



Transmission Expansion Advisory Committee
(TEAC)

Recommendations to the PJM Board

PJM Staff White Paper
December 2019



Executive Summary

On September 29, 2019, the PJM Board of Managers approved changes to the Regional Transmission Expansion Plan (RTEP), totaling \$265.6 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 \$134 million. Scope changes to existing projects will result in a net decrease of \$0.1 million. This yields an overall RTEP net increase of \$133.9 million, for which PJM is recommending Board approval. PJM is also providing the annual update of RTEP Generation and Merchant Transmission Network Upgrades in this white paper. PJM has identified over \$107 million in new network upgrades and over \$67 million increase due to scope changes for projects with an Interconnection service agreement. Additionally, PJM is recommending the cancelation of over \$1,450 million in previously identified network upgrades. With these changes, RTEP projects will total \$37,584.1 million since the first Board approvals in 2000.

PJM seeks Board Reliability Committee consideration and full Board approval of the additional RTEP baseline projects summarized in this white paper.



December 2019 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.

FERC Form No. 715 Transmission Owner Criteria-Driven Enhancements

AEP Transmission Zone:

- Rebuild 3.11 miles of the LaPorte Junction – New Buffalo 69 kV line with 795 ACSR.: \$12.3 million.

ODEC Transmission Zone:

- Create a line terminal at Belle Haven Delivery Point (three-breaker ring bus) and install a new single circuit 69 kV line rated at 55N/55E from Kellam substation to new Bayview substation (21 miles): \$22 million.

Baseline Load Growth Deliverability & Reliability-Driven Enhancements

Penelec Transmission Zone:

- Rebuild 20 miles of the East Towanda - North Meshoppen 115 kV line and adjust relay settings at East Towanda and North Meshoppen 115 kV: \$58.6 million.



Market Efficiency-Driven Enhancements

Note: Additional Information in regards to the following two recommended upgrades can be found in the companion document titled "December 2019 Baseline Market Efficiency Recommendations"

Nipsco Transmission Zone:

- Rebuild of Michigan City-Trail Creek-Bosserman 138 kV line: \$24.69 million (\$22 million is PJM portion).

MetEd Transmission Zone:

- Rebuild the Hunterstown-Lincoln 115 kV line and upgrade substation equipment at the Hunterstown and Lincoln (Project H-L): \$7.21 million.

PJM is also recommending two projects totaling \$1.9 million that include work required to complete the deactivation of two generators whose individual cost estimates are less than \$5 million each.

A more detailed description of the larger-scope projects that PJM is recommending to the Board is provided on the following page:

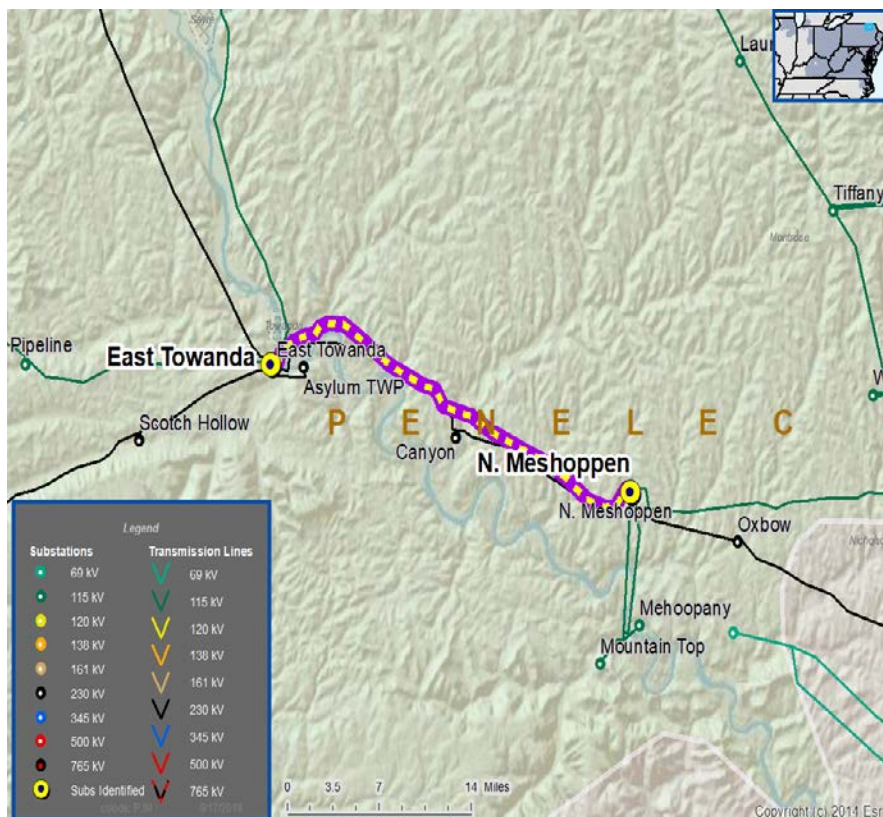
Baseline Project b3137: East Towanda – North Meshoppen 115 kV Line Rebuild

Penelec Transmission Zone

PJM RTEP analysis revealed a thermal violation in the winter generator deliverability results. The East Towanda – North Meshoppen 115 kV circuit (existing rating 167N/202E summer 188N/239E winter) is overloaded for the single contingency loss of the East Towanda – Canyon – North Meshoppen 230 kV circuit.

PJM worked closely with Penelec to evaluate the violation, and developed the following recommended solution:

Map 1: East Towanda – North Meshoppen 230 kV Line.



The recommended solution – Baseline Project b3137, rebuilds 20 miles of the East Towanda - North Meshoppen 115 kV line and adjusts relay settings at East Towanda and North Meshoppen 115 kV substations (new rating 202N/245E summer 228N/290E winter). The recommended solution addresses the baseline needs in the area. The estimated cost for this project is \$58.6 million, and the projected in-service date is June 2024. The local transmission owner, Penelec, will be designated to complete this work.

