

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

PJM Staff Whitepaper
November 2014



EXECUTIVE SUMMARY

The PJM Board of Managers previously approved changes to the Regional Transmission Expansion Plan (RTEP) on July 22, 2014. Those changes totaled \$143.6 million, and were primarily to resolve identified baseline reliability criteria violations.

Since that time PJM identified additional baseline reliability criteria violations within the planning horizon as part of the 2014 RTEP. Transmission upgrades were identified to resolve these reliability criteria violations. The total increase to the RTEP to include these baseline project additions is \$608.5 million. In addition, there were a number of changes to previously approved baseline projects. The cost and scope of some projects changed and in some instances the upgrades are no longer needed and their removal from the RTEP was recommended. The total decrease to the RTEP associated with these changes to previously approved baseline projects is \$98.5 million. The net change to the RTEP to include the new baseline upgrades and changes to previously approved baseline projects is \$510 million.

As part of the 2014 RTEP PJM staff also completed 143 System Impact Studies and 193 interconnection projects were withdrawn. The impact of these changes to the interconnection queue was a net decrease of \$4,159.3 million. The cancellation of several large 765kV reinforcements due to withdrawn projects from the interconnection queue attributed to the large decrease in the network upgrade total.

The total change in the RTEP to include the new baseline projects, incorporate the changes to previously approved baseline projects, and include the changes associated with the interconnection projects is a net decrease of \$3,649 million. With these changes, the RTEP includes over \$25.659 billion of transmission additions and upgrades since the first plan was approved by the Board in 2000.

On November 5, 2014, the elements of the 2014 RTEP for the 143 System Impact Studies and additional baseline upgrades were presented for the Board Reliability Committee's (BRC) consideration and for recommendation to the PJM Board for approval and inclusion in the RTEP. The Board approved the changes as summarized below.



SUMMARY OF UPGRADES

2014 Baseline Transmission Upgrades Changes and Additions

One aspect of the development of the Regional Transmission Expansion Planning Process 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 the Transmission Expansion Advisory Committee (TEAC). The cost of transmission upgrades to mitigate such criteria violations are the responsibility of the PJM transmission owners.

In 2012 PJM filed proposed changes to the Operating Agreement in compliance with FERC Order 1000. Those changes were approved by the FERC and are being implemented for the first time as part of the 2014 RTEP. Consistent with the changes to the Operating Agreement, PJM administered a 30 day near-term proposal window from Friday, June 27th, 2014, through Monday, July 28th, 2014, to solicit solutions to reliability criteria violations that were identified as part of the 2014 RTEP. This window was the first of its kind in that PJM requested solutions for near term (years 3-5) reliability criteria violations that were identified for several test criteria. The test criteria that were included in Window #1 included baseline N-1 thermal, Generator Deliverability thermal, load deliverability thermal and voltage, Common Mode Outage thermal, and N-1-1 thermal.

PJM staff identified potential reliability criteria violations associated with 112 flowgates (transmission facility and contingency/outage pairs). Reliability criteria violations were identified for approximately 50 individual transmission facilities due to one or more test procedures. PJM received 106 baseline upgrade proposals during Window #1 to address the reliability criteria violations. The Window produced a wide range of proposals, from 15 different entities including incumbent transmission owners and their affiliates as well as non-incumbent transmission developers. Notably, several affiliates of PJM Transmission Owners proposed “Greenfield Projects” (i.e. new facilities that are not upgrades to existing facilities) in other PJM Transmission Owner zones. The non-incumbent transmission developers included ITC Mid-Atlantic Development LLC, NextEra Energy Transmission, LLC and Northeast Transmission Development/LS Power. Of the 106 proposals, 46 were Transmission Owner Upgrades and 60 were Greenfield Projects. The locations of the various proposals are shown on the map below.

2014 RTEP Proposal Window #1 Proposals

- Approximately 50 individual facilities with reliability criteria violations
 - Approximately 112 flow gates are addressed
- 15 proposing entities
- 106 proposals
 - 46 Transmission Owner Upgrades
 - Cost range of \$0.02M to \$139.2M
 - 60 Greenfield Projects
 - Cost range of \$10.2M to \$1,367.00M
- 18 target TO zones
- Proposals span 10 States
 - DE, IL, IN, KY, MD, NJ, OH, PA, VA, WV



PJM staff reviewed all of the proposals as well as their evaluation of the effectiveness of each of the proposals with stakeholders through the Transmission Expansion Advisory Committee (TEAC). PJM staff recommended 22 of the 106 proposals to resolve reliability criteria violations. The 22 recommendations included several line reconductor projects, replacement of existing transformers with larger transformers, upgrades to terminal equipment on existing facilities, circuit breaker replacements at several locations and finally a new 138 kV transmission facility. All of the 22 recommended projects are Transmission Owner Upgrades with a total estimated cost of \$81.545 million. Additional information about the recommended projects is included in this white paper.

In addition to the reliability upgrades that were developed as part of the proposal window, a number of immediate need reliability projects were also recommended to the Board for their consideration. These immediate need reliability projects include several projects to address significant load additions in eastern Ohio, western Pennsylvania and West Virginia that are largely being driven by shale gas industry development. These additional projects are also described in this white paper.

A summary of the more significant baseline projects with expected costs greater than \$5 million are detailed below. A complete listing of all of the new recommended projects is attached at the end of this white paper. The projects that cost less than \$5 million include circuit breaker upgrades or replacements to address short circuit problems, terminal equipment upgrades and conductor replacements to increase the ratings of transmission lines to address thermal violations.

Mid-Atlantic Region System Upgrade

- Atlantic Electric Transmission Zone
 - Replace the Middle T3 138/69 kV transformer with a larger 225 MVA transformer - \$7.5 M



- MetEd Transmission Zone
 - Loop the 2026 line (TMI - Hosensack 500 kV) in to the Lauschtown substation and upgrade the relay at TMI 500 kV - \$5.25 M
- PENELEC Transmission Zone
 - Rebuild and reconductor the 115 kV line from East Towanda to S. Troy and upgrade the terminal equipment at East Towanda, Tennessee Gas and South Troy - \$40 M
 - Construct a Warren 230 kV ring bus and install a second Warren 230/115 kV transformer - \$15 M
- PSE&G Transmission Zone
 - Rebuild the Athenia 138 kV station to 80kA capability - \$131 M

Western Region System Upgrades

- AEP Transmission Zone
 - Conesville - Bixby: SAG study mitigation work - \$5.25 M
 - Construct a new 138/69 kV Yager station by tapping 2-138 kV FE circuits (Nottingham – Cloverdale and Nottingham - Harmon) - \$55 M
 - Build a new Nottingham station by tapping 6-138 kV FE circuits (Holloway – Brookside, Holloway - Harmon (#1), Holloway - Reeds, Holloway - New Stacy, Holloway - Cloverdale). Exit the 138 kV circuit from the new station to Freebyrd station. - \$90 M
 - Replace the Robinson Park 138 kV breakers A1, A2, B1, B2, C1, C2, D1, D2, E1, E2, and F1 with 63 kA breakers - \$15 M
- APS Transmission Zone
 - Construct a new line between Oak Mound 138 kV substation and Waldo Run 138 kV substation - \$38 M
 - Construct a new 138 kV substation (Shuman Hill substation) connected to the Fairview - Willow Island (84) 138 kV line - \$40 M
 - Construct a new 138 kV six breaker ring bus Hillman substation - \$31.5 M
- ATSI Transmission Zone
 - At Avon substation, replace the existing 345/138 kV 448 MVA #92 transformer with a 560 MVA unit - \$5.4 M
 - Reconductor the Black River - Lorain 138 kV line and upgrade Black River and Lorain substation terminal end equipment - \$9.6 M
 - Construct a second 138 kV line between West Fremont and Hayes substation on open tower position of the West Fremont - Groton - Hayes 138 kV line - \$7.4 M
- DLCO Transmission Zone
 - Operate with the Crescent 345/138 kV #3 autotransformer in-service by replacing 8 overdutied 138 kV breakers at Crescent, 3 138 kV breakers at Beaver Valley, install #1 section 345 kV breaker for 331 circuit at Crescent - \$7.285 M

Southern Region System Upgrades

- Dominion Transmission Zone

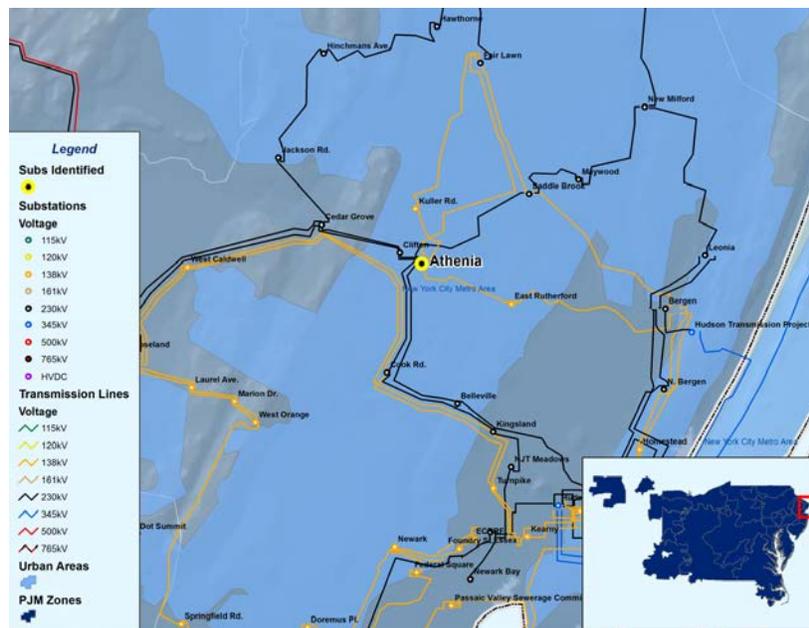
- Replace Midlothian 500 kV breaker 563T576 and motor operated switches with 3 breaker 500 kV ring bus. Terminate Lines #563 Carson - Midlothian, #576 Midlothian - North Anna, Transformer #2 in the new ring bus - \$9M
- Rebuild 115 kV Line #32 from Halifax - South Boston (6 miles) for a minimum of 240 MVA and transfer Welco tap to Line #32. - \$6.5 M
- Install structures in river to remove the 115 kV #65 line (Whitestone - Harmony Village 115 kV) from the bridge and improve reliability of the line - \$30 M

Following is a more detailed description of the larger scope upgrades that were recommended to the PJM Board in November 2014. A description of the criteria driving the need for the upgrade as well as the required in-service date is provided.

