

PJM Generator Interconnection
X3-088 Dickerson 230 kV
440 MW Capacity / 440 MW Energy
Feasibility Study Report

May 2012
DMS #691144v1

Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, §36.2, as well as the Feasibility Study Agreement between Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is Potomac Electric Power Company.

Preface

The intent of this Feasibility Study is to determine a plan, with preliminary cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by IC. As a requirement for interconnection, IC may be responsible for the cost of constructing Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM and the underlying system. All facilities required for interconnection of a generation interconnection project must be designed to meet ITO technical specifications.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. IC is responsible for its right of way, real estate, and construction permit issues.

General

Queue project X3-088 was studied as a 440 MW (440 MW of which was Capacity) injection into PEPCO's system at the Dickerson 230 kV substation. Project X3-088 was evaluated for compliance with reliability criteria for summer peak conditions in 2015.

Primary Option

The following contingencies resulted in overloads for the primary option:

Option 1 Impactful Contingencies	
Contingency Name	File Description
HIRDG_BURTVL	CONTINGENCY 'HIRDG_BURTVL' /* HIGH RIDGE TO BURTONSVILLE CKTS #2314 & #2334 DISCONNECT BUS 220983 /* CKT #2314 HIGH RIDGE - BURTONSVILLE & SANDY SPRINGS 230-2 DISCONNECT BUS 220984 /* CKT #2334 HIGH RIDGE - BURTONSVILLE & SANDY SPRINGS 230-1 END
PJM67	CONTINGENCY 'PJM67' DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /* HUNTERTN CNASTONE 500 500 END
PJM76	CONTINGENCY 'PJM76' REMOVE MACHINE 1 FROM BUS 200034 /* PB2 END
PP1EB	CONTINGENCY 'PP1EB' / NO PATH OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1 / 200003 BRIGHTON 500 200004 CNASTONE 500 1 END

Network Impacts:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

X3-088 Opt. 1 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
001	N-1	PP1EB	METED	Germantown-Germantown Reactor 138 kV line	204530	204531	1	DC	96.15	97.05	ER	104	5.79
002	N-1	PJM67	PJM	EMORY GR500-Conastone 500 kV line	200101	200004	1	DC	93.11	95.52	ER	2901	69.95
003	Non	Non	PJM	EMORY GR500-Conastone 500 kV line	200101	200004	1	DC	87.27	90.47	NR	2338	74.71
004	N-1	PP1EB	BG&E	Columbia-Howard 2312 230 kV line	221010	220953	1	DC	96.65	97.1	ER	941	26.41
005	N-1	PP1EB	METED	Germantown Reactor-Germantown 138/115 kV transformer	204531	204529	1	DC	96.15	97.05	ER	104	5.79
006	N-1	PP1EB	BG&E	Granite 2311 & 2312-North West 2311 & 2310 230 kV line	220972	220962	1	DC	94.76	95.39	ER	621	24.44

Multiple Facility Contingency

(Double Circuit Tower Line Contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

X3-088 Opt. 1 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
007	DCTL	HIRDG_BUR TVL	PEPCO/BG &E	Bowie 043-Bowiebc1 2341 230 kV line	223980	220956	1	DC	98.06	98.6	ER	721	23.92

Contribution to Previously Identified Overloads

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have % allocation of cost responsibility which will be calculated and reported for the Impact Study.)