Transmission Owner Criteria Projects

Of the \$134 million of the new recommended baseline transmission system enhancements, approximately \$39 million is driven by transmission owner planning criteria, which makes up 28.5 percent of the new project cost estimates.

Interconnection Queue Projects

Throughout 2019, PJM has continued to study new service customer requests that are submitted into our interconnection queue. These studies evaluate the impact of the new service request and include an evaluation of new generation interconnections, increases in generation at existing stations, long-term firm transmission service requests and merchant transmission interconnection requests.

These studies were last reviewed with the Reliability Committee of the Board in December of 2018. Since that time PJM has completed 292 System Impact Studies and 312 new service requests have withdrawn. Projects with ISA (Interconnection Service Agreement) and above including several long-standing projects have resulted in \$107.3M in network upgrades. Figure 1 below shows the location of the new units associated with the completed interconnection System Impact Studies along with the fuel type and relative size. A listing of the projects with recently completed impact studies is provided in Attachment C to this white paper. A listing of the network upgrades associated with these projects is shown in Attachment D to this report. The cost for the network upgrades associated with these interconnection projects is the responsibility of the developer.

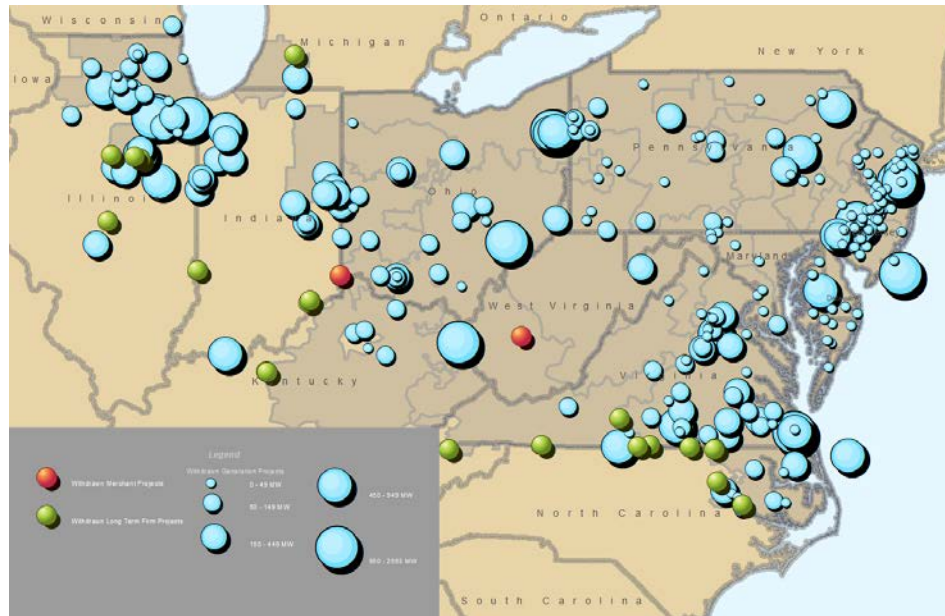


Figure 1. Completed Interconnection System Impact Studies



Changes to Previously Approved Projects

PJM is modifying the scope/cost of the following projects:

- Baseline project b3087 (Construct a new greenfield station west (~1.5 mi.) of existing Fords Branch substation, including six 40 kA 138 kV breakers ring bus arrangement, two 30 MVA 138/34.5 kV transformers, and two 30 MVA 138/12 kV transformers. Existing Fords Branch Station to be retired. Construct approximately 5 miles of new double circuit 138 kV line to loop in new Kewanee substation into existing Beaver Creek – Cedar Creek 138 kV line) requires scope modification. The project was initially driven by a new customer request for 40 MW of distribution load in 2019. Additionally, the need for this project was further aggravated by winter generator deliverability violations observed in the 2023 model. PJM was recently informed that the load increase is canceled. As a result, PJM is recommending to the Board that the scope of this project is modified to address this changing input assumption by delaying the required in-service date to 2023, when the reliability criteria violations are observed. The total cost of this project will decrease as a result of this scope change by \$0.6 million.
- Baseline project b2996 (construct a new Flint Run 500/138 kV substation in APS), required for reliability criteria violations, has overloaded the “Rider 50” and “No. 1 & No. 4” 138 kV breakers at Glen Falls 138 kV substation. PJM is recommending to modify the scope of the existing b2996 project to include work to replace two 138 kV breakers at Glen Falls 138 kV substation with 63 kA breakers. The total cost of this project will increase as a result of this scope change by \$0.487 million.

These changes yield a net RTEP decrease of \$0.113 million.



Review by the Transmission Expansion Advisory Committee (TEAC)

Project needs and recommended solutions as discussed in this report were reviewed with stakeholders during 2019, most recently at the November 2019 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 in Attachment A (for allocation to a single zone) and Attachment B (for allocation to multiple zones).