Baseline Project B2474 – Rebuild Athenia 138 kV to 80 kA - \$131 M

In the PSE&G transmission zone during 2018, the short circuit fault duty at Athenia 138 kV on the '2LH' and '2TH' breakers is expected to exceed their rated interrupting capability value of 63 kA. In addition to replacing these breakers with higher rated 80 kA breakers other significant improvements at Athenia 138 kV to accommodate the higher rated breakers are required including improving the ground grid at the station as well as physical structure improvements to accommodate the increased mechanical force associated with the higher fault duty. As a result, the recommendation is to rebuild the Athenia 138 kV station to 80 kA interrupting capability.

This work is expected to be complete by June of 2018. The estimated cost for the project is \$131 M.

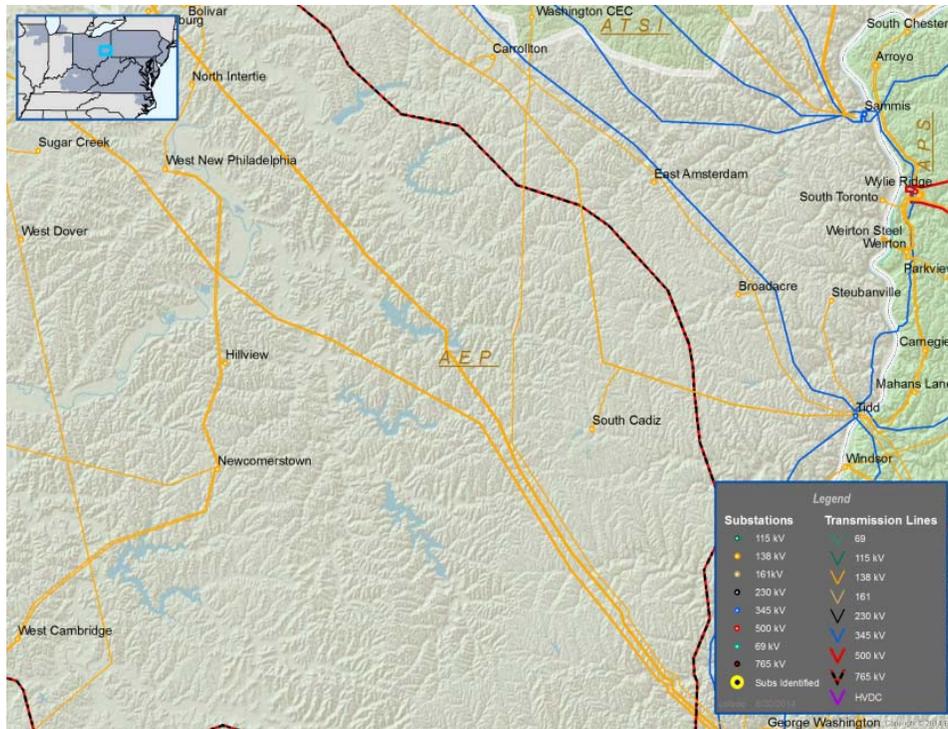


Baseline Project B2501 – Construct a new Yager 138/69 kV station - \$55 M

Eastern Ohio is currently experiencing significant load growth in part due to shale gas development. This increased load is expected to increase facility loadings beyond the existing capabilities of parts of AEP’s 69 kV system and will stress the 138 kV system. The reliability criteria violations include thermal overloads of the Desert – Bowerston 69 kV line, the Leesville – Bowerston 69 kV line and the E. Amsterdam – Miller 69 kV line. Low voltage magnitude is observed at Azalea, Leesville and other nearby 69 kV circuits for the loss of the Desert – Petersburg 69 kV line.

The recommended solution to address these issues is to construct a new 138/69 kV Yager station by tapping the FirstEnergy owned Nottingham – Cloverdale 138 kV and Nottingham – Harmon 138 kV facilities. In addition a new 138 kV line will be built from the new Yager 138 kV substation to the existing Azalea 138 kV station. The 138 kV loop back into Yager 138KV will be closed by converting part of the local 69 kV facilities to 138 kV. In addition, two (2) new 69 kV circuits will be built out of Yager to reinforce the area 69 kV facilities. Finally the conductor between Irish Run 69 kV Switch and Bowerston 69 kV Switch will be upgraded.

This work is expected to be complete by December of 2015. The estimated cost for the project is \$55 M.

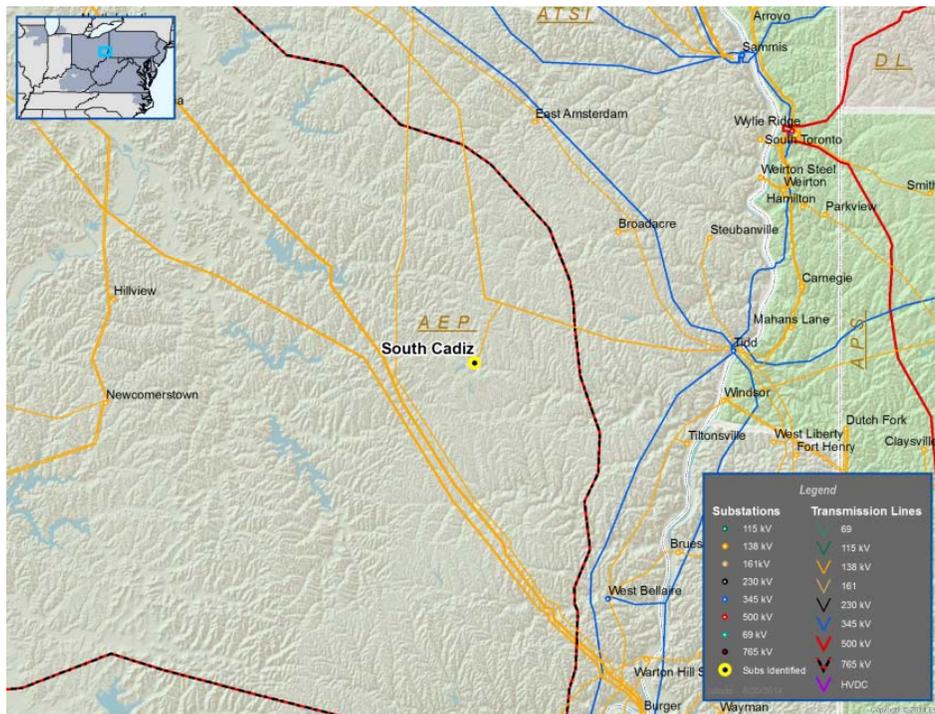


Baseline Project B2502 – Construct a new Nottingham 138 kV switching station - \$90 M

In addition to the reliability criteria violations noted above in the Azalea area of the AEP system, load increases related to shale gas development are also driving reliability criteria violations in the Freebyrd area. The reliability criteria violations include thermal overloads of the Stone Plant – South Cadiz 69KV line, the South Cadiz 138/69KV transformer and the Gable – Tidd 138Kv circuit. These facilities are overloaded in the base case with normal system conditions in addition to several N-1 single contingency thermal violations. In addition to the thermal violations, low voltage violations at Freebyrd, South Cadiz and nearby 69KV facilities are observed for normal system and N-1 conditions.

The recommended solution to address these reliability criteria violations is to construct a new Nottingham 138 kV switching station by tapping six (6) -138 kV FirstEnergy circuits. In addition, the underlying 69 kV system at Freebyrd 69 kV will be converted to 138 kV. The station configuration at South Cadiz 138 kV will also be converted to a breaker and a half configuration.

This work is expected to be complete in December of 2016. The estimate cost of the project is \$90 M.

