Revised Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AA2-076

Linwood 230kV

September 2015

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

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. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

The Interconnection Customer (IC), has proposed an uprate to an existing natural gas generating facility located in Delaware County, Pennsylvania. This project requests an increase to the install capability of 0 MW with 40 MW of this output being recognized by PJM as capacity. The installed facilities will have a total capability of 852 MW with 835 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is May 2018. **This study does not imply a PECO Energy Company (PECO) commitment to this in-service date.**

Point of Interconnection

AA2-076 will interconnect with the PECO transmission system at the Linwood 230kV bus.

Cost Summary

The AA2-076 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 0
Total Costs	**$ 0**

In addition, the AA2-076 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 45,000,000
Previously Identified Upgrades	$ 0
Total Costs	**$ 45,000,000**

Cost allocations for these upgrades will be provided in the System Impact Study Report.

Attachment Facilities

There are no Attachment Facilities to be constructed to support this interconnection request.

Direct Connection Cost Estimate

There are no Direct Connection Facilities to be constructed to support this interconnection request.

Non-Direct Connection Cost Estimate

There are no Non-Direct Connection Facilities to be constructed to support this interconnection request.

Interconnection Customer Requirements

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

Network Impacts

The Queue Project AA2-076 was evaluated as a 40.0 MW (Capacity 40.0 MW) injection at Phillips Island 230kV substation in the PECO area. This is an uprate to the X4-027 project. Project AA2-076 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA2-076 was studied with a commercial probability of 53% on a Summer Peak 2019 case. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
130-43/* $ DELCO $ 130-43 $ L	CONTINGENCY '130-43/* $ DELCO $ 130-43 $ L' TRIP BRANCH FROM BUS 213582 TO BUS 213788 CKT 1 /* EDDYSTN1 138.00 MASTER2 138.00 $ DELCO $ 130-43 $ L END/* $ DELCO $ 130-43 $ L
220-39	CONTINGENCY '220-39' /* $ DELCO $ 220-39 $ L TRIP BRANCH FROM BUS 213490 TO BUS 213750 CKT 1 END
220-43/* $ DELCO $ 220-43 $ L	CONTINGENCY '220-43/* $ DELCO $ 220-43 $ L' TRIP BRANCH FROM BUS 213489 TO BUS 213750 CKT 1 END/* $ DELCO $ 220-43 $ L
220-70/* $ DELCO $ 220-70 $ L	CONTINGENCY '220-70/* $ DELCO $ 220-70 $ L' DISCONNECT BUS 213512 /* CONCORD4 230.00 $ DELCO $ 220-70 $ L DISCONNECT BUS 213737 /* LENAPE8 230.00 $ DELCO $ 220-70 $ L END/* $ DELCO $ 220-70 $ L
L_D-2309	CONTINGENCY 'L_D-2309' /*EAGLE POINT - THOROFARE DISCONNECT BUS 219759 /* EAGEL POINT 3 SECTION DISCONNECT BUS 219121 /* THOROFARE SECTION 1 END
L_D-2309_LT	CONTINGENCY 'L_D-2309_LT' /* EAGLE POINT- THOROFARE DISCONNECT BUS 219759 /* EAGEL POINT 3 SECTION DISCONNECT BUS 219121 /* THOROFARE SECTION 1 CLOSE LINE FROM BUS 219211 TO BUS 219212 CKT 1 /* THOROFARE END

Contingency Name	Description
V2274+P2242_LT	CONTINGENCY 'V2274+P2242_LT' /* EAGEL POINT - GLOUCESTER & DEPTFORD - GLOUCESTER DISCONNECT BUS 219757 /* DEPTFORD SECTION 2 DISCONNECT BUS 219760 /* EAGLE POINT SECTION 4 DISCONNECT BRANCH FROM BUS 219110 TO BUS 219128 CKT 1 /* REMOVE 26KV -1 CLOSE LINE FROM BUS 219255 TO BUS 219256 CKT 1 /* DEPTFORD CLOSE LINE FROM BUS 219180 TO BUS 219181 CKT 1 /* DEPTFORD MOVE 8 MW LOAD FROM BUS 219180 TO BUS 219162 /* INTERSTATION TIE TRANSFER LOAD FROM DEPTFORD TO BEAVERBK T1 MOVE 8 MW LOAD FROM BUS 219181 TO BUS 219163 /* INTERSTATION TIE TRANSFER LOAD FROM DEPTFORD TO BEAVERBK T2 MOVE 8 MW LOAD FROM BUS 219255 TO BUS 219162 /* INTERSTATION TIE TRANSFER LOAD FROM DEPTFORD TO BEAVERBK T1 MOVE 8 MW LOAD FROM BUS 219256 TO BUS 219163 /* INTERSTATION TIE TRANSFER LOAD FROM DEPTFORD TO BEAVERBK T2 END
W2275_O2241	CONTINGENCY 'W2275_O2241' /* DOUBLE CIRCUIT TOWER W-2275(MICKLETON - DEPTFORD) AND O-2241(MICKLETON - THOROFARE) TRIP BRANCH FROM BUS 219762 TO BUS 228401 CKT 1 /* TRIP O-2241(MICKLETON - THOROFARE) 230KV TRIP BRANCH FROM BUS 219121 TO BUS 228401 CKT 1 /* TRIP (MICKLETON - THOROFARE #2) 230KV END
130-43/* $ DELCO $ 130-43 $ L	CONTINGENCY '130-43/* $ DELCO $ 130-43 $ L' TRIP BRANCH FROM BUS 213582 TO BUS 213788 CKT 1 /* EDDYSTN1 138.00 MASTER2 138.00 $ DELCO $ 130-43 $ L END/* $ DELCO $ 130-43 $ L

Generator Deliverability

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

	Contingency		Affected		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
1	N-1	220-39	PECO	LINWOOD-CHICHST1 230 kV line	213750	213489	1	DC	98.8	100.47	ER	1593	26.64	1
2	N-1	220-43/* $ DELCO $ 220-43 $ L	PECO	LINWOOD-CHICHST2 230 kV line	213750	213490	1	DC	98.66	100.33	ER	1593	26.61	2
3	Non	Non	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	45.33	46.67	NR	456	6.09	3
4	N-1	L_D-2309	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	59.82	60.95	ER	572	6.48	
5	N-1	L_D-2309_LT	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	59.68	60.81	ER	572	6.48	
6	Non	Non	PECO	TUNNEL-PARRISH9 230 kV line	213984	213859	1	DC	51.75	52.89	NR	812	9.27	4
7	N-1	220-70/* $ DELCO $ 220-70 $ L	PECO	TUNNEL-PARRISH9 230 kV line	213984	213859	1	DC	49.58	50.88	ER	965	12.61	
8	N-1	130-43/* $ DELCO $ 130-43 $ L	PECO	TUNNEL-PARRISH9 230 kV line	213984	213859	1	DC	50.93	51.96	ER	965	9.94	
9	Non	Non	PECO	GRAYSFRY4-TUNNEL2 230 kV line	214074	213986	1	DC	55.32	56.43	NR	831	9.27	5
10	N-1	220-70/* $ DELCO $ 220-70 $ L	PECO	GRAYSFRY4-TUNNEL2 230 kV line	214074	213986	1	DC	52.63	53.91	ER	984	12.61	
11	N-1	130-43/* $ DELCO $ 130-43 $ L	PECO	GRAYSFRY4-TUNNEL2 230 kV line	214074	213986	1	DC	53.96	54.97	ER	984	9.94	

Note: Please see Attachment 1 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
12	DCTL	V2274+P2242_ LT	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	60.88	61.39	ER	572	6.47	
13	DCTL	W2275_O2241	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	57.46	57.97	ER	572	6.48	

Note: Please see Attachment 1 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None.

Short Circuit

(Summary of impacted circuit breakers)

Not required.

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

None.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
1, 2	LINWOOD-CHICHST1 230 kV line	Upgrade the metering, disconnects and circuit breakers on the line. Estimated Cost: $5 M; Estimated Time: 3 years; this cost does not include the time or cost to purchase ROW and/or permits to construct if required. The time estimate does not include consideration of line outage availability.	Pending	**$ 5,000,000**
3, 4, 5, 12, 13	MASTER-N PHILA8 230 kV line	Rebuild the Master – N Philadelphia 230 kV line. Estimated Cost: $35 M; Estimated Time: 3 years; this cost does not include the time or cost to purchase ROW and/or permits to construct if required. The time estimate does not include consideration of line outage availability. This overload is caused by a later AA2 queue project. PJM's cost allocation rules state that upgrades caused within the AA2 queue costing less than $5,000,000 will be allocated amongst all projects that contribute to the loading and overloading of the facility. Cost allocations will be confirmed in the System Impact Study phase. This Queue Position would not have cost allocation towards this upgrade if these costs and conditions remain the same during the System Impact Study.	Pending	**$ 35,000,000**
6, 7, 8	TUNNEL-PARRISH9 230 kV line	Re-conductor the Tunnel – Parrish 230 kV line. Estimated Cost: $4 M; Estimated Time: 3 years; this cost does not include the time or cost to purchase ROW and/or permits to construct if required. The time estimate does not include consideration of line outage availability. This overload is caused by a later AA2 queue project. PJM's cost allocation rules state that upgrades caused within the AA2 queue costing less than $5,000,000 will be allocated amongst all projects that contribute to the loading and overloading of the facility. Cost allocations will be confirmed in the System Impact Study phase.	Pending	**$ 4,000,000**

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
9, 10, 11	GRAYSFRY4-TUNNEL2 230 kV line	Re-conductor the Grays Ferry - Tunnel 230 kV line and replace meters. Estimated Cost: $1 M; Estimated Time: 3 years; this cost does not include the time or cost to purchase ROW and/or permits to construct if required. The time estimate does not include consideration of line outage availability. This overload is caused by a later AA2 queue project. PJM's cost allocation rules state that upgrades caused within the AA2 queue costing less than $5,000,000 will be allocated amongst all projects that contribute to the loading and overloading of the facility. Cost allocations will be confirmed in the System Impact Study phase.	Pending	**$ 1,000,000**
			Total New Network Upgrades	**$ 45,000,000**

Contribution to Previously Identified System Reinforcements

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

None.

Attachment 1. Flowgate Details

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(PECO - PECO) The LINWOOD-CHICHST1 230 kV line (from bus 213750 to bus 213489 ckt 1) loads from 98.8% to 100.47% (DC power flow) of its emergency rating (1593 MVA) for the single line contingency outage of '220-39'. This project contributes approximately 26.64 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
231131	BLOOM ENRGY	0.48
231919	CHRIST1	0.68
231920	CHRIST2	0.66
231902	DC CT7	1.54
231917	EM10	0.46
231916	EM3	2.78
231901	EM4	5.66
231900	EM5	20.8
231903	GEN4	1.25
231908	HR1	4.07
231909	HR2	4.03
231910	HR3	4.07
231505	HR4	8.55
232923	MR1	2.9
232924	MR2	2.9
213888	PHLISCT1	9.81
213889	PHLISCT2	9.81
213890	PHLISCT3	9.81
213893	PHLISST1	13.59
297076	V2-028 C	0.42
231918	WEST 1	0.49
907211	X1-074	46.48
909411	X2-083	0.07
910591	X3-015 C	1.37

Bus Number	Bus Name	Full Contribution
912161	X4-027 CT1	0.66
912162	X4-027 CT2	0.66
912163	X4-027 CT3	0.66
915751	Y3-033	3.22
915752	Y3-033	21.54
916231	Z1-076 C	0.97
916241	Z1-077 C	0.69
916281	Z1-081 C	0.44
916471	Z1-103	0.76
917081	Z2-012 C	1.38
917431	Z2-076 C	0.72
917441	Z2-077 C	0.72
917581	Z2-097 C	0.68
918111	AA1-025	0.67
918121	AA1-026	0.67
918161	AA1-027	0.67
918171	AA1-028	0.67
918181	AA1-033	12.78
918441	AA1-059 C	0.78
918461	AA1-061 C	2.48
918831	AA1-102	6.83
918911	AA1-110 C	0.77
919161	AA1-140 C	1.37
919171	AA1-141 C	1.04

Bus Number	Bus Name	Full Contribution
919181	AA1-142 C	1.39
919191	AA1-143 C	1.44
919561	AA2-021 C	0.51
919601	AA2-036 C	0.98
919611	AA2-037 C	0.35
919831	AA2-069	90.49
919871	AA2-076 1	8.88

Bus Number	Bus Name	Full Contribution
919881	AA2-076 2	8.88
919891	AA2-076 3	8.88
920321	AA2-130	0.36
920461	AA2-144 C	1.26
920491	AA2-147 C	0.5
920521	AA2-150 C	1.28

Appendix 2

(PECO - PECO) The LINWOOD-CHICHST2 230 kV line (from bus 213750 to bus 213490 ckt 1) loads from 98.66% to 100.33% (DC power flow) of its emergency rating (1593 MVA) for the single line contingency outage of '220-43/* $ DELCO $ 220-43 $ L'. This project contributes approximately 26.61 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
231131	BLOOM ENRGY	0.48
231919	CHRIST1	0.68
231920	CHRIST2	0.66
231902	DC CT7	1.54
231917	EM10	0.46
231916	EM3	2.77
231901	EM4	5.66
231900	EM5	20.77
231903	GEN4	1.24
231908	HR1	4.06
231909	HR2	4.03
231910	HR3	4.06
231505	HR4	8.54
232923	MR1	2.9
232924	MR2	2.9
213888	PHLISCT1	9.79
213889	PHLISCT2	9.79
213890	PHLISCT3	9.79
213893	PHLISST1	13.57
297076	V2-028 C	0.42
231918	WEST 1	0.49
907211	X1-074	46.41
909411	X2-083	0.07
910591	X3-015 C	1.37
912161	X4-027 CT1	0.66
912162	X4-027 CT2	0.66
912163	X4-027 CT3	0.66

Bus Number	Bus Name	Full Contribution
915751	Y3-033	3.21
915752	Y3-033	21.51
916231	Z1-076 C	0.97
916241	Z1-077 C	0.69
916281	Z1-081 C	0.44
916471	Z1-103	0.76
917081	Z2-012 C	1.38
917431	Z2-076 C	0.72
917441	Z2-077 C	0.72
917581	Z2-097 C	0.68
918111	AA1-025	0.67
918121	AA1-026	0.67
918161	AA1-027	0.67
918171	AA1-028	0.67
918181	AA1-033	12.76
918441	AA1-059 C	0.78
918461	AA1-061 C	2.48
918831	AA1-102	6.82
918911	AA1-110 C	0.77
919161	AA1-140 C	1.37
919171	AA1-141 C	1.03
919181	AA1-142 C	1.39
919191	AA1-143 C	1.44
919561	AA2-021 C	0.51
919601	AA2-036 C	0.98
919611	AA2-037 C	0.35
919831	AA2-069	90.35

Bus Number	Bus Name	Full Contribution
919871	AA2-076 1	8.87
919881	AA2-076 2	8.87
919891	AA2-076 3	8.87
920321	AA2-130	0.36

Bus Number	Bus Name	Full Contribution
920461	AA2-144 C	1.26
920491	AA2-147 C	0.5
920521	AA2-150 C	1.28

Appendix 3

(PECO - PECO) The MASTER-N PHILA8 230 kV line (from bus 213783 to bus 213819 ckt 1) loads from 45.33% to 46.67% (DC power flow) of its normal rating (456 MVA) for non-contingency condition. This project contributes approximately 6.09 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
213497	CHSTR7-9	0.68
213575	EDDYST10	0.26
213577	EDDYST20	0.24
213587	EDDYSTN3	7.64
213589	EDDYSTN4	7.6
213590	EDY30-40	0.68
231901	EM4	1.27
231900	EM5	4.7
213962	FPL MH50	0.87
213632	GFCP	4.22
231505	HR4	1.93
213685	KIMCLARK	0.97
213738	LIBE_CT1	3.2
213739	LIBE_CT2	3.2
213740	LIBE_ST1	4.49
213888	PHLISCT1	2.24
213889	PHLISCT2	2.24
213890	PHLISCT3	2.24
213893	PHLISST1	3.1

Bus Number	Bus Name	Full Contribution
213942	SCHUYLKILL	0.73
213957	STHWK3-4	0.51
213958	STHWK5-6	0.51
901871	W1-108	0.37
903991	W3-080 C	-0.78
905231	W4-029 C	-0.07
912161	X4-027 CT1	0.15
912162	X4-027 CT2	0.15
912163	X4-027 CT3	0.15
914141	Y2-064	4.5
919871	AA2-076 1	2.03
919881	AA2-076 2	2.03
919891	AA2-076 3	2.03
919931	AA2-077	66.73
919941	AA2-078	39.43
920141	AA2-110 1 OP	128.02
920151	AA2-110 2 OP	117.53
920421	AA2-140	8.3

Appendix 4

(PECO - PECO) The TUNNEL-PARRISH9 230 kV line (from bus 213984 to bus 213859 ckt 1) loads from 51.75% to 52.89% (DC power flow) of its normal rating (812 MVA) for non-contingency condition. This project contributes approximately 9.27 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
213497	CHSTR7-9	0.9
213575	EDDYST10	0.27
213577	EDDYST20	0.32
213587	EDDYSTN3	11.45

Bus Number	Bus Name	Full Contribution
213589	EDDYSTN4	11.37
213590	EDY30-40	1.02
231901	EM4	2.03
231900	EM5	7.28

Bus Number	Bus Name	Full Contribution
213962	FPL MH50	1.15
213632	GFCP	6.91
231505	HR4	2.99
213685	KIMCLARK	1.22
213738	LIBE_CT1	4.81
213739	LIBE_CT2	4.81
213740	LIBE_ST1	6.74
213888	PHLISCT1	3.41
213889	PHLISCT2	3.41
213890	PHLISCT3	3.41
213893	PHLISST1	4.73
213942	SCHUYLKILL	1.07
213957	STHWK3-4	0.82
213958	STHWK5-6	0.82

Bus Number	Bus Name	Full Contribution
901871	W1-108	0.6
912161	X4-027 CT1	0.23
912162	X4-027 CT2	0.23
912163	X4-027 CT3	0.23
914141	Y2-064	6.76
919871	AA2-076 1	3.09
919881	AA2-076 2	3.09
919891	AA2-076 3	3.09
919931	AA2-077	107.19
919941	AA2-078	63.34
920141	AA2-110 1 OP	135.07
920151	AA2-110 2 OP	158.47
920421	AA2-140	12.46

Appendix 5

(PECO - PECO) The GRAYSFRY4-TUNNEL2 230 kV line (from bus 214074 to bus 213986 ckt 1) loads from 55.32% to 56.43% (DC power flow) of its normal rating (831 MVA) for non-contingency condition. This project contributes approximately 9.27 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
213497	CHSTR7-9	0.9
213575	EDDYST10	0.27
213577	EDDYST20	0.32
213587	EDDYSTN3	11.45
213589	EDDYSTN4	11.37
213590	EDY30-40	1.02
231901	EM4	2.03
231900	EM5	7.28
213962	FPL MH50	1.15
213632	GFCP	6.91
231505	HR4	2.99
213685	KIMCLARK	1.22
213738	LIBE_CT1	4.81
213739	LIBE_CT2	4.81
213740	LIBE_ST1	6.74
213888	PHLISCT1	3.41
213889	PHLISCT2	3.41
213890	PHLISCT3	3.41

Bus Number	Bus Name	Full Contribution
213893	PHLISST1	4.73
213942	SCHUYLKILL	1.07
213957	STHWK3-4	0.82
213958	STHWK5-6	0.82
901871	W1-108	0.6
912161	X4-027 CT1	0.23
912162	X4-027 CT2	0.23
912163	X4-027 CT3	0.23
914141	Y2-064	6.76
919871	AA2-076 1	3.09
919881	AA2-076 2	3.09
919891	AA2-076 3	3.09
919931	AA2-077	107.19
919941	AA2-078	63.34
920141	AA2-110 1 OP	135.07
920151	AA2-110 2 OP	158.47
920421	AA2-140	12.46

Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AA2-076

Linwood 230kV

August 2015

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

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. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

The Interconnection Customer (IC), has proposed an uprate to an existing natural gas generating facility located in Delaware County, Pennsylvania. This project requests an increase to the install capability of 0 MW with 40 MW of this output being recognized by PJM as capacity. The installed facilities will have a total capability of 852 MW with 835 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is May 2018. **This study does not imply a PECO Energy Company (PECO) commitment to this in-service date.**

Point of Interconnection

AA2-076 will interconnect with the PECO transmission system at the Linwood 230kV bus.

Cost Summary

The AA2-076 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 0
Total Costs	**$ 0**

In addition, the AA2-076 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 45,000,000
Previously Identified Upgrades	$ 0
Total Costs	**$ 45,000,000**

Cost allocations for these upgrades will be provided in the System Impact Study Report.

Attachment Facilities

There are no Attachment Facilities to be constructed to support this interconnection request.

Direct Connection Cost Estimate

There are no Direct Connection Facilities to be constructed to support this interconnection request.

Non-Direct Connection Cost Estimate

There are no Non-Direct Connection Facilities to be constructed to support this interconnection request.

Interconnection Customer Requirements

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

Network Impacts

The Queue Project AA2-076 was evaluated as a 40.0 MW (Capacity 40.0 MW) injection at Phillips Island 230kV substation in the PECO area. This is an uprate to the X4-027 project. Project AA2-076 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA2-076 was studied with a commercial probability of 53% on a Summer Peak 2019 case. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
130-43/* $ DELCO $ 130-43 $ L	CONTINGENCY '130-43/* $ DELCO $ 130-43 $ L' TRIP BRANCH FROM BUS 213582 TO BUS 213788 CKT 1 /* EDDYSTN1 138.00 MASTER2 138.00 $ DELCO $ 130-43 $ L END/* $ DELCO $ 130-43 $ L
220-39	CONTINGENCY '220-39' /* $ DELCO $ 220-39 $ L TRIP BRANCH FROM BUS 213490 TO BUS 213750 CKT 1 END
220-43/* $ DELCO $ 220-43 $ L	CONTINGENCY '220-43/* $ DELCO $ 220-43 $ L' TRIP BRANCH FROM BUS 213489 TO BUS 213750 CKT 1 END/* $ DELCO $ 220-43 $ L
220-70/* $ DELCO $ 220-70 $ L	CONTINGENCY '220-70/* $ DELCO $ 220-70 $ L' DISCONNECT BUS 213512 /* CONCORD4 230.00 $ DELCO $ 220-70 $ L DISCONNECT BUS 213737 /* LENAPE8 230.00 $ DELCO $ 220-70 $ L END/* $ DELCO $ 220-70 $ L
L_D-2309	CONTINGENCY 'L_D-2309' /*EAGLE POINT - THOROFARE DISCONNECT BUS 219759 /* EAGEL POINT 3 SECTION DISCONNECT BUS 219121 /* THOROFARE SECTION 1 END
L_D-2309_LT	CONTINGENCY 'L_D-2309_LT' /* EAGLE POINT- THOROFARE DISCONNECT BUS 219759 /* EAGEL POINT 3 SECTION DISCONNECT BUS 219121 /* THOROFARE SECTION 1 CLOSE LINE FROM BUS 219211 TO BUS 219212 CKT 1 /* THOROFARE END

Contingency Name	Description
V2274+P2242_LT	CONTINGENCY 'V2274+P2242_LT' /* EAGEL POINT - GLOUCESTER & DEPTFORD - GLOUCESTER DISCONNECT BUS 219757 /* DEPTFORD SECTION 2 DISCONNECT BUS 219760 /* EAGLE POINT SECTION 4 DISCONNECT BRANCH FROM BUS 219110 TO BUS 219128 CKT 1 /* REMOVE 26KV -1 CLOSE LINE FROM BUS 219255 TO BUS 219256 CKT 1 /* DEPTFORD CLOSE LINE FROM BUS 219180 TO BUS 219181 CKT 1 /* DEPTFORD MOVE 8 MW LOAD FROM BUS 219180 TO BUS 219162 /* INTERSTATION TIE TRANSFER LOAD FROM DEPTFORD TO BEAVERBK T1 MOVE 8 MW LOAD FROM BUS 219181 TO BUS 219163 /* INTERSTATION TIE TRANSFER LOAD FROM DEPTFORD TO BEAVERBK T2 MOVE 8 MW LOAD FROM BUS 219255 TO BUS 219162 /* INTERSTATION TIE TRANSFER LOAD FROM DEPTFORD TO BEAVERBK T1 MOVE 8 MW LOAD FROM BUS 219256 TO BUS 219163 /* INTERSTATION TIE TRANSFER LOAD FROM DEPTFORD TO BEAVERBK T2 END
W2275_O2241	CONTINGENCY 'W2275_O2241' /* DOUBLE CIRCUIT TOWER W-2275(MICKLETON - DEPTFORD) AND O-2241(MICKLETON - THOROFARE) TRIP BRANCH FROM BUS 219762 TO BUS 228401 CKT 1 /* TRIP O-2241(MICKLETON - THOROFARE) 230KV TRIP BRANCH FROM BUS 219121 TO BUS 228401 CKT 1 /* TRIP (MICKLETON - THOROFARE #2) 230KV END
130-43/* $ DELCO $ 130-43 $ L	CONTINGENCY '130-43/* $ DELCO $ 130-43 $ L' TRIP BRANCH FROM BUS 213582 TO BUS 213788 CKT 1 /* EDDYSTN1 138.00 MASTER2 138.00 $ DELCO $ 130-43 $ L END/* $ DELCO $ 130-43 $ L

Generator Deliverability

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

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
1	N-1	220-39	PECO	LINWOOD-CHICHST1 230 kV line	213750	213489	1	DC	98.8	100.47	ER	1593	26.64	1
2	N-1	220-43/* $ DELCO $ 220-43 $ L	PECO	LINWOOD-CHICHST2 230 kV line	213750	213490	1	DC	98.66	100.33	ER	1593	26.61	2
3	Non	Non	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	45.33	46.67	NR	456	6.09	3
4	N-1	L_D-2309	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	59.82	60.95	ER	572	6.48	
5	N-1	L_D-2309_LT	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	59.68	60.81	ER	572	6.48	
6	Non	Non	PECO	TUNNEL-PARRISH9 230 kV line	213984	213859	1	DC	51.75	52.89	NR	812	9.27	4
7	N-1	220-70/* $ DELCO $ 220-70 $ L	PECO	TUNNEL-PARRISH9 230 kV line	213984	213859	1	DC	49.58	50.88	ER	965	12.61	
8	N-1	130-43/* $ DELCO $ 130-43 $ L	PECO	TUNNEL-PARRISH9 230 kV line	213984	213859	1	DC	50.93	51.96	ER	965	9.94	
9	Non	Non	PECO	GRAYSFRY4-TUNNEL2 230 kV line	214074	213986	1	DC	55.32	56.43	NR	831	9.27	5
10	N-1	220-70/* $ DELCO $ 220-70 $ L	PECO	GRAYSFRY4-TUNNEL2 230 kV line	214074	213986	1	DC	52.63	53.91	ER	984	12.61	
11	N-1	130-43/* $ DELCO $ 130-43 $ L	PECO	GRAYSFRY4-TUNNEL2 230 kV line	214074	213986	1	DC	53.96	54.97	ER	984	9.94	

Note: Please see Attachment 1 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
12	DCTL	V2274+P2242_ LT	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	60.88	61.39	ER	572	6.47	
13	DCTL	W2275_O2241	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	57.46	57.97	ER	572	6.48	

Note: Please see Attachment 1 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None.

Short Circuit

(Summary of impacted circuit breakers)

Not required.

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

None.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
1, 2	LINWOOD-CHICHST1 230 kV line	Upgrade the metering, disconnects and circuit breakers on the line. Estimated Cost: $5 M; Estimated Time: 3 years; this cost does not include the time or cost to purchase ROW and/or permits to construct if required. The time estimate does not include consideration of line outage availability.	Pending	**$ 5,000,000**
3, 4, 5, 12, 13	MASTER-N PHILA8 230 kV line	Rebuild the Master – N Philadelphia 230 kV line. Estimated Cost: $35 M; Estimated Time: 3 years; this cost does not include the time or cost to purchase ROW and/or permits to construct if required. The time estimate does not include consideration of line outage availability.	Pending	**$ 35,000,000**
6, 7, 8	TUNNEL-PARRISH9 230 kV line	Re-conductor the Tunnel – Parrish 230 kV line. Estimated Cost: $4 M; Estimated Time: 3 years; this cost does not include the time or cost to purchase ROW and/or permits to construct if required. The time estimate does not include consideration of line outage availability.	Pending	**$ 4,000,000**
9, 10, 11	GRAYSFRY4-TUNNEL2 230 kV line	Re-conductor the Grays Ferry - Tunnel 230 kV line and replace meters. Estimated Cost: $1 M; Estimated Time: 3 years; this cost does not include the time or cost to purchase ROW and/or permits to construct if required. The time estimate does not include consideration of line outage availability.	Pending	**$ 1,000,000**
			Total New Network Upgrades	**$ 45,000,000**

Contribution to Previously Identified System Reinforcements

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

None.

Attachment 1. Flowgate Details

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(PECO - PECO) The LINWOOD-CHICHST1 230 kV line (from bus 213750 to bus 213489 ckt 1) loads from 98.8% to 100.47% (DC power flow) of its emergency rating (1593 MVA) for the single line contingency outage of '220-39'. This project contributes approximately 26.64 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
231131	BLOOM ENRGY	0.48
231919	CHRIST1	0.68
231920	CHRIST2	0.66
231902	DC CT7	1.54
231917	EM10	0.46
231916	EM3	2.78
231901	EM4	5.66
231900	EM5	20.8
231903	GEN4	1.25
231908	HR1	4.07
231909	HR2	4.03
231910	HR3	4.07
231505	HR4	8.55
232923	MR1	2.9
232924	MR2	2.9
213888	PHLISCT1	9.81
213889	PHLISCT2	9.81
213890	PHLISCT3	9.81
213893	PHLISST1	13.59
297076	V2-028 C	0.42
231918	WEST 1	0.49
907211	X1-074	46.48
909411	X2-083	0.07
910591	X3-015 C	1.37

Bus Number	Bus Name	Full Contribution
912161	X4-027 CT1	0.66
912162	X4-027 CT2	0.66
912163	X4-027 CT3	0.66
915751	Y3-033	3.22
915752	Y3-033	21.54
916231	Z1-076 C	0.97
916241	Z1-077 C	0.69
916281	Z1-081 C	0.44
916471	Z1-103	0.76
917081	Z2-012 C	1.38
917431	Z2-076 C	0.72
917441	Z2-077 C	0.72
917581	Z2-097 C	0.68
918111	AA1-025	0.67
918121	AA1-026	0.67
918161	AA1-027	0.67
918171	AA1-028	0.67
918181	AA1-033	12.78
918441	AA1-059 C	0.78
918461	AA1-061 C	2.48
918831	AA1-102	6.83
918911	AA1-110 C	0.77
919161	AA1-140 C	1.37
919171	AA1-141 C	1.04

Bus Number	Bus Name	Full Contribution
919181	AA1-142 C	1.39
919191	AA1-143 C	1.44
919561	AA2-021 C	0.51
919601	AA2-036 C	0.98
919611	AA2-037 C	0.35
919831	AA2-069	90.49
919871	AA2-076 1	8.88

Bus Number	Bus Name	Full Contribution
919881	AA2-076 2	8.88
919891	AA2-076 3	8.88
920321	AA2-130	0.36
920461	AA2-144 C	1.26
920491	AA2-147 C	0.5
920521	AA2-150 C	1.28

Appendix 2

(PECO - PECO) The LINWOOD-CHICHST2 230 kV line (from bus 213750 to bus 213490 ckt 1) loads from 98.66% to 100.33% (DC power flow) of its emergency rating (1593 MVA) for the single line contingency outage of '220-43/* $ DELCO $ 220-43 $ L'. This project contributes approximately 26.61 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
231131	BLOOM ENRGY	0.48
231919	CHRIST1	0.68
231920	CHRIST2	0.66
231902	DC CT7	1.54
231917	EM10	0.46
231916	EM3	2.77
231901	EM4	5.66
231900	EM5	20.77
231903	GEN4	1.24
231908	HR1	4.06
231909	HR2	4.03
231910	HR3	4.06
231505	HR4	8.54
232923	MR1	2.9
232924	MR2	2.9
213888	PHLISCT1	9.79
213889	PHLISCT2	9.79
213890	PHLISCT3	9.79
213893	PHLISST1	13.57
297076	V2-028 C	0.42
231918	WEST 1	0.49
907211	X1-074	46.41
909411	X2-083	0.07
910591	X3-015 C	1.37
912161	X4-027 CT1	0.66
912162	X4-027 CT2	0.66
912163	X4-027 CT3	0.66

Bus Number	Bus Name	Full Contribution
915751	Y3-033	3.21
915752	Y3-033	21.51
916231	Z1-076 C	0.97
916241	Z1-077 C	0.69
916281	Z1-081 C	0.44
916471	Z1-103	0.76
917081	Z2-012 C	1.38
917431	Z2-076 C	0.72
917441	Z2-077 C	0.72
917581	Z2-097 C	0.68
918111	AA1-025	0.67
918121	AA1-026	0.67
918161	AA1-027	0.67
918171	AA1-028	0.67
918181	AA1-033	12.76
918441	AA1-059 C	0.78
918461	AA1-061 C	2.48
918831	AA1-102	6.82
918911	AA1-110 C	0.77
919161	AA1-140 C	1.37
919171	AA1-141 C	1.03
919181	AA1-142 C	1.39
919191	AA1-143 C	1.44
919561	AA2-021 C	0.51
919601	AA2-036 C	0.98
919611	AA2-037 C	0.35
919831	AA2-069	90.35

Bus Number	Bus Name	Full Contribution
919871	AA2-076 1	8.87
919881	AA2-076 2	8.87
919891	AA2-076 3	8.87
920321	AA2-130	0.36

Bus Number	Bus Name	Full Contribution
920461	AA2-144 C	1.26
920491	AA2-147 C	0.5
920521	AA2-150 C	1.28

Appendix 3

(PECO - PECO) The MASTER-N PHILA8 230 kV line (from bus 213783 to bus 213819 ckt 1) loads from 45.33% to 46.67% (DC power flow) of its normal rating (456 MVA) for non-contingency condition. This project contributes approximately 6.09 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
213497	CHSTR7-9	0.68
213575	EDDYST10	0.26
213577	EDDYST20	0.24
213587	EDDYSTN3	7.64
213589	EDDYSTN4	7.6
213590	EDY30-40	0.68
231901	EM4	1.27
231900	EM5	4.7
213962	FPL MH50	0.87
213632	GFCP	4.22
231505	HR4	1.93
213685	KIMCLARK	0.97
213738	LIBE_CT1	3.2
213739	LIBE_CT2	3.2
213740	LIBE_ST1	4.49
213888	PHLISCT1	2.24
213889	PHLISCT2	2.24
213890	PHLISCT3	2.24
213893	PHLISST1	3.1

Bus Number	Bus Name	Full Contribution
213942	SCHUYLKILL	0.73
213957	STHWK3-4	0.51
213958	STHWK5-6	0.51
901871	W1-108	0.37
903991	W3-080 C	-0.78
905231	W4-029 C	-0.07
912161	X4-027 CT1	0.15
912162	X4-027 CT2	0.15
912163	X4-027 CT3	0.15
914141	Y2-064	4.5
919871	AA2-076 1	2.03
919881	AA2-076 2	2.03
919891	AA2-076 3	2.03
919931	AA2-077	66.73
919941	AA2-078	39.43
920141	AA2-110 1 OP	128.02
920151	AA2-110 2 OP	117.53
920421	AA2-140	8.3

Appendix 4

(PECO - PECO) The TUNNEL-PARRISH9 230 kV line (from bus 213984 to bus 213859 ckt 1) loads from 51.75% to 52.89% (DC power flow) of its normal rating (812 MVA) for non-contingency condition. This project contributes approximately 9.27 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
213497	CHSTR7-9	0.9
213575	EDDYST10	0.27
213577	EDDYST20	0.32
213587	EDDYSTN3	11.45

Bus Number	Bus Name	Full Contribution
213589	EDDYSTN4	11.37
213590	EDY30-40	1.02
231901	EM4	2.03
231900	EM5	7.28

Bus Number	Bus Name	Full Contribution
213962	FPL MH50	1.15
213632	GFCP	6.91
231505	HR4	2.99
213685	KIMCLARK	1.22
213738	LIBE_CT1	4.81
213739	LIBE_CT2	4.81
213740	LIBE_ST1	6.74
213888	PHLISCT1	3.41
213889	PHLISCT2	3.41
213890	PHLISCT3	3.41
213893	PHLISST1	4.73
213942	SCHUYLKILL	1.07
213957	STHWK3-4	0.82
213958	STHWK5-6	0.82

Bus Number	Bus Name	Full Contribution
901871	W1-108	0.6
912161	X4-027 CT1	0.23
912162	X4-027 CT2	0.23
912163	X4-027 CT3	0.23
914141	Y2-064	6.76
919871	AA2-076 1	3.09
919881	AA2-076 2	3.09
919891	AA2-076 3	3.09
919931	AA2-077	107.19
919941	AA2-078	63.34
920141	AA2-110 1 OP	135.07
920151	AA2-110 2 OP	158.47
920421	AA2-140	12.46

Appendix 5

(PECO - PECO) The GRAYSFRY4-TUNNEL2 230 kV line (from bus 214074 to bus 213986 ckt 1) loads from 55.32% to 56.43% (DC power flow) of its normal rating (831 MVA) for non-contingency condition. This project contributes approximately 9.27 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
213497	CHSTR7-9	0.9
213575	EDDYST10	0.27
213577	EDDYST20	0.32
213587	EDDYSTN3	11.45
213589	EDDYSTN4	11.37
213590	EDY30-40	1.02
231901	EM4	2.03
231900	EM5	7.28
213962	FPL MH50	1.15
213632	GFCP	6.91
231505	HR4	2.99
213685	KIMCLARK	1.22
213738	LIBE_CT1	4.81
213739	LIBE_CT2	4.81
213740	LIBE_ST1	6.74
213888	PHLISCT1	3.41
213889	PHLISCT2	3.41
213890	PHLISCT3	3.41

Bus Number	Bus Name	Full Contribution
213893	PHLISST1	4.73
213942	SCHUYLKILL	1.07
213957	STHWK3-4	0.82
213958	STHWK5-6	0.82
901871	W1-108	0.6
912161	X4-027 CT1	0.23
912162	X4-027 CT2	0.23
912163	X4-027 CT3	0.23
914141	Y2-064	6.76
919871	AA2-076 1	3.09
919881	AA2-076 2	3.09
919891	AA2-076 3	3.09
919931	AA2-077	107.19
919941	AA2-078	63.34
920141	AA2-110 1 OP	135.07
920151	AA2-110 2 OP	158.47
920421	AA2-140	12.46

Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AA2-076

Linwood 230kV

August 2015

Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

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. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

The Interconnection Customer (IC), has proposed an uprate to an existing natural gas generating facility located in Delaware County, Pennsylvania. This project requests an increase to the install capability of 0 MW with 40 MW of this output being recognized by PJM as capacity. The installed facilities will have a total capability of 852 MW with 835 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is May 2018. **This study does not imply a PECO Energy Company (PECO) commitment to this in-service date.**

Point of Interconnection

AA2-076 will interconnect with the PECO transmission system at the Linwood 230kV bus.

Cost Summary

The AA2-076 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 0
Total Costs	**$ 0**

In addition, the AA2-076 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 45,000,000
Previously Identified Upgrades	$ 0
Total Costs	**$ 45,000,000**

Cost allocations for these upgrades will be provided in the System Impact Study Report.

Attachment Facilities

There are no Attachment Facilities to be constructed to support this interconnection request.

Direct Connection Cost Estimate

There are no Direct Connection Facilities to be constructed to support this interconnection request.

Non-Direct Connection Cost Estimate

There are no Non-Direct Connection Facilities to be constructed to support this interconnection request.

Interconnection Customer Requirements

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

Network Impacts

The Queue Project AA2-076 was evaluated as a 40.0 MW (Capacity 40.0 MW) injection at Phillips Island 230kV substation in the PECO area. This is an uprate to the X4-027 project. Project AA2-076 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA2-076 was studied with a commercial probability of 53% on a Summer Peak 2019 case. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
130-43/* $ DELCO $ 130-43 $ L	CONTINGENCY '130-43/* $ DELCO $ 130-43 $ L' TRIP BRANCH FROM BUS 213582 TO BUS 213788 CKT 1 /* EDDYSTN1 138.00 MASTER2 138.00 $ DELCO $ 130-43 $ L END/* $ DELCO $ 130-43 $ L
220-39	CONTINGENCY '220-39' /* $ DELCO $ 220-39 $ L TRIP BRANCH FROM BUS 213490 TO BUS 213750 CKT 1 END
220-43/* $ DELCO $ 220-43 $ L	CONTINGENCY '220-43/* $ DELCO $ 220-43 $ L' TRIP BRANCH FROM BUS 213489 TO BUS 213750 CKT 1 END/* $ DELCO $ 220-43 $ L
220-70/* $ DELCO $ 220-70 $ L	CONTINGENCY '220-70/* $ DELCO $ 220-70 $ L' DISCONNECT BUS 213512 /* CONCORD4 230.00 $ DELCO $ 220-70 $ L DISCONNECT BUS 213737 /* LENAPE8 230.00 $ DELCO $ 220-70 $ L END/* $ DELCO $ 220-70 $ L
L_D-2309	CONTINGENCY 'L_D-2309' /*EAGLE POINT - THOROFARE DISCONNECT BUS 219759 /* EAGEL POINT 3 SECTION DISCONNECT BUS 219121 /* THOROFARE SECTION 1 END
L_D-2309_LT	CONTINGENCY 'L_D-2309_LT' /* EAGLE POINT- THOROFARE DISCONNECT BUS 219759 /* EAGEL POINT 3 SECTION DISCONNECT BUS 219121 /* THOROFARE SECTION 1 CLOSE LINE FROM BUS 219211 TO BUS 219212 CKT 1 /* THOROFARE END

Contingency Name	Description
V2274+P2242_LT	CONTINGENCY 'V2274+P2242_LT' /* EAGEL POINT - GLOUCESTER & DEPTFORD - GLOUCESTER DISCONNECT BUS 219757 /* DEPTFORD SECTION 2 DISCONNECT BUS 219760 /* EAGLE POINT SECTION 4 DISCONNECT BRANCH FROM BUS 219110 TO BUS 219128 CKT 1 /* REMOVE 26KV -1 CLOSE LINE FROM BUS 219255 TO BUS 219256 CKT 1 /* DEPTFORD CLOSE LINE FROM BUS 219180 TO BUS 219181 CKT 1 /* DEPTFORD MOVE 8 MW LOAD FROM BUS 219180 TO BUS 219162 /* INTERSTATION TIE TRANSFER LOAD FROM DEPTFORD TO BEAVERBK T1 MOVE 8 MW LOAD FROM BUS 219181 TO BUS 219163 /* INTERSTATION TIE TRANSFER LOAD FROM DEPTFORD TO BEAVERBK T2 MOVE 8 MW LOAD FROM BUS 219255 TO BUS 219162 /* INTERSTATION TIE TRANSFER LOAD FROM DEPTFORD TO BEAVERBK T1 MOVE 8 MW LOAD FROM BUS 219256 TO BUS 219163 /* INTERSTATION TIE TRANSFER LOAD FROM DEPTFORD TO BEAVERBK T2 END
W2275_O2241	CONTINGENCY 'W2275_O2241' /* DOUBLE CIRCUIT TOWER W-2275(MICKLETON - DEPTFORD) AND O-2241(MICKLETON - THOROFARE) TRIP BRANCH FROM BUS 219762 TO BUS 228401 CKT 1 /* TRIP O-2241(MICKLETON - THOROFARE) 230KV TRIP BRANCH FROM BUS 219121 TO BUS 228401 CKT 1 /* TRIP (MICKLETON - THOROFARE #2) 230KV END
130-43/* $ DELCO $ 130-43 $ L	CONTINGENCY '130-43/* $ DELCO $ 130-43 $ L' TRIP BRANCH FROM BUS 213582 TO BUS 213788 CKT 1 /* EDDYSTN1 138.00 MASTER2 138.00 $ DELCO $ 130-43 $ L END/* $ DELCO $ 130-43 $ L

Generator Deliverability

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

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
1	N-1	220-39	PECO	LINWOOD-CHICHST1 230 kV line	213750	213489	1	DC	98.8	100.47	ER	1593	26.64	1
2	N-1	220-43/* $ DELCO $ 220-43 $ L	PECO	LINWOOD-CHICHST2 230 kV line	213750	213490	1	DC	98.66	100.33	ER	1593	26.61	2
3	Non	Non	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	45.33	46.67	NR	456	6.09	3
4	N-1	L_D-2309	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	59.82	60.95	ER	572	6.48	
5	N-1	L_D-2309_LT	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	59.68	60.81	ER	572	6.48	
6	Non	Non	PECO	TUNNEL-PARRISH9 230 kV line	213984	213859	1	DC	51.75	52.89	NR	812	9.27	4
7	N-1	220-70/* $ DELCO $ 220-70 $ L	PECO	TUNNEL-PARRISH9 230 kV line	213984	213859	1	DC	49.58	50.88	ER	965	12.61	
8	N-1	130-43/* $ DELCO $ 130-43 $ L	PECO	TUNNEL-PARRISH9 230 kV line	213984	213859	1	DC	50.93	51.96	ER	965	9.94	
9	Non	Non	PECO	GRAYSFRY4-TUNNEL2 230 kV line	214074	213986	1	DC	55.32	56.43	NR	831	9.27	5
10	N-1	220-70/* $ DELCO $ 220-70 $ L	PECO	GRAYSFRY4-TUNNEL2 230 kV line	214074	213986	1	DC	52.63	53.91	ER	984	12.61	
11	N-1	130-43/* $ DELCO $ 130-43 $ L	PECO	GRAYSFRY4-TUNNEL2 230 kV line	214074	213986	1	DC	53.96	54.97	ER	984	9.94	

Note: Please see Attachment 1 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
12	DCTL	V2274+P2242_ LT	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	60.88	61.39	ER	572	6.47	
13	DCTL	W2275_O2241	PECO	MASTER-N PHILA8 230 kV line	213783	213819	1	DC	57.46	57.97	ER	572	6.48	

Note: Please see Attachment 1 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None.

Short Circuit

(Summary of impacted circuit breakers)

Not required.

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

None.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
1, 2	LINWOOD-CHICHST1 230 kV line	Upgrade the metering, disconnects and circuit breakers on the line. Estimated Cost: $5 M; Estimated Time: 3 years; this cost does not include the time or cost to purchase ROW and/or permits to construct if required. The time estimate does not include consideration of line outage availability.	Pending	**$ 5,000,000**
3, 4, 5, 12, 13	MASTER-N PHILA8 230 kV line	Rebuild the Master – N Philadelphia 230 kV line. Estimated Cost: $35 M; Estimated Time: 3 years; this cost does not include the time or cost to purchase ROW and/or permits to construct if required. The time estimate does not include consideration of line outage availability.	Pending	**$ 35,000,000**
6, 7, 8	TUNNEL-PARRISH9 230 kV line	Re-conductor the Tunnel – Parrish 230 kV line. Estimated Cost: $4 M; Estimated Time: 3 years; this cost does not include the time or cost to purchase ROW and/or permits to construct if required. The time estimate does not include consideration of line outage availability.	Pending	**$ 4,000,000**
9, 10, 11	GRAYSFRY4-TUNNEL2 230 kV line	Re-conductor the Grays Ferry - Tunnel 230 kV line and replace meters. Estimated Cost: $1 M; Estimated Time: 3 years; this cost does not include the time or cost to purchase ROW and/or permits to construct if required. The time estimate does not include consideration of line outage availability.	Pending	**$ 1,000,000**
			Total New Network Upgrades	**$ 45,000,000**

Contribution to Previously Identified System Reinforcements

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

None.

Attachment 1. Flowgate Details

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 1

(PECO - PECO) The LINWOOD-CHICHST1 230 kV line (from bus 213750 to bus 213489 ckt 1) loads from 98.8% to 100.47% (DC power flow) of its emergency rating (1593 MVA) for the single line contingency outage of '220-39'. This project contributes approximately 26.64 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
231131	BLOOM ENRGY	0.48
231919	CHRIST1	0.68
231920	CHRIST2	0.66
231902	DC CT7	1.54
231917	EM10	0.46
231916	EM3	2.78
231901	EM4	5.66
231900	EM5	20.8
231903	GEN4	1.25
231908	HR1	4.07
231909	HR2	4.03
231910	HR3	4.07
231505	HR4	8.55
232923	MR1	2.9
232924	MR2	2.9
213888	PHLISCT1	9.81
213889	PHLISCT2	9.81
213890	PHLISCT3	9.81
213893	PHLISST1	13.59
297076	V2-028 C	0.42
231918	WEST 1	0.49
907211	X1-074	46.48
909411	X2-083	0.07
910591	X3-015 C	1.37

Bus Number	Bus Name	Full Contribution
912161	X4-027 CT1	0.66
912162	X4-027 CT2	0.66
912163	X4-027 CT3	0.66
915751	Y3-033	3.22
915752	Y3-033	21.54
916231	Z1-076 C	0.97
916241	Z1-077 C	0.69
916281	Z1-081 C	0.44
916471	Z1-103	0.76
917081	Z2-012 C	1.38
917431	Z2-076 C	0.72
917441	Z2-077 C	0.72
917581	Z2-097 C	0.68
918111	AA1-025	0.67
918121	AA1-026	0.67
918161	AA1-027	0.67
918171	AA1-028	0.67
918181	AA1-033	12.78
918441	AA1-059 C	0.78
918461	AA1-061 C	2.48
918831	AA1-102	6.83
918911	AA1-110 C	0.77
919161	AA1-140 C	1.37
919171	AA1-141 C	1.04

Bus Number	Bus Name	Full Contribution
919181	AA1-142 C	1.39
919191	AA1-143 C	1.44
919561	AA2-021 C	0.51
919601	AA2-036 C	0.98
919611	AA2-037 C	0.35
919831	AA2-069	90.49
919871	AA2-076 1	8.88

Bus Number	Bus Name	Full Contribution
919881	AA2-076 2	8.88
919891	AA2-076 3	8.88
920321	AA2-130	0.36
920461	AA2-144 C	1.26
920491	AA2-147 C	0.5
920521	AA2-150 C	1.28

Appendix 2

(PECO - PECO) The LINWOOD-CHICHST2 230 kV line (from bus 213750 to bus 213490 ckt 1) loads from 98.66% to 100.33% (DC power flow) of its emergency rating (1593 MVA) for the single line contingency outage of '220-43/* $ DELCO $ 220-43 $ L'. This project contributes approximately 26.61 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
231131	BLOOM ENRGY	0.48
231919	CHRIST1	0.68
231920	CHRIST2	0.66
231902	DC CT7	1.54
231917	EM10	0.46
231916	EM3	2.77
231901	EM4	5.66
231900	EM5	20.77
231903	GEN4	1.24
231908	HR1	4.06
231909	HR2	4.03
231910	HR3	4.06
231505	HR4	8.54
232923	MR1	2.9
232924	MR2	2.9
213888	PHLISCT1	9.79
213889	PHLISCT2	9.79
213890	PHLISCT3	9.79
213893	PHLISST1	13.57
297076	V2-028 C	0.42
231918	WEST 1	0.49
907211	X1-074	46.41
909411	X2-083	0.07
910591	X3-015 C	1.37
912161	X4-027 CT1	0.66
912162	X4-027 CT2	0.66
912163	X4-027 CT3	0.66

Bus Number	Bus Name	Full Contribution
915751	Y3-033	3.21
915752	Y3-033	21.51
916231	Z1-076 C	0.97
916241	Z1-077 C	0.69
916281	Z1-081 C	0.44
916471	Z1-103	0.76
917081	Z2-012 C	1.38
917431	Z2-076 C	0.72
917441	Z2-077 C	0.72
917581	Z2-097 C	0.68
918111	AA1-025	0.67
918121	AA1-026	0.67
918161	AA1-027	0.67
918171	AA1-028	0.67
918181	AA1-033	12.76
918441	AA1-059 C	0.78
918461	AA1-061 C	2.48
918831	AA1-102	6.82
918911	AA1-110 C	0.77
919161	AA1-140 C	1.37
919171	AA1-141 C	1.03
919181	AA1-142 C	1.39
919191	AA1-143 C	1.44
919561	AA2-021 C	0.51
919601	AA2-036 C	0.98
919611	AA2-037 C	0.35
919831	AA2-069	90.35

Bus Number	Bus Name	Full Contribution
919871	AA2-076 1	8.87
919881	AA2-076 2	8.87
919891	AA2-076 3	8.87
920321	AA2-130	0.36

Bus Number	Bus Name	Full Contribution
920461	AA2-144 C	1.26
920491	AA2-147 C	0.5
920521	AA2-150 C	1.28

Appendix 3

(PECO - PECO) The MASTER-N PHILA8 230 kV line (from bus 213783 to bus 213819 ckt 1) loads from 45.33% to 46.67% (DC power flow) of its normal rating (456 MVA) for non-contingency condition. This project contributes approximately 6.09 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
213497	CHSTR7-9	0.68
213575	EDDYST10	0.26
213577	EDDYST20	0.24
213587	EDDYSTN3	7.64
213589	EDDYSTN4	7.6
213590	EDY30-40	0.68
231901	EM4	1.27
231900	EM5	4.7
213962	FPL MH50	0.87
213632	GFCP	4.22
231505	HR4	1.93
213685	KIMCLARK	0.97
213738	LIBE_CT1	3.2
213739	LIBE_CT2	3.2
213740	LIBE_ST1	4.49
213888	PHLISCT1	2.24
213889	PHLISCT2	2.24
213890	PHLISCT3	2.24
213893	PHLISST1	3.1

Bus Number	Bus Name	Full Contribution
213942	SCHUYLKILL	0.73
213957	STHWK3-4	0.51
213958	STHWK5-6	0.51
901871	W1-108	0.37
903991	W3-080 C	-0.78
905231	W4-029 C	-0.07
912161	X4-027 CT1	0.15
912162	X4-027 CT2	0.15
912163	X4-027 CT3	0.15
914141	Y2-064	4.5
919871	AA2-076 1	2.03
919881	AA2-076 2	2.03
919891	AA2-076 3	2.03
919931	AA2-077	66.73
919941	AA2-078	39.43
920141	AA2-110 1 OP	128.02
920151	AA2-110 2 OP	117.53
920421	AA2-140	8.3

Appendix 4

(PECO - PECO) The TUNNEL-PARRISH9 230 kV line (from bus 213984 to bus 213859 ckt 1) loads from 51.75% to 52.89% (DC power flow) of its normal rating (812 MVA) for non-contingency condition. This project contributes approximately 9.27 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
213497	CHSTR7-9	0.9
213575	EDDYST10	0.27
213577	EDDYST20	0.32
213587	EDDYSTN3	11.45

Bus Number	Bus Name	Full Contribution
213589	EDDYSTN4	11.37
213590	EDY30-40	1.02
231901	EM4	2.03
231900	EM5	7.28

Bus Number	Bus Name	Full Contribution
213962	FPL MH50	1.15
213632	GFCP	6.91
231505	HR4	2.99
213685	KIMCLARK	1.22
213738	LIBE_CT1	4.81
213739	LIBE_CT2	4.81
213740	LIBE_ST1	6.74
213888	PHLISCT1	3.41
213889	PHLISCT2	3.41
213890	PHLISCT3	3.41
213893	PHLISST1	4.73
213942	SCHUYLKILL	1.07
213957	STHWK3-4	0.82
213958	STHWK5-6	0.82

Bus Number	Bus Name	Full Contribution
901871	W1-108	0.6
912161	X4-027 CT1	0.23
912162	X4-027 CT2	0.23
912163	X4-027 CT3	0.23
914141	Y2-064	6.76
919871	AA2-076 1	3.09
919881	AA2-076 2	3.09
919891	AA2-076 3	3.09
919931	AA2-077	107.19
919941	AA2-078	63.34
920141	AA2-110 1 OP	135.07
920151	AA2-110 2 OP	158.47
920421	AA2-140	12.46

Appendix 5

(PECO - PECO) The GRAYSFRY4-TUNNEL2 230 kV line (from bus 214074 to bus 213986 ckt 1) loads from 55.32% to 56.43% (DC power flow) of its normal rating (831 MVA) for non-contingency condition. This project contributes approximately 9.27 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
213497	CHSTR7-9	0.9
213575	EDDYST10	0.27
213577	EDDYST20	0.32
213587	EDDYSTN3	11.45
213589	EDDYSTN4	11.37
213590	EDY30-40	1.02
231901	EM4	2.03
231900	EM5	7.28
213962	FPL MH50	1.15
213632	GFCP	6.91
231505	HR4	2.99
213685	KIMCLARK	1.22
213738	LIBE_CT1	4.81
213739	LIBE_CT2	4.81
213740	LIBE_ST1	6.74
213888	PHLISCT1	3.41
213889	PHLISCT2	3.41
213890	PHLISCT3	3.41

Bus Number	Bus Name	Full Contribution
213893	PHLISST1	4.73
213942	SCHUYLKILL	1.07
213957	STHWK3-4	0.82
213958	STHWK5-6	0.82
901871	W1-108	0.6
912161	X4-027 CT1	0.23
912162	X4-027 CT2	0.23
912163	X4-027 CT3	0.23
914141	Y2-064	6.76
919871	AA2-076 1	3.09
919881	AA2-076 2	3.09
919891	AA2-076 3	3.09
919931	AA2-077	107.19
919941	AA2-078	63.34
920141	AA2-110 1 OP	135.07
920151	AA2-110 2 OP	158.47
920421	AA2-140	12.46