Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD1-143

Hauto-Siegfried 69kV 11.84 MW Capacity / 90 MW Energy

February 2018

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), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is PPL Electric utilities (PPL EU).

Preface

The intent of the Feasibility Study is to determine a plan, with high level estimated cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the IC. The IC may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the IC 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 IC is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by ITO, the costs may be included in the study.

General

The IC has proposed a Wind-Battery hybrid generating facility located in the Carbon County of Pennsylvania, which is part of the PPL Electric Utilities (PPL EU) Central Region. The generating facility consists of 80 MWE (11.44 MWC) of wind generation and 10 MWE (0.4 MW) of battery storage. The installed facilities will have a total capability of 90 MW with 11.84 MW of this output being recognized by PJM as Capacity. The planned in service date is December 31, 2019. **This study does not imply a PPL EU commitment to this in service date.**

In order to eliminate the PPL identified thermal overloads created by AD1-143, supplemental projects s0524, s0525 and s0526 will be necessary for the acceptable interconnection of AD1 143. These supplemental projects are currently scheduled to be in service by December 2020. However, the in-service date is subject to change with PPL EU's annual review of the system. **Since these supplemental projects cannot be accelerated, AD1-143 cannot interconnect with the PPL EU system prior to December 2020.**

Point of Interconnection

The IC requested a transmission level interconnection. As a result, AD1-143 will interconnect with the PPL EU transmission network via the Hauto-Siegfried #1 and Hauto-Siegfried #4 69kV lines.

A total capability of 90 MWE will be across both Hauto-Siegfried #1 and Hauto-Siegfried #4 69kV lines. The IC generation on the Hauto-Siegfried #1 69kV line shall not exceed 45 MWE. The IC generation on the Hauto-Siegfried #4 69kV line shall not exceed 45 MWE.

Any imbalance of IC generation across both lines may result in thermal and voltage violations at PPL EU substations in the vicinity that are normally tapped to both Hauto-Siegfried #1 and Hauto-Siegfried #4 69kV lines. Therefore, PPL EU at times may require the IC to provide a prescribed amount of generation across both lines. Maintaining a proper balance of IC generation across both lines will prevent such violations from occurring at these PPL EU substations.

Cost Summary

The AD1-143 project will be responsible for the following costs:

Description	Total Estimated Costs
Attachment Facilities	$ 4,198,000
Direct Connection Network Upgrades	$ 0
Non-Direct Connection Network Upgrades	$ 179,400
TOTAL ESTIMATED COSTS	**$ 4,377,400**

In addition, the AD1-143 project may be responsible for a contribution to the following costs:

Description	Total Estimate Cost
New System Upgrades	$ 0
Previously Identified Upgrades	$ 15,824,700
Total Costs	**$ 15,824,700**

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

System Reinforcement

Violation #	Upgrade Description	Upgrade Cost
	CONTRIBUTIONS TO PREVIOUSLY IDENTIFIED UPGRADES	
5-8	PPL Scope: Existing Upgrade n5166: Re-conductor approximately 1700 feet of transmission three-phase (5100 feet of single-phase) 1590 ACSR with 1590 ACSS between the Springfield substation deadend structure and pole 66848S43231. Re-conductor approximately 50 feet of Springfield substation deadend structure downcomer three-phase (150 feet of single-phase) 1590 ACSR with 1590 ACSS. Estimated Cost: $500,000. Estimated ISD: 06/01/2020.	$ 500,000
5-8	JCPL Scope: Existing Upgrade n5165: On the Gilbert to Springfield 230 kV tie-line re-conductor 11 miles of 1590 ACSR with 1590 ACSS. Replace 2000 A line end wave trap with a 4000 A trap and upgrade all limiting components at Gilbert substation including the relay thermal limitations. New FE ratings for Gilbert to Springfield 230 kV tie-line = 913/ 1147 MVA (SN / SE). Estimated Cost: $15,324,700. Estimated ISD: 06/01/2020.	$ 15,324,700
	Total Network Upgrades	**$ 15,824,700**

Transmission Owner Scope of Work

Attachment Facilities

69kV Attachment Line ($4,080,000)

- Install approximately two miles of new 69kV double circuit transmission line, tapping the existing Hauto-Siegfried #1 and Hauto-Siegfried #4 69kV lines and terminating at the IC substation deadend structure(s).

- Install two (2) customer isolation device Motor Operated Load Break Air Break (MOLBAB) switch structure assemblies with fault indicators; one near each of the Hauto-Siegfried #1 and Hauto-Siegfried #4 69kV lines.

- To ensure that the accumulation of line charging currents are kept within acceptable limits, install four (4) sectionalizing MOLBAB switch structure assemblies with fault indicators at the following locations and within two miles of each line tap:

    - One (1) on the existing Hauto-Siegfried #1 69kV line on the Siegfried substation side of the new Hauto-Siegfried #1 69kV line tap.

    - One (1) on the existing Hauto-Siegfried #1 69kV line on the Hauto substation side of the new Hauto-Siegfried #1 69kV line tap.

    - One (1) on the existing Hauto-Siegfried #4 69kV line on the Siegfried substation side of the new Hauto-Siegfried #4 69kV line tap.

    - One (1) on the existing Hauto-Siegfried #4 69kV line on the Hauto substation side of the new Hauto-Siegfried #4 69kV line tap.

Metering ($118,000)

- Provide metering current transformers (CTs), potential transformers (PTs) and metering cabinet for IC to install in the IC substation.

- Provide testing, commissioning and start-up support of the metering equipment in the IC substation.

Direct Connection Cost Estimate

None.

Non-Direct Connection Cost Estimate

System Protection ($179,400)

- 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).

- The following upgrades are required at the Siegfried substation:

  - Install new telephone-based DTT equipment.

  - Modify the existing Hauto 69kV #1 circuit breaker (HAUTO 1 EAST CB) protection and control scheme.

  - Modify the existing Hauto 69kV #4 circuit breaker (HAUTO 4 EAST CB) protection and control scheme.

  - Modify the existing SCADA for new alarms.

  - Modify the existing Alarm Management System (AMS).

  - Install new cables and modify control wiring for the above.

  - Perform system checks and test equipment before placing in service.

Estimated Schedule

The estimated time is 24 months from engineering start to construction finish, after the PJM three-party Interconnection Service Agreement (ISA) and Construction Service Agreement (CSA) are signed.

Assumptions

- Estimates may vary depending upon IC substation location and orientation.
- No major environmental, real estate, or permitting issues are anticipated.
- The IC shall purchase the property rights needed for PPL EU facilities and transfer the rights to PPL EU. All rights shall meet PPL EU standards.
- PA PUC approval and property rights are obtained within 15 months and no litigation or condemnation is required.
- Lead-time to obtain custom-designed steel transmission poles is 32 to 42 weeks.
- Suitable line/equipment outages can be scheduled as required. Failure to meet a scheduled facility outage may result in project delays.
- 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.

- For 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.

Interconnection Customer Requirements

IC RTU/SCADA and Voice Communication Circuit Requirements

PPL EU will require independent communication paths for RTU/SCADA and voice circuits. In this case, PPL EU anticipates that either telephone circuits or an IP interface will be required to establish these paths. The IC will be responsible to procure the following:

- One (1) 4-wire dedicated phone line or DNP over IP (DNP/IP) for SCADA. It is at PPL EU's discretion as to which SCADA (4-wire or DNP/IP) is required to be provided.
- One (1) normal dialup telephone line for voice communication.

Phone lines tend to be long lead-time items and must be in place and operational for equipment testing. The IC should investigate with the local phone company the possibility of obtaining this type of service at their facility.

All installation, maintenance, and monthly lease or billing charges for communications facilities are the responsibility of the IC.

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 telephone circuit with the Siegfried substation.

To ensure reliable communication, the IC shall also provide DTT relaying equipment identical to the PPL EU DTT relaying equipment. All DTT relaying equipment shall connect to the respective telephone communication path. The IC would be responsible for all installation, maintenance, and monthly lease or billing charges for the telephone communications facilities. All DTT relaying equipment should reside within the same location as the IPR and Point of Contact (POC) relaying equipment.