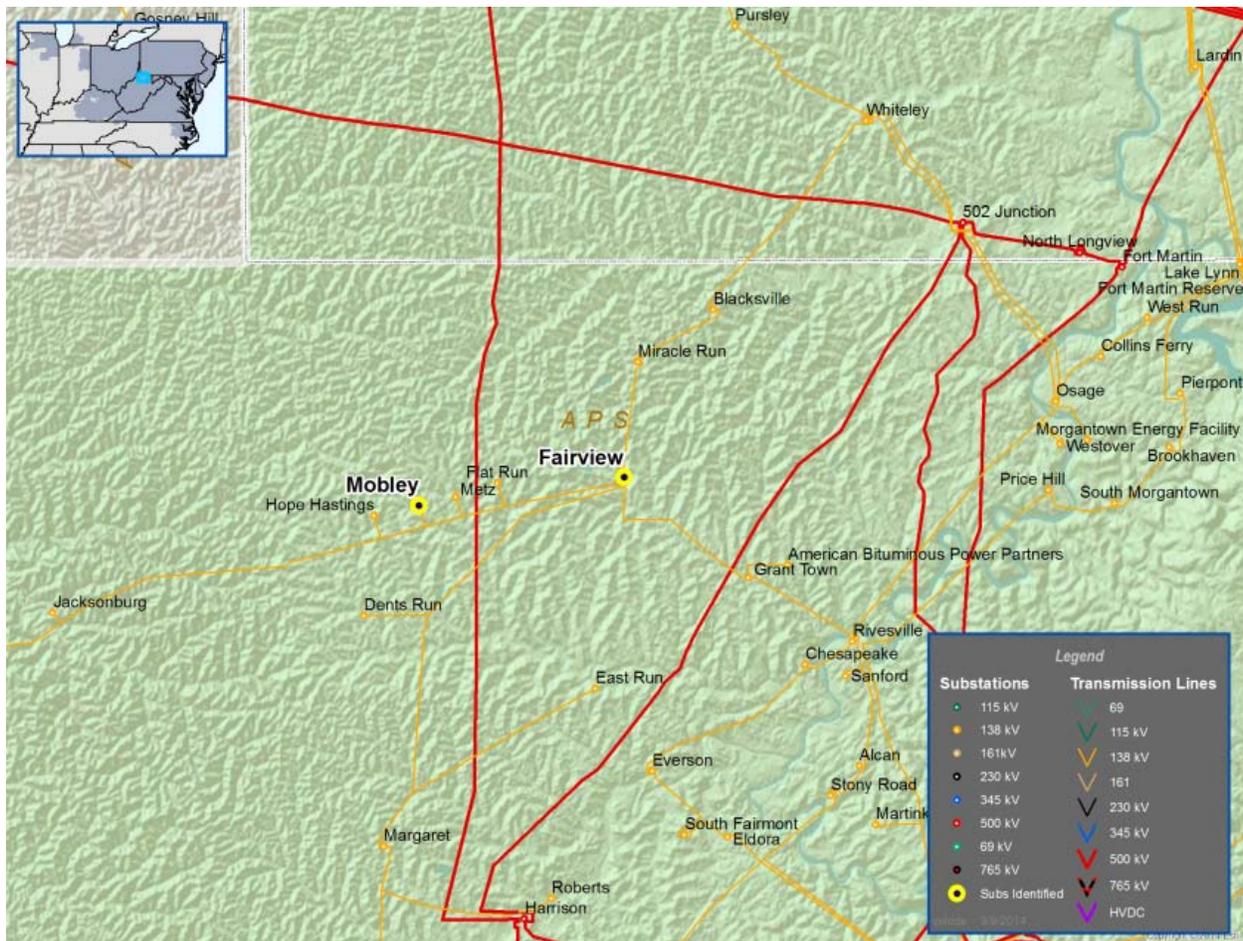


Baseline Project B2525 – Construct a new Shuman Hill 138 kV substation - \$40 M

Block load additions that are expected to occur by 2016 related to shale gas development in northern West Virginia in the APS transmission zone will lead to N-1 low voltage magnitude and voltage drop violations at the Mobley 138 kV substation and surrounding buses. These reliability criteria violations occur for various contingencies.

The recommended solution to resolve these reliability criteria is to install a new Shuman Hill 138 kV ring bus with five active positions and two 52.8 MVAR capacitors. The existing Fairview - Willow Island 138 kV line will then be looped into the new Shuman Hill 138 kV Station. In addition, a new +90/-30 MVAR SVC will be installed at Shuman Hill 138 kV. As a result of this work, the 31.7 MVAR capacitor bank at the existing Mobley 138 kV substation will be removed.

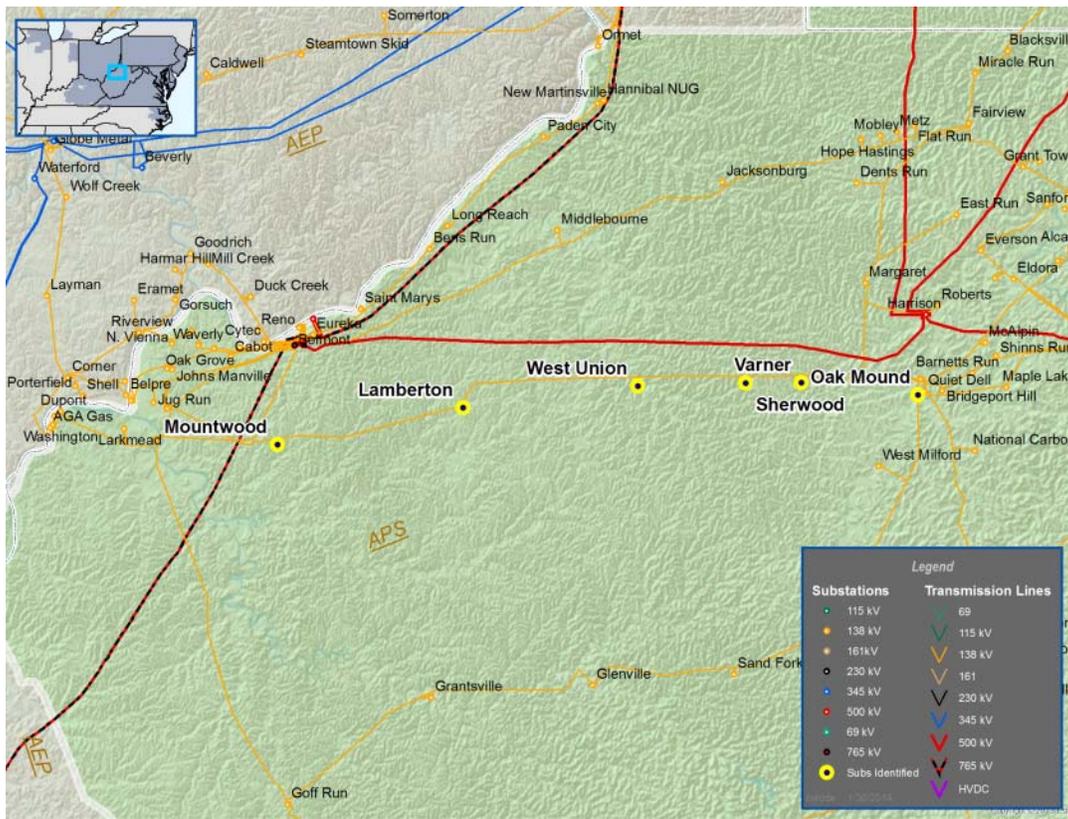
The project is expected to be complete by 7/1/2015. The estimated cost for the project is \$40 M.



Baseline Project B2475 – Construct a new line between Oak Mound 138 kV Substation and Waldo Run 138 kV - \$38 M

In addition to the project noted above in the northern West Virginia portion of the APS transmission zone block load additions in 2016 related to shale gas development will lead to additional N-1 low voltage magnitude and voltage drop violations at West Union, Varner, Mountwood, Lambertson and Sherwood 138 kV buses for several contingencies. The recommended solution is to install a new line between Oak Mound 138 kV substation and Waldo Run 138 kV substation.

This project is expected to be complete by the end of 2015 and is anticipated to cost \$38 M.



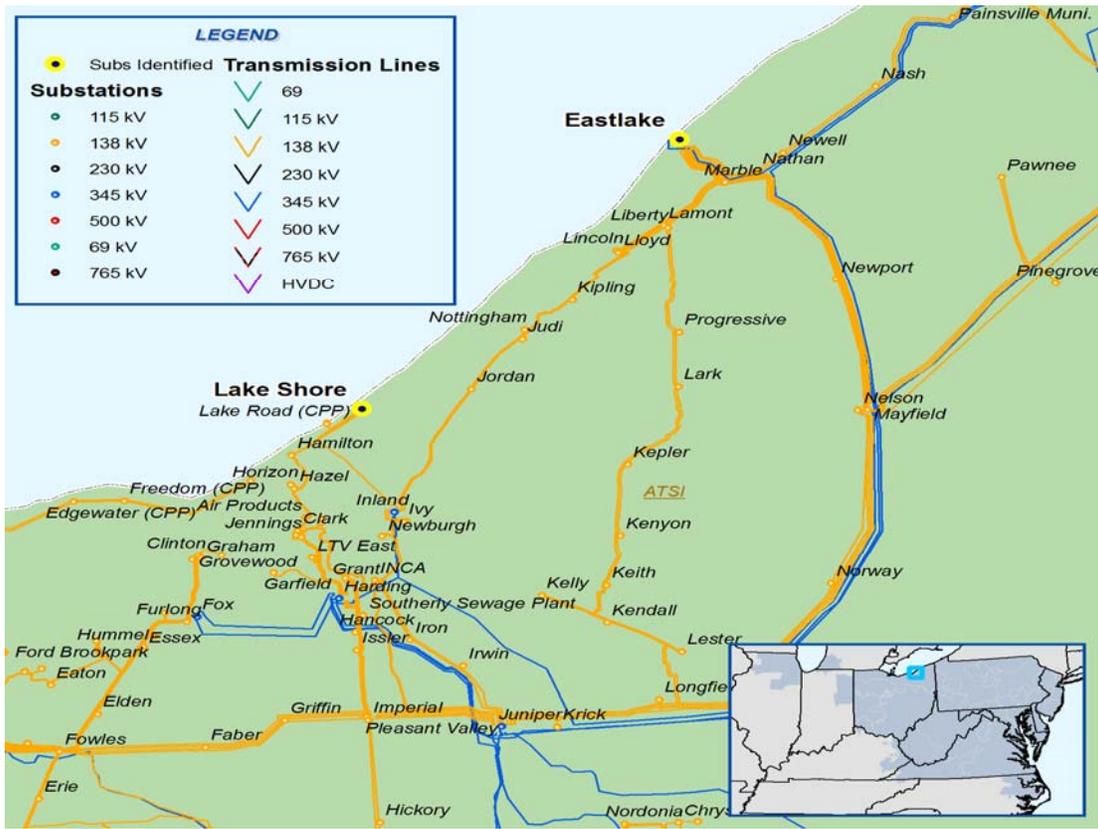
Baseline Project B2463 – Rebuild and Reconductor East Towanda – South Troy 115 kV - \$40 M

PJM staff identified a light load reliability criteria violation in 2016 on the South Troy – East Towanda 115 kV circuit for several single contingencies. The proposed solution to address these reliability criteria violations is to rebuild and reconductor the 115 kV line from East Towanda to S. Troy & upgrade terminal equipment at East Towanda, Tennessee Gas & South Troy substations. This project is required to be complete by 3/1/2016 and is anticipated to cost an estimated \$40 M.



