PJM Generator Interconnection

X4-026 Aquasco 230 kV

650 MW Capacity / 792 MW Energy

Feasibility Study Report

July 2012
DMS #700225v1

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

The queue project X4-026 was studied as a 792 MW (Capacity 650 MW) injection in to the ITO area. Project X4-026 was evaluated for compliance with reliability criteria for summer peak conditions in 2015. Potential network impacts were as follows:

Impactful Contingencies

The following contingencies resulted in overloads:

Option 1	
Contingency Name	**File Description**
6PEPCO	CONTINGENCY '6PEPCO' /* BOWIE043 TO OAKGV23 DISCONNECT BRANCH FROM BUS 223980 TO BUS 223961 CKT 1 DISCONNECT BRANCH FROM BUS 223978 TO BUS 223961 CKT 1 DISCONNECT BRANCH FROM BUS 223978 TO BUS 223982 CKT 1 END
PJM17	CONTINGENCY 'PJM17' DISCONNECT BRANCH FROM BUS 200004 TO BUS 200013 CKT 1 /* CNASTONE PEACHBTM 500 500 END
5PEPCO	CONTINGENCY '5PEPCO' /* CHALK230 TO BOWIE044 DISCONNECT BRANCH FROM BUS 223983 TO BUS 224600 CKT 1 /* OAKGV230 TO AQUASCO1 DISCONNECT BRANCH FROM BUS 224600 TO BUS 224060 CKT 1 /* AQUASCO1 TO BOWIE044. 2/17/09 DISCONNECT BRANCH FROM BUS 224060 TO BUS 223979 CKT 1 DISCONNECT BRANCH FROM BUS 223982 TO BUS 223977 CKT 1 DISCONNECT BRANCH FROM BUS 223977 TO BUS 223962 CKT 1 END
PJM40	CONTINGENCY 'PJM40' DISCONNECT BRANCH FROM BUS 200013 TO BUS 200024 CKT 1 /* PEACHBTM LIMERICK 500 500 END
8OX _8POSSUM _043	CONTINGENCY '8OX _8POSSUM _043' DISCONNECT BRANCH FROM BUS 314919 TO BUS 314922 CKT 1 /* 500/500KV, AREA 345/345. END
8PEPCO	CONTINGENCY '8PEPCO' /* BOWIE044 TO CHALK230 DISCONNECT BRANCH FROM BUS 224060 TO BUS 223979 CKT 1 /* OAKGV053 TO BOWIE043 DISCONNECT BRANCH FROM BUS 223983 TO BUS 224600 CKT 1 /* OAKGV230 TO AQUASCO1 DISCONNECT BRANCH FROM BUS 224600 TO BUS 224060 CKT 1 /* AQUASCO1 TO BOWIE044. 2/17/09 DISCONNECT BRANCH FROM BUS 224061 TO BUS 223980 CKT 1 DISCONNECT BRANCH FROM BUS 292454 TO BUS 223982 CKT 1 /BUS 223983 -> 292454. T133 END
9PEPCO	CONTINGENCY '9PEPCO' /* CHALK230 TO OAKGV230 DISCONNECT BRANCH FROM BUS 223983 TO BUS 223982 CKT 1 /* ADDED BY PEPCO 1/12/09 DISCONNECT BRANCH FROM BUS 223983 TO BUS 292456 CKT 1 DISCONNECT BRANCH FROM BUS 223982 TO BUS 224601 CKT 1 END
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
PJM76	CONTINGENCY 'PJM76' REMOVE MACHINE 1 FROM BUS 200034 /* PB2 END
PJM77	CONTINGENCY 'PJM77' REMOVE MACHINE 1 FROM BUS 200035 /* PB3 END
PP45A	CONTINGENCY 'PP45A' OPEN BRANCH FROM BUS 224060 TO BUS 224600 CKT 1 / 224060 OAKGV054 230 224000 AQUASCO 230 1 / BUS 224601 IS REPLACED WITH 224600. 2/13/09 OPEN BRANCH FROM BUS 223982 TO BUS 224601 CKT 1 / 223983 CHALK230 230 224000 AQUASCO 230 1 END
PP27	CONTINGENCY 'PP27' OPEN BRANCH FROM BUS 220983 TO BUS 223961 CKT 1 / 220983 SANDY14T 230 223961 BURT2314 230 1 END

Network Impacts:

Generator Deliverability

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

X4-026 -1- ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Power Flow	Loading		Rating		MW Contribution
	Type	Name			From	To			Initial	Final	Type	MVA	
001	N-1	PJM77	PJM	CNASTONE-PEACHBTM 500 kV line	200004	200013	1	DC	97.27	101.34	NR	2815	114.7
002	N-1	PJM76	PJM	CNASTONE-PEACHBTM 500 kV line	200004	200013	1	DC	97.27	101.34	NR	2815	114.7
003	N-1	PP45A	PHI	T133 2-CHALK230 230 kV line	292456	223983	1	DC	28.65	107.31	NR	680	534.84
004	Non	Non	PHI	T133 2-AQUASCO2 230 kV line	292456	224601	1	DC	82.95	118.13	NR	559	196.61

The following ITO upgrade addresses 003 and 004:

ITO must restring the west 230kV circuits, with two circuits from Chalk to Bowie using 1594 ACCR conductor.

a. From Chalk Point to Oak Grove, the west circuit is 22 miles long and both circuits must be restrung by at IC expense. The cost estimate for this portion is $30 million; and

b. From Oak Grove to Bowie, since the circuits do not physically stop at Oak Grove, only one circuit the responsibility of the IC. The other circuit is being upgraded by RTEP project b1592. The IC cost is $19 million.

c. The work at Bowie substation includes replacing two breakers, four disconnect switches and conductor upgrade. At Oak Grove, the conductor needs to be replaced. The total substation work costs are estimated to be $3.7 million.

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)

X4-026 -1- ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Power Flow	Loading		Rating		MW Contribution
	Type	Name			From	To			Initial	Final	Type	MVA	
005	DCTL	9PEPCO	PHI	OAKGV054-BOWIE044 230 kV line	224060	223979	1	DC	81.55	106.13	NR	730	179.39
006	DCTL	8PEPCO	PHI	T133TAP1-T133 2 230 kV line	292453	292456	1	DC	28.81	106.64	NR	999	777.6
007	DCTL	9PEPCO	PHI	AQUASCO1-OAKGV054 230 kV line	224600	224060	1	DC	82.21	106.78	NR	730	179.39
008	DCTL	8PEPCO	PHI	AQUASCO2-OAKGV230 230 kV line	224601	223982	1	DC	83.91	110.76	NR	680	182.56
009	DCTL	9PEPCO	PHI	T133 2-AQUASCO2 230 kV line	292456	224601	1	DC	37.74	143.8	NR	680	721.17

005 through 009 are addressed by the fix described for 003 above.

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.)

X4-026 -1- ###	Contingency		Affected Area	Facility Description	Bus		Circuit	Power Flow	Loading		Rating		MW Contribution
	Type	Name			From	To			Initial	Final	Type	MVA	
010	N-1	PP27	PJM	SANDY34T-H.RDGE16 230 kV line	220984	220941	1	DC	100.46	101.3	NR	941	48.85
011	N-1	PJM40	PJM	PEACHBTM-U2-74 TAP 500 kV line	200013	293025	1	DC	104.69	106.33	NR	2611	50.99
012	Non	Non	PJM	BOWIE042-BURT2334 230 kV line	223977	223962	1	DC	106.11	107.72	NR	608	60.67
013	Non	Non	PJM	OAKGV230-BOWIE042 230 kV line	223982	223977	1	DC	106.54	108.15	NR	608	60.67
014	Non	Non	PJM	BOWIE045-BURT2314 230 kV line	223978	223961	1	DC	108.6	110.26	NR	608	62.15
015	Non	Non	PJM	OAKGV230-BOWIE045 230 kV line	223982	223978	1	DC	108.82	110.47	NR	608	62.15
016	N-1	PJM40	PJM	U2-74 TAP-ROCKSPGS 500 kV line	293025	200051	1	DC	108.43	110.28	NR	2611	50.99
017	DCTL	6PEPCO	PJM	BOWIE042-BURT2334 230 kV line	223977	223962	1	DC	113.58	115.63	NR	730	92.4
018	DCTL	6PEPCO	PJM	OAKGV230-BOWIE042 230 kV line	223982	223977	1	DC	113.94	115.98	NR	730	92.4
019	DCTL	HIRDG_BURTVL	PJM	BOWIE044-BOWIEBC0 230 kV line	223979	220959	1	DC	102.55	116.9	NR	720	103.35
020	N-1	8OX _8POSSUM _043	PJM	8POSSUM 500/230 kV transformer	314922	314074	1	DC	106.69	107.88	NR	969	71.55
021	N-1	PJM17	PJM	CONASTON-OTCR 230 kV line	220963	208048	1	DC	114.52	115.35	NR	531	33.34
022	DCTL	5PEPCO	PJM	BOWIE045-BURT2314 230 kV line	223978	223961	1	DC	130.63	133.16	NR	730	113.97
023	DCTL	5PEPCO	PJM	OAKGV230-BOWIE045 230 kV line	223982	223978	1	DC	130.8	133.32	NR	730	113.97
024	N-1	PJM17	PJM	COOPER-PCHBTMTP 230 kV line	214089	213869	1	DC	134	134.83	NR	485	29.7
025	N-1	PJM17	PJM	GRACETON-COOPER 230 kV line	220964	214089	1	DC	136.78	137.61	NR	485	29.7

Short Circuit

(Report Overdutied breakers here)

BUS_NO	BUS	BREAKER	Rating Type	Duty Percent With x4-026_PEPCO	Duty Percent Without x4-026_PEPCO	Duty Percent Difference	Note
223983	GSE 230-1 230.kV	ABB GCB	S	125.80%	116.50%	9.30%	Over 100%, > 3% contribution
223983	GSE 230-1 230.kV	GE OCB	S	125.80%	116.50%	9.30%	Over 100%, > 3% contribution
223983	GSE 230-1 230.kV	WEST OCB	S	125.80%	116.50%	9.30%	Over 100%, > 3% contribution
223988	GSF 230 230.kV	WEST OCB	T	104.50%	103.60%	0.90%	Over 100%, < 3% contribution

The GSE violations above are for ITO Chalk Point Substation E and identify 23 over duty breakers. These breakers are identified as PJM baseline upgrades. They are required to be completed before this generator synchronizes with the system. The GSF breakers represent 18 breakers at Morgantown Substation F. These will cost approximately $18M to replace and are estimated to take 48 months to complete.

ITO Analyses

Attachment Facilities:

It is assumed that the customer will construct the Attachment Facility between the Interconnection Customer collector bus and the Point of Interconnection. ITO included the limited Attachment Facilities for them to construct in the substation cost estimates below.

Direct Connection Network Upgrades:

Transmission Line work:

$3,000,000 for turning poles and $3,000,000 per mile for new transmission line and will be coordinated with substation tie-in.

Substation Engineering Cost Estimate

$26,600,000 for an eight breaker, breaker-and-a-half substation with associated costs and 24-36 months to construct.

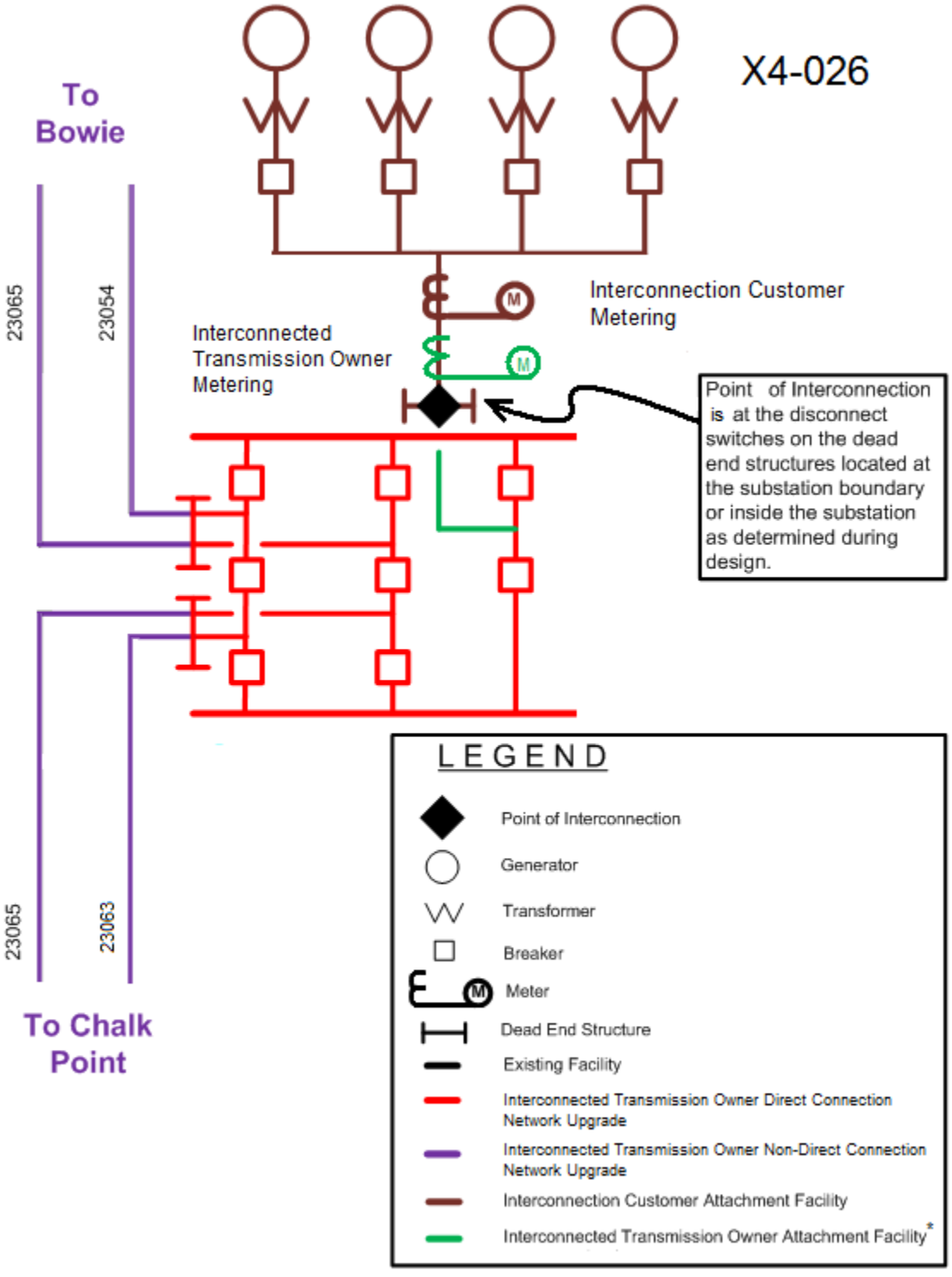
Non-Direct Connection Network Upgrades:

Overload #	ITO	Work Description	Estimated Cost	Approximate Duration (Months)
001	BGE/PECO	BGE: (n2138) Rebuild bay with breakers A B C to 4000 A. New rating is 2939/3733. To rebuild bay cost estimate is $6,600,000, time estimate is 24-36 months. PECO: (n2139)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). Cost estimate is - $5 million, 3 years	$11,600,000	36
002	BGE/PECO	Same as 001	Same as 001	Same as 001
003	PEPCO	(Chalk Point - T133 2 - Aquasco 2 - Oak Grove) Feeders 23061/23152 share a tower with feeder 23064 (Chalk Point - Oak Grove) Cost to upgrade of these feeders is 15 Million.	$15,000,000	36
004	PEPCO	Same as 003	Same as 003	Same as 003
005	PEPCO	The estimated cost to upgrade the Oak Grove -Bowie 230 kV circuit (23042) is $5,000,000. This cost represents the addition of a second 230kV conductor to circuit 23042 from Oak Grove to Bowie (approximately 12 miles).	$5,000,000	36
006	PEPCO	Same as 003	Same as 003	Same as 003
007	PEPCO	(Chalk Point - Aquasco 1 - Oak Grove - Bowie) Feeders 23063/23153 share a tower with feeder 23065 (Chalk Point - Bowie) NOTE: These circuits do not physically stop at Oak Grove. Cost to upgrade of these feeders is 34 Million.	$34,000,000	36

Overload #	ITO	Work Description	Estimated Cost	Approximate Duration (Months)
008	PEPCO	Same as 003	Same as 003	Same as 003
009	PEPCO	Same as 003	Same as 003	Same as 003
010	BGE	Existing circuits using 1590 ACSR @ 160 degC Overload of 108% on 923 MVA rating = 996 MVA 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
011	PECO	The rating of the PECO portion of the 5014 Line (Peach Bottom to Rock Springs) is 2931 MVA. Therefore the 2808 MVA loading is within the emergency limit of the PECO portion of the line. No reinforcements need to be provided by PECO.	Not applicable	Not applicable
012	PEPCO	The estimated cost to upgrade the Bowie -Burtonsville 230 kV circuit (23042) is $3,400,000. This cost represents the addition of a second 230 kV conductor to circuit 23042 from Bowie to Burtonsville (approximately 8 miles).	$3,400,000	36
013	PEPCO	The estimated cost to upgrade the Oak Grove - Bowie 230 kV circuit (23042) is $5,000,000. This cost represents the addition of a second 230kV conductor to circuit 23042 from Oak Grove to Bowie (approximately 12 miles).	$5,000,000	36
014	PEPCO	The estimated cost to upgrade the Bowie - Burtonsville 230 kV circuit (23045) is $3,400,000. This cost represents the addition of a second 230kV conductor to circuit 23045 from Bowie to Burtonsville (approximately 8 miles).	$3,400,000	36
015	PEPCO	The estimated cost to upgrade the Oak Grove - Bowie 230 kV circuit (23045) is $5,000,000. This cost represents the addition of a second 230kV conductor to circuit 23045 from Oak Grove to Bowie (approximately 12 miles).	$5,000,000	36
016	PECO	Same as 11	Not applicable	Not applicable
017	PEPCO	Same as 12		
018	PEPCO	Same as 13		
019	BGE	Substation Engineering estimates the replacement of the metering and associated equipment to be $250K. This would raise the emergency limit to the conductor rating of 800 MVA.	$250,000	12
20	Dominion	Dominion would need to install a second 500-230 kV transformer at this location to resolve this overload. The estimated cost of this is $20 million.	$20,000,000	36
021	BGE	Otter Creek to Conastone 230Kv line 4.7 mile total rebuild 2302 to Pa Border. New rating 648/802. Total time 60 months cost $19 million	$19,000,000	36
022	Dominion	Same as 20		
023	BGE	Same as 21		
024	PECO	Reconductor Line 220-08 from Peach Bottom Tap to Cooper Substation to get a minimum summer emergency rating of 741 MVA. The line is approximately	$1,000,000	24

Overload #	ITO	Work Description	Estimated Cost	Approximate Duration (Months)
		1.4 miles long. The estimated cost to perform this work is $1.0M, and will require 24 months to complete.		
025	BGE/PECO	PECO: Reconductor Line 220-93 from Cooper Substation to Graceton Substation to get a minimum summer emergency rating of 725 MVA. The line is approximately 4 miles long. This cost is for the PECO portion only. The estimated cost to perform this wrk is $2.8M, and will require 24 months to complete. BGE: Cooper to Graceton 230Kv line 1.85 miles total rebuild to PA border with 2167 MCM conductor. New rating 799/974.	$10,300,000	54
Short Circuit	PEPCO	Morgantown Breakers	$18,000,000	48
		TOTAL	**$160,950,000**	**60**

Primary Option One-line:



* Interconnected Transmission Owner check meter will be installed at Interconnected Transmission Owner Expense if Interconnection Customer installs its own meter