IC Protective Relaying Requirements

The IC will need to install suitable protection and control equipment at its facilities based on PPL EU parallel generation requirements. This includes DTT, IPR and POC relaying equipment. Refer to the website addresses shown below for the IPR and POC requirements:

IPR Requirements
http://www.pjm.com/-/media/planning/plan-standards/private-ppl/parallel-generation-requirements.ashx?la=en

POC Requirements
http://www.pjm.com/-/media/planning/plan-standards/private-ppl/point-of-contact-requirements.ashx?la=en

IC Substation IPR and POC FID Requirements

The IC provided IPR FIDs, two (2) 69kV rated circuit breakers in this case, shall be equipped with dual trip coils and capable of interrupting worst-case scenario fault currents with a rated speed of three (3) cycles or less. The IPR FID circuit breakers shall be operated by their respective DTT and IPR relaying equipment. The IC provided POC FIDs, two (2) 69kV rated circuit breakers in this case, are identical to the IPR FIDs and shall also be operated by their respective POC relaying equipment.

IC Generator Harmonic and Flicker Requirements

On the PPL EU 69kV 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 the IC equipment, then the IC will be responsible for taking corrective measures to mitigate harmonic currents.

Concerning voltage flicker, the IC 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 POI is generally not acceptable. The frequency and severity of the voltage variation will be considered when determining whether the IC 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 IC 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.

IC Generator Voltage Schedule Requirements

The IC shall not alter the voltage along the Hauto-Siegfried #1 and Hauto-Siegfried #4 69kV lines. The 69kV network voltage is regulated by the PPL EU Transmission Control Center (TCC), via Bulk Electric System power transformer load tap changer adjustments, to ensure that the distribution voltages delivered to PPL EU customers remain within the prescribed secondary bandwidth as mandated by the Pennsylvania Public Utilities Commission (PA PUC). The PPL EU distribution area supply substations, tapped to the 69kV network, have power transformers that are fixed on particular taps to achieve acceptable voltage ranges on their low sides. Therefore, IC generation that alters the 69kV voltage on the high side of the distribution area supply substation power transformers will result in voltages on their low sides that may not remain within mandated PA PUC limits.

In lieu of voltage schedules, power factor schedules ensure that PPL EU can maintain acceptable voltage ranges along the impacted 69kV transmission lines. The expectation is that the 69kV line voltage will not be altered by the injection of IC generation. Therefore, PPL EU may request an exemption from providing voltage schedules, in accordance with PJM Manual 3 section 3.3, to providing power factor schedules (i.e., MW/MVAR schedules) as an alternative to achieve the desired results on the PPL EU network.

PPL EU requires that the IC has a power factor delivery at continuous rated power output, at the generator terminals, of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs). A power factor (MW/MVAR) schedule will be developed around the time of the Facilities Study, based on the latest IC machine and step-up transformer data received to date.

IC Distribution Service Requirements

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

IC PA PUC Certification & Environmental Issues

All required land and right-of-way (ROW) will be made available to PPL EU at no cost from the IC. To avoid overlap of permitting boundaries and duplication of permitting efforts and costs, PPL EU recommends that the IC share pertinent detail with PPL EU during the permitting process. If the IC chooses to self-perform the ROW acquisition, then the IC shall purchase the PPL EU standard bundle of rights.

IC SCADA Equipment Requirements

PPL EU will require the 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 IC substation. SCADA equipment will also provide capability to trip and monitor the associated IC FID(s). PPL EU will provide detailed specifications and design drawings for this equipment should the IC proceed to an ISA/CSA.

Revenue Metering and SCADA Requirements

PJM Requirements

The IC 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.

Meteorological Data Reporting Requirement

The wind generation facility shall, at a minimum, be required to provide the Transmission Provider with site-specific meteorological data including:

- Temperature (degrees Fahrenheit)
- Wind speed (meters/second)
- Wind direction (degrees from True North)
- Atmosphere pressure (hectopascals)
- Forced outage data (wind turbine and MW unavailability)

PPL Requirements

IC Revenue Metering Equipment Installation at the IC Substation

Installation of revenue grade Bi-directional Metering Equipment will be required in the vicinity of the IC 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 bi-directional 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.

Network Impacts

The Queue Project AD1-143 was evaluated as a 90.0 MW (Capacity 11.8 MW) injection tapping both the Hauto to Siegfried ckt 1 and Hauto to Siegfried ckt 4 in the PPL area. Project AD1-143 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-143 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
JC-P2-3-JCN-230-4	CONTINGENCY 'JC-P2-3-JCN-230-4' /* GILBERT-GLEN GARDNER & GILBERT-TEWKSBERRY-MORRISTOWN DISCONNECT BRANCH FROM BUS 206236 TO BUS 206233 CKT 1 /* 28GILBERT 230 28G GARDNR 230 DISCONNECT BRANCH FROM BUS 206236 TO BUS 206375 CKT 1 /* 28GILBERT 230 28TEWKSBRY 230 DISCONNECT BRANCH FROM BUS 206375 TO BUS 206243 CKT 1 /* 28TEWKSBRY 230 28MO-TOWN 230 DISCONNECT BRANCH FROM BUS 206243 TO BUS 206204 CKT 5 /* 28MO-TOWN 230 28MORRISTO 35 SET BUS 206204 SHUNT TO 11 MVAR /* 28MORRISTO 35 REMOVE LOAD 1 FROM BUS 206204 /* 28MORRISTO 35 END
JC-P2-3-JCN-230-4LT	CONTINGENCY 'JC-P2-3-JCN-230-4LT' /* GILBERT-GLEN GARDNER & GILBERT-TEWKSBERRY-MORRISTOWN DISCONNECT BRANCH FROM BUS 206236 TO BUS 206233 CKT 1 /* 28GILBERT 230 28G GARDNR 230 DISCONNECT BRANCH FROM BUS 206236 TO BUS 206375 CKT 1 /* 28GILBERT 230 28TEWKSBRY 230 DISCONNECT BRANCH FROM BUS 206375 TO BUS 206243 CKT 1 /* 28TEWKSBRY 230 28MO-TOWN 230 DISCONNECT BRANCH FROM BUS 206243 TO BUS 206204 CKT 5 /* 28MO-TOWN 230 28MORRISTO 35 SET BUS 206204 SHUNT TO 11 MVAR /* 28MORRISTO 35 END

Contingency Name	Description
JC-P7-1-JCN-230-2	CONTINGENCY 'JC-P7-1-JCN-230-2' /* GILBERT-GLEN GARDNER & GILBERT-MORRISTOWN 230 KV DISCONNECT BRANCH FROM BUS 206236 TO BUS 206233 CKT 1 /* 28GILBERT 230 28G GARDNR 230 DISCONNECT BRANCH FROM BUS 206236 TO BUS 206375 CKT 1 /* 28GILBERT 230 28TEWKSBRY 230 DISCONNECT BRANCH FROM BUS 206375 TO BUS 206243 CKT 1 /* 28TEWKSBRY 230 28MO-TOWN 230 DISCONNECT BRANCH FROM BUS 206243 TO BUS 206204 CKT 5 /* 28MO-TOWN 230 28MORRISTO 35 SET BUS 206204 SHUNT TO 11 MVAR /* 28MORRISTO 35 REMOVE LOAD 1 FROM BUS 206204 /* 28MORRISTO 35 END
JC-P7-1-JCN-230-2LT	CONTINGENCY 'JC-P7-1-JCN-230-2LT' /* GILBERT-GLEN GARDNER & GILBERT-MORRISTOWN 230 KV DISCONNECT BRANCH FROM BUS 206236 TO BUS 206233 CKT 1 /* 28GILBERT 230 28G GARDNR 230 DISCONNECT BRANCH FROM BUS 206236 TO BUS 206375 CKT 1 /* 28GILBERT 230 28TEWKSBRY 230 DISCONNECT BRANCH FROM BUS 206375 TO BUS 206243 CKT 1 /* 28TEWKSBRY 230 28MO-TOWN 230 DISCONNECT BRANCH FROM BUS 206243 TO BUS 206204 CKT 5 /* 28MO-TOWN 230 28MORRISTO 35 SET BUS 206204 SHUNT TO 11 MVAR /* 28MORRISTO 35 END

Contingency Name	Description
PL:60:P42:101831	PL:60:P42:101831 = **107.07 % Loading**: 210405 ASHF CC4 69.0 211160 SIEG 69.0 4 (HAUT-SIEG 4) CONTINGENCY PL:60:P42:101831 /* STUCK BREAKER SIEG-HAUT 1 69 CONNECTED TO SIEG T1 DISCONNECT BUS 211268 /* TREI TP1 69 DISCONNECT BUS 211273 /* TREI DC 69 DISCONNECT BUS 211270 /* TREI 69 DISCONNECT BUS 211190 /* SSLA 1 69 DISCONNECT BUS 210404 /* ASHF CC1 69 DISCONNECT BUS 211365 /* ASHF TP1 69 DISCONNECT BUS 211698 /* LNFD 69 DISCONNECT BUS 211061 /* PSPA TP1 69 DISCONNECT BUS 211063 /* PSPA DC 69 DISCONNECT BUS 211064 /* PSPA 69 DISCONNECT BUS 211596 /* HAUT 1 69 DISCONNECT BUS 211269 /* TREI TP DISCONNECT BRANCH FROM BUS 208072 TO BUS 211160 CKT 1 /* SIEG T1

Contingency Name	Description
PL:60:P42:101832	PL:60:P42:101832 = **108.79 % Loading**: 210404 ASHF CC1 69.0 211269 TREI TP 69.0 1 (HAUT-SIEG 1) CONTINGENCY PL:60:P42:101832 /* STUCK BREAKER SIEG-HAUT 2 69 CONNECTED TO SIEG T1 DISCONNECT BUS 211272 /* TREI TP2 69 DISCONNECT BUS 211193 /* SSLA 2 69SSLA 2 69 DISCONNECT BUS 210405 /* ASHF CC4 69 DISCONNECT BUS 211366 /* ASHF TP2 69 DISCONNECT BUS 211062 /* PSPA TP2 69 DISCONNECT BUS 211597 /* HAUT 2 69 DISCONNECT BRANCH FROM BUS 208072 TO BUS 211160 CKT 1 /* SIEG T1
PL:60:P42:101844	PL:60:P42:101844 = 108.92 % Loading: 210404 ASHF CC1 69.0 211269 TREI TP 69.0 1 (HAUT-SIEG 1) CONTINGENCY PL:60:P42:101844 /* STUCK BREAKER SIEG-HAUT 2 69 CONNECTED TO SIEG-KECE 2 DISCONNECT BUS 211272 /* TREI TP2 69 DISCONNECT BUS 211193 /* SSLA 2 69SSLA 2 69 DISCONNECT BUS 210405 /* ASHF CC4 69 DISCONNECT BUS 211366 /* ASHF TP2 69 DISCONNECT BUS 211062 /* PSPA TP2 69 DISCONNECT BUS 211597 /* HAUT 2 69 DISCONNECT BUS 210756 /* KECE1TP2 69 DISCONNECT BUS 210758 /* KECE2TP2 69 DISCONNECT BUS 210762 /* KECE 1-2 69

Contingency Name	Description
PL:60:P42:101845	PL:60:P42:101845 = **108.12 % Loading**: 210405 ASHF CC4 69.0 211160 SIEG 69.0 4 (HAUT-SIEG 4) CONTINGENCY PL:60:P42:101845 /* STUCK BREAKER SIEG-HAUT 1 69 CONNECTED TO SIEG-KECE 1 DISCONNECT BUS 211268 /* TREI TP1 69 DISCONNECT BUS 211273 /* TREI DC 69 DISCONNECT BUS 211270 /* TREI 69 DISCONNECT BUS 211190 /* SSLA 1 69 DISCONNECT BUS 210404 /* ASHF CC1 69 DISCONNECT BUS 211365 /* ASHF TP1 69 DISCONNECT BUS 211698 /* LNFD 69 DISCONNECT BUS 211061 /* PSPA TP1 69 DISCONNECT BUS 211063 /* PSPA DC 69 DISCONNECT BUS 211064 /* PSPA 69 DISCONNECT BUS 211596 /* HAUT 1 69 DISCONNECT BUS 211269 /* TREI TP DISCONNECT BUS 210756 /* KECE1TP2 69 DISCONNECT BUS 210758 /* KECE2TP2 69 DISCONNECT BUS 210762 /* KECE 1-2 69

Summer Peak Analysis – 2021

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)

PPL EU identified thermal violations when modeling a 45 MWE split between circuits during a multiple facility contingency. The overloads listed below only pertain to the 45 MWE split between circuits.

	Contingency		Affected		Bus			Power	Rating	
#	Type	Name	Area	Facility Description	From	To	Cir.	Flow	Final	Type
1	LFFB	PL:60:P42:1 01844	PL - PL	ASHF – TREI TP 69kV	210404	211269	1	DC	108.92	ER
2	LFFB	PL:60:P42:1 01832	PL - PL	ASHF – TREI TP 69kV	210404	211269	1	DC	108.79	ER
3	LFFB	PL:60:P42:1 01845	PL - PL	ASHF – SIEG 69kV	210405	211160	4	DC	108.12	ER
4	LFFB	PL:60:P42:1 01831	PL - PL	ASHF – SIEG 69kV	210405	211160	4	DC	107.07	ER

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Contributions to previously identified circuit breakers found to be over-duty:

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		Affected	Facility Description	Bus		Cir.	Power	Loading %		Rating		MW	Ref
	Type	Name	Area		From	To		Flow	Initial	Final	Type	MVA	Contribution	
5	LFFB	JC-P2-3-JCN-230-4	JCPL - PL	28GILBERT-SFLD 230 kV line	206236	208091	1	DC	112.15	112.63	ER	783	8.28	1
6	DCTL	JC-P7-1-JCN-230-2	JCPL - PL	28GILBERT-SFLD 230 kV line	206236	208091	1	DC	112.15	112.63	ER	783	8.28	
7	LFFB	JC-P2-3-JCN-230-4LT	JCPL - PL	28GILBERT-SFLD 230 kV line	206236	208091	1	DC	111.99	112.47	ER	783	8.28	
8	DCTL	JC-P7-1-JCN-230-2LT	JCPL - PL	28GILBERT-SFLD 230 kV line	206236	208091	1	DC	111.99	112.47	ER	783	8.28	

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

To be determined during Impact Study

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined during Impact Study

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
1-4	ASHF – TREI TP 69kV; ASHF – SIEG 69kV	In order to eliminate the thermal overloads created by AD1-143, supplemental projects s0524, s0525 and s0526 will be necessary for the acceptable interconnection of AD1-143. Since these supplemental projects cannot be accelerated, the earliest scheduled date that AD1-143 can interconnect with the PPL EU system is December 2020. The estimated cost to eliminate the thermal overloads created by AD1-143 is $47,200,000. Note: These costs are not included in the New System Upgrades identified at the beginning of the report, since it is assumed that AD1-143 will interconnect after the completion of the supplemental projects identified.	S0524, S0525, S0526	$ 47,200,000
			Total New Network Upgrades	**$ 47, 200,000**

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)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
5-8	28GILBERT-SFLD 230 kV line	PPL: Existing Upgrade n5166: Re-conductor approximately 1700 feet of transmission three-phase (5100 feet of single-phase) 1590 ACSR with 1590 ACSS between the Springfield substation deadend structure and pole 66848S43231. Re-conductor approximately 50 feet of Springfield substation deadend structure downcomer three-phase (150 feet of single-phase) 1590 ACSR with 1590 ACSS. Estimated Cost: $500,000. Estimated ISD: 06/01/2020.	n5166	$ 500,000
5-8	28GILBERT-SFLD 230 kV line	JCPL: Existing Upgrade n5165: On the Gilbert to Springfield 230 kV tie-line re-conductor 11 miles of 1590 ACSR with 1590 ACSS. Replace 2000 A line end wave trap with a 4000 A trap and upgrade all limiting components at Gilbert substation including the relay thermal limitations. New FE ratings for Gilbert to Springfield 230 kV tie-line = 913/ 1147 MVA (SN / SE). Estimated Cost: $15,324,700. Estimated ISD: 06/01/2020.	n5165	$ 15,324,700
			Total New Network Upgrades	**$ 15,824,700**

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 IC 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.

Light Load Analysis

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

Affected System Analysis & Mitigation

NYISO Impacts:

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

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

(JCPL - PL) The 28GILBERT-SFLD 230 kV line (from bus 206236 to bus 208091 ckt 1) loads from 112.15% to 112.63% (**DC power flow**) of its emergency rating (783 MVA) for the line fault with failed breaker contingency outage of 'JC-P2-3-JCN-230-4'. This project contributes approximately 8.28 MW to the thermal violation.

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CONTINGENCY 'JC-P2-3-JCN-230-4'                    /* GILBERT-GLEN GARDNER & GILBERT-TEWKSBERRY-MORRISTOWN
  DISCONNECT BRANCH FROM BUS 206236 TO BUS 206233 CKT 1          /* 28GILBERT 230 28G GARDNR 230
  DISCONNECT BRANCH FROM BUS 206236 TO BUS 206375 CKT 1          /* 28GILBERT 230 28TEWKSBRY 230
  DISCONNECT BRANCH FROM BUS 206375 TO BUS 206243 CKT 1          /* 28TEWKSBRY 230 28MO-TOWN 230
  DISCONNECT BRANCH FROM BUS 206243 TO BUS 206204 CKT 5          /* 28MO-TOWN 230 28MORRISTO 35
  SET BUS 206204 SHUNT TO 11 MVAR                    /* 28MORRISTO 35
  REMOVE LOAD 1 FROM BUS 206204                      /* 28MORRISTO 35
  END
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Bus Number	*Bus Name*	*Full Contribution*
206747	*28DSM_X3-029*	*1.39*
206342	*28GIL 6&7*	*7.83*
206330	*28GILCT9*	*11.9*
206679	*28M&M S721*	*0.89*
206346	*28MILF GEN*	*1.23*
206345	*28N27_Y2-018*	*0.26*
206740	*28WCRR*	*1.24*
933231	*AC2-134 C*	*0.13*
933232	*AC2-134 E*	*0.54*
933322	*AC2-144 E*	*0.02*
933582	*AC2-175 E*	*0.11*
934091	*AD1-037*	*17.98*
935071	*AD1-143 C1*	*0.53*
935081	*AD1-143 C2*	*0.02*

935091	*AD1-143 C3*	*0.53*
935101	*AD1-143 C4*	*0.02*
935072	*AD1-143 E1*	*3.15*
935082	*AD1-143 E2*	*0.44*
935092	*AD1-143 E3*	*3.15*
935102	*AD1-143 E4*	*0.44*
211064	*PSPA*	*0.92*
205900	*Q73E R57E*	*-0.34*
290131	*U2-059E*	*0.27*
904512	*V4-052 E*	*-0.27*
901612	*W1-082E*	*2.94*
902062	*W1-127E*	*0.43*
902292	*W2-016E*	*1.37*
903042	*W2-091E*	*1.7*
903631	*W3-044C OP1*	*0.86*
903632	*W3-044E OP1*	*1.4*
903961	*W3-077C*	*0.97*
903962	*W3-077E*	*1.58*
903672	*W3-106 E*	*0.81*
903682	*W3-110 E*	*0.36*
904582	*W3-139 E*	*1.7*
905442	*W4-046 E*	*0.72*
905542	*W4-064 E*	*0.16*
905602	*W4-073 E*	*2.4*
905762	*W4-097 E*	*0.47*
907012	*X1-012 E*	*0.48*
914044	*Y2-018 E*	*0.15*
919531	*AA2-017 C1*	*1.07*

919541	*AA2-017 C2*	*1.07*
919532	*AA2-017 E1*	*3.06*
919542	*AA2-017 E2*	*3.06*
919742	*AA2-060 E*	*0.47*
919752	*AA2-061 E*	*0.63*
919982	*AA2-082 E*	*4.71*
931051	*AB1-154 C*	*410.19*
931052	*AB1-154 E*	*25.62*
923781	*AB2-012*	*1.54*
924142	*AB2-058 E*	*0.99*
925461	*AC1-018 C*	*0.11*
925462	*AC1-018 E*	*0.2*
926081	*AC1-087 C*	*0.35*
926082	*AC1-087 E*	*0.57*