

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request
Queue Position AD1-097***

“Linwood 230 kV II”

88 MFO, 109.3 MWC Uprate

January 2018

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 increase in output of their existing Marcus Hook (Phillips Island) natural gas generating facility located at 100 Green Street, Marcus Hook, Pennsylvania. The uprate will increase the maximum facility output (MFO) of the facility by **88 MW**, for a total plant MFO of 940 MW. The uprate will also increase the Capacity value by **109.3 MW**, for a total of 922.3 MW being recognized by PJM as Capacity. (See the summary tables below.) The proposed in-service date for this project is **May 31, 2019**. **This study does not imply a PECO Energy Company (PECO) commitment to this in-service date.**

	Summer	Winter
Net Energy Existing (MW)	813	852
Net Energy Increase (MW)	109.3	88
Total Net Energy (MW)	922.3	940

	Existing (MW)	Uprate (MW)	Total (MW)
Capacity	813	109.3	922.3
MFO	852	88	940

PJM studied the proposed request and evaluated it for compliance with reliability criteria for summer peak conditions in 2021.

Point of Interconnection

AD1-097 “Linwood 230 kV II” uprate project will be at increase to the existing Marcus Hook (Phillips Island) natural gas generation plant which interconnects to the PECO transmission system at the Linwood Substation 230 kV bus.

Attachment 1 shows the one line diagram of the project and the existing point of interconnection with the Linwood 230 kV substation.

Cost Summary

The AD1-097 “Linwood 230 kV II” project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$ 0
Direct Connection Network Upgrades	\$ 0
Non Direct Connection Network Upgrades (PECO)	\$ 15,000
Total Costs	\$ 15,000

In addition, the AD1-097 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades (PECO)	\$ 11,100,000
Previously Identified Upgrades (ACE)	\$ 905,000
Total Costs	\$ 12,005,000

The transmission and substation costs given above exclude any applicable state or federal taxes. If at a future date Federal CIAC (contribution in aid of construction) taxes are deemed necessary by the IRS for this project, PECO and Atlantic City Electric (ACE) shall be reimbursed by the Interconnection Customer for such taxes.

The required Attachment Facilities, Direct Connection, and Non-Direct Connection work for the interconnection of the AD1-097 generation uprate project to the PECO Transmission System is detailed in the following sections. The associated one-line with the generation project is shown in **Attachment 1**.

Note that all cost estimates contained in this document were produced without a detailed engineering review and are therefore subject to change. The IC will be responsible for the actual cost of the work that is implemented. PECO and ACE herein reserve the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any reinforcements to the transmission or subtransmission systems.

Attachment Facilities

There is no Attachment Facilities work required for this project.

Direct Connection Cost Estimate

There is no Direct Connection scope of work required for this project.

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Protection System changes at Linwood Substation (PECO)	\$ 15,000
Total Non-Direct Connection Facility Costs	\$ 15,000

The total Non-Direct Connection cost estimate for the AD1-097 project is approximately **\$15,000**. This work is to review the protection system settings at PECO's Linwood Substation and to implement any necessary changes.

PECO Interconnection Requirements

The Interconnection Customer facilities must be designed in accordance with the "Exelon Utilities Transmission Facility Interconnection Requirements" document dated January 1, 2016. This document is located at the following link:

<http://www.pjm.com/~media/planning/plan-standards/private-ce/exelon-utilities-transmission-facility-interconnection-requirements.ashx>

Schedule

Based on the extent of the PECO and ACE's primary Non-Direct Connection and Network Upgrade work required to support the AD1-097 generation project, it is expected to take a **minimum of 60 months** (60 months for Chichester to Trainer 230 kV line rebuild and 18 months for replacement of limiting equipment on the Delco Tap to Mickleton 230 kV line assuming both can be done concurrently) from the date of a fully executed Interconnection Construction Service Agreement to complete the installation subject to market conditions and

vendor lead times. This includes the requirement for the Interconnection Customer to make a preliminary payment to PECO and ACE which funds the construction of the Non-Direct Connection facilities and Network Upgrade work. It assumes that there will be no environmental or permitting issues to implement the upgrades required for this uprate project and that all system outages will be allowed when requested.

Revenue Metering and SCADA Requirements

PJM Requirements

Existing metering is adequate for this request.

