Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD2-055

Moshannon-East Towanda 230 kV

August 2018

Preface

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

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

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

General

The Interconnection Customer (IC), has proposed an uprate to a planned natural gas generating facility located in Clinton County, Pennsylvania. The proposed uprate will have a capability of 44 MW with 35 MW of this output being recognized by PJM as capacity. This project is an increase to the Interconnection Customer's AA1-111 & AB1-092 projects, which will share the same property and connection point. The AA1-111 project will have a capability of 463 MW with 463 MW being recognized as capacity. The AB1-092 project will have a capability of 41 MW with 17 MW being recognized as capacity. The total capability of the combined AA1-111, AB1-092, & AD2-055 projects will be 548 MW with 515 MW being recognized by PJM as capacity. The proposed in-service date for the AB1-092 project is December 1, 2020. **This study does not imply a Mid-Atlantic Interstate Transmission (MAIT) commitment to this in-service date.**

Point of Interconnection

AD2-055 will interconnect with the MAIT transmission system along the Moshannon-East Towanda 230kV line.

Cost Summary

The AD2-055 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 0

Description	Total Cost
Total Costs	**$ 0**

In addition, the AD2-055 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 59,926,100
Previously Identified Upgrades	$ 52,999,800
Total Costs	**$ 112,925,900**

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

General Information

Interconnected Transmission Owner ("TO"): Mid-Atlantic Interstate Transmission, LLC ("MAIT")

Affected TO(s) (if applicable): Mid-Atlantic Interstate Transmission, LLC ("MAIT"), West Penn Power Company ("West Penn")

PJM Zone: Penelec

FE Operating Company or Planning Region: Penelec

Customer Connection Request

Requested Backfeed Date: 10/15/2020

Requested Commercial Operation Date: 7/1/2021

This study does not imply a FirstEnergy commitment to these dates.

New Facilities		Existing Facilities	
Capacity:	35 MW	Capacity:	480 MW
Energy:	44 MW	Energy:	504 MW
MFO[1]:	548 MW	MFO:	504 MW
Fuel:	Natural Gas	Prior Queue Position(s):	AA1-111, AB1-092

[1] Maximum Facility Output

Attachment Facilities

No Attachment Facilities are required to support this interconnection request.

Direct Connection Cost Estimate

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

Non-Direct Connection Cost Estimate

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

Interconnection Customer Requirements

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

4. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.

5. The purchase and installation of supervisory control and data acquisition ("SCADA") equipment to provide information in a compatible format to the FE Transmission System Control Center.

6. Compliance with the FE and PJM generator power factor and voltage control requirements.

7. The execution of a back-up service agreement to serve the customer load supplied from the AD2-055 generation project metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

8. Power Factor Requirements: The existing 463 MW portion of the Customer Facility shall retain its existing ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.90 lagging (supplying VARs) measured at the generator's terminals. The increase of 41 MW to the Customer Facilities associated with the AB1-093 project shall be designed with the ability to maintain a Power Factor of at least 1.0 (unity) to 0.90 lagging (supplying VARs) measured at the generator's terminals. The increase of 44 MW to the Customer Facilities associated with the AD2-055 project shall be designed with the ability to maintain a Power Factor of at least 1.0 (unity) to 0.90 lagging (supplying VARs) measured at the generator's terminals.

Revenue Metering, SCADA, and Protection 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.

FE Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

http://www.firstenergycorp.com/feconnect
http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx

System Protection

The IC must design it's Customer Facilities in accordance with all applicable standards, including the standards in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the project enters the construction phase.

Metering

The IC will be require to comply with all FE revenue metering requirements for generation interconnection customers which can be found in FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx

Network Impacts

The Queue Project AD2-055 was evaluated as a 35.0 MW (Capacity 35.0 MW) injection at the tap of the Chapman – Lobo 230 kV line in the PenElec area. Project AD2-055 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-055 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2021

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
AP-P1-2-WP-230-324T-A	CONTINGENCY 'AP-P1-2-WP-230-324T-A' /* MOSHANNON-MARSHALL 230KV APS-PN TIE DISCONNECT BRANCH FROM BUS 235220 TO BUS 200908 CKT 1 /* 01MOSHAN 230 26CHAPMAN+ 230 DISCONNECT BRANCH FROM BUS 200908 TO BUS 919490 CKT 1 /* 26CHAPMAN+ 230 AA2-000 TAP 230 END
AP-P2_3-WP-230-0001-3	CONTINGENCY 'AP-P2_3-WP-230-0001-3' /* MOSHANNON STUCK BREAKER B3 (ELKO/AA1-111) OPEN BUS 235236 /* QUEHANNA OPEN BUS 200908 /* CHAPMAN END

Contingency Name	Description
AP-P2-2-WP-230-001T	CONTINGENCY 'AP-P2-2-WP-230-001T' /* ELKO #2 230KV BUS DISCONNECT BRANCH FROM BUS 235175 TO BUS 235158 CKT 1 /* 01ELKO 230 01CARB 230 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1 /* 01ELKO 230 01QUEHAN 230 DISCONNECT BRANCH FROM BUS 235175 TO BUS 200726 CKT 1 /* 01ELKO 230 26SHAWVL 2 230 REDUCE BUS 237007 SHUNT BY 100 PERCENT /* 01ELKO CAP 138 DISCONNECT BUS 237007 /* 01ELKO CAP 138 END
AP-P2-3-WP-230-443T	CONTINGENCY 'AP-P2-3-WP-230-443T' */ UPDATED CON AJK 3-31-16 DISCONNECT BRANCH FROM BUS 200726 TO BUS 235175 CKT 1 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1 DISCONNECT BUS 235158 END
AP-P2-3-WP-230-446T	CONTINGENCY 'AP-P2-3-WP-230-446T' /* ELKO-MOSHANNON STK BKR AT ELKO DISCONNECT BRANCH FROM BUS 200726 TO BUS 235175 CKT 1 /* 26SHAWVL 2 230 01ELKO 230 DISCONNECT BRANCH FROM BUS 235158 TO BUS 235175 CKT 1 /* 01CARB 230 01ELKO 230 DISCONNECT BRANCH FROM BUS 235175 TO BUS 235236 CKT 1 /* 01ELKO 230 01QUEHAN 230 DISCONNECT BRANCH FROM BUS 235220 TO BUS 235236 CKT 1 /* 01MOSHAN 230 01QUEHAN 230 DISCONNECT BRANCH FROM BUS 235236 TO BUS 236732 CKT 81 /* 01QUEHAN 230 01QUEHANNA 46 END

Contingency Name	Description
ATSI-P1-2-CEI-345-700T	CONTINGENCY 'ATSI-P1-2-CEI-345-700T' /* PN/ATSI ERIE WEST - ASHTABULA - PERRY 345KV DISCONNECT BRANCH FROM BUS 239036 TO BUS 238547 CKT 1 /* 02PERRY 345 02AT 345 DISCONNECT BRANCH FROM BUS 238547 TO BUS 239082 CKT 1 /* 02AT 345 02S8-ATT 345 DISCONNECT BRANCH FROM BUS 239082 TO BUS 238544 CKT 8 /* 02S8-ATT 345 02ASH_3 138 DISCONNECT BRANCH FROM BUS 238547 TO BUS 200599 CKT 1 /* 02AT 345 26ERIE W 345 END
PJM_P1_ JEFF-LACK 500_A	CONTINGENCY 'PJM_P1_ 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_P1_ JEFF-LACK 500_B	CONTINGENCY 'PJM_P1_ JEFF-LACK 500_B' OPEN BRANCH FROM BUS 200098 TO BUS 200074 CKT 1 / 91 JEFFERSN 500 74 LACKAW 500 1 END
PN-P1-2-PN-230-012B	CONTINGENCY 'PN-P1-2-PN-230-012B' /* EAST TOWANDA - MARSHALL 230KV DISCONNECT BRANCH FROM BUS 919200 TO BUS 200940 CKT 1 /* AA1-144 230 26SCOTCHHLLW230 DISCONNECT BRANCH FROM BUS 200940 TO BUS 200675 CKT 1 /* 26SCOTCHHLLW230 26E.TWANDA 230 END

Contingency Name	Description
PN-P1-2-PN-230-013	CONTINGENCY 'PN-P1-2-PN-230-013' /* EAST TOWANDA - NORTH MESHOPPEN 230KV DISCONNECT BRANCH FROM BUS 200675 TO BUS 200924 CKT 1 /* 26E.TWANDA 230 26CANYON 230 DISCONNECT BRANCH FROM BUS 200924 TO BUS 200706 CKT 1 /* 26CANYON 230 26N.MESHPN 230 DISCONNECT BRANCH FROM BUS 200706 TO BUS 200677 CKT 4 /* 26N.MESHPN 230 26NO MESHO 115 END
PN-P1-2-PN-230-102T	CONTINGENCY 'PN-P1-2-PN-230-102T' /* NORTH MESHOPPEN - LACKAWANNA 230KV DISCONNECT BRANCH FROM BUS 200706 TO BUS 200708 CKT 1 /* 26N.MESHPN 230 26OXBOW 230 DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1 /* 26OXBOW 230 LACK 230 DISCONNECT BRANCH FROM BUS 200706 TO BUS 200825 CKT 3 /* 26N.MESHPN 230 26MESH2REA 115 DISCONNECT BRANCH FROM BUS 200708 TO BUS 200709 CKT 1 /* 26OXBOW 230 26OXBOW 35 DISCONNECT BRANCH FROM BUS 200825 TO BUS 200677 CKT 3 /* 26MESH2REA 115 26NO MESHO 115 END
PN-P1-2-PN-345-107T	CONTINGENCY 'PN-P1-2-PN-345-107T' /* ERIE WEST - ASHTABULA - PERRY 345KV DISCONNECT BRANCH FROM BUS 200599 TO BUS 238547 CKT 1 /* 26ERIE W 345 02AT 345 DISCONNECT BRANCH FROM BUS 238547 TO BUS 239082 CKT 1 /* 02AT 345 02S8-ATT 345 DISCONNECT BRANCH FROM BUS 238547 TO BUS 239036 CKT 1 /* 02AT 345 02PERRY 345 DISCONNECT BUS 238547 /* 02AT 345 END

Contingency Name	Description
PN-P2-3-PN-115-46FT	CONTINGENCY 'PN-P2-3-PN-115-46FT' /* 756 DISCONNECT BRANCH FROM BUS 200677 TO BUS 200699 CKT 1 /* 26NO MESHO 115 26MEHOP 3 115 DISCONNECT BRANCH FROM BUS 200677 TO BUS 200678 CKT 1 /* 26NO MESHO 115 26LENOX 115 DISCONNECT BRANCH FROM BUS 200677 TO BUS 200684 CKT 1 /* 26NO MESHO 115 26N MESH 35 DISCONNECT BRANCH FROM BUS 200706 TO BUS 200708 CKT 1 /* 26N.MESHPN 230 26OXBOW 230 DISCONNECT BRANCH FROM BUS 200708 TO BUS 208009 CKT 1 /* 26OXBOW 230 LACK 230 DISCONNECT BRANCH FROM BUS 200825 TO BUS 200706 CKT 3 /* 26MESH2REA 115 26N.MESHPN 230 DISCONNECT BRANCH FROM BUS 200677 TO BUS 200825 CKT 3 /* 26NO MESHO 115 26MESH2REA 115 DISCONNECT BRANCH FROM BUS 200708 TO BUS 200709 CKT 1 /* 26OXBOW 230 26OXBOW 35 REDUCE BUS 200677 SHUNT BY 100 PERCENT /* 26NO MESHO 115 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_P1_ JEFF-LACK 500_B	PENELEC - NYISO	26E.TWANDA-HILSD230 230 kV line	200675	130763	1	DC	99.89	100.43	ER	531	2.84	1
2	N-1	PJM_P1_ JEFF-LACK 500_A	PENELEC - NYISO	26E.TWANDA-HILSD230 230 kV line	200675	130763	1	DC	99.89	100.43	ER	531	2.84	
3	Non	Non	PENELEC - AP	26CHAPMAN+- 01MOSHAN 230 kV line	200908	235220	1	DC	97.55	102.14	NR	520	23.83	
4	N-1	PN-P1-2-PN-230-102T	PENELEC - AP	26CHAPMAN+- 01MOSHAN 230 kV line	200908	235220	1	DC	96.9	100.94	ER	621	25.05	
5	N-1	PN-P1-2-PN-230-012B	PENELEC	AA2-000 TAP- 26CHAPMAN+ 230 kV line	919490	200908	1	DC	95.37	100.32	ER	666	32.97	2

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		Affected		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
6	N-1	PN-P1-2-PN-230-013	PENELEC	26TOWANDA-26NO MESHO 115 kV line	200674	200677	1	DC	119.28	120.51	ER	172	2.12	3
7	LFFB	AP-P2_3-WP-230-0001-3	PENELEC	26E.TWANDA-26CANYON 230 kV line	200675	200924	1	DC	152.43	154.8	ER	615	14.55	4
8	N-1	AP-P1-2-WP-230-324T-A	PENELEC	26E.TWANDA-26CANYON 230 kV line	200675	200924	1	DC	126.35	128.71	ER	615	14.54	
9	N-1	"200908	PENELEC	26E.TWANDA-26CANYON 230 kV line	200675	200924	1	DC	126.35	128.71	ER	615	14.54	
10	Non	Non	PENELEC	26E.TWANDA-26CANYON 230 kV line	200675	200924	1	DC	118.27	119.42	NR	515	5.89	
11	N-1	PN-P1-2-PN-230-013	PENELEC	26NO MESHO-26MESH2REA 115 kV line	200677	200825	3	DC	128.34	128.83	ER	197	2.13	5
12	LFFB	AP-P2_3-WP-230-0001-3	PENELEC	26N.MESHPN-26OXBOW 230 kV line	200706	200708	1	DC	111.88	113.53	ER	984	15.65	6
13	LFFB	AP-P2_3-WP-230-0001-3	PENELEC - PL	26OXBOW-LACK 230 kV line	200708	208009	1	DC	104.25	104.98	ER	984	15.82	7
14	N-1	PN-P1-2-PN-230-013	PENELEC	26N.MESHPN 230/115 kV transformer	200825	200706	3	DC	134.48	135	ER	188	2.13	8
15	N-1	PN-P1-2-PN-230-012B	PENELEC - AP	26CHAPMAN+-01MOSHAN 230 kV line	200908	235220	1	DC	102.24	107.55	ER	621	32.97	9

#	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
16	LFFB	AP-P2_3-WP-230-0001-3	PENELEC	26CANYON-26N.MESHPN 230 kV line	200924	200706	1	DC	138.13	140.32	ER	666	14.55	10
17	N-1	AP-P1-2-WP-230-324T-A	PENELEC	26CANYON-26N.MESHPN 230 kV line	200924	200706	1	DC	114.05	116.23	ER	666	14.54	
18	N-1	"200908	PENELEC	26CANYON-26N.MESHPN 230 kV line	200924	200706	1	DC	114.05	116.23	ER	666	14.54	
19	Non	Non	PENELEC	26CANYON-26N.MESHPN 230 kV line	200924	200706	1	DC	108.35	109.43	NR	546	5.89	
20	LFFB	AP-P2_3-WP-230-0001-3	PENELEC	26SCOTCHHLLW-26E.TWANDA 230 kV line	200940	200675	1	DC	123.16	129.04	ER	570	33.51	11
21	N-1	"200908	PENELEC	26SCOTCHHLLW-26E.TWANDA 230 kV line	200940	200675	1	DC	111.97	117.85	ER	570	33.51	
22	N-1	AP-P1-2-WP-230-324T-A	PENELEC	26SCOTCHHLLW-26E.TWANDA 230 kV line	200940	200675	1	DC	111.97	117.85	ER	570	33.51	
23	LFFB	PN-P2-3-PN-115-46FT	AP - PENELEC	01SHINGL-26LEWISTWN 230 kV line	235248	200513	1	DC	103.53	105.34	ER	554	10	12
24	LFFB	AP-P2-3-WP-230-446T	AP - PENELEC	01SHINGL-26LEWISTWN 230 kV line	235248	200513	1	DC	102.34	104.17	ER	554	13.63	
25	LFFB	AP-P2-3-WP-230-443T	AP - PENELEC	01SHINGL-26LEWISTWN 230 kV line	235248	200513	1	DC	102.18	104.01	ER	554	13.63	
26	BUS	AP-P2-2-WP-230-001T	AP - PENELEC	01SHINGL-26LEWISTWN 230 kV line	235248	200513	1	DC	102.16	103.99	ER	554	13.63	

#	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
27	LFFB	AP-P2-2-WP-230-001T	AP - PENELEC	01SHINGL-26LEWISTWN 230 kV line	235248	200513	1	DC	102.16	103.99	ER	554	13.63	
28	LFFB	AP-P2_3-WP-230-0001-3	PENELEC	AA1-144 TAP-26SCOTCHHLLW 230 kV line	919200	200940	1	DC	114.3	119.7	ER	621	33.51	13
29	N-1	"200908	PENELEC	AA1-144 TAP-26SCOTCHHLLW 230 kV line	919200	200940	1	DC	104.03	109.43	ER	621	33.51	
30	N-1	AP-P1-2-WP-230-324T-A	PENELEC	AA1-144 TAP-26SCOTCHHLLW 230 kV line	919200	200940	1	DC	104.03	109.43	ER	621	33.51	
31	N-1	PN-P1-2-PN-345-107T	AP - AP	01KARNSC-01BUTLER 138 kV line	235197	235152	1	DC	126.29	126.82	ER	179	2.07	14
32	N-1	ATSI-P1-2-CEI-345-700T	AP - AP	01KARNSC-01BUTLER 138 kV line	235197	235152	1	DC	126.29	126.82	ER	179	2.07	

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

Affected System Analysis & Mitigation

NYISO Impacts:

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

Light Load Analysis - 2021

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

Winter Analysis - 2021

Winter Studies to be conducted during later study phases

Steady-State Voltage Requirements

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

Steady State Voltage Studies to be conducted during later study phases

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

Stability Studies to be conducted during later study phases

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.

None.

New System Reinforcements

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

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
#1, 2	26E.TWANDA-HILSD230 230 kV line	In order to mitigate the E. Towanda (PENELEC) – Hillside (NYSEG) 230 kV line overload: • Replacing the wavetrap at NYSEG's Hillside substation is required. The estimated cost is $62,569, and will take 6-8 months to complete. The AA1-144 project is identified as the driver for this overload and the network upgrade is assigned to the AA1-144 project. If the AA1-144 project or any of the prior projects withdraw, then PJM will retool the AA1-111 analysis. If this occurs, then AA1-111 may become the driver for this overload or it could get a cost allocation towards the upgrade. At this time, the AA1-111 project does not have cost responsibility for this upgrade.		**$ 0**
#3, 4, 5, 15	Chapman tap – Moshannon 230 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • PENELEC: Rebuild from Moshannon Sub to Chapman Sub, approximately 29.3 miles, on the existing Marshall-Moshannon 230kV circuit. @ Moshannon-Chapman 230kV Rebuild. Estimated Cost Excluding Tax: $56,222,600. • PENELEC: Moshannon - Upgrade loadability of 230kV Marshall line terminal and update relay settings. Estimated Cost Excluding Tax: $32,300. • PENELEC: Project Management, Construction Management, Commissioning, Environmental, and Forestry. Estimated Cost Excluding Tax: $3,671,200. The estimated time to complete would be 19 months after signing an interconnection agreement.		**$ 59,926,100**
			Total New Network Upgrades	**$ 59,926,100**

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
#6	East Towanda – N. Meshoppen 115 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • PENELEC: East Towanda – Upgrade North Meshoppen terminal equipment. Estimated cost excluding tax: $86,000. • PENELEC: North Meshoppen – Upgrade East Towanda terminal equipment. Estimated cost excluding tax: $39,200. The estimated time to complete would be 19 months after signing an interconnection agreement.		**$ 125,200**
#7, 8, 9, 10	East Towanda – Canyon 230kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • PENELEC: Reconductor the East Towanda-Canyon section of the East Towanda-North Meshoppen 230kV line with 1033.5 kcmil ACSS, 12.4 miles. @ East Towanda-Canyon 230kV Reconductor. Estimated Cost Excluding Tax: $19,256,800. • PENELEC: Upgrade terminal equipment @ East Towanda SS. Estimated Cost Excluding Tax: $45,500. • PENELEC: Upgrade terminal equipment @ Canyon SS. Estimated Cost Excluding Tax: $88,700. The estimated time to complete would be 22 months after signing an interconnection agreement.		**$ 19,391,000**
#11, 14	26NO MESHO-26MESH2REA 115 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • PENELEC: Replace the North Meshoppen #3 230/115kV transformer eliminating the old reactor and installing two breakers to complete a 230kV ring bus at North Meshoppen. (PJM Upgrade Id: b2952) The scheduled in-service date is 06/01/2022.	b2952	**$ 0**

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
#12, 13	26N.MESHPN-26OXBOW 230 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • PENELEC: Stability Reinforcement for AA1-111 described below • Install a 230kV line connection between the proposed AA1-111 ring bus and the NYSEG Q496 Station, approximately 1 mile in length. @ AA1-111 to NYSEG 230kV Connection. • AA1-111 Interconnect - Install a 345/230kV transformer, 230kV breaker, and 345kV breaker. The Estimated Time to Complete: 28 Months Note: This reinforcement will be evaluated in the Impact Study Phase to analyze the impacts of this reinforcement on the transmission system.	n5740	**$ 12,572,600**
#16, 17, 18	Canyon– N. Meshoppen 230 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • PENELEC: Reconductor the North Meshoppen-Canyon section of the East Towanda-North Meshoppen 230kV line with 1033.5 kcmil ACSS, 9.8 miles. @ North Meshoppen-Canyon 230kV Reconductor. Estimated Cost Excluding Tax: $15,359,600. • PENELEC: Replace switch. @ Canyon SS. Estimated Cost Excluding Tax: $86,700. The estimated time to complete would be 17 months after signing an interconnection agreement.		**$ 15,446,300**
#20, 21, 22	26SCOTCHHLLW-26E.TWANDA 230 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • PENELEC: Reconductor 2.1 miles from East Towanda to Scotch Hollow 230kV circuit with 1033 ACSS Conductor. @ East Towanda to Scotch Hollow 230kV Reconductor. Estimated Cost Excluding Tax: $3,764,000. • PENELEC: Upgrade terminal equipment. @ Scotch Hollow SS. Estimated Cost Excluding Tax: $170,100. • PENELEC: Upgrade terminal equipment. @ East Towanda SS. Estimated Cost Excluding Tax: $109,000. The estimated time to complete would be 9 months after signing an interconnection agreement.		**$ 4,043,100**
#23, 24, 25, 26, 27	01SHINGL-26LEWISTWN 230 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • PENELEC: Upgrade terminal equipment on Lewistown line exit @ Shingletown SS. Estimated Cost Excluding Tax: $445,200. The estimated time to complete would be 12 months after signing an interconnection agreement		**$ 445,200**

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost
#28, 29, 30	AA1-144 TAP-26SCOTCHHLLW 230 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • PENELEC: Reconductor 0.5 miles of AA1-144-Scotch Hollow 230kV with 1033 ACSS Conductor. @ AA1-144 to Scotch Hollow 230kV 0.5 mile Reconductor. Estimated Cost Excluding Tax: $885,800. • PENELEC: Upgrade terminals. @ Scotch Hollow SS. