Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position Z2-101

Frackville-Fischbach 69kV

August 2014

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.

The conduct of light load analysis as required under the PJM planning process is not performed during the Generation Interconnection Feasibility Study phase of the PJM study process. Additional reinforcement requirements for this Interconnection Request may be defined during the conduct of the light load analysis which shall be performed following execution of the System Impact Study agreement.

General

The Interconnection Customer (IC), has proposed a wind generating facility located in Schuylkill County, Pennsylvania. The installed facilities will have a total capability of 67.5 MW with 8.78 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 2016. **This study does not imply a PPL Electric Utilities (PPL EU) commitment to this in-service date.**

Point of Interconnection

Z2-101 will interconnect with the PPL EU transmission system along the Frackville-Fishbach #3 69kV line between Frackville Substation and the High Ridge Tap. The Z2-101 69 kV Project is located approximately near the PPL EU High Ridge Tap, per the information provided by the Interconnection Customer..

Cost Summary

The Z2-101 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 2,950,000
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 150,000
Total Costs	**$ 3,100,000**

The 69 kV connection estimate is based on the assumptions stated in the following Transmission Attachment Facilities and Substation Non- Direct Connection Work sections. This estimate may vary depending upon the Queue Z2-101 substation location and orientation.

Note: Before the Impact Study stage, the exact location of the Interconnection Substation must be identified by the Z2-101 IC in order to refine the cost estimate.

In addition, the Z2-101 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 0
Previously Identified Upgrades	$ 113,000,000
Total Costs	**$ 113,000,000**

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

Attachment Facilities

69kV Transmission Tap Work

The transmission direct connection work includes tapping the Frackville-Fishbach #3 69 kV line in the vicinity of PPL EU High Ridge Tap and building approximately 600’ of 69 kV tap line using 556.5 Kcmil ACSR conductors with ½” EHS overhead ground wire (OHGW) to the dead end structure inside the customer’s substation (Point of Interconnection). The tap line will be a 69 kV steel pole design. At the tapping point, a mini yard with a motor-operated switch and a 69kV circuit breaker will be installed. A small control house will house the circuit breaker relays and communication devices.

The transmission network upgrade work includes installation of two MOLBAB (Motor Operated Load Break Air Break) switch on the PPL EU Frackville - Fishbach#3 69 kV line on either side

of the interconnection point for the isolation of Z2-101 tap. The switches would be installed on a custom designed steel pole with concrete foundations. See Figure 1 for the connection schematic.

It is assumed Z2-101 will provide a 100 ft. wide right-of-way for an approximate length of 600 feet from the PPL EU 69 kV line to IPP Z2-101 dead-end structure. The tap will be designed for and operated at 69 kV and therefore will not require PUC certification. PUC certification is required only on overhead transmission lines built for 100kV and above. The estimate does not include costs to mitigate extraordinary environmental situations.

Substation Work for Mini Yard

At the tapping point, a mini yard with a motor-operated switch and 69 kV breaker will be installed. A small control house will contain the circuit breaker relays and communication devices. Refer to Attachment 1 for clarity.

Cost

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
Transmission Tap	$ 2,200,000
Substation work	$ 750,000
Total Attachment Facility Costs	**$ 2,950,000**

Direct Connection Cost Estimate

There are no Direct Connection facilities required by PPL EU.

Non-Direct Connection Cost Estimate

To accommodate Z2-101, the following upgrades are required at PPL EU's Frackville 69 kV Substation.

- Install one telephone line based Direct Transfer Trip (DTT) Cabinet
- Install new telephone line protection equipment
- Modify the controls for the Fishbach #3 69 kV Circuit breaker for trip and close
- Modify SCADA for new alarms
- Modify AMS (Alarm Management system)
- Perform system checks and test equipment before placing in service

This work includes installation of phone line based DTT equipment and control design modifications for the Fishbach #3 69 kV circuit breaker at the PPL EU Frackville Substation. The scheme will provide a trip signal to Z2-101 Tap circuit breaker for any line fault, or any other condition that will cause the PPL EU Frackville circuit breakers to trip or open or any other condition that will result in the formation of an island. This trip signal to Z2-101 Tap will be

maintained for as long as the PPL EU breaker at Frackville substation remains open or the island condition exists.

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
Frackville work	$ 150,000
Total Non-Direct Connection Facility Costs	**$ 150,000**

Alternate Outlet

The IC has not requested an alternate outlet for their generation. When the Frackville-Fishbach #3 69 kV line needs to come off line for any line maintenance or repair activities, the generator will be asked come off line.

Preliminary Schedule

The estimated PPL EU elapsed time to complete the 69 kV attachment facility transmission tap and the non-direct connection substation upgrades is approximately 15 months after the receipt of a fully executed ISA/CSA.