Cost allocations were calculated in accordance with 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. The allocations will be filed at 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
b2996.3	Upgrade two (2) existing 138 kV breakers (Rider 50 and #1/4 transformer breaker) at Glen Falls with 63 kA, 3000 A units	\$0.49	APS	APS	5/31/2020
b3087.1	Construct a new greenfield station to the west (~1.5 mi.) of the existing Fords Branch Station potentially in/near the new Kentucky Enterprise Industrial Park. . This new station will consist of 4 -138 kV breaker ring bus and two 30 MVA 138/34.5 kV transformers. The existing Fords Branch Station will be retired.	\$2.80	AEP	AEP	12/1/2023
b3087.2	Construct approximately 5 miles of new double circuit 138 kV line in order to loop the new Fords Branch station into the existing Beaver Creek – Cedar Creek 138 kV circuit.	\$19.90	AEP	AEP	12/1/2023
b3087.3	Remote end work will be required at Cedar Creek Station.	\$0.50	AEP	AEP	12/1/2023
b3120	Replace the Whitpain 230 kV breaker "125" with a 63 kA breaker.	\$0.60	PECO	PECO	6/1/2021
b3124	Separate metering, station power, and communication at Bruce Mansfield 345 kV station	\$0.40	ATSI	ATSI	12/31/2020
b3129	At Conesville 138 kV station: Remove line leads to generating units, transfer plant AC service to existing station service feeds in Conesville 345/138 kV yard, and separate and reconfigure protection schemes	\$1.50	AEP	AEP	12/31/2020
b3131	At East Lima and Haviland 138 kV stations, replace line relays and wavetrap on the East Lima-Haviland 138 kV facility.	\$1.50	AEP	AEP	12/1/2024
b3132	Rebuild 3.11 miles of the LaPorte Junction – New Buffalo 69 kV line with 795 ACSR	\$12.30	AEP	AEP	6/1/2022
b3133	Move the existing Botkins 69 kV capacitor from the Sidney-Botkins side of the existing breaker at Botkins to the Botkins-Jackson Center side. This will keep the capacitor in-service for the loss of Sidney-Botkins. This reduces the voltage drop to less than 3% and also resolves the overload on the Blue Jacket Tap-Huntsville 69 kV line.	\$0.20	Dayton	Dayton	6/1/2024
b3134	Build a new single circuit 69 kV overhead from Kellam sub to new Bayview substation (21 miles) and create a line terminal at Belle Haven delivery point (three-breaker ring bus)	\$22.00	ODEC	ODEC	6/1/2019
b3134.1	Reconfigure the Belle Haven 69 kV bus to three-breaker ring bus and create a line terminal for the new 69 kV circuit to Bayview	\$0.00	ODEC	ODEC	6/1/2019
b3134.2	Build a new single circuit 69 kV overhead from Kellam sub to new Bayview Substation (21 miles)	\$0.00	ODEC	ODEC	6/1/2019
b3135	Install back-up relay on the 138 kV bus at Corson substation	\$0.30	AEC	AEC	6/1/2019
b3136	Replace bus conductor at Smith 115 kV substation	\$0.15	ME	ME	6/1/2024
b3137	Rebuild 20 miles of the East Towanda - North Meshoppen 115 kV line	\$58.60	PENELEC	PENELEC	6/1/2024

b3138	Move 2 MVA load from the Roxborough to Bala substation. Adjust the tap setting on the Master 138/69 kV transformer No.2	\$0.02	PECO	PECO	6/1/2024
b3211	Rebuild the 1.3 mile section of 500 kV Line No.569 (Loudoun - Morrisville) with single-circuit 500 kV structures at the current 500 kV standard. This will increase the rating of the line to 3424 MVA.	\$4.50	Dominion	Dominion	6/1/2019

Attachment B – Reliability Project Multi-Zone Allocations

Upgrade ID	Description	Cost Estimate (\$M)	Trans Owner	Cost Responsibility	Required IS Date
b2633.1	Build a new 230 kV transmission line between Hope Creek and Silver Run	\$129.60	LS POWER	AEC (8.01%) / BGE (1.94%) / DPL (12.99%) / JCPL (13.85%) / ME (5.88%) / NEPTUNE* (3.45%) / PECO (17.62%) / PPL (14.85%) / PSEG (20.79%) / RE (0.62%)	6/1/2020
b2633.2	Construct a new Silver Run 230 kV substation	\$16.40	LS POWER	AEC (8.01%) / BGE (1.94%) / DPL (12.99%) / JCPL (13.85%) / ME (5.88%) / NEPTUNE* (3.45%) / PECO (17.62%) / PPL (14.85%) / PSEG (20.79%) / RE (0.62%)	6/1/2020
b2633.4	Add a new 500 kV bay at Hope Creek (Expansion of Hope Creek substation)	\$51.50	PSEG	AEC (4.81%) / AEP (7.05%) / APS (2.90%) / ATSI (3.98%) / BGE (3.03%) / ComEd (6.62%) / Dayton (1.04%) / DEOK (1.61%) / DL (0.87%) / Dominion (6.59%) / DPL (7.74%) / EKPC (1.07%) / JCPL (8.78%) / ME (3.88%) / NEPTUNE* (1.94%) / PECO (11.48%) / PENELEC (0.93%) / PEPSCO (1.99%) / PPL (9.81%) / PSEG (13.49%) / RE (0.44%)	6/1/2020
b2633.5	Add a new 500/230 kV autotransformer at Hope Creek and a new Hope Creek 230 kV substation	\$67.00	PSEG	AEC (8.01%) / BGE (1.94%) / DPL (12.99%) / JCPL (13.85%) / ME (5.88%) / NEPTUNE* (3.45%) / PECO (17.62%) / PPL (14.85%) / PSEG (20.79%) / RE (0.62%)	6/1/2020
b2633.10	Interconnect the new Silver Run 230 kV substation with existing Red Lion - Cartanza and Red Lion - Cedar Creek 230 kV lines	\$2.00	DPL	AEC (8.01%) / BGE (1.94%) / DPL (12.99%) / JCPL (13.85%) / ME (5.88%) / NEPTUNE* (3.45%) / PECO (17.62%) / PPL (14.85%) / PSEG (20.79%) / RE (0.62%)	6/1/2020
b3142	Rebuild Michigan City-Trail Creek-Bosserman 138 kV	\$24.69	NIPSCO	ComEd (89.10%) / MISO (10.90%)	1/1/2023
b3145	Rebuild the Hunterstown - Lincoln 115 kV line (No.962) (~2.6 mi.). Upgrade limiting terminal equipment at Hunterstown and Lincoln.	\$7.21	ME	AEP (16.60%) / APS (8.09%) / BGE (2.74%) / Dayton (2.00%) / DEOK (0.35%) / DL (1.31%) / Dominion (52.77%) / EKPC (1.54%) / OVEC (0.06%) / PEPSCO (14.54%)	6/1/2023