Baseline Project B2459 – Install a SVC at Lake Shore 138 kV - \$38 M

During the 2012 RTEP, deactivation studies were performed for the Armstrong 1 & 2, Ashtabula 5, Bayshore 2-4, Eastlake 1-5, Lake Shore 18, and R Paul Smith 3 & 4 deactivation requests. At that time, a baseline upgrade to convert the Lake Shore unit 18 to a synchronous condenser was approved to address voltage violations in and around the city of Cleveland. The original estimated cost of the work to convert the Lake Shore unit 18 to a synchronous condenser was \$20 M. Following a more detailed engineering design, updated cost estimates for converting the unit to a synchronous condenser now exceed the estimated cost of a new SVC installation. Given that PJM staff is recommending that that an SVC with a reactive capability of +260/-150 MVAR be installed at Lake Shore 138 kV. This revised project is expected to be in-service by 6/1/2015 and has an estimated cost of \$34.7 M.



Changes to Previously Approved Projects

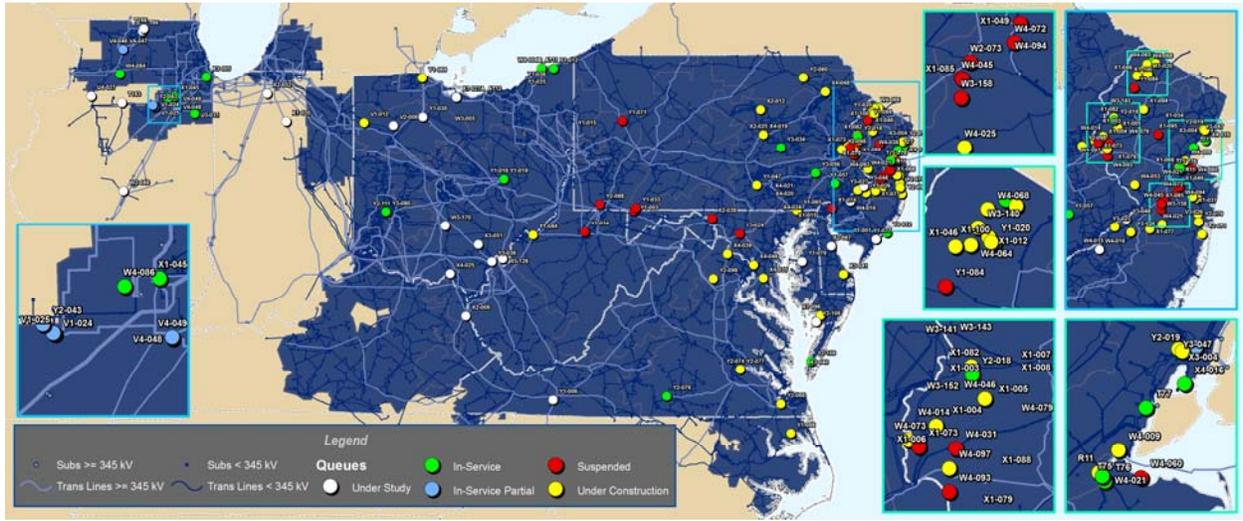
There are a number of previously approved projects in the AEP transmission zone for “sag” studies to be completed. The “sag” study included a physical line clearance survey and additional engineering analysis to calculate updated ratings based on the as-built configuration of the facility. In some instances remediation work is required to attain a rating that is high enough to satisfy reliability criteria. The remediation that has been identified is generally relatively small in scope and includes limited transmission structure modification or replacement, modification of distribution or third party underbuild and conductor



hardware replacement. The increased cost to the RTEP to include the additional scope for the sag study mitigations is \$36.65 M. In addition to the sag study remediation work, the cost and scope of a number of previously approved RTEP baseline projects have been updated. In addition, a number of previously approved projects have been cancelled as they are no longer required. The net result of all of these changes to previously approved baseline projects, including the sag study mitigation work is a net decrease in the RTEP of \$98.5 million.

Interconnection Projects

Since the last PJM Board of Managers approval in December 2013, PJM completed 143 interconnection System Impact Studies and 193 interconnection projects withdrew. The changes associated with the new and withdrawn projects resulted in a net decrease in the RTEP of \$4,159.3 million for the network upgrades and attachment facilities. The cancelled transmission projects include several new 765kV circuits previously required to reliably interconnect larger generation projects which have since withdrawn from the queue. The map below shows the location of the units associated with the completed interconnection System Impact Studies. A listing of the projects with recently completed impact studies is provided in Attachment D to this white paper. A listing of the network upgrades associated with these projects is shown in Attachment C to this report.





Summary of Interconnection Queue Activity (MW)

Status of Generation Interconnection Queues							
Queue	Active	Under Construction	In-Service*	Withdrawn	Suspended	Total MW Request**	
A through T	1,241	7,602	34,303	189,978	1,040	234,159	
U1	0	12	159	7,938	50	8,158	
U2	455	660	68	15,787	210	17,180	
U3	100	20	334	2,515	0	2,969	
U4	1,010	0	85	3,735	200	5,030	
V1	0	250	138	2,251	132	2,771	
V2	150	16	990	3,469	6	4,631	
V3	600	1,159	73	3,113	10	4,955	
V4	1,022	43	612	3,337	0	5,014	
W1	14	129	207	5,089	381	5,819	
W2	701	132	164	2,260	152	3,408	
W3	1,181	544	132	6,058	1,323	9,238	
W4	896	1,059	127	3,569	77	5,727	
X1	2,015	1,080	204	3,693	313	7,304	
X2	2,072	2,887	46	4,877	8	9,891	
X3	1,604	102	45	6,023	2	7,775	
X4	82	2,944	10	2,326	6	5,368	
Y1	255	1,861	60	5,542	568	8,286	
Y2	4,324	379	63	6,494	20	11,281	
Y3	2,402	63	17	3,756	4	6,243	
Z1	5,266	83	40	2,868	0	8,257	
Z2	5,108	22	2	1,092	0	6,223	
AA1	5,715	0	0	5	0	5,719	
TOTAL	36,213	21,047	37,879	285,775	4,502	385,406	

* In-service MW can and do change to account for units that are phased into commercial operation
 **Total MW Requests can change due to MW reduction in certain phases of the study process
 Data Valid as of:
 10/28/2014

Review by the Transmission Expansion Advisory Committee (TEAC)

The results of the analyses summarized in this report were reviewed with the TEAC and Subregional RTEP Committees. The most recent analysis, along with recommended solutions, were reviewed at the September 25, 2014 meeting. Written comments were requested to be submitted to PJM communicating any concerns with the recommendation and any alternative transmission solutions for consideration. No comments were received on the projects presented to the TEAC.

Cost Allocation



Preliminary cost allocations for the recommended projects are shown in Attachment A for the projects that are allocated to a single transmission zone and in Attachment B for the projects that are allocated to multiple transmission zones.

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 2014 RTEP. The PJM Board Reliability Committee also endorsed the new interconnection related network upgrades. The PJM Board of Managers approved the changes to the RTEP.



Attachment A – New Baseline Reliability Single Zone Cost Allocations

Upgrade ID	Description	Cost Estimate (\$M)	Trans Owner	Required IS Date
b1793.1	Remove the Carolina 22 SPS to include relay logic changes, minor control wiring, relay resets and SCADA programming upon completion of project	0.025	Dominion - 100%	5/1/2016
b2006.2.1	Upgrade relay at South Reading on the 1072 230 V line	0.25	ME - 100%	5/1/2016
b2019.2	Terminate Burger-Longview 138 kV, Burger-Brookside 138 kV, Burger-Cloverdale 138 kV #1, and Burger-Harmon 138 kV #2 into Holloway substation; Loop Burger-Harmon #1 138 kV and Burger-Knox 138 kV into Holloway substation	1.5	ATSI - 100%	6/1/2014
b2019.3	Reconfigure Burger 138 kV substation to accommodate two 138 kV line exits and generation facilities		ATSI - 100%	6/1/2014
b2443.1	Replace the Idylwood 230 kV breaker '203512' with 50kA breaker	0.255	Dominion - 100%	6/1/2018
b2443.2	Replace the Ox 230 kV breaker '206342' with 63kA breaker	0.27	Dominion - 100%	6/1/2018
b2451	Replace the Charles 138 kV breaker '919' with 63 kA	0.25	DEOK - 100%	6/1/2018
b2452.3	Replace the Hunterstown 115 kV breaker '96192' with 40 kA rated breaker	0.285478	ME - 100%	6/1/2017
b2457	Replace 24 115 kV wood h-frames with 230 kV Dominion pole H-frame structures on the Clubhouse - Purdy 115 kV line	2.9	Dominion - 100%	6/1/2014
b2458.1	Replace 12 wood H-frame structures with steel H-frame structures and install shunts on all conductor splices on Carolina - Woodland 115 kV	4.9	Dominion - 100%	5/1/2016
b2458.2	Upgrade all line switches and substation components at Carolina 115 kV to meet or exceed new conductor rating of 174 MVA		Dominion - 100%	5/1/2016
b2458.3	Replace 14 wood H-frame structures on Carolina - Woodland 115 kV		Dominion - 100%	5/1/2016
b2458.4	Replace 2.5 miles of static wire on Carolina - Woodland 115 kV		Dominion - 100%	5/1/2016
b2460.1	Replace Hanover 230 kV substation line switches with 3000A switches	0.25	Dominion - 100%	5/1/2016
b2460.2	Replace wave traps at Four River 230 kV and Elmont 230 kV substations with 3000A wave traps		Dominion - 100%	5/1/2016
b2462	Add two 138 kV circuit breakers at Fremont station to fix tower contingency '408_2'	1.2	AEP - 100%	6/1/2015
b2463	Rebuild and reconnector 115 kV line from East Towanda to S. Troy and upgrade terminal equipment at East Towanda, Tennessee Gas and South Troy	40	PENELEC - 100%	3/1/2016
b2465	Replace the Skokie 138 kV breaker '88 L8809' with a 63 kA breaker	1.79	ComEd - 100%	6/1/2016
b2466	Replace the Skokie 138 kV breaker '88 L8810' with 63kA breaker	1.79	ComEd - 100%	6/1/2016
b2467	Replace the Skokie 138 kV breaker '88 L11416' with 63kA breaker	1.79	ComEd - 100%	6/1/2016
b2468	Replace the Skokie 138 kV breaker '88 L8803' with 63kA breaker	1.79	ComEd - 100%	6/1/2016
b2469	Replace the Des Plaines 138 kV breaker '46 11702' with 63kA breaker	1.88	ComEd - 100%	6/1/2016
b2472	Replace the Ringgold 138 kV breaker 'RCM1' with 40kA breakers	0.25	APS - 100%	6/1/2018
b2473	Replace the Ringgold 138 kV breaker '#4 XMFR' with 40kA breakers	0.25	APS - 100%	6/1/2018
b2474	Rebuild Athenia 138 kV to 80kA	131	PSEG - 100%	6/1/2018
b2475	Construct a new line between Oak Mound 138 kV substation and Waldo Run 138 kV substation	38	APS - 100%	12/31/2015
Upgrade ID	Description	Cost Estimate (\$M)	Trans Owner	Required IS Date