The schedule for the 69 kV transmission and substation work to accommodate Z2-101 would depend on the project start date. The work to accommodate Z2-101 will require an outage of the Frackville-Fishbach #3 69 kV line. PPL EU's outage windows for construction are typically available in the spring and fall of the year. Missing an outage window could result in project delays.

The transmission and substation work can be completed concurrently. PPL EU will commence siting, engineering design, material purchase and construction of the facilities identified in this study after receiving written authorization by PJM to begin work. This time frame is contingent upon the acquisition of all rights of way in the stated time frame before the start of construction and detailed design.

Assumptions and Notes

- For the custom-designed steel transmission poles, the lead-time is approximately 32 to 42 weeks. It is estimated that custom designed steel poles will be needed for this project.
- During construction, if extreme weather conditions or other system safety concerns arise, field construction may need to be rescheduled, which could possibly delay the schedule.
- This magnitude estimate has been prepared without extensive research or field review.

- For the new 69 kV tap from Z2-101 to the Frackville-Fishbach #3 69 kV line, it is as assumed that a new ROW and siting study would be required and the tap would be owned by PPL EU.

- No environmental, real estate, or permitting issues were reviewed for the estimate of this project.

- Excepting any operational, governmental, and/or environmental regulatory delays, the use of additional resources, such as overtime, premiums for expedited material, and/or contractor labor, may enable PPL EU to decrease this construction period but no guarantees can be made. It is also assumed that all rights-of-way and easements are secured by the anticipated construction start dates.

- PPL EU recommends that an Interim ISA be completed during the Facilities Study stage to address critical path items, such as long lead-time purchases and any other compressed project schedule issues.

- The ISA/CSA or an Interim Interconnection Service Agreement (IISA) must be signed by the Z2-101 Interconnection Customer, PJM, and PPL EU before any PPL EU design and construction activities may commence.

Interconnection Customer Requirements

Queue Z2-101 Interconnection Customer will be responsible for the construction of all their generating station facilities on the Z2-101 side of the POI (Point of Interconnection).

Z2-101 Inverter and GSU modeling Data (incomplete, need more information)

Per the Z2-101 supplied data, the following was used in modeling of GSUs:

Intertie Transformers:

Intertie Step-up transformer: One 69/34.5 kV, 45/60/75 MVA
Impedance- 8% at 45 MVA base, X/R ratio = 32

The Z2-101 Interconnection Customer must provide PPL EU and PJM with the intertie transformer test reports once they are available in order to perform a more detailed short circuit analysis.

Telephone Circuit Requirements

PPL EU will require communication paths between the Z2-101 customer substation and PPL EU's Frackville Substation for DTT, Voice and SCADA.

For the telephone communication path, the Interconnection Customer will be responsible to procure the following to communicate with PPL EU Frackville substation:

1. A 4-wire dedicated FDDA-type phone line for SCADA.
2. A normal dialup telephone line for voice communication.

3. A protective relay-grade telephone circuit for the DTT communication requirements, type PRDA. This phone line needs to communicate between the Interconnection Customer's control house and PPL EU's Frackville Substation.

The SCADA phone line will go to one of our Service centers, to be determined during the Facility study. The Interconnection Customer should secure the necessary phone lines as soon as possible.

All installation, maintenance, and monthly lease or billing charges for communications facilities for SCADA, Voice, Metering, etc., are the responsibility of the Interconnection Customer.

Intertie and POC Protective Relaying Equipment

The Interconnection Customer will need to install suitable protection and control equipment at its facilities based on PPL EU parallel generation requirements. This includes both Intertie Protective Relaying (IPR) and Point of Contact (POC) relaying. Please refer to the PPL EU web site for the IPR and POC requirements. The website addresses are shown below:

IPR Requirements:

https://www.pplelectric.com/at-your-service/electric-rates-and-rules/customer-owned-generation.aspx

POC Requirements:

https://www.pplelectric.com/at-your-service/electric-rates-and-rules/point-of-contact-requirements-for-high-voltage-facilities.aspx

Isolation Breaker Requirement at the Interconnection Customer's Substation

It is assumed that the customer will provide a high side circuit breaker at 69 kV with a manually operated 69 kV disconnect switch on the PPL EU line side of this breaker. Unless otherwise indicated, it is assumed that this be will be the "Isolation Circuit Breaker" and will be operated by the IPR relay and the DTT signal. It is requested that the customer confirm this or provide alternate isolation breaker.

Z2-101 Generator Harmonic and Flicker Requirements

On the PPL EU 69 kV system, the total harmonic distortion to the fundamental voltage wave from a single customer is limited to 1.5% of nominal. In addition, no individual harmonic component can exceed 1.0% of the fundamental system voltage.