Attachment C – Interconnection Queue Projects

Queue Position	Path Name	Request Type	Transmission Owner
AD2-083	Larrabee 230kV	Merchant Transmission	JCPL
AD2-084	Cardiff 230kV	Merchant Transmission	AEC

Queue Position	Queue Name	Request Type	MWs
AD2-098	PJM-WEC	Long-Term Firm	4
AD1-092	AMIL-PJM	Long-Term Firm	105
AD1-093	AMIL-PJM	Long-Term Firm	180
AD1-094	AMIL-PJM	Long-Term Firm	34
AD1-120	DUK-PJM	Long-Term Firm	109
AD1-121	CPLP-PJM	Long-Term Firm	109
AD1-122	PJM-DUK	Long-Term Firm	130

Queue Position	Transmission Owner	Fuel Type	MW Energy (nFTIR/nFTWR)	MW Capacity (FTIR/FTWR)
AE1-085	Dominion	Solar	75	50
AE1-123	PENELEC	Natural Gas	18	18
AE1-151	BGE	Natural Gas	9	9
AE1-179	AEC	Solar	59.7	35
AE1-229	AEC	Solar	149.3	89
AE1-238	JCPL	Offshore Wind	816	225
AE1-240	AEC	Solar	49.7	29
AE1-247	EKPC	Solar, Storage	205	137.1
AD2-008	Dominion	Solar	52.1	16.4
AE1-007	Dayton	Solar	20	7.6
AE1-012	PEPCO	Solar	0.54	0.2268
AE1-013	PEPCO	Solar	0.9	0.378
AE1-015	PEPCO	Solar	1.35	0.567
AE1-016	PEPCO	Solar	1.08	0.4536
AE1-021	AEP	Coal	11	11
AE1-050	AEP	Coal	18	18
AE1-053	PENELEC	Storage	0	10
AE1-054	APS	Storage	0	7.5
AE1-060	JCPL	Storage	19.8	0
AE1-061	AEC	Storage	10	5
AE1-090	AEP	Solar	50	21.56

AE1-091	AEP	Solar	110	46.93
AE1-102	AEP	Solar	26	15.6
AE1-107	DPL	Solar	53.1	31
AE1-116	PENELEC	Storage	0	4.5
AE1-120	DEOK	Solar	0	44
AE1-128	PENELEC	Solar	120	72
AE1-143	EKPC	Solar, Storage	96	64.163
AE1-144	EKPC	Solar, Storage	120	80.2
AE1-149	Dominion	Solar	100	60
AE1-160	PENELEC	Solar	20	12.7
AE1-161	AEC	Storage	50	20
AE1-170	AEP	Solar	150	63
AE1-203	JCPL	Storage	8.8	0
AE1-206	Dominion	Solar	300	180
AE1-212	AEP	Solar	90	53.3
AE1-246	EKPC	Solar, Storage	120	80.7
AE1-249	Dominion	Solar, Storage	70	40.1
AE1-051	PPL	Storage	0	10
AE1-058	PPL	Hydro	500	250
AE1-059	PPL	Hydro	500	250
AE1-062	AEC	Storage	20	10
AE1-074	Dominion	Solar	20	13.3
AE1-080	APS	Natural Gas	50	80
AE1-101	APS	Solar, Storage	150	100.5
AE1-103	Dominion	Solar	50	21
AE1-104	AEC	Offshore Wind	432	121.4
AE1-124	Dominion	Solar	20	13.3
AE1-132	APS	Solar	85	51
AE1-138	ME	Solar	22	13.2
AE1-139	ME	Solar	65	39
AE1-174	Dominion	Storage	5	2
AE1-175	Dominion	Solar	19.9	13.3
AE1-181	PPL	Solar	45	27
AE1-185	ME	Solar	20	12.6
AE1-187	ME	Solar	20	12.6
AE1-196	ME	Solar	20	12.6
AE1-219	AEC	Solar	4.4	1.8
AE2-010	PECO	Natural Gas	29	3
AE1-040	Dayton	Solar	48	31.6
AE1-071	PENELEC	Solar	100.1	62.1
AE1-079	ATSI	Solar, Storage	19.9	13.5

AE1-086	APS	Wind	5	0.6
AE1-092	Dayton	Solar	229.5	96.4
AE1-147	APS	Solar	20	12
AE1-162	Dominion	Solar	20	12
AE1-183	ATSI	Solar	20	12
AE1-237	ATSI	Solar, Storage	19.9	13.5
AE1-075	Dominion	Solar	18	12.1
AE1-088	Dominion	Storage	20	20
AE1-129	ME	Solar	79.6	47
AE1-131	ME	Solar	65	39
AE1-142	JCPL	Solar	20	8.2
AE1-153	Dominion	Solar	149	89.4
AE1-167	DPL	Solar	11.09	6
AE1-182	PPL	Solar	10	6
AE1-188	APS	Solar	20	12.6
AE1-190	Dominion	Solar	20	12
AE1-191	Dominion	Solar	80	48
AE1-225	PPL	Solar	19.8	9.4
AE1-226	PPL	Solar	19.8	9.4
AE1-244	JCPL	Storage	19.8	0
AE1-231	SMECO	Solar, Storage	20	9.4
AE1-038	DPL	Solar	20	8.4
AE1-006	ME	Solar	20	7.6
AE1-046	AEC	Solar	3	2
AE1-127	PPL	Solar	45	20
AE1-202	PPL	Storage	4	0
AE1-218	AEC	Solar	2	0.82
AE1-243	JCPL	Storage	20	0
AE1-154	Dominion	Solar	17	10
AE1-004	Dominion	Solar	20	7.6
AE1-044	Dominion	Solar	200	111.7933
AE1-084	Dominion	Solar	83	49.8
AE1-115	AEC	Storage	20	10
AE1-035	Dominion	Solar	20	13.4
AE1-155	Dominion	Solar	127	76.2
AD2-113	APS	Natural Gas	70	60.6
AD2-114	APS	Natural Gas	410	400
AE1-039	AEP	Methane	0.8	0.8
AE2-006	Dominion	Solar	0	2.9
AE2-064	PSEG	Solar	2.6	1.09
AE2-065	PSEG	Solar	1.8	0.76