Attachment A – New Baseline Reliability Single Zone Cost Allocations

b2492	Replace the Beaver 138 kV breaker '426-B-2' with 63kA breaker	0.35	ATSI - 100%	6/1/2016
b2493	Replace the Hoytdale 138kV breaker '83-B-30' with 63kA breaker	0.35	ATSI - 100%	6/1/2016
b2494	Construct Warren 230 kV ring bus and install a second Warren 230/115 kV transformer	15	PENELEC - 100%	6/1/2016
b2495	Replace transformer leads on the Glen Gardner 230/34.5 kV #1 transformer	0.1	JCPL - 100%	6/1/2015
b2496	Replace Franklin 115/34.5 kV transformer #2 with 90 MVA transformer	3	JCPL - 100%	6/1/2015
b2497	Reconductor 0.9 miles of the Captive Plastics to Morris Park 34.5 kV circuit (397 ACSR) with 556 ACSR	0.6	JCPL - 100%	6/1/2015
b2498	Extend 5.8 miles of 34.5 kV circuit from North Branch substation to Lebanon substation with 397 ACSR and install 34.5 kV breaker at Lebanon substation	2	JCPL - 100%	6/1/2015
b2500	Upgrade terminal equipment at Monroe on the Englishtown to Monroe (H34) 34.5 kV circuit	0.1	JCPL - 100%	6/1/2015
b2501	Construct a new 138/69 kV Yager station by tapping 2-138 kV FE circuits (Nottingham-Cloverdale, Nottingham-Harmon)	55	AEP - 100%	6/1/2014
b2501.2	Build a new 138 kV line from new Yager station to Azalea station		AEP - 100%	6/1/2014
b2501.3	Close the 138 kV loop back into Yager 138 kV by converting part of local 69 kV facilities to 138 kV		AEP - 100%	6/1/2014
b2501.4	Build 2 new 69 kV exits to reinforce 69 kV facilities and upgrade conductor between Irish Run 69 kV Switch and Bowerstown 69 kV Switch		AEP - 100%	6/1/2014
b2502.1	Construct a new 138 kV switching station Nottingham tapping 6-138 kV FE circuits (Holloway-Brookside, Holloway-Harmon (#1), Holloway-Reeds, Holloway-New Stacy, Holloway-Cloverdale). Exit 138 kV circuit from new station to Freebyrd station.	90	AEP - 100%	6/1/2014
b2502.2	Convert Freebyrd 69 kV to 138 kV		AEP - 100%	6/1/2014
b2502.3	Rebuild/convert Freebyrd - South Cadiz 69 kV circuit to 138 kV		AEP - 100%	6/1/2014
b2502.4	Upgrade South Cadiz to 138 kV breaker and a half		AEP - 100%	6/1/2014
b2504	Rebuild 115 kV Line #32 from Halifax-South Boston (6 miles) for min. of 240 MVA and transfer Welco tap to Line #32. Moving Welco to Line #32 requires disabling auto-sectionalizing scheme	6.5	Dominion - 100%	6/30/2015
b2505	Install structures in river to remove the 115 kV #65 line (Whitstone - Harmony Village 115 kV) from bridge and improve reliability of the line	30	Dominion - 100%	5/31/2016
b2527	Replace Whitpain 230 kV breaker '155' with 80kA breaker	0.6	PECO - 100%	6/1/2016
b2528	Replace Whitpain 230 kV breaker '525' with 80kA breaker	0.6	PECO - 100%	6/1/2016
b2529	Replace Whitpain 230 kV breaker '175' with 80kA breaker	0.6	PECO - 100%	6/1/2016
b2530	Replace the Sporn 138 kV breaker 'G1' with 80kA breaker	1	AEP - 100%	6/1/2018
b2531	Replace the Sporn 138 kV breaker 'D' with 80kA breaker	1	AEP - 100%	6/1/2018
b2532	Replace the Sporn 138 kV breaker 'O1' with 80kA breaker	1	AEP - 100%	6/1/2018
b2533	Replace the Sporn 138 kV breaker 'P2' with 80kA breaker	1	AEP - 100%	6/1/2018
b2534	Replace the Sporn 138 kV breaker 'U' with 80kA breaker	1	AEP - 100%	6/1/2018
b2535	Replace the Sporn 138 kV breaker 'O' with 80kA breaker	1	AEP - 100%	6/1/2018
b2536	Replace the Sporn 138 kV breaker 'O2' with 80kA breaker	1	AEP - 100%	6/1/2018
b2537	Replace the Robinson Park 138 kV breakers A1, A2, B1, B2, C1, C2, D1, D2, E1, E2, and F1 with 63 kA breakers	15	AEP - 100%	6/1/2016
Upgrade ID	Description	Cost Estimate (\$M)	Trans Owner	Required IS Date
b2538	Replace the Mickleton 230kV 'MK' breaker with 63kA breaker	0.4	AEC - 100%	6/1/2016



Attachment A – New Baseline Reliability Single Zone Cost Allocations

b2540	Increase rating of Shelby-E. Sidney-Quincy-Logan 138 kV line to 224 MVA by replace/raise three pole swing out structure; push/pull/retension conductors on two spans; lower eight spans of single phase	0.042	Dayton - 100%	6/1/2015
b2541	As needed in PJM Operations connect two 30MVAR mobile shunts to Eldean and Sidney 69 kV buses; Block LTCs for Eldean 138/69 kV and Sidney 138/69kV transformers after loss of Shelby-Sidney 138 kV line	0	Dayton - 100%	10/1/2014
b2544	Increase the MOT of the 266.8 MCM ACSR section (1.4 miles), of the Kargle - KU Elizabethtown 69 kV line section to 266 degrees F	0.0276	EKPC - 100%	6/1/2015
b2545.1	Construct a new 138 kV substation (Shuman Hill substation) connected to the Fairview - Willow Island (84) 138 kV line	40	APS - 100%	7/1/2015
b2545.2	Install a ring bus station with five active positions and two 52.8 MVAR capacitors with 0.941 mH reactors		APS - 100%	2/1/2016
b2545.3	Install a +90/-30 MVAR SVC protected by a 138 kV breaker		APS - 100%	2/1/2016
b2545.4	Remove the 31.7 MVAR capacitor bank at Mobley 138 kV		APS - 100%	2/1/2016
b2546	Install a 51.8 MVAR (rated) 138 kV capacitor at Nyswaner 138 kV substation	1	APS - 100%	4/1/2015
b2547.1	Construct a new 138 kV six breaker ring bus Hillman substation	31.5	APS - 100%	2/1/2016
b2547.2	Loop Smith - Imperial 138 kV line into the new Hillman substation		APS - 100%	2/1/2016
b2547.3	Install +125/-75 MVAR SVC at Hillman substation		APS - 100%	2/1/2016
b2547.4	Install two 31.7 MVAR 138 kV capacitors		APS - 100%	2/1/2016
b2548	Eliminate clearance de-rate on Wylie Ridge - Smith 138 kV line and upgrade terminals at Smith 138 kV, new line ratings 294 MVA (Rate A)/350 MVA (Rate B)	2.3	APS - 100%	2/1/2016
b2549	Replace terminal equipment inside Chichester substation on the 220-36 (Chichester – Eddystone) 230 kV line	0.4	PECO - 100%	6/1/2019
b2550	Replace terminal equipment inside Nottingham substation on the 220-05 (Nottingham – Daleville – Bradford) 230 kV line	0.1	PECO - 100%	6/1/2019
b2551	Replace terminal equipment inside Llanerch substation on the 130-45 (Eddystone to Llanerch) 138 kV line	0.1	PECO - 100%	6/1/2019
b2552	Reconductor the North Meshoppen – Oxbow - Lackawanna 230 kV circuit and upgrade terminal equipment	26.5	PENELEC - 100%	6/1/2019
b2553	Replace Middle T3 138/69 kV transformer with 225 MVA nameplate	7.5	AEC - 100%	6/1/2019
b2555	Reconductor 0.5 miles of Tiltonville - Windsor 138 kV and string the vacant side of the 4.5 mile section using 556 ACSR in a six wire configuration	2	AEP - 100%	6/1/2019
b2556	Install two 138 kV prop structures to increase the maximum operating temperature of the Clinch River - Clinch Field 138 kV line	1.1	AEP - 100%	6/1/2019
b2557	At Avon substation, replace the existing 345/138 kV 448 MVA #92 transformer with a 560 MVA unit	5.4	ATSI - 100%	6/1/2019
b2558	Close normally open switch A 13404 to create a Richland J Bus - Richland K Bus 138 kV line	0.02	ATSI - 100%	6/1/2019
b2559	Reconductor the Black River - Lorain 138 kV line and upgrade Black River and Lorain substation terminal end equipment	9.6	ATSI - 100%	6/1/2019
Upgrade ID	Description	Cost Estimate (\$M)	Trans Owner	Required IS Date



