Wavetrap at Segreto substation	0.4	6/1/2019
n5487	Rebuild depending on the existing structure, approximately 22 miles of Cook – Benton Harbor 345 kV line.	40	6/1/2020
n5490	Reconductor 2.0 miles of the Lallendorf - Bayshore 345 kV line with bundled 795 ACSS, reconductor Lallendorf line drops, and replaces Lallendorf terminal rod gaps with arrestors. New ratings to be 1743/2278 MVA SN/SE	2.0893	6/1/2021
n5961	Replace Twin Brach substation Line Riser	0.2	9/1/2018
n5962	An engineering study will need to be conducted to determine if the relay thermal limit settings at Twin Branch can be adjusted. A new relay package will be required if the relay thermal settings cannot be adjusted	0.625	9/1/2018
n5967	A sag study will be required on the 19.33 mile AEP section of line to mitigate the overload. Depending on the sag study results, cost for the upgrade is expected to be between $78,000 (no remediation required just sag study) or $39.0 million (complete line rebuild required)	0.078	6/1/2020

n4377	Construct Transmission line from Covert Station to Segreto Station	1.5	3/1/2010
n5171.1	All existing 138kV circuit breakers at Kewanee are 3-cycle devices with achievable clearing time of 6/11 cycles. Relay upgrade on line L6101 will be required to support this clearing time.	0.14	12/31/2018
n5171.2	All existing 138kV circuit breakers at Kewanee are 3-cycle devices with achievable clearing time of 6/11 cycles. Relay upgrade on line L7411 will be required to support this clearing time.	0.14	12/31/2018
n5171.3	All existing 138kV circuit breakers at Kewanee are 3-cycle devices with achievable clearing time of 6/11 cycles. Relay upgrade on line L7421 will be required to support this clearing time.	0.14	12/31/2018
n5171.4	All existing 138kV circuit breakers at Kewanee are 3-cycle devices with achievable clearing time of 6/11 cycles. Relay upgrade on line L7423 will be required to support this clearing time.	0.14	12/31/2018
n5171.5	All existing 138kV circuit breakers at Kewanee are 3-cycle devices with achievable clearing time of 6/11 cycles. Relay upgrade on line L94301 will be required to support this clearing time.	0.14	12/31/2018
n5171.6	All existing 138kV circuit breakers at Kewanee are 3-cycle devices with achievable clearing time of 6/11 cycles. Relay upgrade on line segment of L15508 from Kewanee to U4-027 (new line number 7408)	0.14	12/31/2018

n5173	Add high-speed backup relaying and associated communications to 138kV line Kewanee to U4-027 (7408)	2.8	12/31/2018
n5533	Replace B13250 line trap, line tuner, coax, line relays, and carrier set at Richland Substation	0.3381	10/31/2018
n5479	Construct TSS 188 Mt. Pulaski on Brokaw-Lanesville Line 2107 (Engineering Oversight only)	1.67	12/31/2018
n5480	Cut in 2107 Line into TSS 188 Mt. Pulaski	1.381	12/31/2018
n5481	Relay and Communications oversight for Brokaw and Lanesville	0.1	12/31/2018
n5903	Engineering for realignment of antennas at Brokaw and Lanesville substations, and adding microwave radio and JMUX fiber optic at Mount Pulaski TSS 188	0.132	12/31/2018
n3647	Install current limiting reactors at Raritan River Substation on the Neptune Line	2.28	6/1/2016
n5034	Build a new Sullivan - Reynolds 765 kV line.	464	6/1/2021
n5035	Upgrade wave trap at Dumont on the Dumont - X1-020 765 kV line.	1	6/1/2021
n5469	Reconductor the Trimble - Clifty 345 kV line with a high temperature conductor and upgrade any necessary terminal equipment.	17.4	6/1/2021
n5741	Install a 230kV PAR on the Dunkirk-S.Ripley 230 kV line	15	3/30/2021
n4332	Upgrade carrier equipment and install DTT on the 115kV Niles Valley line. Utilize existing equipment on Everts Drive (future Mainesburg) line to receive breaker status from Mainesburg breaker.	0.16	9/21/2018

n4333	Install anti-islanding scheme at Mainesburg to transmit breaker open status of the Mansfield 115kV line breaker.	0.09	9/21/2018
n4334	Install anti-islanding scheme at Pierce Brook to transmit breaker open status of the Potter 115kV line breaker.	0.09	9/21/2018
n4335	Upgrade relay and carrier equipment at 115kV Potter substation	0.28	9/21/2018
n4276	Reimbursement for b2955. These costs are based upon the New Service Customer's needs to reconfigure one span of the the VFT to Warinanco U-2273 circuit to remove a clearance issue.	0.21	6/1/2017
n5607	Line #2114 Elk Run – Gainsville 230 kV: reconductor the line of 21 miles increase its line rating to 1203 MVA (normal), 1203 MVA (emergency), and 1383 MVA (load dump). It is estimated to cost $28,000,000 and 44-48 months to engineer, permit, and construct. A Va CPCN is required.	28	12/31/2019
n5609	Line #576 Midlothian – North Anna 500 kV: wreck and rebuild the line of 41 miles increase its line rating to 4453 MVA (normal), 4453 MVA (emergency), and 5121 MVA (load dump). It is estimated to cost $123,390,000 and 44-48 months to engineer, permit, and construct. A Va CPCN is required.	123.39	12/1/2021
n5605	Install second 115 kV bus tie breaker at Hooversville and relocate the Ralphton 115 kV line	3.8268	12/13/2019
n5564	Reconductor the Williams-Cedar Grove 230 kV Line with 1590	19.092	6/1/2019

	ACSS		
n5565	Reconductor Roseland-Cedar Grove 230 kVLine with 1590 ACSS	18.698	6/1/2019