AE2-268	Dominion	Solar	15	9.6
AE2-304	Dominion	Solar	5	3.3
AE2-061	Essential Power	Natural Gas	0	7
AE2-132	Dominion	Natural Gas	0	17.7
AE2-155	Dominion	Solar	5	3.5
AE2-272	AEC	Solar		0.8
AE2-057	JCPL	Solar	1	0.5
AE2-070	BGE	Solar	4	1.7
AE2-115	DL	Solar	17.1	10.26
AE2-116	DL	Solar	17.1	10.26
AE2-114	DL	Solar	17.1	10.26
AC2-016	AEP	Natural Gas	6	20
AE2-081	JCPL	Solar	3.2	1.57
AE2-056	JCPL	Solar	3	1.6
AE2-134	Dominion	Solar	0	16.5
AD1-148	ComEd	Wind	0	49
AE2-097	PSEG	Solar	2	0
AE2-100	PSEG	Solar	2.3	0
AE2-143	PSEG	Solar, Storage	3.905	0
AE2-144	PSEG	Solar, Storage	4.03	0
AE2-165	PSEG	Solar	2.6	1.092
AE2-213	PSEG	Solar, Storage	3.145	1.1025
AE2-225	Dominion	Solar	20	12
AE2-229	Dominion	Solar	15	9
AD2-036	EKPC	Solar	60	40
AD2-043	Dominion	Solar	65.5	30
AD2-048	EKPC	Solar	70	46.7
AD2-133	PENELEC	Wind	100.33	18
AE2-018	PSEG	Solar	3.5	2.3333
AE2-163	PSEG	Solar	1	0.42
AE2-164	PSEG	Solar	1.4	0.588
AE2-125	APS	Solar	13.8	8.28
AE2-273	PPL	Solar	0	0.4
AE2-274	PPL	Solar	0	0.4
AD2-108	APS	Natural Gas	0	8
AD2-033	Dominion	Solar	130	78
AD2-002	APS	Natural Gas	20	20
AD2-063	Dominion	Solar	149.5	90
AD2-035	ME	Natural Gas	38.9	14
AD2-151	DEOK	Solar	100	42

AD2-074	Dominion	Solar	86	32.68
AB2-096	ComEd	Natural Gas	350	350
AB2-173	ComEd	Natural Gas	16	28
AD2-068	Dominion	Solar	50	33
AD2-160	Dominion	Solar	50	32.8
AD2-120	ATSI	Solar	120	50.4
AE1-018	AEP	Solar	5	2.8
AD2-171	PSEG	Natural Gas	700	700
AD2-192	APS	Natural Gas	45	20
AD2-158	APS	Solar	77.5	46.5
AD2-109	APS	Natural Gas	4	12
AE1-041	PSEG	Solar, Storage	1.1	0.2
AD2-070	JCPL	Solar	7.5	3.2
AD2-180	APS	Wind	110	15.08
AC2-177	AEP	Wind	200	26
AA2-039	ComEd	Wind	150	19.5
AC2-157	AEP	Solar	200	76
AC2-125	Dominion	Natural Gas	19	14.9
AC2-126	Dominion	Natural Gas	19	15
AB1-087	AEP	Natural Gas	575	550
AB1-088	AEP	Natural Gas	575	550
AC2-111	AEP	Solar	80	30.4
AD2-213	JCPL	Storage	20	0
AD2-157	APS	Solar	100	42
AC1-214	ComEd	Wind	79.4	19
AD2-115	ME	Solar	20	13
AC2-127	Dominion	Natural Gas	19	8.2
AC2-128	Dominion	Natural Gas	19	7.9
AC2-129	Dominion	Natural Gas	19	7.4
AD1-152	Dominion	Solar	80	48
AD2-052	AEC	Solar	10	6.7
AD1-050	Dominion	Solar	42	27.2
AD1-082	Dominion	Solar	68	43.3
AD2-082	Dominion	Solar	15	10.1
AD2-116	ME	Solar	20	13
AD1-033	Dominion	Solar	70	42
AD1-151	Dominion	Solar	150	90
AD2-045	DPL	Solar	20	12.2
AD2-076	DPL	Solar	49	18.62
AD2-167	Essential Power	Natural Gas	90	52

AD2-009	APS	Solar	70	48.1
AD2-026	JCPL	Solar	0	4.1
AD2-058	PEPCO	Solar	5.6	2.38
AD2-064	AEC	Solar	1.26	0.53
AD2-065	AEC	Solar	5.22	2.19
AD2-072	EKPC	Solar	95	63.75
AD2-117	ME	Solar	15	7.7
AD2-135	AEC	Solar	1.62	0.6
AD2-163	ATSI	Solar	180	120.7
AD2-165	JCPL	Natural Gas, Storage	105	40
AD2-166	ME	Natural Gas	75	89.8
AD2-199	PEPCO	Solar	3	1.26
AD2-210	JCPL	Storage	2	0
AE1-156	JCPL	Solar	7.6	4.1
AD2-049	Dominion	Storage	10	10
AD2-059	DPL	Storage	0.993	0.24
AC2-038	AEP	Solar	20	12
AC2-044	AEP	Solar	20	7.6
AD2-007	Dominion	Solar	7.6	4.5
AD2-039	Dominion	Solar	20	7.6
AD2-073	Dominion	Solar	19.92	13.32
AD2-085	Dominion	Solar	51	19.38
AD2-215	Dominion	Solar	15	9.8
AD2-030	Dominion	Solar	19.8	13.1
AD2-097	Dominion	Natural Gas	66	11
AD2-164	Dominion	Natural Gas	26.7	26.7
AC1-141	AEP	Natural Gas	91	91
AE1-027	Dominion	Solar	20	13.1
AE1-028	Dominion	Solar	12	7.6
AE1-098	Dominion	Solar	15.7	10.4
AE1-099	Dominion	Solar	15.7	10.4
AD1-130	AEP	Solar	170	115
AD1-037	PPL	Natural Gas	39.8	86.6
AC1-168	ComEd	Wind	78.65	10.2
AB1-122	ComEd	Natural Gas	1150	1150
AE1-081	JCPL	Solar	2.3	0.96
AE1-036	JCPL	Natural Gas, Other	0	9
AE1-221	PECO	Natural Gas	0	14
AC2-036	AEP	Solar	20	12

