Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AB1-151

Paupack 230kV

February 2016

Preface

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

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

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

The Interconnection Customer (IC), has proposed a natural gas generating facility located in Wayne County, Pennsylvania. The installed facilities will have a total capability of 575 MW with 550 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is June 2020. **This study does not imply a PPL Electric Utilities (PPL EU) commitment to this in-service date.**

Point of Interconnection

The 230 kV generator lead line will interconnect into the Paupack 230-69 kV Substation. It is assumed for this study that PPL EU will design, construct, and own the 230 kV generator lead line between the IC's facility and the Paupack Substation. The Point of Interconnection will be the first deadend structure inside the IC's fence.

Cost Summary

The AB1-151 project will be responsible for the following costs (Option 1 only):

Description	Total Cost
Attachment Facilities	$ 29,930,000
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 2,628,250
Total Costs	**$ 32,558,250**

The 230 kV connection estimate is based on the assumptions stated in the following Transmission Attachment Facilities, Direct Connection, and Non-Direct Connection work sections. This estimate may vary depending upon the Queue AB1-151 substation location and orientation.

In addition, the AB1-151 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 1,500,000
Previously Identified Upgrades	$ 533,000,000
Total Costs	**$ 534,500,000**

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

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.

Note: Before the Impact Study stage, the exact location and orientation of the Interconnection Substation must be identified by the AB1-151 IC in order to refine the cost estimate.

Attachment Facilities

The Interconnection Customer indicated that they want the Feasibility Study estimate to include PPL EU constructing and owning the 230 kV transmission line to their facility from Paupack. The attachment facilities are scoped and estimated accordingly.

The AB1-151 Project will require siting to identify a suitable route for the 150'wide right-of-way needed to construct the 9.5 mile 230 kV single circuit transmission line and optical ground wire (OPGW) from Paupack 230-69 kV Substation to the dead end structure inside the IC's substation.

Itemized list of the transmission requirements:

Steel Poles:

There are approximately eighty (80) custom single circuit steel structures on foundations required for this scope of work. Twenty-seven (27) custom dead-end single circuit steel structures with the average height of 150' will be required due to heavy angles and townships the line will have to pass through.

Additionally, fifty-three (53) custom suspension single circuit steel structures with the average height of 150' will be on foundations throughout the route.

Conductor and OPGW:

Conductor:

- Total Length: 160,000 ft (for all three phases)
- Average Span Length: 650' average span length for 1590 kcmil bare 45/7 ACSR (at 60 deg F for all phases)

OPGW:

- Total Length: 109,000 ft (for both sets)
- Average Span Length: 650' 0.752 Diameter OPGW (dual OPGW length at 60 deg F)

The transmission lead line will need to be filed with the PUC. The lead time required from filing preparation to PA PUC approval is approximately 12 months. This timeline assumes that no litigation or condemnation is required. The approved filing is needed before construction can start. PPL EU will determine environmental impacts and mitigation strategies of the facilities being certified (i.e. - the transmission lines). These costs are not included in this estimate.

If the Interconnection Customer chooses at a later study phase to own the lead line then the IC will need to install a visible break (switches) at the fence of the PPL-EU substation. The POI will then be located at the high side of the switch. If PPL owns the lead line, the visible break can be located at the Interconnection Customer's facility.

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 work	$ 29,930,000
Total Attachment Facility Costs	**$ 29,930,000**

Direct Connection Cost Estimate

No Direct Connection Facilities are required to support this interconnection request.

Non-Direct Connection Cost Estimate

The following describes the non-direct connection work that will be needed for the proposed connection to the Paupack 230-69 kV Substation.

- A new double bus/double breaker bay will be required in the Paupack 230 kV Substation.
    - This bay will consist of two 230 kV circuit breakers, each with two 230 kV motor operated disconnect switches.
    - A North and South bays may need to be moved to accommodate the new location bay.
- The 230 kV termination will have with three 230 kV CCVTs for line potential indication.
- The 230 kV will be provided with primary and backup line protection, type and details to be determined during detailed design. Associated 230 kV bus protection and 230 kV breaker failure protection will be required.
- All PPL EU owned protection and control equipment will be located in a Paupack 230kV Substation control cubicle.
- A bi-directional fiber-based DTT (Direct Transfer Trip) will be required for communication paths between the AB1-151 customer's substation and PPL EU's Paupack 230 kV substation. Matching fiber-based DTT equipment is required for both locations.
- The DTT scheme is required for protection of the 230 kV line paths to isolate faults under breaker failure conditions. Redundant fiber-based communications will also be required for the 230 kV line protection schemes to be installed between the customer's substation and PPL EU's Paupack 230 kV substation.
- SCADA and an alarm management system will be required.

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
Substation work	$ 2,296,600
Circuit breakers	$ 331,650
Total Non-Direct Connection Facility Costs	**$ 2,628,250**

Preliminary Work Schedules

The estimated PPL EU elapsed time to complete the 230 kV Attachment Facilities and Direct Connection substation work is approximately 50 months after the receipt of a fully executed ISA/ICSA assuming no public opposition to the project.

The schedule for the 230 kV substation work to accommodate AB1-151 would depend on the project's start date. The work to accommodate AB1-151 will require substation facility outages. 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.

Transmission Owner Assumptions in Developing the Cost Estimates

- For the custom-designed steel transmission poles, the lead time is approximately 32-42 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 230 kV line from Paupack 230 kV substation to the 230 kV generation facility switchyard, it is as assumed that a new ROW and siting study would be required and the line would be owned by PPL EU.
- The transmission lead line will need to be filed with the PUC. The lead time required from filing preparation to PA PUC approval is approximately 12 months. This timeline assumes that no litigation or condemnation is required.
- No environmental, real estate, or permitting issues were reviewed for the estimate of this project.
- This estimate assumes that suitable facility outages can be scheduled as required to install the new switchyard. Failure to meet a scheduled facility outage may result in project delays.
- 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 AB1-151 Interconnection Customer, PJM, and PPL EU before any PPL EU design and construction activities may commence.

Interconnection Customer Requirements

AB1-151 Generator, GSU, and Line Modeling

The Generator interconnect consists of 1 CTG and 1 STG Units.

The Generators were modeled and inject 550 MW (capacity) and 575 MW (energy) into PPL EU's system.