Network Impacts

The Queue Project AD1-097 was evaluated as a **109.3 MW (Capacity 109.3 MW)** uprate to the Philip Island CT1, CT2, CT3, & ST1 generating station in the PECO area. Project AD1-097 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-097 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
PECO_P2-2_CHI230B1	CONTINGENCY 'PECO_P2-2_CHI230B1' /* \$ DELCO \$ CHI230B1 \$ B
	DISCONNECT BUS 213489 /* CHICHST1 230.00 \$ DELCO \$ CHI230B1 \$ B
	END
PECO_P4_CHICH045	CONTINGENCY 'PECO_P4_CHICH045' /*\$ DELCO \$ CHICH045 \$ STBK
	DISCONNECT BUS 213489 /* CHICHST1 230.00 \$ DELCO \$ CHICH045 \$ STBK
	DISCONNECT BUS 213627 /* FOULK8 230.00 \$ DELCO \$ CHICH045 \$ STBK
	END

Generator Deliverability

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

None

Multiple Facility Contingency

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

AD1-097 Multiple Facility Contingency														
Overload Number	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Flowgate Appendix
					From	To	Circuit		Initial	Final	Type	MVA		
1	BUS	PECO_P2-2_CHI230B1	PECO - PECO	CHIREACT_53-TRAINER 230 kV line	213496	213972	1	DC	96.31	100.84	ER	841	39.12	1
2	LFFB	PECO_P4_CHICH045	PECO - PECO	CHIREACT_53-TRAINER 230 kV line	213496	213972	1	DC	96.3	100.83	ER	841	39.12	

Note: Please see Attachment 2 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper Appendix 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)

AD1-097 Contribution to Previously Identified Overloads														
Overload Number	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus			Power Flow	Loading %		Rating		MW Contribution	Flowgate Appendix
					From	To	Circuit		Initial	Final	Type	MVA		
3	BUS	PECO_P2-2_CHI230B1	PECO - AE	DELCOTAP-MCKLTON 230 kV line	213559	228401	1	DC	105.31	110.57	ER	725	39.08	2
4	LFFB	PECO_P4_CHICH045	PECO - AE	DELCOTAP-MCKLTON 230 kV line	213559	228401	1	DC	105.31	110.57	ER	725	39.08	

Note: Please see Attachment 2 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper Appendix in the Attachment.

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

To be provided in the System Impact Study.

Short Circuit

(Summary of impacted circuit breakers)

None

Affected System Analysis & Mitigation

LGEE Impacts:

LGEE Impacts to be determined during later study phases (as applicable).

MISO Impacts:

MISO Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

OVEC Impacts to be determined during later study phases (as applicable).

Delivery of Energy Portion of Interconnection Request

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.

Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

None

Light Load Analysis - 2021

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

System Reinforcements

Short Circuit

(Summary form of Cost allocation for breakers will be inserted here if any)

None

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

To be determined in System Impact Study.

Summer Peak Load Flow Analysis Reinforcements

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	CHIREACT_53- TRAINER 230 kV line	Rebuild Chichester to Trainer 230 kV line. (PECO) Time to complete: 60 months	Pending	\$11,100,000
Total New Network Upgrades				\$11,100,000

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)

(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
#3, 4	DELCOTAP-MCKLTON 230 kV line	Replace substation equipment and substation bus at Mickleton Substation to increase the emergency rating of the Delco Tap to Mickleton 230 kV line to 828 MVA. Time to Complete: 18 months	Pending	\$905,000
			Total	\$905,000

Light Load Load Flow Analysis Reinforcements

New System Reinforcements

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

None

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)

(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

None

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Attachment 1.
AD1-097 “Linwood 230 kV II”
One Line Diagram

Attachment 2. Flowgate Details

Appendices

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 CHIREACT_53-TRAINER 230 kV line (from bus 213496 to bus 213972 ckt 1) loads from 96.31% to 100.84% (**DC power flow**) of its emergency rating (841 MVA) for the bus fault outage of 'PECO_P2-2_CHI230B1'. This project contributes approximately 39.12 MW to the thermal violation.

CONTINGENCY 'PECO_P2-2_CHI230B1'
DISCONNECT BUS 213489
END

/* \$ DELCO \$ CHI230B1 \$ B
/* CHICHST1 230.00 \$ DELCO \$ CHI230B1 \$ B

Appendix 1							
Bus Number	Bus Name	Full Contribution	Project Status	Bus Number	Bus Name	Full Contribution	Project Status
932161	AC2-023 C	1.93	Active	930921	AB1-141 C	1.14	Active
932162	AC2-023 E	1.41	Active	930922	AB1-141 E	0.53	Active
933641	AC2-186 C	0.26	Active	930931	AB1-142 C	1.14	Active
933642	AC2-186 E	0.42	Active	930932	AB1-142 E	0.53	Active
933651	AC2-187 C	0.52	Active	931111	AB1-162 C	0.53	Active
933652	AC2-187 E	0.85	Active	931112	AB1-162 E	0.87	Active
933661	AC2-188 C	0.52	Active	931261	AB1-176 C	0.28	Active
933662	AC2-188 E	0.85	Active	931262	AB1-176 E	0.47	Active
933671	AC2-189 1	0.69	Active	923921	AB2-032 C	1.15	Active
933681	AC2-189 2C	0.05	Active	923922	AB2-032 E	0.54	Active
933682	AC2-189 2E	0.09	Active	923931	AB2-033 C	0.51	Active
934641	AD1-095	0.14	Active	923932	AB2-033 E	0.2	Active
934661	AD1-097 1	10.89	Active	923951	AB2-036 C	2.89	Active
934671	AD1-097 2	10.89	Active	923952	AB2-036 E	4.72	Active
934681	AD1-097 3	10.89	Active	923961	AB2-037 C	6.29	Active
934691	AD1-097 4	6.44	Active	923962	AB2-037 E	10.28	Active
935121	AD1-145	0.68	Active	924191	AB2-063 C	0.63	Active
935131	AD1-146 C	0.26	Active	924192	AB2-063 E	1.04	Active
935132	AD1-146 E	0.43	Active	924361	AB2-084 C	0.27	EP