AD2-042	PSEG	Solar	13.2	5
AD2-021	Dominion	Solar	1.2	1.3
AB2-188	Dominion	Solar	20	14
AD2-027	PSEG	Solar	10	3.8
AD1-105	Dominion	Solar	77	45.43
AC2-131	Dominion	Natural Gas	14	14.3
AC2-132	Dominion	Natural Gas	11	8.8
AD1-078	Dominion	Solar	20	12.6
AD1-087	Dominion	Solar	71	48.3
AD1-088	Dominion	Solar	110.5	75.2
AD1-025	Dominion	Solar	150	94.2
AD1-041	Dominion	Solar	50	30
AD1-055	Dominion	Solar	20	15.9
AD1-103	ATSI	Wind	500.4	65.052
AD1-154	PENELEC	Natural Gas	20	20
AB2-099	Dominion	Solar	5	3.5
AD1-026	ATSI	Natural Gas	0	130
AD1-140	ATSI	Solar	175	95.8
AD2-044	Dominion	Solar	3.2	1.5
AD1-058	Dominion	Solar	45.9	36.6
AD1-115	Dominion	Solar	50	19
AD1-131	Dominion	Solar	20	8.3
AD1-160	Dominion	Solar	15.7	6.6
AB2-072	Dominion	Solar	18	12.2
AB2-186	Dominion	Solar	5	3.5
AD1-061	APS	Solar	20	7.6
AD1-018	APS	Solar	20	7.6
AB2-035	Dominion	Solar	3	2.1
AD1-044	Dominion	Solar	20	12
AD1-045	Dominion	Solar	20	12
AD1-046	Dominion	Solar	11.2	6.7
AC2-103	ATSI	Wind	297.66	38.69
AB2-088	Dominion	Solar	4	2.7
AB1-108	PPL	Natural Gas	485	485
AC1-033	ComEd	Wind	100.8	13.1
AD2-205	AEP	Storage	4	0
AD1-097	PECO	Natural Gas	67	34.8
AD1-143	PPL	Storage, Wind	90	11.84
AD1-081	ATSI	Solar	20	13.2
AD1-083	APS	Solar	100	60.1
AD1-145	DPL	Methane	9.6	9.6

AD1-069	APS	Wind	80	11.76
AD1-155	APS	Solar	75	37.2
AC2-165	Dominion	Solar	99.9	57
AD1-065	PPL	Wind	175.8	25.84
AB2-047	ComEd	Wind	250	32.5
AC2-130	Dominion	Coal	14	13.2
AD1-020	ME	Solar, Storage	100	53.6
AD1-114	PEPCO	Natural Gas	75	75
AD1-153	PEPCO	Solar	2.76	1.0488
AB2-070	ComEd	Wind	200	26
AD1-019	AEC	Natural Gas	7.6	0
AD1-052	ATSI	Natural Gas	38	26.3
AD1-085	APS	Solar	20	12.3
AD1-099	APS	Natural Gas	0	70
AD1-146	DPL	Solar	10	3.8
AB1-089	ComEd	Natural Gas	575	550
AB1-090	ComEd	Natural Gas	575	550
AB1-091	ComEd	Natural Gas	575	550
AD1-113	JCPL	Natural Gas	35	75
AA2-030	ComEd	Natural Gas	190	157
AA2-035	ComEd	Natural Gas	1019.3	1019.3
AA2-107	ComEd	Storage	20	0
AC2-083	Dominion	Solar	20	13.4
AC2-084	Dominion	Solar	60	40.2
AC2-124	AEP	Solar	50	19
AC2-048	AEP	Solar	60	22.8
AC1-182	DEOK	Coal	20	20
AC1-038	AEP	Natural Gas	13	13
AC2-172	AEP	Natural Gas	17	12

Attachment D – Interconnection Network Upgrades

Upgrade ID	Description	Cost Estimate (\$M)	Required In Service Date
n2194	Add terminal equipment at Mickleton 230 kV sub to provide a bus position for the IA customer's 230 kV line to the Q90 site.	0.862	6/1/2014
n2195	Construct a 230 kV direct connect line from the Mickleton 230 kV sub to the POI on existing ROW owned by ACE Company.	3.5	6/1/2014
n0930	Buchanan Hydro-Niles - Construct the new 69kV interconnection substation for T111.	0.056	7/1/2008
n0931	Buchanan Hydro - Niles - Construct the 69kV double circuit loop between the Buchanan Hydro - Niles circuit and new interconnection substation	0	7/1/2008
n0932	Buchanan Hydro - Niles - Tie in the 69kV loop into the circuit	0	7/1/2008
n0933	Buchanan Hydro - Niles - Upgrade line relays at AEP Niles 69kV station	0.3831	7/1/2008
n0934	Buchanan Hydro - Niles - Upgrade line relays at AEP Buchanan Hydro 69kV station	0.3997	7/1/2008
n3038	Remote end work at Dunkirk. Replace relay.	0.276	11/1/2012
n3039	Remote end work at East Lima. Replace relay.	0.264	12/1/2012
n3961	Install 345kV revenue metering at new switchyard	2.29	8/31/2017
n3962	Remote end work at Canton Central Station	0.06	8/31/2017
n3963	Remote end relay work at Tidd Station	0.06	8/31/2017
n4731	Add a 2nd Benton 345/138 kV transformer	3.5	
n1057	Albright - Modify relay and control setting changes	0.045856	12/31/2009
n1058	William - Modify relay and control setting changes	0.044663	12/31/2009
n1059	Roth Rock - Perform design and engineering for communication cable between existing Albright/William substation and new Roth Rock substation	0.0105	12/31/2009
n1593	Leadsville - Cut the Pruntytown-Loughs Lane 138kV circuit approx. 6.1 miles from Loughs Lane substation and loop the line through the Leadsville 138kV substation, 0.1 mile, 954 kcmil ACSR conductor	0.192	12/31/2008
n2140	Option to Build: Provide design review and construction oversight for the construction of the Mount St Mary's substation. Loop the Catoctin – Taneytown 2 34.5kV line into the new station.	0.25	12/1/2011

n2141	Install anti-islanding (transfer trip) facilities at Catoclin substation	0.13	12/1/2011
n2142	Install anti-islanding (transfer trip) facilities at Carroll substation	0.13	12/1/2011
n2143	Install anti-islanding (transfer trip) facilities at Taneytown 2 substation.	0.26	12/1/2011
n2146	Expand Frostburg#1 substation. Extend 138kV bus, install 1-138kV breaker, 3-138kV disconnect switches, 138kV metering, arresters, line traps and CVTs.	1.553	12/1/2010
n2196	Install transfer trip facilities to Cross School switching station at Albright switching station	0.04	12/15/2008
n2197	Install transfer trip facilities to Cross School switching station at Black Oak switching station	0.04	12/15/2008
n2198	Construct line tap to new switching station, Cross School	0.15	12/15/2008
n2199	Cross School switching station option to build	0.29	12/15/2008
n3141	Upgrade the line risers and replace the relaying and metering.	0.28	6/1/2012
n3142	Increase line loadability	2.14	6/1/2012
n3143	Replace risers with HT conductor and connectors.	0.09	6/1/2012
n3144	Increase loadability (MTEP #3186 & PJM W1-078) by adding new 954 kcmil ACSS conductors (bundled)	1.9	6/1/2012
n3508	Replace the Ridgeley 'A' 34.5kV breaker	0.1	10/31/2010
n4607	Install a wave trap on the tap to Tennessee Gas to support new anti-islanding scheme in the area.	0	12/1/2009
n4947	Loop the Tidd – Wylie Ridge 345 kV transmission line to Abby Lane three breaker substation. Install a loop, approximately 700' in length, consisting of two steel deadend and two steel angle structures with concrete foundations.	1.56	6/1/2020
n4948	Install line relaying equipment on the Tidd 345 kV line in Wylie Ridge substation including associated carrier and transfer-trip equipment.	0.19	6/1/2020
n4950	Adjust remote end relaying and metering settings at Ronco 500kV Substation.	0.0127	10/1/2016
n5107.1	Cumberland Substation: Replace Ridgeley 138 kV breaker, replace Ridgely 138 kV line and bus side disconnect switches, replace Ridgeley terminal wave trap and breaker risers	0.47	12/15/2016
n5107.2	Ridgely Substation: Replace Cumberland 138 kV line and bus side disconnect switches, replace Cumberland terminal wave trap and breaker risers	0.21	12/15/2016

n5107.3	Reconductor approximately 1 mile of the Ridgeley – Cumberland 138 kV line with 795 kcmil ACSS	1.25	12/15/2016
n5412	Install estimated 15-miles of ADSS fiber for backhaul of SCADA communications at Abby Lane substation.	1.83	6/1/2020
n5514	Doubs Substation – Install (1) 230kV motor-operated air-breaker switch (MOABS) and remove wave trap and line tuner on Eastalco exit (Line #205). Replace line relaying and install ADSS (All-Dielectric Self-Supporting) fiber cable for new AB2-129 connection.	0.43	6/1/2019
n5515	Doubs Substation – Reconfigure and re-energize the last span into Doubs Substation on the Doubs-Eastalco (Line #205) 230kV line terminal.	0.71	6/1/2019
n5934	Construct 500 kV three breaker ring bus substation. Cut and loop in the 500 kV Wylie Ridge-Harrison line and install new tie line to new generation. (At Strope Road Substation)	14.72	7/1/2019
n5935	Strope Road substation (OTB) - Project Management, Engineering oversight, Testing & Commissioning, and transfer of operation for AB1-069 3-Breaker 500 kV ring bus Substation.	1.31	7/1/2019
n5948	Install and upgrade relays/controls and install fiber interface for new AC1-097 fiber or optical ground wire (“OPGW”) at the Hatfield Substation	0.34	6/2/2021
n5949	Hatfield Substation – Fiber Work inside the Substation – For Optical Ground Wire (“OPGW”) construction, install fiber cable runs to represent All-Dielectric Self-Supporting (“ADSS”) cable extension from substation control house to the telecommunication line structure	0.05	6/2/2021
n5957	OTB, Construct three-breaker 345 kV ring bus at Abby Lane substation.	0.67	6/1/2020
n2184	Installation of nine surge arresters at North Lima Substation on the Boardman- Columbiana 69 kV Line for Mahoning Landfill project	0.0242	11/30/2011
n4906	Upgrade the wire drops to the high side circuit switcher. Change the tap settings on the Pumphrey breakers B31 & B32 current transformers to correspond to 3000 amps and adjust relays to accommodate. Reset 6 additional relays and change out an auxiliary	0.15	1/1/2016
n2087	Replace line trap on Burnham-Munster 345kV line at TSS 177 Burnham	0.1	12/31/2012
n2089	Reconductor approximately 12.5 miles of 345kV Line 6607 and upgrade terminal equipment to match. Same as	10	12/31/2012

	b1773		
n2090	Reconductor approximately 9.2 miles and replace relays on 138kV line 12204. Same as b1775	7.2	12/31/2012
n2091	Reconductor approximately 2 miles of 345kV line 0403, replace substation conductor	2.1	12/31/2012
n2093	Reconductor approximately 11.5 miles of 138kV line 12205, replace substation conductor, replace line trap. Same as b1777	8.85	12/31/2012
n2094	Reconductor 7.7 miles of 138kV line 11106, replace line trap	6.1	12/31/2012
n5950	Replace 4 splices on the Frankfort—University Park North 345 kV line	1.6356	6/1/2020
n3244	Zimmer substation relays	0.016377	12/31/2013
n3245	Spurlock substation relays	0.016377	12/31/2013
n4324	Replace 138 kV disconnect switch 866 in Pierce Substation with a 3000 Ampere rated switch.	0.075466	6/1/2017
n4325	Replace 138 kV circuit breaker 922 in Beckjord Substation with a 3000 Ampere rated breaker.	0.398998	6/1/2017
n1487	Arnolds Corner - Replace 2 existing hydraulic three phase reclosers, 340 R169 and 340 R140 with 2 three phase electronic reclosers with transfer trip capability	0.089	10/1/2008
n1506	Shackleford - Replace 3 existing single phase hydraulic reclosers, 303R79, with a 3 phase electronic recloser 303R453 with transfer trip	0.1	9/1/2008
n3027	Construct Attachment Line to Customer Wind Farm Bus	0.41	12/30/2012
n3028	Create 3 breaker ring bus substation to be name SWAMP at Interconnection Customer Property along Winfall - Suffolk 230 kV line	2.93	12/30/2012
n3029	Build necessary 230 kV transmission lines to loop in and out the Winfall - Suffolk 230 kV line to new Swamp substation	0.53	12/30/2012
n3030	Purchase and install dual (2) SEL 421-5 transmission panel.	0.1	12/30/2012
n3031	Purchase and install dual (2) SEL 421-5 transmission panel.	0.1	12/30/2012
n3670	Replace six poles, add two poles and upgrade approximately one mile of OH conductor to 477 aluminum.	0.24	6/1/2015
n4784	Construct new Rocky Forge 230kV (3) three breaker ring bus switching station	6.759	8/19/2014
n4785	Re-arrange the Lexington – Low Moor 230kV line #2084 in order to loop it into the new Rocky Forge switching station	0.919	8/19/2014

n4786	Remote protection and communication changes to allow for interconnection of the proposed generating facility	0.081	8/19/2014
n5142	Install new relay panel at Old Church substation	0.066	8/31/2016
n5143	Old Church - Build circuit #474 extension for 4 miles	0.9749	8/31/2016
n1036	Raritan River - Replace G1047E breaker at the 230kV Substation	0.06	6/1/2008
n1037	Raritan River - Replace G1047F breaker at the 230kV Substation	0.06	6/1/2008
n1038	Raritan River - Replace T1034E breaker at the 230kV Substation	0.06	6/1/2008
n3001	A riser pole will be on the west side of Route 33 and tap the existing three phase with new conductors from pole #JC 87-1 MPNA53. 12kV primary metering will be installed at the riser pole.	0.0579	3/31/2011
n3002	Replace relays and associated equipment with a SEL-351 electronic relays for the Transformer breaker at the Manalapan substation. Add bi-directional LTC control.	0.043434	3/31/2011
n3003	Replace relays and associated equipment with a SEL-351 electronic relays for the #47351 distribution circuit at the Manalapan substation	0.034233	3/31/2011
n3004	Replace relays and associated equipment with a SEL-351 electronic relays for the #47350 distribution circuit at the Manalapan substation.	0.034233	3/31/2011
n3014	Install a new riser pole and tap the existing circuit for the POI. Install 12kV metering at new riser pole and communication equipment. Install fuses on the Morris Park #27052 12kV circuit	0.05135	4/30/2011
n3015	Replace existing electromechanical relays with SEL-351 relay on distribution circuit #27052 at the Morris Park substation	0.0736	4/30/2011
n3016	Install bi-directional LTC on the transformer at the Morris Park substation	0.0092	4/30/2011
n3017	Replace existing electromechanical relays with SEL-351 relay on distribution circuit #27051 at the Morris Park substation	0.0736	4/30/2011
n3019	Add SEL-351A reclosing relay to W75 34.5 kV circuit breaker	0.0509	4/30/2011
n3590	Add one 230kV CB at Raritan River 230kV sub to accommodate the direct connection of an underground 230kV transmission line for the W4-009 generation project.	2.8	5/15/2015

n2170	Add a 115kV line terminal to the Krayn Substation for the Highland #2 developer substation.	0.29	
n2171	Install new RFL-9745 DTT transmitter to transmit Rachel Hill Sub– Krayn exit breaker status to R32 (Highland #2)	0.0745	
n2172	Install new RFL-9745 DTT transmitter to transmit Hilltop Hill Sub– Krayn exit breaker status to R32 (Highland #2)	0.0745	
n2173	Salix Sub - Install new SEL-2505 or SEL-2506 to transmit MOAB status to R32 (Highland #2).	0.063	
n2174	Fiber - An SEL-2505, RFL-9745 (for Rachel Hill Bkr Status); second RFL-9745(for HilltopBkr Status) is to be installed to implement the logic to trip #2 Generator	0.0248	
n2175	Engineering Oversight and Commissioning Support of the Interconnection Customer substation including support of protective relay installation	0.0639	
n3678	Install two breakers (13H and 23H) on the high side of two 230/138kV autotransformers.	3	12/31/2015
n4793	Install a new 63 kA breaker into existing bus position at the Sewaren 230 kV substation along with the associated disconnect switches, equipment and structures.	6.48	
n5177	Reconductor 3 spans (2 structures) of the Roseland-Williams 230kV Line with 1590 ACSS conductor.	0.57	6/1/2018
n5411	New 26kV tap connection to the Gloucester 26kV (Q121) circuit	0.2	5/31/2018