Per the AB1-151 supplied data the following was used in modeling the generator and the GSU:

AB1-151 Generator:

- (1) Combustion Gas Turbine Generator:
- (1) Steam Turbine Generator:
    - Net MW Output: 575 MW
    - Voltage Level: 25 kV

Transformers:

- GSU (Generator Step Up Transformer):
    - Number of machines per GSU: 1
    - Rating: 230/310/380 MVA
    - MVA Base: 230 MVA
    - Voltage Levels: 230/25.0 kV

Transmision Line:

- Voltage Level: 230 kV
- MVA Base: 100 MVA
- Length: 9.5 miles

Telephone / Communication Circuit Requirements (At the IPP)

PPL EU will require a communication path for SCADA and voice circuits. PPL EU anticipates that either telephone circuits or IP will be required to establish these paths. The Interconnection Customer will be responsible to procure the following:

- SCADA – either a 4-wire dedicated FDDA-type phone line or DNP over IP. It is at PPL's discretion as to which SCADA (4 wire or DNP/IP) is required to be provided.
- A 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 Interconnection Customer 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 Interconnection Customer.

Intertie and POC Protective Relaying Equipment

At 230 kV levels, the protection equipment necessary are based on PJM, NERC, FERC, etc., requirements and PPL EU does not use POC or IPR relaying, as this is more likely a base load plant. The protection must be suitable for the proposed system and the surrounding or connected lines. This relaying is determined on a case by case basis.

The Interconnection Customer will need to install suitable protection and control equipment based on PPL EU Parallel generation requirements. The new 230 kV customer generation facility protection must meet all applicable PPL EU, NERC and FERC requirements. The protection must be suitable for the proposed system and must integrate appropriately with existing interconnected lines. This relaying is typically determined on a case by case basis. The IC should consult with PPL EU Engineering to determine the appropriate protection requirements should the IC proceed to an ISA/ICSA.

The protection equipment and schemes will be identified during the Facilities Study. Relaying requirements for 230 kV and above are not posted, however, Intertie Protective Relaying (IPR) and Point of Contact (POC) relaying documents for voltages below 230 kV can be referred to on the PPL EU website. 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

AB1-151 Generator Harmonic and Flicker Requirements

On the PPL EU 230 kV system, the total harmonic distortion to the fundamental voltage wave from a single customer is limited to 1.0% of nominal. In addition, no individual harmonic component can exceed 0.7% 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 AB1-151's equipment, the Queue AB1-151 Interconnection Customer will be responsible for taking corrective measures to mitigate harmonic currents.

Concerning voltage flicker, the AB1-151 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 AB1-151 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.

AB1-151 Generator Regulation or Reactive Support Requirements

As specified in Part VI, Attachment O Appendix 2 at 4.7.1.1 of the PJM OATT, the Project AB1-151 generator shall design its "Facility" to maintain a composite power factor delivery at continuous rated power output at the generators terminals at a power factor of at least 0.95 leading (absorbing vars) to 0.90 lagging (supplying vars).

The PJM OATT states:

"For all new generating facilities to be interconnected pursuant to the Tariff, other than wind-powered and other non-synchronous generation facilities, the Generation Interconnection Customer shall design its Customer Facility to maintain a composite power delivery at continuous rated power output at a factor of at least 0.95 leading to 0.90 lagging."

AA1-151 Generator Voltage Schedule Requirements

PPL EU requires that the generator has a power factor delivery at continuous rated power output at the generator terminals at a power factor of at least 0.95 leading (absorbing VARs) to 0.90 lagging (supplying VARs) A voltage schedule will be developed at the time of the Facilities Study.

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 Requirements

PPL EU will require the installation of PPL EU approved SCADA equipment that will connect to its existing SCADA system. PPL EU will provide detailed specifications and design drawings for this equipment should the IC proceed to an ISA/ICSA.

Metering Equipment Installation at the POI (Point of Interconnection)

Installation of revenue grade Bi-directional Metering Equipment will be required at the Queue AA1-151 Point of Interconnection (POI) to measure KWh and KVARh. PPL EU will review the design of the high voltage metering equipment. PPL EU will supply the required metering equipment but the installation 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 revenue meters should be housed in a control cabinet or similar enclosure (per PPL EU specification) and must be accessible to PPL EU metering personnel.

Maintenance Considerations

The Queue AB1-151 facility will not be able to generate into the PPL EU network during maintenance on the new 230 kV generator lead line. PPL EU on-going annual and long-term planned maintenance of this line will require PPL EU to remove the circuit from operation as (1) time every two (2) years for an outage period of approximately two (2) weeks. The actual duration may be shorter.

During maintenance periods, the circuit may or may not be returned to service during the evening hours. That decision depends on the type of work being performed. Unexpected and unplanned maintenance outages are not included in the one-in-two number and duration time. Annual inspections that uncover damaged supports, structures, or hardware, which require immediate repair are scheduled as soon as practicable. These types of unplanned outages may last up to 16 hours but could incur significant downtime for any major issues identified.

Network Impacts

Option 1

The Queue Project AB1-151 was evaluated as a 575.0 MW (Capacity 550.0 MW) injection at the Paup 230kV substation in the PPL area. Project AB1-151 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB1-151 was studied with a commercial probability of 53% using a 2019 Summer Peak case. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
BF_HOPT_5-6	CONTINGENCY 'BF_HOPT_5-6' TRIP LINE FROM BUS 200091 TO BUS 200098 CKT 1 /* LAKE WANNA TRIP LINE FROM BUS 200091 TO BUS 200094 CKT 1 /* ROSELAND TO HOPATCONG END
PJM JEFF-LACK 500_A	CONTINGENCY 'PJM JEFF-LACK 500_A' OPEN BRANCH FROM BUS 200091 TO BUS 200098 CKT 1 / 91 JEFFERSN 500 74 LACKAW 500 1 / BUS 200074 -> 200098. END
PJM JEFF-LACK 500_B	CONTINGENCY 'PJM JEFF-LACK 500_B' OPEN BRANCH FROM BUS 200098 TO BUS 200074 CKT 1 / 91 JEFFERSN 500 74 LACKAW 500 1 END
PJM8	CONTINGENCY 'PJM8' /* SUSQUEHANNA BUS BREAKER TO WESCOSVILLE DISCONNECT BRANCH FROM BUS 200023 TO BUS 200022 CKT 1 /* WESCOVLE SUSQUEHA 500500 DISCONNECT BRANCH FROM BUS 200023 TO BUS 200075 CKT 1 /* WESCOVLE BREININGSVILLE 500500 DISCONNECT BRANCH FROM BUS 200023 TO BUS 211321 CKT 3 /* WESCOVLE WESCOVLE 500138 DISCONNECT BRANCH FROM BUS 200022 TO BUS 208116 CKT 21 /* SUSQHANA SUSQHNA 500230 END
PL100009	CONTINGENCY 'PL100009' /*WESCOSVILLE 500KV BREAKER (SUB BREAKER) DISCONNECT BRANCH FROM BUS 200022 TO BUS 200023 CKT 1 /* DUE TO NEW 500 KV CB AFTER BREIN PROJECT DISCONNECT BRANCH FROM BUS 200023 TO BUS 211321 CKT 3 /* DUE TO NEW 500 KV CB AFTER BREIN PROJECT END
PL100329	CONTINGENCY 'PL100329' /* LACK 230KV WEST BUS & LACK T1 DISCONNECT BRANCH FROM BUS 200074 TO BUS 208009 CKT 3 DISCONNECT BRANCH FROM BUS 211681 TO BUS 208009 CKT 1 END

Contingency Name	Description
PL100347	CONTINGENCY 'PL100347' /* LACK 500/230KV T3 DISCONNECT BRANCH FROM BUS 200074 TO BUS 208009 CKT 3 END
PL100348	CONTINGENCY 'PL100348' /* LACK 500/230KV T4 DISCONNECT BRANCH FROM BUS 200074 TO BUS 208009 CKT 4 END
PL100855	CONTINGENCY 'PL100855' /* STAN-LACK 230KV - STUCK CB AT LACK 4W DISCONNECT BRANCH FROM BUS 208009 TO BUS 211681 CKT 1 DISCONNECT BRANCH FROM BUS 200074 TO BUS 208009 CKT 3 /* LACK T3 DISCONNECT BRANCH FROM BUS 208009 TO BUS 208094 CKT 1 /* STAN-LACK END
PL100858	CONTINGENCY 'PL100858' /* MOUN-LACK 230KV - STUCK CB AT LACK 3W DISCONNECT BRANCH FROM BUS 208009 TO BUS 211681 CKT 1 /* LACK T1 230-69 KV DISCONNECT BUS 234253 /* MOUN-LACK DISCONNECT BRANCH FROM BUS 200074 TO BUS 208009 CKT 3 /* LACK T3 500-230 KV END
PL100872_A	CONTINGENCY 'PL100872_A' /* SUSQ-LACK 500KV - STUCK CB AT LACK500 1W DISCONNECT BRANCH FROM BUS 917350 TO BUS 200074 CKT 1 /Z2-046 TAP DISCONNECT BRANCH FROM BUS 200074 TO BUS 208009 CKT 3 END
PL100873_A	CONTINGENCY 'PL100873_A' /* SUSQ-LACK 500KV - STUCK CB AT LACK500 1E DISCONNECT BRANCH FROM BUS 917350 TO BUS 200074 CKT 1 /Z2-046 TAP DISCONNECT BRANCH FROM BUS 200074 TO BUS 208009 CKT 4 END
PL100874	CONTINGENCY 'PL100874' /* LACK-HOPA 500KV - STUCK CB AT LACK500 2W DISCONNECT BRANCH FROM BUS 200074 TO BUS 208009 CKT 3 DISCONNECT BRANCH FROM BUS 200091 TO BUS 200098 CKT 1 DISCONNECT BRANCH FROM BUS 200098 TO BUS 200074 CKT 1 END
PL100875	CONTINGENCY 'PL100875' /* LACK-HOPA 500KV - STUCK CB AT LACK500 2E DISCONNECT BRANCH FROM BUS 200074 TO BUS 208009 CKT 4 DISCONNECT BRANCH FROM BUS 200091 TO BUS 200098 CKT 1 DISCONNECT BRANCH FROM BUS 200098 TO BUS 200074 CKT 1 END

Contingency Name	Description
PL101010	CONTINGENCY 'PL101010' /* SUSQ 500 2T BF- WESC NORTH DISCONNECT BUS 200023 /* WESC 500KV BUS DISCONNECT BRANCH FROM BUS 200022 TO BUS 200187 CKT 1 /* SUSQ 500 CAP B END
PL101277	CONTINGENCY 'PL101277' /* SUSQ-WESC-BREI 500 KV W/ BREI T1 CB STUCK DISCONNECT BUS 200023 /* SUSQ-WESC-BREI 500 KV DISCONNECT BUS 200075 /* BREI 500 KV DISCONNECT BUS 210441 /* BREI T1 500/138 KV END
PL101325	CONTINGENCY 'PL101325' /* WESC-BREI 500 KV DISCONNECT BRANCH FROM BUS 200023 TO BUS 200075 CKT 1 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	N-1	PJM JEFF-LACK 500_B	PL - PL	BLGR TR2-BLGR TR1 230 kV line	207919	207918	1	DC	79.75	100.21	ER	802	169.26	
2	N-1	PJM JEFF-LACK 500_A	PL - PL	BLGR TR2-BLGR TR1 230 kV line	207919	207918	1	DC	79.75	100.21	ER	802	169.26	
3	N-1	PJM JEFF-LACK 500_B	PL - PL	PAUP-BLGR TR2 230 kV line	208049	207919	1	DC	83.99	104.5	ER	802	169.72	
4	N-1	PJM JEFF-LACK 500_A	PL - PL	PAUP-BLGR TR2 230 kV line	208049	207919	1	DC	83.99	104.5	ER	802	169.72	

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, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
5	LFFB	PL100875	PL - PL	BLGR TR1-BUSH 230 kV line	207918	207930	1	DC	85.9	108.61	ER	802	182.78	1
6	LFFB	PL100874	PL - PL	BLGR TR1-BUSH 230 kV line	207918	207930	1	DC	85.9	108.61	ER	802	182.78	
7	LFFB	BF_HOPT_5-6	PL - PL	BLGR TR1-BUSH 230 kV line	207918	207930	1	DC	84.9	106.94	ER	802	177.14	
8	LFFB	PL100875	PL - PL	BLGR TR2-BLGR TR1 230 kV line	207919	207918	1	DC	89.98	112.64	ER	802	182.41	2
9	LFFB	PL100874	PL - PL	BLGR TR2-BLGR TR1 230 kV line	207919	207918	1	DC	89.98	112.64	ER	802	182.41	

#	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
10	LFFB	BF_HOPT_5-6	PL - PL	BLGR TR2-BLGR TR1 230 kV line	207919	207918	1	DC	88.55	110.54	ER	802	176.78	
11	LFFB	PL100875	PL - PL	PAUP-BLGR TR2 230 kV line	208049	207919	1	DC	93.83	116.56	ER	802	182.91	3
12	LFFB	PL100874	PL - PL	PAUP-BLGR TR2 230 kV line	208049	207919	1	DC	93.83	116.56	ER	802	182.91	
13	LFFB	BF_HOPT_5-6	PL - PL	PAUP-BLGR TR2 230 kV line	208049	207919	1	DC	92.83	114.88	ER	802	177.27	

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.

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
14	LFFB	PL101010	PJM500 - PJM500	LACKJEFF_TIE-HOPATCONG 500 kV line	200098	200091	1	DC	108.16	109.49	ER	3040	118.58	4
15	LFFB	PL100009	PJM500 - PJM500	LACKJEFF_TIE-HOPATCONG 500 kV line	200098	200091	1	DC	108.15	109.47	ER	3040	118.58	
16	LFFB	PL101277	PJM500 - PJM500	LACKJEFF_TIE-HOPATCONG 500 kV line	200098	200091	1	DC	108	109.33	ER	3040	118.58	
17	LFFB	PJM8	PJM500 - PJM500	LACKJEFF_TIE-HOPATCONG 500 kV line	200098	200091	1	DC	106.34	108.01	ER	3040	114.57	
18	LFFB	PL100874	PL - PL	BUSH-BUSH TP 230 kV line	207930	207928	1	DC	120.04	151.83	ER	573	182.78	5
19	LFFB	PL100875	PL - PL	BUSH-BUSH TP 230 kV line	207930	207928	1	DC	120.04	151.83	ER	573	182.78	
20	LFFB	BF_HOPT_5-6	PL - PL	BUSH-BUSH TP 230 kV line	207930	207928	1	DC	118.63	149.47	ER	573	177.14	

#	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
21	N-1	PJM JEFF-LACK 500_A	PL - PL	BUSH-BUSH TP 230 kV line	207930	207928	1	DC	106.29	134.99	ER	573	169.59	
22	N-1	PJM JEFF-LACK 500_B	PL - PL	BUSH-BUSH TP 230 kV line	207930	207928	1	DC	106.29	134.99	ER	573	169.59	
23	LFFB	PL100873_A	PL - PJM500	LACKAW 500/230 kV transformer	208009	200074	3	DC	139.04	143.94	ER	1165	128.24	6
24	N-1	PL100348	PL - PJM500	LACKAW 500/230 kV transformer	208009	200074	3	DC	104.71	118.2	ER	1165	157.96	
25	LFFB	PL100872_A	PL - PJM500	LACKAW 500/230 kV transformer	208009	200074	4	DC	139.04	143.94	ER	1165	128.24	7
26	LFFB	PL100855	PL - PJM500	LACKAW 500/230 kV transformer	208009	200074	4	DC	125.94	132.54	ER	1165	171.25	
27	LFFB	PL100858	PL - PJM500	LACKAW 500/230 kV transformer	208009	200074	4	DC	116.53	123.47	ER	1165	180.57	
28	BUS	PL100329	PL - PJM500	LACKAW 500/230 kV transformer	208009	200074	4	DC	115.33	121.67	ER	1165	165.2	
29	N-1	PL100347	PL - PJM500	LACKAW 500/230 kV transformer	208009	200074	4	DC	104.71	118.2	ER	1165	157.96	

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)

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

#	Area	Bus No.	Bus	Breaker	Rating Type	Rating (A)	Duty Percent Without AB1-151	Duty Percent With AB1-151	Duty Percent Difference
30	PPL	208009	LACK 230.kV	PECKVILLE NO	S	50000	99.40%	101.09%	1.69%
31	PPL	208009	LACK 230.kV	STANTON EAST	S	50000	99.40%	101.09%	1.69%

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
32	N-1	PL101325	PJM500 - PJM500	LACKJEFF_TIE-HOPATCONG 500 kV line	200098	200091	1	DC	105.81	107.16	ER	3040	118.72	
33	N-1	PJM JEFF-LACK 500_A	PL - PL	BLGR TR1-BUSH 230 kV line	207918	207930	1	DC	83.65	105.71	ER	802	177.3	
34	N-1	PJM JEFF-LACK 500_B	PL - PL	BLGR TR2-BLGR TR1 230 kV line	207919	207918	1	DC	87.31	109.33	ER	802	176.95	
35	N-1	PJM JEFF-LACK 500_A	PL - PL	BUSH-BUSH TP 230 kV line	207930	207928	1	DC	116.89	147.76	ER	573	177.3	

#	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
36	N-1	PL100348	PL - PJM500	LACKAW 500/230 kV transformer	208009	200074	3	DC	115.01	121.36	ER	1165	165.14	
37	N-1	PL100347	PL - PJM500	LACKAW 500/230 kV transformer	208009	200074	4	DC	115.01	121.36	ER	1165	165.14	
38	N-1	PJM JEFF-LACK 500_A	PL - PL	PAUP-BLGR TR2 230 kV line	208049	207919	1	DC	91.58	113.65	ER	802	177.44	

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
30	LACK 230.kV PECKVILLE NO circuit breaker	Replace circuit breakers. Expected time to completion is 24 months.	Pending	**$ 1,500,000**
31	LACK 230.kV STANTON EAST circuit breaker			
			Total New Network Upgrades	**$ 1,500,000**

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
1, 2, 8, 9, 10	BLGR TR2-BLGR TR1 230 kV line	Rebuild approximately 36 miles of 230kV path between Paupack and Bushkill with a double 1590 ACSR conductor. This work is expected to take 5 years to complete.	Pending	**$ 144,000,000**
3, 4, 11, 12, 13	PAUP-BLGR TR2 230 kV line			
5, 6, 7	BLGR TR1-BUSH 230 kV line			
18, 19, 20, 21, 22	BUSH-BUSH TP 230 kV line			

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
14, 15, 16, 17	LACKJEFF_TIE-HOPATCONG 500 kV line	Build a new 500-230 kV substation (Catawissa) where SUNB-SUSQ 500 kV and 230 kV line cross each other. Convert approximately 22 miles of the existing COLU-FRAC 230 kV line between the proposed substation and Frackville substation for 500 kV operations. Build approximately 30 miles of new 500 kV line between the Frackville substation and the Existing Juniata-Alburtis 500 kV line. Build a new 500 kV switchyard on the JUNI-ALBU 500 kV line where new 500 kV line from the new Catawissa substation will terminate. This work will take 6 years to complete.	Pending	**$ 297,000,000**
23, 24, 25, 26, 27, 28, 29	LACKAW 500/230 kV transformer	Build a standard 500-230 kV substation at Stanton. String approximately 14 miles of 500 kV line on existing SUSQ-LACK 500 kV line between Stanton and Lackawanna sub. This work is expected to take 5 years to complete.	Pending	**$ 92,000,000**
			Total Previously Identified Network Upgrades	**$ 533,000,000**

Option 2

The Queue Project AB1-151 was evaluated as a 575.0 MW (Capacity 550.0 MW) injection tapping the Lackawanna-Hopatcong 500kV line in the PPL area. Project AB1-151 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB1-151 was studied with a commercial probability of 53% using a 2019 Summer Peak case. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
B_PN230-SX-#8	CONTINGENCY 'B_PN230-SX-#8' /* EAST TOWANDA - HILLSIDE (ETH) 230 KV DISCONNECT BRANCH FROM BUS 200675 TO BUS 130763 CKT 1 END
BF_HOPT_5-6	CONTINGENCY 'BF_HOPT_5-6' TRIP LINE FROM BUS 200091 TO BUS 200098 CKT 1 /* LAKE WANNA TRIP LINE FROM BUS 200091 TO BUS 200094 CKT 1 /* ROSELAND TO HOPATCONG END
PJM JEFF-LACK 500_A	CONTINGENCY 'PJM JEFF-LACK 500_A' OPEN BRANCH FROM BUS 200091 TO BUS 200098 CKT 1 / 91 JEFFERSN 500 74 LACKAW 500 1 / BUS 200074 -> 200098. END
PL101197	CONTINGENCY 'PL101197' /* SUSQ-WESC-BREI 500 KV DISCONNECT BUS 200023 END
PL101325	CONTINGENCY 'PL101325' /* WESC-BREI 500 KV DISCONNECT BRANCH FROM BUS 200023 TO BUS 200075 CKT 1 /* 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	N-1	PL101197	PJM500 - PJM500	LACKJEFF_TIE-HOPATCONG 500 kV line	200098	200091	1	DC	99.17	110.1	ER	3040	349.89	1
2	N-1	PL101325	PJM500 - PJM500	LACKJEFF_TIE-HOPATCONG 500 kV line	200098	200091	1	DC	96.62	107.53	ER	3040	348.68	

Note: Please see Attachment 3 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Multiple Facility Contingency

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

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
3	N-1	B_PN230-SX-#8	PENELEC - NYISO	26E.SAYRE-N.WAV115 115 kV line	200676	130836	1	DC	133.88	134.23	ER	128	8.07	2
4	LFFB	BF_HOPT_5-6	PL - PL	BUSH-BUSH TP 230 kV line	207930	207928	1	DC	113.11	116.66	ER	573	45.59	3
5	N-1	PJM JEFF-LACK 500_A	PL - PL	BUSH-BUSH TP 230 kV line	207930	207928	1	DC	100.06	107	ER	573	43.28	

Note: Please see Attachment 3 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
6	N-1	PL101197	PJM500 - PJM500	LACKJEFF_TIE-HOPATCONG 500 kV line	200098	200091	1	DC	110.86	122.2	ER	3040	365.79	
7	Non	Non	PJM500 - PJM500	LACKJEFF_TIE-HOPATCONG 500 kV line	200098	200091	1	DC	93.42	106.65	NR	2650	352.02	
8	N-1	B_PN230-SX-#8	PENELEC - NYISO	26E.SAYRE-N.WAV115 115 kV line	200676	130836	1	DC	157.24	157.87	ER	128	8.44	
9	N-1	PJM JEFF-LACK 500_A	PL - PL	BUSH-BUSH TP 230 kV line	207930	207928	1	DC	111.37	114.89	ER	573	45.25	

Attachment 1. Single Line Diagram

Attachment 2. Option 1 Flowgate Details

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

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

Appendix 1

(PL - PL) The BLGR TR1-BUSH 230 kV line (from bus 207918 to bus 207930 ckt 1) loads from 85.9% to 108.61% (DC power flow) of its emergency rating (802 MVA) for the line fault with failed breaker contingency outage of 'PL100875'. This project contributes approximately 182.78 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
206679	28M&M S721	-0.82
206638	28PEAPACK	-0.23
209003	KSTN IPP	0.06
292590	L-018 E	2.53
294573	P-028 E	10.14
209010	PEIP 1	0.3
209009	PEIP 2	0.48
903951	W3-076 C	-0.39
903961	W3-077 C	-0.36
209029	WAYM IPP	0.1
209031	WAYMART E	7.91
208920	WLPK	1.87
907383	X1-094 C	-0.44
907462	X1-109 E	6.16
910522	X3-003 E	1.69
910612	X3-029 E	-0.76
912251	X4-048	11.33
913381	Y1-084 C OP1	-0.07
914041	Y2-042	1.87
914151	Y2-060	0.3
914271	Y2-089	49.36
916051	Z1-038	1.71
916351	Z1-091	1.42
916361	Z1-092	1.19
916422	Z1-098 E	2.59
916541	Z1-110	1.2
917072	Z2-011	1.2
917351	Z2-046 C1	24.05
917353	Z2-046 C2	24.05
917621	Z2-103	0.08
917631	Z2-104	0.16
917662	Z2-107 E	2.59
918211	AA1-036 OP	13.05
918521	AA1-066	4.28
918601	AA1-077 C	5.87
918602	AA1-077 E	9.21
918682	AA1-082 E	4.16
918871	AA1-106	1.2
919201	AA1-144 OP	11.66
919742	AA2-060 E	0.49
919752	AA2-061 E	0.65
919762	AA2-062 E	0.62
919772	AA2-063 E	0.71
919782	AA2-064 E	1.53

Bus Number	Bus Name	Full Contribution
919792	AA2-065 E	0.53
919982	AA2-082 E	1.16
919991	AA2-083 OP2	1.19
920171	AA2-112	1.32
920192	AA2-114 E	1.35
920762	AA2-117 E OP	1.26
920341	AA2-132	1.29
920351	AA2-133	1.55

Bus Number	Bus Name	Full Contribution
920371	AA2-135	1.43
920611	AA2-167	1.19
930431	AB1-084	2.58
930641	AB1-108 OP1	109.44
931021	AB1-151 C OP	174.83
931022	AB1-151 E OP	7.95
931942	AB1-182 E	2.44

Appendix 2

(PL - PL) The BLGR TR2-BLGR TR1 230 kV line (from bus 207919 to bus 207918 ckt 1) loads from 89.98% to 112.64% (DC power flow) of its emergency rating (802 MVA) for the line fault with failed breaker contingency outage of 'PL100875'. This project contributes approximately 182.41 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
206679	28M&M S721	-0.82
206638	28PEAPACK	-0.23
209003	KSTN IPP	0.05
292590	L-018 E	2.53
294573	P-028 E	10.14
200888	P-047 E	4.07
209010	PEIP 1	0.3
209009	PEIP 2	0.48
297050	V2-019 E	0.03
903951	W3-076 C	-0.39
903961	W3-077 C	-0.36
209029	WAYM IPP	0.1
209031	WAYMART E	7.9
907383	X1-094 C	-0.44
907462	X1-109 E	6.15
910522	X3-003 E	1.69
910612	X3-029 E	-0.75
912251	X4-048	11.31
913381	Y1-084 C OP1	-0.07
914041	Y2-042	1.87
914151	Y2-060	0.3
914271	Y2-089	49.29
916051	Z1-038	1.71
916351	Z1-091	1.42
916361	Z1-092	1.19
916422	Z1-098 E	2.58

Bus Number	Bus Name	Full Contribution
916541	Z1-110	1.2
917072	Z2-011	1.2
917351	Z2-046 C1	24.04
917353	Z2-046 C2	24.04
917621	Z2-103	0.08
917631	Z2-104	0.16
917662	Z2-107 E	2.58
918211	AA1-036 OP	13.04
918521	AA1-066	4.27
918601	AA1-077 C	5.86
918602	AA1-077 E	9.19
918682	AA1-082 E	4.16
918871	AA1-106	1.2
919201	AA1-144 OP	11.65
919742	AA2-060 E	0.49
919752	AA2-061 E	0.65
919762	AA2-062 E	0.62
919772	AA2-063 E	0.71
919782	AA2-064 E	1.52
919792	AA2-065 E	0.53
919982	AA2-082 E	1.16
919991	AA2-083 OP2	1.19
920171	AA2-112	1.32
920192	AA2-114 E	1.35
920762	AA2-117 E OP	1.25
920341	AA2-132	1.29

Bus Number	Bus Name	Full Contribution
920351	AA2-133	1.55
920371	AA2-135	1.42
920611	AA2-167	1.19
930431	AB1-084	2.57

Bus Number	Bus Name	Full Contribution
930641	AB1-108 OP1	109.23
931021	AB1-151 C OP	174.48
931022	AB1-151 E OP	7.93
931942	AB1-182 E	2.43

Appendix 3

(PL - PL) The PAUP-BLGR TR2 230 kV line (from bus 208049 to bus 207919 ckt 1) loads from 93.83% to 116.56% (DC power flow) of its emergency rating (802 MVA) for the line fault with failed breaker contingency outage of 'PL100875'. This project contributes approximately 182.91 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
206679	28M&M S721	-0.82
206638	28PEAPACK	-0.23
209003	KSTN IPP	0.06
292590	L-018 E	2.54
294573	P-028 E	10.17
209010	PEIP 1	0.3
209009	PEIP 2	0.48
903951	W3-076 C	-0.39
903961	W3-077 C	-0.36
209029	WAYM IPP	0.1
209031	WAYMART E	7.92
907383	X1-094 C	-0.44
907462	X1-109 E	6.18
910522	X3-003 E	1.7
910612	X3-029 E	-0.76
912251	X4-048	11.35
913381	Y1-084 C OP1	-0.07
914041	Y2-042	1.88
914151	Y2-060	0.3
914271	Y2-089	49.45
916051	Z1-038	1.72
916351	Z1-091	1.42
916361	Z1-092	1.19
916422	Z1-098 E	2.59
916541	Z1-110	1.2
917072	Z2-011	1.2
917351	Z2-046 C1	24.15
917353	Z2-046 C2	24.15
917621	Z2-103	0.08

Bus Number	Bus Name	Full Contribution
917631	Z2-104	0.16
917662	Z2-107 E	2.59
918211	AA1-036 OP	13.09
918521	AA1-066	4.29
918601	AA1-077 C	5.88
918602	AA1-077 E	9.22
918682	AA1-082 E	4.18
918871	AA1-106	1.2
919201	AA1-144 OP	11.7
919742	AA2-060 E	0.49
919752	AA2-061 E	0.65
919762	AA2-062 E	0.62
919772	AA2-063 E	0.71
919782	AA2-064 E	1.52
919792	AA2-065 E	0.53
919982	AA2-082 E	1.16
919991	AA2-083 OP2	1.2
920171	AA2-112	1.32
920192	AA2-114 E	1.35
920762	AA2-117 E OP	1.25
920341	AA2-132	1.3
920351	AA2-133	1.56
920371	AA2-135	1.43
920611	AA2-167	1.19
930431	AB1-084	2.58
930641	AB1-108 OP1	109.55
931021	AB1-151 C OP	174.96
931022	AB1-151 E OP	7.95
931942	AB1-182 E	2.44

Appendix 4

(PJM500 - PJM500) The LACKJEFF_TIE-HOPATCONG 500 kV line (from bus 200098 to bus 200091 ckt 1) loads from 108.16% to 109.49% (DC power flow) of its emergency rating (3040 MVA) for the line fault with failed breaker contingency outage of 'PL101010'. This project contributes approximately 118.58 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200857	26MARSHALL	7.39
99210	G07_NEW	11.85
209003	KSTN IPP	0.12
292590	L-018 E	4.95
212265	LOR1_N14_E	2.52
209027	LOR2_Q27_E	10.82
94130	O66_NONFIRM	45.17
294573	P-028 E	22.24
200888	P-047 E	9.12
209010	PEIP 1	0.63
209009	PEIP 2	1.03
212388	R-043 E	2.16
209014	SUNBIPP1	10.85
209015	SUNBIPP2	10.85
209016	SUNBIPP3	14.78
209017	SUNBIPP4	19.76
292935	U2-015 E	14.49
292078	V1-034	0.38
297050	V2-019 E	0.06
901902	W1-111 E	3.4
901932	W1-114 E	0.25
901942	W1-115 E	0.25
903011	W2-088 C	-0.69
905501	W4-060 C OP1	-0.42
209029	WAYM IPP	0.21
209031	WAYMART E	16.98
907991	X1-078	60.85
907271	X1-085 C	-0.19
907462	X1-109 E	13.57
909022	X2-012 E	14.18
910522	X3-003 E	3.71
910762	X3-052 E	-0.38
912042	X4-005 E	-6.77
912292	X4-044 E	-1.01
912251	X4-048	24.54
914031	Y2-015 C	46.39
914032	Y2-015 E	0.96
914041	Y2-042	4.09
LTF	Y2-044	8.73
914151	Y2-060	0.65
914271	Y2-089	106.89
LTF	Z1-019	63.25
916051	Z1-038	3.75
916341	Z1-090	54.72
916351	Z1-091	3.13
916361	Z1-092	2.64
916422	Z1-098 E	5.56
916541	Z1-110	2.67
917061	Z2-009 C OP1	1.13
917062	Z2-009 E OP1	7.62
917072	Z2-011	2.67
917351	Z2-046 C1	140.93
917353	Z2-046 C2	140.93
917621	Z2-103	0.19
917631	Z2-104	0.36
917662	Z2-107 E	5.56
917682	Z2-109 E	2.24
918211	AA1-036 OP	39.37
918431	AA1-057	2.54
918521	AA1-066	25.05
918601	AA1-077 C	12.71
918602	AA1-077 E	19.93
918682	AA1-082 E	9.18
918841	AA1-103 C	3.1
918842	AA1-103 E	21.33
918871	AA1-106	2.67
918951	AA1-114 C	1.3
918952	AA1-114 E	8.8
919201	AA1-144 OP	25.72
919512	AA2-008 E	9.51
919662	AA2-048 E	0.73
919672	AA2-049 E	0.32
919991	AA2-083 OP2	2.65
920171	AA2-112	2.91

Bus Number	Bus Name	Full Contribution
920262	AA2-122 E	2.24
920341	AA2-132	2.86
920351	AA2-133	3.41
920371	AA2-135	3.14
920611	AA2-167	2.64
920651	AA2-171 C	8.62
920711	AA2-182 C	140.31

Bus Number	Bus Name	Full Contribution
920712	AA2-182 E	7.61
930291	AB1-068	2.75
930431	AB1-084	5.53
930641	AB1-108 OP1	120.07
931021	AB1-151 C OP	113.43
931022	AB1-151 E OP	5.16
931942	AB1-182 E	4.76

Appendix 5

(PL - PL) The BUSH-BUSH TP 230 kV line (from bus 207930 to bus 207928 ckt 1) loads from 120.04% to 151.83% (DC power flow) of its emergency rating (573 MVA) for the line fault with failed breaker contingency outage of 'PL100874'. This project contributes approximately 182.78 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
206679	28M&M S721	-0.82
206638	28PEAPACK	-0.23
209003	KSTN IPP	0.06
292590	L-018 E	2.53
294573	P-028 E	10.14
209010	PEIP 1	0.3
209009	PEIP 2	0.48
903951	W3-076 C	-0.39
903961	W3-077 C	-0.36
209029	WAYM IPP	0.1
209031	WAYMART E	7.91
208920	WLPK	1.87
907383	X1-094 C	-0.44
907462	X1-109 E	6.16
910522	X3-003 E	1.69
910612	X3-029 E	-0.76
912251	X4-048	11.33
913381	Y1-084 C OP1	-0.07
914041	Y2-042	1.87
914151	Y2-060	0.3
914271	Y2-089	49.36
916051	Z1-038	1.71
916351	Z1-091	1.42
916361	Z1-092	1.19
916422	Z1-098 E	2.59
916541	Z1-110	1.2
917072	Z2-011	1.2

Bus Number	Bus Name	Full Contribution
917351	Z2-046 C1	24.05
917353	Z2-046 C2	24.05
917621	Z2-103	0.08
917631	Z2-104	0.16
917662	Z2-107 E	2.59
918211	AA1-036 OP	13.05
918521	AA1-066	4.28
918601	AA1-077 C	5.87
918602	AA1-077 E	9.21
918682	AA1-082 E	4.16
918871	AA1-106	1.2
919201	AA1-144 OP	11.66
919742	AA2-060 E	0.49
919752	AA2-061 E	0.65
919762	AA2-062 E	0.62
919772	AA2-063 E	0.71
919782	AA2-064 E	1.53
919792	AA2-065 E	0.53
919982	AA2-082 E	1.16
919991	AA2-083 OP2	1.19
920171	AA2-112	1.32
920192	AA2-114 E	1.35
920762	AA2-117 E OP	1.26
920341	AA2-132	1.29
920351	AA2-133	1.55
920371	AA2-135	1.43
920611	AA2-167	1.19

Bus Number	Bus Name	Full Contribution
930431	AB1-084	2.58
930641	AB1-108 OP1	109.44
931021	AB1-151 C OP	174.83

Bus Number	Bus Name	Full Contribution
931022	AB1-151 E OP	7.95
931942	AB1-182 E	2.44

Appendix 6

(PL - PJM500) The LACKAW 500/230 kV transformer (from bus 208009 to bus 200074 ckt 3) loads from 139.04% to 143.94% (DC power flow) of its emergency rating (1165 MVA) for the line fault with failed breaker contingency outage of 'PL100873_A'. This project contributes approximately 128.24 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200857	26MARSHALL	7.59
209003	KSTN IPP	0.13
292590	L-018 E	4.43
294573	P-028 E	24.15
200888	P-047 E	9.49
209010	PEIP 1	0.68
209009	PEIP 2	1.1
297050	V2-019 E	0.06
209029	WAYM IPP	0.22
209031	WAYMART E	18.14
907462	X1-109 E	14.58
910522	X3-003 E	4.02
912251	X4-048	27.26
914041	Y2-042	4.48
LTF	Y2-044	9.02
914151	Y2-060	0.7
914271	Y2-089	118.77
LTF	Z1-019	65.41
916051	Z1-038	4.08
916351	Z1-091	3.36
916361	Z1-092	2.79
916422	Z1-098 E	5.94
916541	Z1-110	2.82

Bus Number	Bus Name	Full Contribution
917072	Z2-011	2.82
917621	Z2-103	0.2
917631	Z2-104	0.39
917662	Z2-107 E	5.94
918211	AA1-036 OP	28.21
918601	AA1-077 C	14.12
918602	AA1-077 E	22.15
918682	AA1-082 E	9.86
918871	AA1-106	2.82
919201	AA1-144 OP	27.59
919991	AA2-083 OP2	2.81
920171	AA2-112	3.11
920241	AA2-120 OP	25.31
920341	AA2-132	3.05
920351	AA2-133	3.68
920371	AA2-135	3.37
920611	AA2-167	2.79
930431	AB1-084	5.91
930641	AB1-108 OP1	131.92
931021	AB1-151 C OP	122.66
931022	AB1-151 E OP	5.58
931942	AB1-182 E	4.26

Appendix 7

(PL - PJM500) The LACKAW 500/230 kV transformer (from bus 208009 to bus 200074 ckt 4) loads from 139.04% to 143.94% (DC power flow) of its emergency rating (1165 MVA) for the line fault with failed breaker contingency outage of 'PL100872_A'. This project contributes approximately 128.24 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200857	26MARSHALL	7.59
209003	KSTN IPP	0.13
292590	L-018 E	4.43
294573	P-028 E	24.15
200888	P-047 E	9.49
209010	PEIP 1	0.68
209009	PEIP 2	1.1
297050	V2-019 E	0.06
209029	WAYM IPP	0.22
209031	WAYMART E	18.14
907462	X1-109 E	14.58
910522	X3-003 E	4.02
912251	X4-048	27.26
914041	Y2-042	4.48
LTF	Y2-044	9.02
914151	Y2-060	0.7
914271	Y2-089	118.77
LTF	Z1-019	65.41
916051	Z1-038	4.08
916351	Z1-091	3.36
916361	Z1-092	2.79
916422	Z1-098 E	5.94
916541	Z1-110	2.82

Bus Number	Bus Name	Full Contribution
917072	Z2-011	2.82
917621	Z2-103	0.2
917631	Z2-104	0.39
917662	Z2-107 E	5.94
918211	AA1-036 OP	28.21
918601	AA1-077 C	14.12
918602	AA1-077 E	22.15
918682	AA1-082 E	9.86
918871	AA1-106	2.82
919201	AA1-144 OP	27.59
919991	AA2-083 OP2	2.81
920171	AA2-112	3.11
920241	AA2-120 OP	25.31
920341	AA2-132	3.05
920351	AA2-133	3.68
920371	AA2-135	3.37
920611	AA2-167	2.79
930431	AB1-084	5.91
930641	AB1-108 OP1	131.92
931021	AB1-151 C OP	122.66
931022	AB1-151 E OP	5.58
931942	AB1-182 E	4.26

Attachment 3. Option 2 Flowgate Details

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

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

Appendix 1

(PJM500 - PJM500) The LACKJEFF_TIE-HOPATCONG 500 kV line (from bus 200098 to bus 200091 ckt 1) loads from 99.17% to 110.1% (DC power flow) of its emergency rating (3040 MVA) for the single line contingency outage of 'PL101197'. This project contributes approximately 349.89 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
208972	BECR K09	0.11
234305	HUN GEN4	0.82
234311	HUN GEN5	0.93
234312	HUN GEN6	0.93
208944	JENK CT	0.57
209003	KSTN IPP	0.12
209010	PEIP 1	0.63
209009	PEIP 2	1.03
209014	SUNBIPP1	10.84
209015	SUNBIPP2	10.84
209016	SUNBIPP3	14.77
209017	SUNBIPP4	19.76
200038	SUSQ 2	27.04
292078	V1-034	0.38
903011	W2-088 C	-0.69
905501	W4-060 C OP1	-0.42
209029	WAYM IPP	0.21
907991	X1-078	60.78
907271	X1-085 C	-0.19
912251	X4-048	24.45
914031	Y2-015 C	46.42
914041	Y2-042	4.07
LTF	Y2-044	8.71
914151	Y2-060	0.65
914271	Y2-089	106.53
LTF	Z1-019	63.13
916051	Z1-038	3.74
916341	Z1-090	54.69
916351	Z1-091	3.12
916361	Z1-092	2.63
916541	Z1-110	2.66
917061	Z2-009 C OP1	1.13
917072	Z2-011	2.66
917351	Z2-046 C1	140.77
917621	Z2-103	0.18
917631	Z2-104	0.36
918211	AA1-036 OP	39.33
918431	AA1-057	2.54
918521	AA1-066	25.03
918601	AA1-077 C	12.67
918841	AA1-103 C	3.11
918871	AA1-106	2.66
918951	AA1-114 C	1.3
919201	AA1-144 OP	25.65

Bus Number	Bus Name	Full Contribution
919991	AA2-083 OP2	2.65
920171	AA2-112	2.9
920341	AA2-132	2.85
920351	AA2-133	3.4
920371	AA2-135	3.13
920611	AA2-167	2.63

Bus Number	Bus Name	Full Contribution
920651	AA2-171 C	8.61
920711	AA2-182 C	140.24
930291	AB1-068	2.75
930431	AB1-084	5.51
930641	AB1-108 OP2	139.64
931021	AB1-151 C OP	349.89

Appendix 2

(PENELEC - NYISO) The 26E.SAYRE-N.WAV115 115 kV line (from bus 200676 to bus 130836 ckt 1) loads from 133.88% to 134.23% (DC power flow) of its emergency rating (128 MVA) for the single line contingency outage of 'B_PN230-SX-#8'. This project contributes approximately 8.07 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
203283	26MANOR	0.02
200851	26MEHOOP3	0.41
294572	P-028 C	0.21
907461	X1-109 C	7.85
913191	Y1-047 OP1	0.11
914041	Y2-042	1.27
914151	Y2-060	0.29
915951	Y3-092	21.07
916051	Z1-038	1.82
916361	Z1-092	11.45
916541	Z1-110	1.6
917072	Z2-011	1.6

Bus Number	Bus Name	Full Contribution
917351	Z2-046 C1	7.5
917621	Z2-103	0.08
917631	Z2-104	0.11
918871	AA1-106	1.6
919201	AA1-144 OP	19.34
919991	AA2-083 OP2	1.58
920351	AA2-133	2.65
920371	AA2-135	3.31
920611	AA2-167	11.45
931021	AB1-151 C OP	8.07
931051	AB1-154 C	9.34

Appendix 3

(PL - PL) The BUSH-BUSH TP 230 kV line (from bus 207930 to bus 207928 ckt 1) loads from 113.11% to 116.66% (DC power flow) of its emergency rating (573 MVA) for the line fault with failed breaker contingency outage of 'BF_HOPT_5-6'. This project contributes approximately 45.59 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
206617	28EXXON	-0.36
206679	28M&M S721	-0.86
206638	28PEAPACK	-0.24
209003	KSTN IPP	0.05
292590	L-018 E	2.37
294573	P-028 E	9.36
209010	PEIP 1	0.27

Bus Number	Bus Name	Full Contribution
209009	PEIP 2	0.44
903951	W3-076 C	-0.41
903961	W3-077 C	-0.38
209029	WAYM IPP	0.09
209031	WAYMART E	7.29
208920	WLPK	1.81
907383	X1-094 C	-0.46

Bus Number	Bus Name	Full Contribution
907393	X1-095 C OP1	-0.06
907462	X1-109 E	5.69
910522	X3-003 E	1.56
910612	X3-029 E	-0.79
912251	X4-048	10.41
913381	Y1-084 C OP1	-0.08
914041	Y2-042	1.73
914151	Y2-060	0.27
914271	Y2-089	45.37
916051	Z1-038	1.58
916351	Z1-091	1.31
916361	Z1-092	1.1
916422	Z1-098 E	2.39
916541	Z1-110	1.11
917072	Z2-011	1.11
917351	Z2-046 C1	28.12
917353	Z2-046 C2	28.12
917621	Z2-103	0.08
917631	Z2-104	0.15
917662	Z2-107 E	2.39
918211	AA1-036 OP	12.36
918521	AA1-066	5.
918601	AA1-077 C	5.39
918602	AA1-077 E	8.46

Bus Number	Bus Name	Full Contribution
918682	AA1-082 E	3.85
918871	AA1-106	1.11
919201	AA1-144 OP	10.78
919742	AA2-060 E	0.51
919752	AA2-061 E	0.68
919762	AA2-062 E	0.65
919772	AA2-063 E	0.74
919782	AA2-064 E	1.61
919792	AA2-065 E	0.56
919982	AA2-082 E	1.21
919991	AA2-083 OP2	1.11
920171	AA2-112	1.22
920192	AA2-114 E	1.42
920762	AA2-117 E OP	1.33
920341	AA2-132	1.2
920351	AA2-133	1.43
920371	AA2-135	1.32
920611	AA2-167	1.1
930431	AB1-084	2.37
930641	AB1-108 OP2	59.47
931021	AB1-151 C OP	43.61
931022	AB1-151 E OP	1.98
931942	AB1-182 E	2.28