If PPL EU discovers that objectionable harmonics in excess of the stated limits are being injected into the system from Z2-101's equipment, the Queue Z2-101 Interconnection Customer will be responsible for taking corrective measures to mitigate harmonic currents.

Concerning voltage flicker, the Z2-101 Project must limit the severity of their voltage variation to within a level which will not cause objectionable flickers to other customers. A voltage drop greater than 5% at the point of interconnection is generally not acceptable. The frequency and severity of the voltage variation will be considered when determining whether a customer's equipment is violating PPL EU flicker guidelines. PPL EU uses the General Electric flicker-irritation curves as a guideline to determine if the system is operating within acceptable limits.

PPL EU will require corrective actions by the Z2-101 customer if their operation causes flickers that exceed PPL EU guidelines. One such correction could be the installation of static var compensators (SVC) to hold a constant voltage.

Z2-101 Inverter Regulation or Reactive Supply Requirements

As specified in Interconnection Service Agreement, Appendix 2, and Section 4.7.1.1 of the PJM OATT (Open Access Transmission Tariff), the Z2-101 Project shall design its Facility to meet the following power factor requirement:

"For all new wind-powered and other non-synchronous generation facilities, if determined in the system Feasibility study to be required for the safety or reliability of the Transmission System, the Generation Interconnection Customer shall design its Customer Facility with the ability to maintain a composite power delivery at continuous rated power output at a power factor of at least 0.95 leading to 0.95 lagging."

This indicates that the interconnection customer must maintain a composite power factor at the point of interconnection in between .95 leading (absorbing 22.2 MVARs) or .95 lagging (supplying 22.2 MVARs). If this capability cannot be met, the Z2-101 Project must provide a STATCOM or SVC device at its substation.

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.

PPL EU Requirements

SCADA Equipment Requirements

PPL EU will require installation of PPL EU approved SCADA equipment that will connect to its existing SCADA system to provide real time values of KW, KVAR, and kV metering data at the POC. SCADA equipment will also provide capability to trip and the status monitoring of the POC isolating circuit breaker. In addition to that, monitoring of other abnormal conditions at developer's plant will be provided where deemed necessary. This connection will be a 4-wire dedicated FDDA-type phone line. PPL EU will provide detailed specifications and design drawings for this equipment.

Revenue Metering Equipment Installation at the Point of Interconnection

Installation of revenue grade Bi-directional Metering Equipment will be required at the Queue Z2-101 Point of Interconnection (POI) to measure KWh and KVARh. PPL EU will design and supply the required metering equipment but all the installation cost would be borne by the developer including CT/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 bi-directional revenue metering (KWH and KVARH) and real-time data (KW, KVAR, circuit breaker status, and generator bus voltages) for the developer's generating resource. The equipment should be housed in a control cabinet or similar enclosure and must be accessible to PPL EU metering personnel.

Other Issues Impacting the Interconnection Customer

Alternate Outlet for Generation Operation during PPL EU Maintenance

No alternate outlet for the generation was requested by the Z2-101 developer. As such, Z2-101 will not be able to generate power during PPL EU line maintenance/outages.

Distribution Service Requirements

The Interconnection Customer must submit a request for electric service through PPL EU's Industrial and Commercial Services (ICS) group if the Z2-101 requires back-up electric service at a voltage less than 69 kV. The ICS Help Desk can be reached at 1-888-220-9991. Cost for distribution electric service is NOT included in the PPL scope of work transmission or substation estimates.

PPL EU phase rotation at 69 kV

PPL EU 69kV phase rotation in this region is CBA and will require connection of POC transformer high side bushings in a certain way. Please refer to the below mentioned POC document for phase rotation and transformer connection requirements.

POC Requirements:

https://www.pplelectric.com/at-your-service/electric-rates-and-rules/point-of-contact-requirements-for-high-voltage-facilities.aspx

Future Conversion of line to 138 kV from 69 kV

PPL EU presently has no plans to convert this line to 138 kV in the next 15-20 years. If the transmission system in this area is converted to 138 kV in the future, the Interconnection Customer would be responsible for conversion of its substation to 138kV at that time.

PA PUC Certification & Environmental Issues

All required land and right of way will be made available to PPL EU at no cost from the Interconnection Customer developer. It is assumed here that the transmission tap would be owned by PPL EU.

PA PUC certification will not be required because the tap will be designed for 69 kV.

Intertie 69-34.5 kV Transformer Turns Ratio

PPL EU typically procures the transformers with the following high side (69 kV) taps:

70.6 kV, 68.8 kV, 67.0 kV, 65.2 kV, 63.4 kV with nominal midpoint voltage is 67 kV, this provides a range of 5% above (in two 2.5% steps) and 5% below (in two 2.5% steps) to the midpoint range of 67 kV. The PPL 69 kV system is operated at around 67.9 kV at the PPL EU Frackville substation.