Attachment A – New Baseline Reliability Single Zone Cost Allocations

b2560	Construct a second 138 kV line between West Fremont and Hayes substation on open tower position of the West Fremont - Groton - Hayes 138 kV line	7.4	ATSI - 100%	6/1/2019
b2561	Install a new 345 kV circuit breaker 5-7 at Elwood substation	2.6	ComEd - 100%	6/1/2019
b2562	Remove 2.0 miles of wood poles on 138 kV line 17105, erect new steel structures, and install new 1113 kcmil ACSR conductor from Roscoe Bert to Harlem	4.6	ComEd - 100%	6/1/2019
b2563	Operate with the Crescent 345/138 kV #3 autotransformer in-service by replacing 8 overdutied 138 kV breakers at Crescent, 3 138 kV breakers at Beaver Valley, install #1 section 345 kV breaker for 331 circuit at Crescent	7.285	DLCO - 100%	6/1/2019
b2564	Add two breakers at Miami Fort 138 kV	2	DEOK - 100%	6/1/2019
b2565	Replace wave trap at Carver Substation with a 2000A wave trap	0.04	Dominion - 100%	6/1/2019
b2566	Reconductor 1.41 miles of existing line between ACCA and Hermitage and upgrade associated terminal equipment	1.82	Dominion - 100%	6/1/2019
b2567	Upgrade the Riverside 115kV substation strain bus conductors on circuits 115012 and 115011 with double bundled 1272 ACSR to achieve ratings of 491/577 MVA SN/SE on both transformer leads	1.14	BGE - 100%	6/1/2019
b2568	Reconductor Northwest – Northwest #2 115kV 110574 substation tie circuit with 2167 ACSR to achieve ratings of 400/462 MVA SN/SE	1.2	BGE - 100%	6/1/2019
b2569	Replace Terminal equipment at Silverside 69 kV substation	0.04	DPL - 100%	6/1/2019
b2570	Upgrade limiting terminal facilities at Freneau, Parlin, and Williams substations	0.6	JCPL - 100%	6/1/2019
b2571	Upgrade the limiting terminal facilities at both Jackson and North Hanover	0.1	JCPL - 100%	6/1/2019



Attachment B – New Baseline Reliability Multi Zone Cost Allocations

Upgrade ID	Description	Cost Estimate (\$M)	Cost Allocation	Required IS Date
b2006.1.1	Loop the 2026 (TMI - Hosensack 500 kV) line in to the Lauschtown substation and upgrade relay at TMI 500 kV	\$5.25	AEC - 0.87%, AEP - 7.21%, APS - 2.74%, ATSI - 4.15%, BGE - 10.87%, COMED - 7.02%, ConEd - 0.29%, DAYTON - 1.08%, DEOK - 1.63%, DL - 0.93%, DPL - 1.27%, DVP - 5.92%, ECP - 0.1%, EKPC - 0%, JCPL - 2.01%, ME - 11.06%, NEPTUNE - 0.21%, HTP - 0.01%, PECO - 2.72%, PENELEC - 0.98%, PEPCO - 2.06%, PPL - 33.51%, PSEG - 3.29%, RE - 0.14%	6/1/2017
b2471	Replace Midlothian 500 kV breaker 563T576 and motor operated switches with 3 breaker 500 kV ring bus. Terminate Lines #563 Carson - Midlothian, #576 Midlothian - North Anna, Transformer #2 in new ring	\$9.00	AEC - 0.87%, AEP - 7.21%, APS - 2.74%, ATSI - 4.15%, BGE - 2.16%, ComEd - 7.02%, ConEd - 0.29%, Dayton - 1.08%, DEOK - 1.63%, DL - 0.93%, DVP - 55.92%, DPL - 1.27%, ECP - 0.1%, EKPC - 0%, O66 - 0.01%, JCPL - 2.01%, ME - 0.95%, NEPTUNE - 0.21%, PECO - 2.72%, PENELEC - 0.98%, PEPCO - 2.06%, PPL - 2.33%, PSEG - 3.29%, RE - 0.14%	11/1/2015



Attachment C – Interconnection Network Upgrades

Upgrade ID	Project Description	Transmission Owner	Cost Estimate (\$M)	ISA In Service Date
n1832.1	Relay and SCADA modifications	ComEd	0.36	12/31/2009
n1832.2	Relay and SCADA modifications	ComEd	0.60	12/31/2009
n1832.3	Relay and SCADA modifications	ComEd	0.14	12/31/2009
n2130	Install new 345kV bus tie circuit breaker at TSS 900 Elwood Energy Center	ComEd	5.00	12/1/2013
n3904	Protection system modifications.	PPL	0.25	7/4/2015
n3906	Replace wave trap and protective relays.	PPL	0.25	7/4/2015
n3908	Rebuild the Eldred-Frackville 230kV line using double 1590 ACSR conductor (12 miles)	PPL	34.62	7/4/2015
n3909	Replace the substation conductors with 1590 ACSR. Replace two breakers, 4 switches and associated equipment with 3000amp rated equipment.	PPL	4.00	7/4/2015
n3910	Replace the substation conductors with 1590 ACSR. Replace two breakers, 4 switches and associated equipment with 3000amp rated equipment.	PPL	3.00	7/4/2015
n3935.1	Upgrade Clifton breakers 26582, 265T266 & 26682 from 50kA to 63kA	Dominion	0.94	6/1/2016
n3935.2	Upgrade Clifton breakers 26582, 265T266 & 26682 from 50kA to 63kA	Dominion	0.94	6/1/2016
n3935.3	Upgrade Clifton breakers 26582, 265T266 & 26682 from 50kA to 63kA	Dominion	0.94	6/1/2016
n3960	Construct new 345kV (Stemple) station switchyard	AEP	13.15	8/31/2017
n3968	Upgrade the line described in N3562 to be triple bundled 1590 ACSR.	PPI	1.81	6/1/2015
n3969	Upgrade the equipment described in N3563 to be rated for 4000A	PPI	0.43	6/1/2015
n3995	345kV transmission line tie-in	COMED	2.00	10/1/2013
n3996	Install 345kV three breaker ring bus	COMED	15.00	10/1/2011
n3997	Remote-end relay upgrade	COMED	1.00	10/1/2011
n3998	345kV transmission line tie-in	COMED	2.00	12/31/2013
n3999	Install 345kV three breaker ring bus	COMED	15.00	12/31/2013
n4000	Remote-end relay upgrade	COMED	1.00	12/31/2013
n4001	Install an extra three 345kV breakers at TSS 92 Mt. Pulaski substation	COMED	9.00	12/31/2013
n4002	To resolve the 556BKRSTA-8CARSON 500 kV line overload: Upgrade 556BKRSTA-8CARSON 500 kV line (Existing line #556 (Future line#511) to at least 2811MVA (3246Amps). Replace 3000Amp wave trap at Carson w	AEP	0.08	5/15/2016
n4010	Modify relaying at Jacksons Ferry 765 kV Station.	AEP	0.55	5/15/2016
n4015	Replace line traps, station cables, meters, disconnect switches, circuit breakers, reactor and relays	PECO	2.60	6/1/2015
n4018	Installation of interconnection metering, communications, protection and control upgrades to Beckjord circuit breaker 906 necessary to accommodate connection of the new facilities	DEOK	0.23	12/31/2014
n4028	Provide revenue metering equipment.	PENELEC	0.05	
n4035	Willard Station Fiber Optic Option: Protection and Relaying Cost	AEP	0.27	12/1/2013
n4036	SCADA will also be required in the following facilities: Greenwich 69 kV station, General Electric Tiffin 69 kV station, and Tiffin Tap 69 kV station. Estimated Cost (2013 Dollars): \$750,000	AEP	0.75	12/1/2013



Attachment C – Interconnection Network Upgrades

Upgrade ID	Project Description	Transmission Owner	Cost Estimate (\$M)	ISA In Service Date
n4041	Install 3 138kV circuit breakers, revenue metering and associated equipment at Fostoria Central 138kV station	AEP	3.03	12/31/2012
n4042	Modify relays on the Fostoria Central line at North Findlay 138kV station.	AEP	0.37	12/31/2012
n4043	Reconductor the 0.8 mile I1023 line between Lake Nelson and Middlesex with a single 1590 kcmil ACSS conductor, replacing the existing 1590 kcmil ACSR. Replace drop looks on the 230kV Lake Nelson bus with bundled 1590 ACSR.	JCPL	2.24	7/31/2014
n4046	Cedar Street-New Castle (Z-100) 138kV - Reconductor New Castle to Ellwood Steel Tap Section (3.11 Miles) with 795 kcmil ACSS. see notes..	ATSI	2.09	6/1/2016
n4047	Connect Fiber from the tap point at Cedar Point Road and Otter Creek Road to Ironville substation	ATSI	0.25	12/31/2014
n4054	AEP shall install a new 69 kV circuit breaker at Buckskin station, relaying, SCADA, and associated equipment.	AEP	0.71	8/31/2011
n4055	AEP shall install 69 kV revenue metering for this IPP project.	AEP	0.18	8/31/2011
n4056	Replace the Dumont wavetrapp on the Dumont - Sorenson 765 kV line.	AEP	0.50	6/1/2016
n4058	Perform a sag study on the Stillwell - Dumont 345 kV line	AEP	0.03	6/1/2016
n4059	CCVTs, Conductor, Tranceiver, DTT	Dominion	0.10	10/31/2014
n4060	Reconductor 3400' of line 434	Dominion	0.20	10/31/2014
n4061	DTT	Dominion	0.05	10/31/2014
n4062	DTT	Dominion	0.05	10/31/2014
n4073	Expand existing Krayn substation from 4 breaker ring bus to 5 breaker ring bus. Existing substation yard will be expanded to the west.	Penelec	1.64	
n4074	Reconductor ~0.5 miles of 2338 overhead ACAR conductor	ComEd	1.00	1/1/2016
n4076	Upgrade relaying at Fostoria Central 345kV substation. Also replace existing Fostoria Central - Bay Shore 345kV metering on 345kV Bayshore circuit to FirstEnergy.	AEP	0.18	
n4078	Replace Towanda and Canyon 230 kV line with 1033 ACSS conductor. Upgrade terminals at E. Towanda and Canyon.	Penelec	14.27	1/1/2016
n4079	Rebuild N. Meshoppen and Oxbow 230 kV line using 1622 ACSS conductor. Upgrade terminals at N. Meshoppen and Oxbow.	Penelec	13.50	1/1/2017
n4080	Rebuild line using 1033 ACSS conductor. Upgrade terminals at Oxbow and Lackawanna.	Penelec	20.83	1/1/2017
n4081	Upgrade the Easton & Todd Substation Relay Protection and Control Equipment to handle at Least 174 MVA Emergency Rating	DPL	0.56	6/1/2014
n4082	ABINGDON-HILLMAN 69 kV line: Rebuild 4.9 mile section of 69 kV line with an estimated cost: \$5,880,000.	AEP	5.00	5/15/2016
n4083	Replace the Clinch River riser, Replace the Lebanon Switch (1200A), Rebuild 0.16 mile of the Clinch River - Lebanon 138 kV line section, Rebuild 0.06 mile of the Clinch River - Lebanon 138 kV line sect	AEP	0.48	1/1/2016
n4084	Sag study for 05KEYWSS-05BROADF 138 kV line	AEP	49.88	1/1/2016



