Generation Interconnection

Feasibility Study Report

for

Queue Project AF2-418

MILLVILLE TAP 69 KV

12 MW Capacity / 20 MW Energy

July 2020

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1 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 the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), the Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is PPL.

2 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. Cost allocation rules for network upgrades can be found in PJM Manual 14A, Attachment B. 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 Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

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.

3 General

The Interconnection Customer (IC) has proposed a Solar generating facility located in Columbia County, Pennsylvania. The installed facilities will have a total capability of 20 MW with 12 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is October 01, 2021. This study does not imply a TO commitment to this in-service date.

Queue Number	AF2-418
Project Name	MILLVILLE TAP 69 KV
State	Pennsylvania
County	Columbia
Transmission Owner	PPL
MFO	20
MWE	20
MWC	12
Fuel	Solar
Basecase Study Year	2023

New Service Customers proposing queue projects that can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

AF2-418 will interconnect with the PPL EU transmission system via the Millville 69 kV Tap, 1.75 miles from the Millville N.O. bus and 4.15 miles from the Millville bus. The Point of Interconnection (POI) will be at the PPL EU owned termination structure where the Interconnection Customer's transmission line terminates (with insulators).

5 Cost Summary

The AF2-418 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$ 1,104,000
Total System Network Upgrade Costs	$ 0
Total Costs	$ 1,104,000

This cost excludes CIAC Tax Gross Up charges. Cost allocations for any System Upgrades will be provided in the System Impact Study Report

6 Transmission Owner Scope of Work

The total physical interconnection costs is given in the table below:

Description	Total Cost
Attachment Facilities	$ 869,400
Direct Connection Network Upgrade	$ 0
Non Direct Connection Network Upgrades	$ 234,600
Total Physical Interconnection Costs	$ 1,104,000

PPL EU can accommodate this interconnection by constructing a new transmission line tap off the Millville 69 kV Tap line and completing associated remote end relay work.

Risks and Assumptions

- No major environmental, real estate, siting, or permitting issues.
- IC is responsible for acquisition of easements, permits, and right of way for any Direct Connection Network Upgrades and Attachment Facilities per PPL EU standards and requirements.
- PPL EU will perform all grading, site preparation, and establish access roads for the PPL EU owned Attachment Facilities per PPL EU standards and requirements.

6.1 Attachment Facilities

69 kV Transmission Line Tap

PPL EU will tap the Millville 69 kV Tap line at or near GPS Coordinates: 41.1211350, -76.4467280. PPL EU will extend the tap south towards the IC site. PPL EU will install a motor operated switch and POI termination structure. The IC must build the remainder of the Attachment Facilities from the POI termination structure to the IC substation. The IC is responsible for procuring 100 ft. ROW for these facilities. For the purposes of this Feasibility Study Report cost estimate, PPL EU is assuming all engineering and construction responsibility for land development activities, including grading, site preparation, and new access road. During the Facilities Study phase, PPL EU and the IC will review land development activities, and the IC may choose to perform some, or all, of these activities. The cost estimate will be updated accordingly and included in the Facilities Study Report.

PPL EU work will consist of installing the following:

- Install one (1) new single circuit steel pole high tap structure with custom foundation.
- Install one (1) new single circuit, direct-embed, custom steel, motor operated switch structure.
- Install one (1) new single circuit, direct-embed, steel, tension structure with custom foundation with fiber splice box.
- New circuit will consist of three (3) phase 556.6 kcmil 24/7 ACSR conductor and 48-ct optical ground wire (OPGW).

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

Description	Total Cost
69 kV Transmission Line Tap	$ 869,400
Total Attachment Facility Costs	$ 869,400

6.2 Direct Connection Cost Estimate

None.

6.3 Non-Direct Connection Cost Estimate

Remote End Relay Work – Columbia 69 kV Substation

- Complete remote end relay work at Columbia 69 kV Substation for Direct Transfer Trip.
- Model IC in CAPE and conduct a wide area short-circuit study two busses away from the IC facilities. Identify affected relays and revise settings as needed.
- Conduct a review of the IC relay settings and engineering package (submitted by IC to PPL EU).

Millville Tap 69 kV Modifications to tie in the AF2-418 Attachment Facilities

- Tie the new AF2-418 Attachment Facilities into Millville Tap 69 kV line.
- Replace existing transmission structures on either side of the new tap structure (grid #s 35893n35041 and 35893n3504) with custom steel foundation tap pole.
- Install two new fiber splice boxes on existing Millville Tap 69 kV line and route to POI.