231917	EM10	0.55	
231916	EM3	3.31	
231901	EM4	6.75	
231900	EM5	25.5	
231908	HR1	4.85	
231909	HR2	4.81	
231910	HR3	4.85	
231505	HR4	10.48	
213888	PHLISCT1	12.74	
213889	PHLISCT2	12.74	
213890	PHLISCT3	12.74	
213893	PHLISST1	17.64	
297076	V2-028 C	0.17	Suspended
297077	V2-028 E	0.28	Suspended
904210	V4-022C	0.14	
904212	V4-022E	0.22	
901004	W1-003 E	0.33	IS
901014	W1-004 E	0.33	IS
901024	W1-005 E	0.33	IS
901034	W1-006 E	0.33	IS
907052	X1-032 E	0.29	IS
907324	X1-096 E	9.44	UC
909032	X2-013 E	0.2	IS
910572	X3-008 E	0.94	UC
910822	X3-066 E	0.31	IS
913362	Y1-079 E	0.51	IS
913412	Y1-080 E	0.16	IS
915542	Y3-058 E	0.68	IS
917082	Z2-012 E	0.89	IS
917432	Z2-076 E	0.14	UC
917442	Z2-077 E	0.14	UC
917582	Z2-097 E	0.12	UC
918432	AA1-059 E	0.12	UC
918451	AA1-061 C	1.02	Active

924362	AB2-084 E	0.45	EP
924681	AB2-120 C	2.73	Active
924682	AB2-120 E	4.45	Active
924781	AB2-130 C O1	2.29	Active
924782	AB2-130 E O1	3.74	Active
924801	AB2-133 C O1	2.08	Active
924802	AB2-133 E O1	2.63	Active
924821	AB2-135 C	2.41	Active
924822	AB2-135 E	2.75	Active
924831	AB2-136 C	1.87	Active
924832	AB2-136 E	1.98	Active
924971	AB2-153 C	0.64	Active
924972	AB2-153 E	1.05	Active
925091	AB2-166 C	0.14	EP
925092	AB2-166 E	0.25	EP
925111	AB2-168 C	0.39	Active
925112	AB2-168 E	0.53	Active
925151	AB2-172 C	1.45	Active
925152	AB2-172 E	2.36	Active
925251	AB2-179 C	3.5	Active
925252	AB2-179 E	1.15	Active
925261	AB2-180 C	1.02	Active
925262	AB2-180 E	0.44	Active
925271	AB2-185 C	1.16	Active
925272	AB2-185 E	0.5	Active
925381	AC1-009 C	0.55	Active
925382	AC1-009 E	0.89	Active
925651	AC1-041 C	0.14	Active
925652	AC1-041 E	0.22	Active
925731	AC1-049 C	0.1	Active
925732	AC1-049 E	0.17	Active
925741	AC1-050 C	0.14	EP
925742	AC1-050 E	0.22	EP
925761	AC1-052 C	0.46	Active

918452	AA1-061 E	0.5	Active
918852	AA1-104 E	2.29	Active
919161	AA1-140 C	0.53	W
919162	AA1-140 E	0.87	W
919171	AA1-141 C	0.41	W
919172	AA1-141 E	0.67	W
920312	AA2-129 E	1.44	Active
919871	AB1-000 1	2.15	
919881	AB1-000 2	2.15	
919891	AB1-000 3	2.15	
930201	AB1-056 C	4.46	Active
930202	AB1-056 E	12.7	Active
930211	AB1-057 C	4.53	Active
930212	AB1-057 E	12.91	Active
930881	AB1-137 C	0.29	Active
930882	AB1-137 E	0.13	Active

925762	AC1-052 E	0.19	Active
926721	AC1-154 C	0.1	EP
926722	AC1-154 E	0.16	EP
926911	AC1-177	0.29	Active
927031	AC1-190 C	2.66	Active
927032	AC1-190 E	1.14	Active
927191	AC1-213 C	0.23	Active
927192	AC1-213 E	0.15	Active
927241	AC1-220 C	1.29	Active
927242	AC1-220 E	0.9	Active
927272	AC1-224 E	0.08	Active
927311	AC1-228 C	0.08	Active
927312	AC1-228 E	0.14	Active
927321	AC1-229 C	0.26	Active
927322	AC1-229 E	0.42	Active

Appendix 2

(PECO - AE) The DELCOTAP-MCKLTON 230 kV line (from bus 213559 to bus 228401 ckt 1) loads from 105.31% to 110.57% (**DC power flow**) of its emergency rating (725 MVA) for the bus fault outage of 'PECO_P2-2_CHI230B1'. This project contributes approximately 39.08 MW to the thermal violation.

CONTINGENCY 'PECO_P2-2_CHI230B1'
DISCONNECT BUS 213489
END

/* \$ DELCO \$ CHI230B1 \$ B
/* CHICHST1 230.00 \$ DELCO \$ CHI230B1 \$ B

Appendix 2							
Bus Number	Bus Name	Full Contribution	Project Status	Bus Number	Bus Name	Full Contribution	Project Status
932161	AC2-023 C	1.92	Active	931111	AB1-162 C	0.53	Active
932162	AC2-023 E	1.4	Active	931112	AB1-162 E	0.86	Active
933671	AC2-189 1	0.69	Active	931261	AB1-176 C	0.28	Active
933681	AC2-189 2C	0.05	Active	931262	AB1-176 E	0.47	Active
933682	AC2-189 2E	0.09	Active	923921	AB2-032 C	1.14	Active
934661	AD1-097 1	10.88	Active	923922	AB2-032 E	0.54	Active
934671	AD1-097 2	10.88	Active	923951	AB2-036 C	2.87	Active
934681	AD1-097 3	10.88	Active	923952	AB2-036 E	4.7	Active
934691	AD1-097 4	6.44	Active	923961	AB2-037 C	6.26	Active
213400	COVANTA DELA	10.59		923962	AB2-037 E	10.23	Active
231917	EM10	0.55		924191	AB2-063 C	0.63	Active
231916	EM3	3.3		924192	AB2-063 E	1.03	Active
231901	EM4	6.74		924801	AB2-133 C O1	2.07	Active
231900	EM5	25.46		924802	AB2-133 E O1	2.62	Active
231908	HR1	4.84		924821	AB2-135 C	2.4	Active
231909	HR2	4.8		924822	AB2-135 E	2.74	Active
231910	HR3	4.84		924831	AB2-136 C	1.86	Active
231505	HR4	10.47		924832	AB2-136 E	1.97	Active

213888	PHLISCT1	12.72	
213889	PHLISCT2	12.72	
213890	PHLISCT3	12.72	
213893	PHLISST1	17.62	
297076	V2-028 C	0.17	Suspended
297077	V2-028 E	0.28	Suspended
907324	X1-096 E	9.39	UC
909032	X2-013 E	0.2	IS
910572	X3-008 E	0.94	UC
910822	X3-066 E	0.31	IS
913362	Y1-079 E	0.51	IS
913412	Y1-080 E	0.16	IS
915542	Y3-058 E	0.67	IS
917582	Z2-097 E	0.12	UC
918432	AA1-059 E	0.12	UC
918451	AA1-061 C	1.01	Active
918452	AA1-061 E	0.5	Active
918852	AA1-104 E	2.3	Active
919871	AB1-000 1	2.15	
919881	AB1-000 2	2.15	
919891	AB1-000 3	2.15	
930921	AB1-141 C	1.13	Active
930922	AB1-141 E	0.53	Active
930931	AB1-142 C	1.13	Active
930932	AB1-142 E	0.53	Active

924971	AB2-153 C	0.64	Active
924972	AB2-153 E	1.04	Active
925111	AB2-168 C	0.39	Active
925112	AB2-168 E	0.53	Active
925151	AB2-172 C	1.44	Active
925152	AB2-172 E	2.35	Active
925251	AB2-179 C	3.48	Active
925252	AB2-179 E	1.15	Active
925261	AB2-180 C	1.01	Active
925262	AB2-180 E	0.43	Active
925271	AB2-185 C	1.15	Active
925272	AB2-185 E	0.49	Active
925741	AC1-050 C	0.14	EP
925742	AC1-050 E	0.22	EP
926721	AC1-154 C	0.1	EP
926722	AC1-154 E	0.16	EP
926911	AC1-177	0.29	Active
927031	AC1-190 C	2.64	Active
927032	AC1-190 E	1.13	Active
927241	AC1-220 C	1.28	Active
927242	AC1-220 E	0.9	Active
927272	AC1-224 E	0.08	Active
927311	AC1-228 C	0.08	Active
927312	AC1-228 E	0.14	Active