Attachment C – Interconnection Network Upgrades

Upgrade ID	Project Description	Transmission Owner	Cost Estimate (\$M)	ISA In Service Date
n4085	Install three-breaker loop 138kV substation, relaying, metering, RTU, SCADA and other miscellaneous supporting equipment	DL	2.44	5/1/2018
n4086	Replace overdutied 138kV circuit breaker Z-37 Racoon at Beaver Valley substation	DL	0.44	5/1/2018
n4087	Replace overdutied 138kV circuit breaker 50 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4088	Replace overdutied 138kV circuit breaker 54 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4089	Replace overdutied 138kV circuit breaker 34 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4090	Replace overdutied 138kV circuit breaker 38 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4091	Replace overdutied 138kV circuit breaker 27 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4092	Replace overdutied 138kV circuit breaker 65 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4093	Replace overdutied 138kV circuit breaker 30 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4094	Replace overdutied 138kV circuit breaker 19 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4095	Replace overdutied 138kV circuit breaker 8 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4096	Replace overdutied 138kV circuit breaker 23 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4097	Replace overdutied 138kV circuit breaker 12 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4098	Replace overdutied 138kV circuit breaker 61 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4099	Replace overdutied 138kV circuit breaker 57 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4100	Replace overdutied 138kV circuit breaker 46 at Bruce Mansfield substation	ATSI	0.94	5/1/2018
n4102	Replace Bus Ties 3-4 ckt breakers at Braidwood. The rating on the BraidwoodB-E.FrankfurtB 345kV line will be 1134/1528 after the upgrade.	ComEd	2.40	
n4103	Replace Bus Ties 14-15 ckt breakers at Braidwood. The rating on the BraidwoodR-E.FrankfurtR 345kV line will be 1134/1528 after the upgrade.	ComEd	2.40	
n4104	Sag study req -\$48k, If normal rating needs fixed, rebuild required for \$12M.	AEP	12.05	
n4105	Reconductor from Collinsville through Huston to Trenton approx. 12.2 miles along with the structures for \$12M.	AEP	12.05	
n4106	345 kV line between Jefferson and Clifty Creek	AEP	2.00	
n4107	Install a 3rd transformer in parallel to the existing ones at \$6M	AEP	6.00	
n4108	Reconductor 4.54 miles at \$2.5M	AEP	2.50	
n4109	Sag study req - \$4000, if normal rating needs fixed, rebuild required for \$1M	AEP	1.00	
n4110	Terminal equipment needs to be replaced. Cost estimate \$2M.	AEP	2.00	
n4111	Sag study req - \$34,400, if normal rating needs fixed, rebuild required for \$9M	AEP	9.03	
n4112	Replace station conductor on 345 kV line 11601 to achieve new ratings of 1660/1917/2488 for \$0.2M.	ComEd	0.20	



Attachment C – Interconnection Network Upgrades

Upgrade ID	Project Description	Transmission Owner	Cost Estimate (\$M)	ISA In Service Date
n4113	Reconductor 10.2 miles of 138 kV line 0108 from Mazon to LaSalle to achieve new ratings of 208/264/275 for \$17.75M.	ComEd	17.75	
n4114	Reconductor 5.7 miles of 138 kV line 1205 from Mazon to Dresden to achieve new ratings of 292/321/433 for \$9.75M.	ComEd	9.75	
n4115	Install 4th autotransformer at Davis Creek, \$14.6M (IDEV attached).	ComEd	14.60	
n4116	Req rating 1362.7. CE gave 1660 for \$0.145M - Upgrade station conductor at East Frankfort and Goodings Grove	ComEd	0.15	
n4117	upgrade Beckjord-Pierce 138kV line	ComEd	0.35	
n4118	Replace ComEd CB at State Line raises rating to 561	ComEd	1.20	
n4119	Build 0.15 mile 69kV line between the Stanton-Sullivan Trail 69kV line and Y3-104	PPI	1.44	1/1/2015
n4120	Install DTT equipment	PPI	0.26	1/1/2015
n4121.1	Replace 5 disconnect switches, 2 circuit breakers, and 1 line trap at Peach Bottom.	PECO	3.50	6/1/2017
n4121.2	Replace 2 disconnect switches, 2 circuit breakers, and 1 line trap at Conastone	BGE	1.80	6/1/2017
n4122	Rebuild the 9.5 mile line with 3x 1590 ACSR.	ME	61.75	6/1/2017
n4123	Construct a line, approximately 1000 feet long, connecting Y3-041 to the Peckville-Jackson 69kV line and two MOLBAB switches.	PPL	1.26	11/1/2014
n4124	Install transfer trip equipment	PPL	0.27	11/1/2014
n4125	Install transfer trip equipment	PPL	0.23	11/1/2014
n4126	Install transfer trip equipment	PPL	0.24	11/1/2014
n4127	Install transfer trip equipment	PPL	0.28	11/1/2014
n4133	replace 3 circuit breakers, reconductor the line, and replace station conductor	ComEd	40.00	1/1/2016
n4135	Benton 345/138 kV transformer	AEP	3.50	6/1/2017
n4137	reconductoring the Woodville Tap – Lemoyne 138 kV line is required.	ATSI	2.96	6/1/2017
n4138	Upgrade terminal equipment and bus at Mitchell on the Elrama/Wilson terminal.	APS	0.95	6/1/2017
n4139	Reconductor a 3.34 mile portion of the Mitchell-Wilson 138 kV tie line	DL	2.80	6/1/2017
n4140	Construct a 69 kV three-breaker ring bus substation, inclusive of a terminal position for the queue project on the Chestertown - Millington 69 kV line.	DPL	2.00	9/15/2015
n4141	Cut circuit 6773 and loop into and out of the new substation. Install two (2) self-supporting steel poles with anchor bolt foundations, post construction tangent structures, and short span to DPL substation.	DPL	1.00	9/15/2015
n4144	Install two 95 foot self-supporting steel poles on concrete foundations with two spans of 1590 ACSR Lapwing conductor from the Cedar substation to the Interconnection Customer's circuit breaker.	AEC	0.23	9/30/2015
n4145	Replace overdutied circuit breaker B-26 with a circuit breaker rated for 63kA interrupting capability.	ATSI	0.21	6/1/2016
n4146	Replace 138kV breaker B-30 with 63kA breaker.	ATSI	0.20	6/1/2016
n4147	install new 345 kV breakers	ComEd	5.00	6/1/2017
n4176	Construct a 34.5kV 3 breaker ring bus switching station.	APS	2.98	6/30/2015



Attachment C – Interconnection Network Upgrades

Upgrade ID	Project Description	Transmission Owner	Cost Estimate (\$M)	ISA In Service Date
n4177	Line Loop: Loop 34.5kV Line into proposed Metropolitan Court Switching Station.	APS	0.10	6/30/2015
n4178	Install anti-islanding (transfer trip) facilities at Fredrick A substation	APS	0.17	6/30/2015
n4179	Install anti-islanding (transfer trip) facilities at Lime Kiln substation	APS	0.17	6/30/2015
n4180	Install anti-islanding (transfer trip) facilities at Ballenger Creek substation	APS	0.32	6/30/2015
n4181	A fiber optic digital channel between Ballenger Creek & Lime Kiln and the new Metropolitan Court interconnect substation is required. (Est 2.2 miles ADSS)	APS	0.28	6/30/2015
n4182	Ballenger Creek - Detention Center 34.5kV Line: Reconductor 0.01 miles of 34.5kV line and parallel 0.03 miles of underground cable.	APS	0.10	6/30/2015
n4190	upgrade 345kV BT 7-8 & 8-9 CB's at TSS 155 Nelson	ComEd	7.00	
n4193	Replace the George Washington 138/69 kV Transformer #2	AEP	1.94	6/1/2018
n4194	Rebuild 5.83 miles of the Glendale - Brues 69 kV line.	AEP	3.68	6/1/2018
n4195	Rebuild 5.02 miles of the DILLES-SHADYSID 69 kV line	AEP	5.80	6/1/2018
n4196	Rebuild 4.14 miles of the Tilton – Windsor 138 kV line	AEP	3.10	6/1/2018
n4199	The upgrade is to install a new transformer.	ComEd	30.00	6/1/2017
n4200	Install two (2) new 138 kV circuit breakers to connect the proposed generation. SCADA, 138 kV revenue metering, and associated equipment will also need to be installed.	AEP	1.57	6/1/2018
n4201	Line protections and controls at the existing George Washington 138 kV station will need to be upgraded.	AEP	0.12	6/1/2018
n4204	Replace "I" and "K" CBs at Geo Washington Substation	AEP	1.60	6/1/2018
n4205	Replace the George Washington 138/69 kV TR #2	AEP	1.94	6/1/2018
n4206	Rebuild the entire 5.83 mile section of DILLES - SHADYSID 69 kV line	AEP	5.80	6/1/2018
n4207	Rebuild the entire 5.02 mile section of Glendale- Brues 69 kV	AEP	3.68	6/1/2018
n4208	Rebuild entire 4.14 miles of the Tilton – Windsor 138 kV line - (ACSR 556.5 26/7 Dove conductor section 1)	AEP	3.10	6/1/2018
n4209	Construct a 69 kV line tap structure on the Tasley - Kellam 69kV line	ODEC	0.42	
n4210	Construct a new 69 kV line position at the Quinton Substation including one 75' self-supporting steel pole with a gang-motor operated disconnect switch	AEC	0.47	
n4211	Construct and cut in 0.75 miles of new 345kV transmission line	AEP	2.66	8/31/2017
n4213	Construct a new 69 kV 3 breaker ring bus substation adjacent to the Lewis-FAATC 69 kV circuit	AEC	4.30	3/1/2012
n4214	Create a transmission loop by cutting the Lewis-FAATC 69 kV circuit into and out of the newly constructed substation.	AEC	2.00	3/1/2012
n4216	Provide revenue metering equipment in Developer's Generation Substation.	APS	0.11	12/31/2017
n4217	Modify or construct a 230kV terminal at the Burches Hill substation to accept the new direct connect circuit from the Customer Facility	PEPCO	0.00	6/1/2016
n4218	Construct an approximate 6 mile direct connect 230kV circuit from the customer facility to the Burches Hill sub	PEPCO	0.00	6/1/2016
n4219	upgrade the Burches Hill ABB GCB 230kV breaker to 80kV	PEPCO	0.73	6/1/2016



Attachment C – Interconnection Network Upgrades

Upgrade ID	Project Description	Transmission Owner	Cost Estimate (\$M)	ISA In Service Date
n4220	upgrade the Burches Hill ITE OCB 230kV breaker to 80kV	PEPCO	0.73	6/1/2016
n4221	upgrade the Burches Hill West OCB 230kV breaker to 80kV	PEPCO	0.73	6/1/2016
n4222	Install new wave trap, tuner, and TT receiver on the 115kV Warren/Warren South Line exit. Add PT between No. 1 TR and 34.5kV breaker. Replace existing ABB32 and 62T relays with an SEL-351 on reverse power panel....See notes for more details	Penelec	0.57	7/1/2015
n4223	Install CVT, wavetrap, tuner, and transfer trip transmitter on the 115kV Elm Street/Warren South Tap Line exit. Add auto reclosing and sync check relaying for the two 115kV breakers adjacent to the Elm Street/Warren South Tap Line exit.	Penelec	0.40	7/1/2015
n4224	Install new wave trap on the 115kV Warren/Elm Street Line exit.	Penelec	0.09	7/1/2015
n4225	Engineering and design related activities required to construct a new substation adjacent to the Quinton-Roadstown 69 kV circuit. Cut and loop the circuit into the new substataion.	AEC	4.80	6/1/2012
n4226	Create a transmission loop by cutting into the Quinton to Roadstown 69 kV line and constructing a double circuit 69 kV pole line with 795 ACSR conductor and OPGW for a distance of approximately 1,500 feet.	AEC	0.88	6/1/2012
n4227	Install 48SM ADSS fiber cable on the Quinton to Roadstown to Laurel 69kV line, a distance of approximately 15.0 miles.	AEC	0.67	6/1/2012
n4228	New line section for generator lead and upgrade bus relaying	ComEd	3.88	7/8/2005
n4229	Construct a new 230 kV terminal at the Mickleton substation.	AEC	4.60	6/1/2015
n4230	Install a self-supporting 230 kV steel pole with a concrete foundation, motor operated disconnects, and a short span to Mickleton substation.	AEC	0.38	6/1/2015
n4231	Rebuild the MICKLETON-MONROE 230 kV line #ckt #2 to achieve a new emergency rating of 1200A.	AEC	14.30	6/1/2015
n4232	Rebuild the MICKLETON-MONROE 230 kV line #ckt #1 to achieve a new emergency rating of 1200A.	AEC	14.30	6/1/2015



Attachment D – Interconnection Queue Impact Studies

TO	Queue Number	Fuel	MWC (FTIR/FTWR)	MWE (NFTIR/NFTWR)
AEC	Y2-110	Natural Gas	40	40
	Z2-004	Biomass	10	10
	Z2-082	Methane	0.3	0
AEP	X2-029	MTX	55	
	X3-028	MTX	3500	
	Y2-086	Biomass	62.5	62.5
	Y3-038	Coal	36	36
	Y3-068	Natural Gas	525	525
	Y3-097	Storage	0	4
	Y3-106	Hydro	7	7
	Y3-119	Wood	7	19
	Z1-051	Nuclear	83	102
	Z1-063	Storage	0	6
	Z1-064	Storage	0	4
	Z1-094	Storage	0	6
	APS	Y2-054	Natural Gas	13.7
Y2-080		Natural Gas	1065	1065
Y2-096		Biomass	47.2	47.2
Y3-109		Natural Gas	19.9	19.9
Z1-037		MTX		
Z1-113		Natural Gas	5	12
Z2-013		Wind	7	0
Z2-030		Solar	7.6	20
Z2-085		Hydro	1.5	1.5
Z2-105		Natural Gas	19.9	19.9
Z2-106		Natural Gas	19.9	19.9
ATSI		Z1-035	Wind	2.34
	Z1-093	Storage	0	6
	Z2-019	Methane	0	0.85
ComEd	X4-036	ARR		
	X4-037	ARR		
TO	Queue Number	Fuel	MWC (FTIR/FTWR)	MWE (NFTIR/NFTWR)



Attachment D – Interconnection Queue Impact Studies

	Y1-078	Storage	0	20
	Y2-113	Natural Gas	12.6	12.6
	Y3-088	Natural Gas	20	20
	Y3-089	Natural Gas	20	20
	Y3-090	Natural Gas	20	20
	Y3-091	Natural Gas	20	20
	Z1-054	MTX		
	Z1-072	Wind	10	0
	Z1-073	Wind	6	0
	Z1-106	Storage	0	20
	Z1-107	Storage	0	20
	Z1-108	Storage	0	20
	Z1-127	Natural Gas	20	20
Dayton	Z1-097	Natural Gas	30	0
DEOK	Z1-065	Storage	0	6
	Z1-079	Natural Gas	513	513
	Z1-080	Storage	0	6
DL	Y3-103	Natural Gas	97	205
Dominion	Z1-036	Wind	39	300.3
	Z1-086	Natural Gas	1630	1681
	Z2-017	MTX		
	Z2-027	Solar	14	20
DPL	Y3-033	Wind	16.77	129
	Y3-054	Solar	0	12
	Y3-058	Solar	5.7	15
	Z1-057	Natural Gas	15.9	0
	Z1-076	Solar	5.32	14
	Z1-077	Solar	3.8	10
	Z1-081	Solar	2.28	6
	Z1-099	Natural Gas	7	7
TO	Queue Number	Fuel	MWC (FTIR/FTWR)	MWE (NFTIR/NFTWR)



Attachment D – Interconnection Queue Impact Studies

	Z1-100	Solar	4.162	0
	Z1-101	Solar	4.162	0
	Z1-102	Solar	4.162	0
	Z1-103	Solar	4.162	0
EKPC	Y3-031A_EKPC2	Wind	19.53	150.28
Essential Power	Y3-102	Natural Gas	135	135
	Z1-041	Natural Gas	2	2
JCPL	Y2-078	Natural Gas	20	20
	Z1-031	MTX		
	Z1-050	Hydro	20	20
ME	Z1-114	Natural Gas	4	6
PECO	Y3-043	Natural Gas	760	760
	Z1-017	MTX		
	Z1-115	Natural Gas	1	2
PENELEC	Y2-042	Natural Gas	18.3	18.3
	Y2-087	Wind	19.55	150.4
	Y3-062	Wind	2.4	18.7
	Z1-038	Natural Gas	19.9	19.9
	Z1-042	Wind	9.2	46
	Z1-069	Wind	14.7	70
	Z1-087	Hydro	40	40
	Z1-091	Natural Gas	19.94	19.94
	Z1-092	Natural Gas	19.94	19.94
	Z1-110	Natural Gas	19.9	19.9
PEPCO	Z1-052	Natural Gas	44.5	64.5
PPL	Y2-089	Natural Gas	370	370
	Y3-041	Wind	8	62
	Y3-104	Storage	0	20
TO	Queue Number	Fuel	MWC (FTIR/FTWR)	MWE (NFTIR/NFTWR)
	Z1-090	Natural	381	381



Attachment D – Interconnection Queue Impact Studies

		Gas		
	Z1-098	Storage	0	20
PSEG	Y2-081	Solar	1.9	5
	Y3-044	Natural Gas	5	5
	Y3-045	Natural Gas	5	5
	Y3-046	Natural Gas	6	6
	Y3-050	Natural Gas	21	24
	Y3-051	Natural Gas	4	47
	Y3-052	Natural Gas	10	50
	Y3-053	Natural Gas	13	40
	Y3-087	Solar	1.44	3.8
	Y3-107	Natural Gas	45	35
	Z1-058	Natural Gas	36	23
	Z1-059	Natural Gas	18	23
	Z1-082	Storage	0	1
	Z1-096	Solar	2.98	7.84
	Z1-116	Natural Gas	725	785
	Z2-001	Solar	2.7	7.1
	Z2-062	Methane	3	0
Long Term Firm	Y3-022	LTF		
	Y3-028	LTF		
	Y3-032	LTF		
	Y3-059	LTF		
	Y3-067	LTF		
	Y3-069	LTF		
	Y3-072	LTF		
	Y3-083	LTF		
	Y3-094	LTF		
	Y3-115	LTF		
TO	Queue Number	Fuel	MWC (FTIR/FTWR)	MWE (NFTIR/NFTWR)
	Z1-007	LTF		



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Z1-019	LTF
Z1-023	LTF
Z1-025	LTF
Z1-027	LTF
Z1-029	LTF
Z1-043	LTF
Z1-045	LTF
Z1-046	LTF
Z1-067	LTF
Z1-070	LTF
Z1-071	LTF
Z1-112	LTF
Z2-063	LTF
Z2-065	LTF
Z2-066	LTF
Z2-067	LTF
Z2-078	LTF
Z2-111	LTF