Network Impacts

The Queue Project Z2-101 was studied as a 67.5 MW (Capacity 8.8 MW) injection at the High Ridge 69 kV substation in the PPL area. Project Z2-101 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project Z2-101 was studied with a commercial probability of 53%. A Summer 2018 case was used for this analysis.

Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
PJM69	CONTINGENCY 'PJM69' DISCONNECT BRANCH FROM BUS 200021 TO BUS 200009 CKT 1 /* SUNBURY JUNIATA 500 500 DISCONNECT BRANCH FROM BUS 200021 TO BUS 200022 CKT 2 /* SUNBURY SUSQHANA 500 500 / CKT 1 -> 2 DISCONNECT BRANCH FROM BUS 200021 TO BUS 208109 CKT 24 /* SUNBURY SUNBURY 500 230 END
PL100028	CONTINGENCY 'PL100028' /* SIEGFRIED 230KV WEST CB TO FRACKVILLE DISCONNECT BRANCH FROM BUS 208075 TO BUS 211161 CKT 5 /* DISCONNECT BRANCH FROM BUS 208075 TO BUS 208076 CKT 1 /* MACR-SIEG #1 WEST CB DISCONNECT BRANCH FROM BUS 208072 TO BUS 207973 CKT 1 /* SIEG-FRAC 230KV.....CORRECTED BUS NUMBER END
PL100029	CONTINGENCY 'PL100029' /*SIEGFRIED 230KV EAST CB TO FRACKVILLE DISCONNECT BRANCH FROM BUS 208075 TO BUS 208076 CKT 1 /* DISCONNECT BRANCH FROM BUS 208072 TO BUS 207973 CKT 1 /* SIEG-FRAC 230KV.....CORRECTED BUS NUMBER DISCONNECT BRANCH FROM BUS 208074 TO BUS 207980 CKT 1 /* SIEG-HARW 230KV DISCONNECT BRANCH FROM BUS 208074 TO BUS 211161 CKT 4 /* SIEG T4 DISCONNECT BRANCH FROM BUS 208076 TO BUS 208074 CKT 1 /* MACR-SIEG #2 CB END
PL100484	CONTINGENCY 'PL100484' /* D/C MONTOUR-SUSQ 230KV & MONTOUR-SUSQ T10 230KV DISCONNECT BRANCH FROM BUS 208040 TO BUS 208113 CKT 1 /* MONT-SUSQ DISCONNECT BRANCH FROM BUS 208040 TO BUS 208120 CKT 1 /* MONT-SUSQ T10 END

Contingency Name	Description
PL100885	CONTINGENCY 'PL100885' /*FRAC 230KV CB TO SIEG & FRAC T1 DISCONNECT BUS 207973 END
PL100995	CONTINGENCY 'PL100995' /* SUNB 230 4N BF-ELDRED 230KV NORTH DISCONNECT BRANCH FROM BUS 208034 TO BUS 208109 CKT 1 /* SUNB 230 - MONT 230 DISCONNECT BUS 207964 /* SUNB-ELDR & ELDR T1 DISCONNECT BUS 208111 /* SUNB T23 230-69 KV END

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	Non	Non	PPL	W3-022 TAP-ELDR TR2 230kV line	903270	207965	1	DC	99.45	100.25	NR	341	2.73	1

Note: Please see Attachment 2 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 contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

None.

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)

#	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
2	LFFB	PL100995	PPL	FRAC TR3-FRAC 230 kV line	207975	207973	1	DC	100.62	101.85	ER	855	23.23	2
3	DCTL	PL100484	PPL	MILT-SUNB 230kV line	208034	208109	1	DC	101.48	102.15	ER	731	11.01	3
4	DCTL	PL100484	PPL	MONT-MILT 230 kV line	208040	208034	1	DC	106.93	107.55	ER	801	11.01	4
5	LFFB	PL100885	PPL	SUNBTR23-SUNB 230 kV line	208111	208109	1	DC	108.89	111.28	ER	641	33.99	5

#	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
6	LFFB	PL100028	PPL	ELDR TR1-SUNBTR23 230 kV line	207964	208111	1	DC	132.26	135.24	ER	457	30.24	6
7	LFFB	PL100029	PPL	ELDR TR1-SUNBTR23 230 kV line	207964	208111	1	DC	133.52	136.51	ER	457	30.31	7
8	LFFB	PL100028	PPL	ELDR TR2-ELDR TR1 230 kV line	207965	207964	1	DC	136.94	143.57	ER	455	30.19	8
9	LFFB	PL100029	PPL	ELDR TR2-ELDR TR1 230 kV line	207965	207964	1	DC	138.21	144.86	ER	455	30.25	9
10	LFFB	PL100028	PPL	W3-022 TAP-ELDR TR2 230 kV line	903270	207965	1	DC	138.42	145.05	ER	457	30.80	10
11	LFFB	PL100029	PPL	W3-022 TAP-ELDR TR2 230 kV line	903270	207965	1	DC	139.69	146.33	ER	457	30.34	11
12	LFFB	PL100885	PPL	ELDR TR1-SUNBTR23 230 kV line	207964	208111	1	DC	171.16	174.46	ER	457	33.37	12
13	LFFB	PL100885	PPL	ELDR TR2-ELDR TR1 230 kV line	207965	207964	1	DC	176.15	183.47	ER	455	33.31	13
14	LFFB	PL100885	PPL	W3-022 TAP-ELDR TR2 230 kV line	903270	207965	1	DC	177.45	184.77	ER	457	33.41	14

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

Short Circuit

(Summary of impacted circuit breakers)

None.

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.

	Contingency		Affected		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
15	N-1	PJM69	PPL	MONT-SUSQ 230kV line	208040	208113	1	DC	102.77	103.55	ER	753	13.06	N/A
16	Non	Non	PPL	ELDR TR1-SUNBTR23 230 kV line	207964	208111	1	DC	106.33	109.11	NR	341	20.98	N/A
17	N-1	PJM69	PPL	MONT-SU10 230 kV line	208040	208120	1	DC	109.25	110.07	ER	739	13.55	N/A
18	N-1	PJM69	PPL	SUNB-SUNBTR22 230 kV line	208109	208110	1	DC	111.58	112.32	ER	617	10.18	N/A
19	Non	Non	PPL	ELDR TR2-ELDR TR1 230 kV line	207965	207964	1	DC	108.24	114.24	NR	349	20.94	N/A
20	N-1	PJM69	PPL	SUSQHANA 500/230 kV transformer	208116	200022	21	DC	114.36	115.10	ER	1,165	19.06	N/A
21	Non	Non	PPL	W3-022 TAP-ELDR TR2 230 kV line	903270	207965	1	DC	113.30	119.46	NR	341	21.01	N/A
22	N-1	PJM69	PPL	FRAC-SIEG FRA 230 kV line	207973	208072	1	DC	116.87	120.27	ER	801	27.31	N/A

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)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
1, 10, 11, 14	W3-022 TAP-ELDR TR2 230kV line	PPL proposes to build a new Catawissa 500/230kV substation. Loop Catawissa-Frackville 230kV line through W3-022 substation. Estimated in service by 2019	Pending	**$ 113,000,000**
2	FRAC TR3-FRAC 230 kV line			
3	MILT-SUNB 230kV line			
4	MONT-MILT 230 kV line			
5	SUNBTR23-SUNB 230 kV line			
6, 7, 12	ELDR TR1-SUNBTR23 230 kV line			
8, 9, 13	ELDR TR2-ELDR TR1 230 kV line			
			Total New Network Upgrades	**$ 113,000,000**

Attachment 1. Single Line Diagram

Attachment 2. Flowgate Details

The following tables contain additional information about each flowgate presented in the body of the report. For each table, a description of the flowgate and its contingency was included for convenience. However, the intent of the table 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 tables are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Table 1

(PL - PL) The W3-022 TAP-ELDR TR2 230 kV line (from bus 903270 to bus 207965 ckt 1) loads from 99.45% to 100.25% (DC power flow) of its normal rating (341 MVA) for non-contingency condition. This project contributes approximately 2.73 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
208941	FISH CT	0.54
208982	GLBT IPP	1.58
212266	LOR1_N14_C	0.13
209020	LOR2_Q27 C	0.39
212386	R-043 C	0.08
209013	SCEN IPP	1.66
901931	W1-114 C	0.02

Bus Number	Bus Name	Full Contribution
901941	W1-115 C	0.02
903271	W3-022 C OP1	0.5
209022	WHFR IPP	0.83
914011	Y2-015 C	139.83
914031	Y2-037 C	0.02
914131	Y2-063 C	139.83
917601	Z2-101 C	2.73

Table 2

(PL - PL) The FRAC TR3-FRAC 230 kV line (from bus 207975 to bus 207973 ckt 1) loads from 100.62% to 101.85% (DC power flow) of its emergency rating (855 MVA) for the line fault with failed breaker contingency outage of 'PL100995'. This project contributes approximately 23.23 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
212099	BRMO IPP	0.43
208981	FOWH IPP	2.65
212174	INGE	0.49
212265	LOR1_N14_E	7.16
209027	LOR2_Q27_E	27.53
212388	R-043 E	5.51
901932	W1-114 E	0.64
901942	W1-115 E	0.64
903271	W3-022 C OP1	1.2
903272	W3-022 E OP1	8.04

Bus Number	Bus Name	Full Contribution
209021	WEST IPP	2.
914011	Y2-015 C	334.93
914012	Y2-015 E	6.96
914032	Y2-037 E	0.64
914131	Y2-063 C	334.93
914132	Y2-063 E	6.96
915121	Y3-034	0.11
917601	Z2-101 C	3.02
917602	Z2-101 E	20.2

Table 3

(PL - PL) The MILT-SUNB 230 kV line (from bus 208034 to bus 208109 ckt 1) loads from 101.48% to 102.15% (DC power flow) of its emergency rating (731 MVA) for the tower line

contingency outage of 'PL100484'. This project contributes approximately 11.01 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
209004	KOPP IPP	2.47
212265	LOR1_N14_E	3.39
209027	LOR2_Q27_E	13.04
208912	MONT G2	20.05
212388	R-043 E	2.61
901932	W1-114 E	0.3
901942	W1-115 E	0.3

Bus Number	Bus Name	Full Contribution
914011	Y2-015 C	43.32
914012	Y2-015 E	0.9
914032	Y2-037 E	0.3
914131	Y2-063 C	43.32
914132	Y2-063 E	0.9
917601	Z2-101 C	1.43
917602	Z2-101 E	9.57

Table 4

(PL - PL) The MONT-MILT 230 kV line (from bus 208040 to bus 208034 ckt 1) loads from 106.93% to 107.55% (DC power flow) of its emergency rating (801 MVA) for the tower line contingency outage of 'PL100484'. This project contributes approximately 11.01 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
209004	KOPP IPP	2.53
212265	LOR1_N14_E	3.39
209027	LOR2_Q27_E	13.05
208912	MONT G2	20.72
212388	R-043 E	2.61
901932	W1-114 E	0.3
901942	W1-115 E	0.3

Bus Number	Bus Name	Full Contribution
914011	Y2-015 C	43.39
914012	Y2-015 E	0.9
914032	Y2-037 E	0.3
914131	Y2-063 C	43.39
914132	Y2-063 E	0.9
917601	Z2-101 C	1.43
917602	Z2-101 E	9.58

Table 5

(PL - PL) The SUNBTR23-SUNB 230 kV line (from bus 208111 to bus 208109 ckt 1) loads from 108.89% to 111.28% (DC power flow) of its emergency rating (641 MVA) for the line fault with failed breaker contingency outage of 'PL100885'. This project contributes approximately 33.99 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
212099	BRMO IPP	0.37
208981	FOWH IPP	2.28
212174	INGE	0.42
212265	LOR1_N14_E	10.47
209027	LOR2_Q27_E	40.28
212388	R-043 E	8.06
901932	W1-114 E	0.94
901942	W1-115 E	0.94
903271	W3-022 C OP1	1.
903272	W3-022 E OP1	6.67

Bus Number	Bus Name	Full Contribution
209021	WEST IPP	1.72
914011	Y2-015 C	278.14
914012	Y2-015 E	5.78
914032	Y2-037 E	0.94
914131	Y2-063 C	278.14
914132	Y2-063 E	5.78
915121	Y3-034	0.1
917601	Z2-101 C	4.42
917602	Z2-101 E	29.57

Table 6

(PL - PL) The ELDR TR1-SUNBTR23 230 kV line (from bus 207964 to bus 208111 ckt 1) loads from 132.26% to 135.24% (DC power flow) of its emergency rating (457 MVA) for the

line fault with failed breaker contingency outage of 'PL100028'. This project contributes approximately 30.24 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
212099	BRMO IPP	0.27
208981	FOWH IPP	1.65
212174	INGE	0.31
212265	LOR1_N14_E	9.32
209027	LOR2_Q27_E	35.85
212388	R-043 E	7.17
901932	W1-114 E	0.83
901942	W1-115 E	0.83
903271	W3-022 C OP1	0.65
903272	W3-022 E OP1	4.33

Bus Number	Bus Name	Full Contribution
209021	WEST IPP	1.25
914011	Y2-015 C	180.27
914012	Y2-015 E	3.74
914032	Y2-037 E	0.83
914131	Y2-063 C	180.27
914132	Y2-063 E	3.74
915121	Y3-034	0.07
917601	Z2-101 C	3.93
917602	Z2-101 E	26.31

Table 7

(PL - PL) The ELDR TR1-SUNBTR23 230 kV line (from bus 207964 to bus 208111 ckt 1) loads from 133.52% to 136.51% (DC power flow) of its emergency rating (457 MVA) for the line fault with failed breaker contingency outage of 'PL100029'. This project contributes approximately 30.31 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
212099	BRMO IPP	0.27
208981	FOWH IPP	1.65
212174	INGE	0.31
212265	LOR1_N14_E	9.34
209027	LOR2_Q27_E	35.92
212388	R-043 E	7.18
901932	W1-114 E	0.84
901942	W1-115 E	0.84
903271	W3-022 C OP1	0.65
903272	W3-022 E OP1	4.33

Bus Number	Bus Name	Full Contribution
209021	WEST IPP	1.25
914011	Y2-015 C	180.58
914012	Y2-015 E	3.75
914032	Y2-037 E	0.84
914131	Y2-063 C	180.58
914132	Y2-063 E	3.75
915121	Y3-034	0.07
917601	Z2-101 C	3.94
917602	Z2-101 E	26.37

Table 8

(PL - PL) The ELDR TR2-ELDR TR1 230 kV line (from bus 207965 to bus 207964 ckt 1) loads from 136.94% to 143.57% (DC power flow) of its emergency rating (455 MVA) for the line fault with failed breaker contingency outage of 'PL100028'. This project contributes approximately 30.19 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
208941	FISH CT	0.78
208981	FOWH IPP	0.32
208982	GLBT IPP	2.27
212266	LOR1_N14_C	0.18
212265	LOR1_N14_E	9.3
209020	LOR2_Q27 C	0.55
209027	LOR2_Q27_E	35.78
212386	R-043 C	0.11
212388	R-043 E	7.16
209013	SCEN IPP	2.38
901931	W1-114 C	0.03
901932	W1-114 E	0.83
901941	W1-115 C	0.03

Bus Number	Bus Name	Full Contribution
901942	W1-115 E	0.83
903271	W3-022 C OP1	0.64
903272	W3-022 E OP1	4.32
209022	WHFR IPP	1.19
914011	Y2-015 C	179.91
914012	Y2-015 E	3.74
914031	Y2-037 C	0.03
914032	Y2-037 E	0.83
914131	Y2-063 C	179.91
914132	Y2-063 E	3.74
917601	Z2-101 C	3.93
917602	Z2-101 E	26.26

Table 9

(PL - PL) The ELDR TR2-ELDR TR1 230 kV line (from bus 207965 to bus 207964 ckt 1) loads from 138.21% to 144.86% (DC power flow) of its emergency rating (455 MVA) for the line fault with failed breaker contingency outage of 'PL100029'. This project contributes approximately 30.25 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
208941	FISH CT	0.78
208981	FOWH IPP	0.32
208982	GLBT IPP	2.28
212266	LOR1_N14_C	0.18
212265	LOR1_N14_E	9.32
209020	LOR2_Q27 C	0.56
209027	LOR2_Q27_E	35.86
212386	R-043 C	0.11
212388	R-043 E	7.17
209013	SCEN IPP	2.39
901931	W1-114 C	0.03
901932	W1-114 E	0.83
901941	W1-115 C	0.03

Bus Number	Bus Name	Full Contribution
901942	W1-115 E	0.83
903271	W3-022 C OP1	0.65
903272	W3-022 E OP1	4.32
209022	WHFR IPP	1.19
914011	Y2-015 C	180.23
914012	Y2-015 E	3.74
914031	Y2-037 C	0.03
914032	Y2-037 E	0.83
914131	Y2-063 C	180.23
914132	Y2-063 E	3.74
917601	Z2-101 C	3.94
917602	Z2-101 E	26.32

Table 10

(PL - PL) The W3-022 TAP-ELDR TR2 230 kV line (from bus 903270 to bus 207965 ckt 1) loads from 138.42% to 145.05% (DC power flow) of its emergency rating (457 MVA) for the line fault with failed breaker contingency outage of 'PL100028'. This project contributes approximately 30.28 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
208941	FISH CT	0.78
208982	GLBT IPP	2.28
212266	LOR1_N14_C	0.18
212265	LOR1_N14_E	9.33
209020	LOR2_Q27 C	0.56
209027	LOR2_Q27_E	35.89
212386	R-043 C	0.11
212388	R-043 E	7.18
209013	SCEN IPP	2.39
901931	W1-114 C	0.03
901932	W1-114 E	0.83
901941	W1-115 C	0.03

Bus Number	Bus Name	Full Contribution
901942	W1-115 E	0.83
903271	W3-022 C OP1	0.65
903272	W3-022 E OP1	4.33
209022	WHFR IPP	1.2
914011	Y2-015 C	180.44
914012	Y2-015 E	3.75
914031	Y2-037 C	0.03
914032	Y2-037 E	0.83
914131	Y2-063 C	180.44
914132	Y2-063 E	3.75
917601	Z2-101 C	3.94
917602	Z2-101 E	26.34

Table 11

(PL - PL) The W3-022 TAP-ELDR TR2 230 kV line (from bus 903270 to bus 207965 ckt 1) loads from 139.69% to 146.33% (DC power flow) of its emergency rating (457 MVA) for the line fault with failed breaker contingency outage of 'PL100029'. This project contributes approximately 30.34 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
208941	FISH CT	0.78
208982	GLBT IPP	2.28
212266	LOR1_N14_C	0.18
212265	LOR1_N14_E	9.35
209020	LOR2_Q27 C	0.56
209027	LOR2_Q27_E	35.96
212386	R-043 C	0.11
212388	R-043 E	7.19
209013	SCEN IPP	2.4
901931	W1-114 C	0.03
901932	W1-114 E	0.84
901941	W1-115 C	0.03

Bus Number	Bus Name	Full Contribution
901942	W1-115 E	0.84
903271	W3-022 C OP1	0.65
903272	W3-022 E OP1	4.34
209022	WHFR IPP	1.2
914011	Y2-015 C	180.75
914012	Y2-015 E	3.75
914031	Y2-037 C	0.03
914032	Y2-037 E	0.84
914131	Y2-063 C	180.75
914132	Y2-063 E	3.75
917601	Z2-101 C	3.95
917602	Z2-101 E	26.4

Table 12

(PL - PL) The ELDR TR1-SUNBTR23 230 kV line (from bus 207964 to bus 208111 ckt 1) loads from 171.16% to 174.46% (DC power flow) of its emergency rating (457 MVA) for the line fault with failed breaker contingency outage of 'PL100885'. This project contributes approximately 33.37 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
212099	BRMO IPP	0.37
208981	FOWH IPP	2.29
212174	INGE	0.43
212265	LOR1_N14_E	10.28
209027	LOR2_Q27_E	39.55
212388	R-043 E	7.91
901932	W1-114 E	0.92
901942	W1-115 E	0.92
903271	W3-022 C OP1	1.
903272	W3-022 E OP1	6.71

Bus Number	Bus Name	Full Contribution
209021	WEST IPP	1.73
914011	Y2-015 C	279.7
914012	Y2-015 E	5.81
914032	Y2-037 E	0.92
914131	Y2-063 C	279.7
914132	Y2-063 E	5.81
915121	Y3-034	0.1
917601	Z2-101 C	4.34
917602	Z2-101 E	29.03

Table 13

(PL - PL) The ELDR TR2-ELDR TR1 230 kV line (from bus 207965 to bus 207964 ckt 1) loads from 176.15% to 183.47% (DC power flow) of its emergency rating (455 MVA) for the line fault with failed breaker contingency outage of 'PL100885'. This project contributes approximately 33.31 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
208941	FISH CT	0.86
208981	FOWH IPP	0.96
208982	GLBT IPP	2.51
212266	LOR1_N14_C	0.2
212265	LOR1_N14_E	10.26
209020	LOR2_Q27 C	0.61
209027	LOR2_Q27_E	39.48
212386	R-043 C	0.12
212388	R-043 E	7.9
209013	SCEN IPP	2.63
901931	W1-114 C	0.04
901932	W1-114 E	0.92
901941	W1-115 C	0.04

Bus Number	Bus Name	Full Contribution
901942	W1-115 E	0.92
903271	W3-022 C OP1	1.
903272	W3-022 E OP1	6.7
209022	WHFR IPP	1.31
914011	Y2-015 C	279.1
914012	Y2-015 E	5.8
914031	Y2-037 C	0.04
914032	Y2-037 E	0.92
914131	Y2-063 C	279.1
914132	Y2-063 E	5.8
917601	Z2-101 C	4.33
917602	Z2-101 E	28.98

Table 14

(PL - PL) The W3-022 TAP-ELDR TR2 230 kV line (from bus 903270 to bus 207965 ckt 1) loads from 177.45% to 184.77% (DC power flow) of its emergency rating (457 MVA) for the line fault with failed breaker contingency outage of 'PL100885'. This project contributes approximately 33.41 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
208941	FISH CT	0.86
208982	GLBT IPP	2.51
212266	LOR1_N14_C	0.2
212265	LOR1_N14_E	10.29
209020	LOR2_Q27 C	0.61
209027	LOR2_Q27_E	39.59
212386	R-043 C	0.12
212388	R-043 E	7.92
209013	SCEN IPP	2.64
901931	W1-114 C	0.04
901932	W1-114 E	0.92
901941	W1-115 C	0.04

Bus Number	Bus Name	Full Contribution
901942	W1-115 E	0.92
903271	W3-022 C OP1	1.
903272	W3-022 E OP1	6.72
209022	WHFR IPP	1.32
914011	Y2-015 C	279.87
914012	Y2-015 E	5.81
914031	Y2-037 C	0.04
914032	Y2-037 E	0.92
914131	Y2-063 C	279.87
914132	Y2-063 E	5.81
917601	Z2-101 C	4.35
917602	Z2-101 E	29.06