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
Remote End Relay Work – Columbia 69 kV Substation	$ 138,000
Millville Tap 69 kV Modifications to tie in the AF2-418 Attachment Facilities	$ 96,600
Total Non-Direct Connection Facility Costs	$ 234,600

7 Schedule

The estimated time to complete the scope of work is 12-18 months after the PJM three-party Interconnection Service Agreement (ISA) and Interconnection Construction Service Agreement (ICSA) are signed and PPL EU receives Notice to Proceed from the IC.

8 Interconnection Customer Requirements

8.1 PPL EU Interconnection Requirements

PPL EU applicable technical standards that address requirements for interconnection of generation, transmission, and end user facilities can be found at the following link:

https://pjm.com/planning/design-engineering/to-tech-standards/private-ppl.aspx

8.2 IC Direct Transfer Trip (DTT) Requirements

PPL EU will require an independent communication path, for DTT of the IC Intertie Protective Relaying (IPR) Fault Interrupting Devices (FIDs), consisting of one communication circuit with the Columbia 69 kV Substation breaker 13R. The IC may elect to obtain DTT via the Milton-Millville 69 kV line by completing upgrades at the Milton 69 kV Substation. This would enable AF2-418 to generate on the Milton - Millville 69 kV line in the event that the POI is ever sourced from this line. Substation upgrades for the Milton-Millville 69 kV line are not currently in the scope and estimate of this report. PPL EU can evaluate this at the request of the IC during subsequent study phases from both a cost and interconnection analysis perspective.

PPL EU currently has OPGW on the Millville Tap 69 kV line available for DTT to the Columbia 69 kV Substation. PPL EU assumes strands of this fiber will be used for the independent communication pathway. However, the IC may choose to procure a third-party communication circuit at its own discretion in lieu of the OPGW.

9 Revenue Metering and SCADA Requirements

9.1 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 Section 8 of Attachment O.

9.2 Meteorological Data Reporting Requirements

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

9.3 Interconnected Transmission Owner Requirements

Installation of revenue grade Bi-directional Metering Equipment will be required in the vicinity of the POI to measure kWh and kVARh. PPL EU will design and supply the required metering equipment; all installation costs

would be borne by the IC including CTs/PTs. All metering equipment must meet applicable PPL EU tariff requirements as well as being compliant with all applicable requirements of the PJM agreements. The equipment must provide bidirectional revenue metering (kWh and kVARh) and real-time data (kW, kVAR, circuit breaker status, and generator bus voltages) for the IC's generating resource. The metering equipment should be housed in a control cabinet or similar enclosure and must be accessible to PPL EU metering personnel.

10 Summer Peak - Load Flow Analysis

The Queue Project AF2-418 was evaluated as a 20.0 MW (Capacity 12.0 MW) injection at the **Millville 69 kV substation** in the PPL area. Project AF2-418 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-418 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

10.1 Generation Deliverability

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

None

10.2 Multiple Facility Contingency

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

None

10.3 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)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
99758848	207942	COLUTR1	230.0	PPL	207935	CWSA	230.0	PPL	1	PL_P71_101751	tower	1195.0	106.26	107.43	DC	13.98
99758849	207942	COLUTR1	230.0	PPL	207935	CWSA	230.0	PPL	1	PL_P71_101752	tower	1195.0	103.72	104.9	DC	13.98

10.4 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

10.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Index	Facility	Upgrade Description	Cost
99758848 99758849	1	COLU TR1 230.0 kV - CWSA 230.0 kV Ckt 1	PPL_s1106 (1925) : PPL_S_1106_B09121 MONT-MILT-SUNB 230kV: PPL Supplemental project (s1106) to rebuild the MONT-MILT 230 kV line to double circuit and change operating voltage 69kV line between MILT and SUNB to 230kV Project Type : CON Cost : $0 Time Estimate : 36 Months	$0
			TOTAL COST	$0

10.6 Flow Gate Details

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

10.6.1 Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
99758848	207942	COLU TR1	PPL	207935	CWSA	PPL	1	PL_P71_101751	tower	1195.0	106.26	107.43	DC	13.98

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
208911	MONT G1	63.5276	50/50	63.5276
208912	**MONT G2 (Deactivation : 18/02/2019)**	**64.3484**	**50/50**	**64.3484**
208945	LOHA CT	0.7861	50/50	0.7861
208948	WILL CT	1.6974	50/50	1.6974
209018	SUNBIPCT	0.6888	50/50	0.6888
209019	VIKI IPP	1.5086	Adder	1.77
212369	PATRIOT 1	27.7249	50/50	27.7249
212370	PATRIOT 2	27.7249	50/50	27.7249
921653	AA2-008 E	23.9520	50/50	23.9520
939891	AE1-225 C O1	0.8863	Adder	1.04
939892	AE1-225 E O1	0.9806	Adder	1.15
940561	AE2-042 C O1	13.2940	50/50	13.2940
940562	AE2-042 E O1	6.5902	50/50	6.5902
940721	AE2-059 C	2.3861	50/50	2.3861
940722	AE2-059 E	3.2951	50/50	3.2951
940941	AE2-084 C	2.3861	50/50	2.3861
940942	AE2-084 E	3.2951	50/50	3.2951
941161	AE2-110 C	5.8707	50/50	5.8707
941162	AE2-110 E	8.1071	50/50	8.1071
941171	AE2-111 C	0.7623	Adder	0.9
941172	AE2-111 E	1.0527	Adder	1.24
942281	AE2-241 C	5.8707	50/50	5.8707
942282	AE2-241 E	8.1071	50/50	8.1071
942561	AE2-271 C O1	29.6185	50/50	29.6185
942562	AE2-271 E O1	19.7133	50/50	19.7133
943721	AF1-040 C	0.0943	Adder	0.11
943722	AF1-040 E	2.1077	50/50	2.1077
945511	AF1-216 C1O1	14.7636	50/50	14.7636
945512	AF1-216 E1O1	9.8310	50/50	9.8310
945521	AF1-216 C2	14.7628	50/50	14.7628
945522	AF1-216 E2	9.8304	50/50	9.8304
945611	AF1-226 C	10.2737	50/50	10.2737
945612	AF1-226 E	14.1875	50/50	14.1875
946471	AF1-311 C O1	27.6763	50/50	27.6763
946472	AF1-311 E O1	45.1561	50/50	45.1561
946691	AF1-333 C O1	2.2502	50/50	2.2502
946692	AF1-333 E O1	1.5002	50/50	1.5002
946731	AF1-337 C	2.2502	50/50	2.2502
946732	AF1-337 E	1.5002	50/50	1.5002
946741	AF1-338 C	2.2502	50/50	2.2502
946742	AF1-338 E	1.5002	50/50	1.5002

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
946751	AF1-339 C O1	2.2502	50/50	2.2502
946752	AF1-339 E O1	1.5002	50/50	1.5002
946761	AF1-271A C	0.9618	Adder	1.13
946762	AF1-271A E	0.6412	Adder	0.75
957881	AF2-082 C	3.6607	50/50	3.6607
957882	AF2-082 E	2.4405	50/50	2.4405
957921	AF2-086 C O1	8.3867	50/50	8.3867
957922	AF2-086 E O1	5.5911	50/50	5.5911
957991	AF2-093 C	0.5113	50/50	0.5113
957992	AF2-093 E	0.3409	50/50	0.3409
958461	AF2-140	12.6063	50/50	12.6063
958511	AF2-145 C1	5.2592	50/50	5.2592
958512	AF2-145 E1	3.5061	50/50	3.5061
958521	AF2-145 C2	5.2589	50/50	5.2589
958522	AF2-145 E2	3.5059	50/50	3.5059
959121	AF2-203 C	8.3867	50/50	8.3867
959122	AF2-203 E	5.5911	50/50	5.5911
959411	AF2-232 C	16.7734	50/50	16.7734
959412	AF2-232 E	11.1822	50/50	11.1822
959431	AF2-234 C O1	1.1579	Adder	2.57
959432	AF2-234 E O1	0.7719	Adder	1.71
959932	AF2-284 E	0.8169	50/50	0.8169
959982	AF2-289 E	1.2253	50/50	1.2253
959992	AF2-290 E	0.5681	50/50	0.5681
960401	AF2-331 C O1	14.5665	50/50	14.5665
960402	AF2-331 E O1	9.7110	50/50	9.7110
960411	AF2-332 C O1	14.5665	50/50	14.5665
960412	AF2-332 E O1	9.7110	50/50	9.7110
960421	AF2-333 C O1	5.8266	50/50	5.8266
960422	AF2-333 E O1	3.8844	50/50	3.8844
960431	AF2-334 C O1	5.8266	50/50	5.8266
960432	AF2-334 E O1	3.8844	50/50	3.8844
961271	AF2-418 C	8.3867	50/50	8.3867
961272	AF2-418 E	5.5911	50/50	5.5911
961362	AF2-427 E	1.2253	50/50	1.2253
961412	AF2-432 E	1.3978	50/50	1.3978
961421	AF2-433 C O1	8.3867	50/50	8.3867
961422	AF2-433 E O1	5.5911	50/50	5.5911
961431	AF2-434 C O1	8.3867	50/50	8.3867
961432	AF2-434 E O1	5.5911	50/50	5.5911
NEWTON	NEWTON	0.3460	Confirmed LTF	0.3460
FARMERCITY	FARMERCITY	0.0181	Confirmed LTF	0.0181
CALDERWOOD	CALDERWOOD	0.1650	Confirmed LTF	0.1650
NY	NY	0.7443	Confirmed LTF	0.7443
PRAIRIE	PRAIRIE	0.8343	Confirmed LTF	0.8343
O-066	O-066	9.8582	Confirmed LTF	9.8582
CHEOAH	CHEOAH	0.1667	Confirmed LTF	0.1667
EDWARDS	EDWARDS	0.1120	Confirmed LTF	0.1120
TILTON	TILTON	0.2016	Confirmed LTF	0.2016
G-007	G-007	1.3759	Confirmed LTF	1.3759
GIBSON	GIBSON	0.1753	Confirmed LTF	0.1753
BLUEG	BLUEG	0.5573	Confirmed LTF	0.5573

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
TRIMBLE	TRIMBLE	0.1786	Confirmed LTF	0.1786
CATAWBA	CATAWBA	0.1201	Confirmed LTF	0.1201

10.7 Queue Dependencies

The Queue Projects below are listed in one or more indices for the overloads identified in your report. These projects contribute to the loading of the overloaded facilities identified in your report. The percent overload of a facility and cost allocation you may have towards a particular reinforcement could vary depending on the action of these earlier projects. The status of each project at the time of the analysis is presented in the table. This list may change as earlier projects withdraw or modify their requests.

Queue Number	Project Name	Status
AA2-008	Saegers 230 kV	In Service
AE1-225	Columbia-Sunbury 69 kV	Active
AE2-042	Milton 69 kV	Active
AE2-059	Derry Tap-Derry Bus 69 kV	Active
AE2-084	Derry Tap-Derry Bus 69 kV	Active
AE2-110	Columbia-West Bloomsburg 69 kV	Active
AE2-111	Beavertown Tap-Beavertown Weaving Tap 69kV	Active
AE2-241	Bloomsburg-Columbia 69 kV	Active
AE2-271	Montour 230 kV	Active
AF1-040	Dauphin-Pine Grove 69 kV	Active
AF1-216	Lycoming-Lock Haven 69 kV	Active
AF1-226	Bowmans Mill-Scott 69 kV	Active
AF1-271A	Gratz 69 kV	Active
AF1-311	Montour 230 kV	Active
AF1-333	Laurelton-Mifflinburg 69 kV	Active
AF1-337	Laurelton-Mifflinburg 69 kV	Active
AF1-338	Laurelton-Mifflinburg 69 kV	Active
AF1-339	Laurelton-Mifflinburg 69 kV	Active
AF2-082	Dauphin PG Tie–Dauphin Juniata Tie 69 k	Active
AF2-086	Scott Tap-Bowmans Mill Tap 69 kV	Active
AF2-093	Derry 12.47 kV	Active
AF2-140	Saegers 230 kV	Active
AF2-145	Lycoming-Lock Haven 69 kV	Active
AF2-203	Rohrsburg 12.5 kV	Active
AF2-232	Bowmanns Mill Tap-Scott 69 kV	Active
AF2-234	Sunbury Yard #1-Richfield Tie #2 69 kV	Active
AF2-284	Watson 12.47 kV	Active
AF2-289	Watson 12.47 kV	Active
AF2-290	Derry 12.47 kV	Active
AF2-331	Montour 230 kV	Active
AF2-332	Montour 230 kV	Active
AF2-333	Montour 230 kV	Active
AF2-334	Montour 230 kV	Active

Queue Number	Project Name	Status
AF2-418	Millville Tap 69 kV	Active
AF2-427	Watson 12.47 kV	Active
AF2-432	University 12.47 kV	Active
AF2-433	Columbia-Geisinger Tap #1 69 kV	Active
AF2-434	Columbia-Geisinger Tap #1 69 kV	Active

10.8 Contingency Descriptions

Contingency Name	Contingency Definition
PL_P71_101751	CONTINGENCY 'PL_P71_101751' /* MONT-BETA 1 & 2 DISCONNECT BRANCH FROM BUS 207915 TO BUS 208040 CKT 1 /* MONT-BETA 1 DISCONNECT BRANCH FROM BUS 207915 TO BUS 208040 CKT 2 /* MONT-BETA 2 END
PL_P71_101752	CONTINGENCY 'PL_P71_101752' /* D/C BETA-SUSQ & BETA-SU10 230KV LINES DISCONNECT BRANCH FROM BUS 207915 TO BUS 208113 CKT 1 /* BETA-SUSQ 230KV LINE DISCONNECT BRANCH FROM BUS 207915 TO BUS 208120 CKT 1 /* BETA-SU10 230KV LINE END

11 Short Circuit Analysis

Short circuit analysis will be performed during the System Impact Study.

12 Affected Systems

12.1 NYISO

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