X3-088 Opt. 1 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
008	N-1	PP1EB	BG&E	High Ridge 2316-Howard 2332 230 kV line	220941	220954	1	DC	120.74	121.27	ER	941	30.7
009	N-1	PP1EB	BG&E	Howard 2332-Granite 2326 & 2332 230 kV line	220954	220973	1	DC	101.31	101.84	ER	728	23.91
010	N-1	PP1EB	PENELEC	Roxbury-Roxbury 138/115 kV transformer	200532	200520	1	DC	127.44	128.48	ER	138	8.87
011	N-1	PP1EB	BG&E	Sandy Spring 2314-High Ridge 2316 230 kV line	220983	220941	1	DC	104.42	107.86	ER	941	32.38
012	N-1	PP1EB	BG&E	Howard 2312-Granite 2311 & 2312 230 kV line	220953	220972	1	DC	119.35	119.93	ER	728	26.41
013	N-1	PP1EB	BG&E	Sandy Spring 2334-High Ridge 2316 230 kV line	220984	220941	1	DC	106.47	109.9	ER	941	32.44
014	DCTL	HIRDG_BUR TVL	PEPCO/BG &E	Bowie 044-Bowiebc0 2340 230 kV line	223979	220959	1	DC	100.52	101.06	ER	720	24.3
015	N-1	PJM76	PJM	Conastone-Peach Bottom 500 kV line	200004	200013	1	DC	139.97	140.31	ER	2815	77.29
016	N-1	PP1EB	BG&E	High Ridge 2316-Columbia 230 kV line	220941	221010	1	DC	111.5	111.95	ER	941	26.26
017	N-1	PJM76	AP/PJM	Kemptown-EMORY GR500 500 kV line	235632	200101	1	DC	135.66	135.95	ER	2901	68.37
018	Non	Non	AP/PJM	Kemptown-EMORY GR500 500 kV line	235632	200101	1	DC	151.49	151.84	NR	2338	68.37

Short Circuit

(Report Overdutied breakers here)

Analysis found new breakers for the primary option to be over-duty in the Dominion area.

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With x3-088 DOM	Duty Percent Without x3-088 DOM	Duty Percent Difference	Note
314072	PLEASANTVIEW 230.kV	H1T274	S	101.70%	99.70%	2.00%	New Over-duty
314061	LOUDOUN 230.kV	L152	S	100.00%	99.40%	0.60%	New Over-duty
314061	LOUDOUN 230.kV	L252	S	100.00%	99.50%	0.50%	New Over-duty
314918	NORTH ANNA 500.kV	G102-1	S	100.00%	99.90%	0.10%	New Over-duty
314918	NORTH ANNA 500.kV	G202	S	100.00%	99.90%	0.10%	New Over-duty
314918	NORTH ANNA 500.kV	H602	S	100.00%	99.90%	0.10%	New Over-duty
314918	NORTH ANNA 500.kV	WT576	S	100.00%	99.90%	0.10%	New Over-duty
314918	NORTH ANNA 500.kV	XT573	S	100.00%	99.90%	0.10%	New Over-duty

- The estimated cost to replace two overdutied 230 kV breakers L152 and L252 at Loudoun substation with 63 kA breakers will be \$205,000 per breaker and will take 12 months including equipment order time.
- The estimated cost to replace five overdutied 500 kV breakers G102-1, G202, H602, WT576 and XT573 at North Anna substation with 63 kA breakers will be \$685,000 per breaker and will take 17 months including equipment order time.
- The estimated cost to replace one overdutied 230 kV breakers H1T274 at Pleasant View substation with 63 kA breakers will be \$205,000 and will take 12 months including equipment order time.

Secondary Option

The following contingencies resulted in overloads for the secondary option:

Option 2 Impactful Contingencies	
Contingency Name	File Description
PJM67	CONTINGENCY 'PJM67' DISCONNECT BRANCH FROM BUS 200026 TO BUS 200004 CKT 1 /* HUNTERTN CNASTONE 500 500 END
PJM77	CONTINGENCY 'PJM77' REMOVE MACHINE 1 FROM BUS 200035 /* PB3 END
PP1EB	CONTINGENCY 'PP1EB' / NO PATH OPEN BRANCH FROM BUS 200101 TO BUS 235632 CKT 1 / 200003 BRIGHTON 500 200004 CNASTONE 500 1 END

Network Impacts:

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

X3-088 Opt. 2 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
001	N-1	PJM67	PJM	EMORY GR500-Conastone 500 kV line	200101	200004	1	DC	93.11	95.7	ER	2901	75.16
002	Non	Non	PJM	EMORY GR500-Conastone 500 kV line	200101	200004	1	DC	87.29	90.69	NR	2338	79.45
003	N-1	PP1EB	BG&E	Columbia-Howard 2312 230 kV line	221010	220953	1	DC	96.68	97.06	ER	941	22.24

Multiple Facility Contingency

(Double Circuit Tower Line Contingencies only with full energy output. Stuck Breaker and Bus Fault contingencies will be applied during the Impact Study)

None.

Contribution to Previously Identified Overloads

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have % allocation of cost responsibility which will be calculated and reported for the Impact Study.)

X3-088 Opt. 2 ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Analyses Type	Loading		Rating		MW Contribution
	Type	Name			To	From			Before	After	Type	MVA	
004	N-1	PP1EB	BG&E	High Ridge 2316-Howard 2332 230 kV line	220941	220954	1	DC	120.82	121.26	ER	941	25.52
005	N-1	PP1EB	PENELEC	Roxbury-Roxbury 138/115 kV transformer	200532	200520	1	DC	127.58	128.54	ER	138	8.24
006	N-1	PJM77	PJM	Conastone-X3-068 TAP 500 kV line	200004	911010	1	DC	138.91	139.23	ER	2815	76.47
007	N-1	PP1EB	BG&E	Howard 2312-Granite 2311 & 2312 230 kV line	220953	220972	1	DC	119.44	119.93	ER	728	22.24
008	N-1	PP1EB	BG&E	High Ridge 2316-Columbia 230 kV line	220941	221010	1	DC	111.53	111.91	ER	941	22.11
009	N-1	PJM67	AP/PJM	Kemptown-EMORY GR500 500 kV line	235632	200101	1	DC	134.93	136.78	ER	2901	77.87
010	Non	Non	AP/PJM	Kemptown-EMORY GR500 500 kV line	235632	200101	1	DC	148.25	150.94	NR	2338	81.68
011	N-1	PJM77	PJM	X3-068 TAP-Peach Bottom 500 kV line	911010	200013	1	DC	146.15	146.47	ER	2815	76.47

Short Circuit

(Report Overdutied breakers here)

Analysis found new breakers for the secondary option to be over-duty in the Dominion area.

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With x3-088 DOM	Duty Percent Without x3-088 DOM	Duty Percent Difference	Note
314072	PLEASANTVIEW 230.kV	H1T274	S	101.80%	99.70%	2.10%	New Over-duty
314061	LOUDOUN 230.kV	L252	S	100.50%	99.50%	1.00%	New Over-duty
314061	LOUDOUN 230.kV	L152	S	100.40%	99.40%	1.00%	New Over-duty
314922	POSSUM POINT 500.kV	568T571	S	100.20%	99.80%	0.40%	New Over-duty
314918	NORTH ANNA 500.kV	G102-1	S	100.10%	99.90%	0.20%	New Over-duty
314918	NORTH ANNA 500.kV	G202	S	100.10%	99.90%	0.20%	New Over-duty
314918	NORTH ANNA 500.kV	H602	S	100.10%	99.90%	0.20%	New Over-duty
314918	NORTH ANNA 500.kV	WT576	S	100.10%	99.90%	0.20%	New Over-duty
314918	NORTH ANNA 500.kV	XT573	S	100.10%	99.90%	0.20%	New Over-duty

- The estimated cost to replace two overdutied 230 kV breakers L152 and L252 at Loudoun substation with 63 kA breakers will be \$205,000 per breaker and will take 12 months including equipment order time.
- The estimated cost to replace five overdutied 500 kV breakers G102-1, G202, H602, WT576 and XT573 at North Anna substation with 63 kA breakers will be \$685,000 per breaker and will take 17 months including equipment order time.
- The estimated cost to replace one overdutied 230 kV breakers H1T274 at Pleasant View substation with 63 kA breakers will be \$205,000 and will take 12 months including equipment order time.

Primary Option Upgrades:

Attachment Facilities:

It is assumed that IC will construct all Attachment Facilities.

Direct Connection Network Upgrades:

Add 230 kV terminal equipment at Dickerson Station H: \$6 million and 2 years to construct.

Non-Direct Connection Network Upgrades:

X3-088 Opt. 1 ###	ITO	Work Description	Estimated Cost	Approximate Duration
001	METED	Based on an initial review, we have determined that the reactor cannot be upgraded. Therefore the apparent mitigation action will be to replace the Germantown 138/ 115 kV transformer and miscellaneous substation components. Total Cost: \$5,028,600	\$5,028,600	
002	PJM	The two breaker bay at Conastone for the Brighton line is over the continuous rating. Upgrade Conastone bay with two 4000A breakers, four 4000A breaker disconnects and a 4000 A line switch need to be either. New rating 3710.	\$3,000,000	36
003	PJM	Same as X3-088-1-002	already addressed	already addressed
004	BG&E	Rebuild 3.6 miles of double circuit line with bundled 1033.5 MCM conductor. Rate line to 968/1227 MVA and will require with CPCN.	\$12,000,000	48
005	METED	Same as X3-088-1-001	already addressed	already addressed
006	BG&E	The overload can be alleviated by reconductoring the line with 2167 ACSR which will increase the rating to 1105MVA. There will also be substation terminal cost upgrades associated with the reinforcement.	\$23,600,000	72
007	PEPCO/BG&E	PEPCO: The Two tie lines at Bowie 043 and 044 are limited on the Pepco end by metering. This would raise the emergency limit to the conductor rating of 800 MVA. BGE: Pepco equipment limits the line. Removing the limitation then the BGE rating is 799 SN/974 SE.	\$500,000	

X3-088 Opt. 1 ###	ITO	Work Description	Estimated Cost	Approximate Duration
008	BG&E	. Rebuild line to accommodate double bundle 1272 ACSR. Existing: Circuit 2332-A is 1590 kcm ACSR @ 160 deg. C Assumptions: Length of line is 8.9 miles 2+ year CPCN process required Existing tower removal included	\$24,000,000	60
009	BG&E	Replace wire drops and upgrade structures for new rating 825 MVA.	\$500,000	18
010	PENELEC	Install a standard 115kV Circuit Breaker with 3000A.	\$717,300	
011	BG&E	Rebuild existing line using double bundle 1033 ACSR @ 125 degC (1227 MVA). Assumptions: -Full structure replacement required -Existing structure removal included -Line length of 3.61 miles -2+ year CPCN process required	\$10,000,000	\$60
012	BG&E	Same as X3-088-1-009	already addressed	already addressed
013	BG&E	Same as X3-088-1-011	already addressed	already addressed
014	PEPCO/BG&E	Same as X3-088-1-014	already addressed	already addressed
015	PJM	BGE: • At Conastone construct a new two breaker 4000A bay (breakers D, F) with two 63 kA breakers. Includes line termination structures, allowance for a second line and the relocation of the 500kV cap bank. 36 months to complete - \$14M • Construct a new 500kV line from Conastone - Peachbotton rated for a minimum of 2939/3733 SN/SE. Build 9.6 miles 500KV line from Conastone to Pennsylvania line. Purchase 150' R/W. Total for project \$46.8 million 5-7 years. PECO: • Replace existing Peach Bottom-Conastone 500kV Line (5012) terminal equipment at Peach Bottom Substation to match the conductor summer normal and emergency rating of 2920 / 3707 MVA (PECO portion only)- \$5 million, 3 years • Build new second Peach Bottom-Conastone 500kV Line on separate towers from existing 5012 Line with a minimum summer emergency rating of 3510 MVA (PECO portion only)- \$20 million, 5 years [Right-of-way costs are not included]	\$85,800,000	84
016	BG&E	This line is at its full rating requires a total rebuild the 4.4 mile 230kV line and a CPCN is needed. Rebuild with bundle 1590 MCM rate 1604 SE.	\$15,000,000	60
017	AP/PJM	Same as X3-088-1-002	already addressed	already addressed
018	AP/PJM	Same as X3-088-1-002	already addressed	already addressed
Non-Direct Connection Thermal Upgrades Summary			\$180,145,900	84

Primary Option Contingency OverLoad Summary:

Option 1											
Contingency	Overloads Identified										
	1	2	3	4	5	6	7	8	9	10	11
HIRDG_BURTVL	007	014									
Non	003	018									
PJM67	002										
PJM76	015	017									
PP1EB	001	004	005	006	008	009	010	011	012	013	016

Secondary Option Upgrades:

Attachment Facilities:

It is assumed that IC will construct all Attachment Facilities.

Direct Connection Network Upgrades:

New 500 kV station is estimated to cost \$20 million and may take 2-3 years to construct.

Non-Direct Connection Network Upgrades:

Not provided for secondary option.

Secondary Option Contingency OverLoad Summary:

Option 2					
Contingency	Overloads Identified				
	1	2	3	4	5
Non	002	010			
PJM67	001	009			
PJM77	006	011			
PP1EB	003	004	005	007	008

Secondary Option One-Line:

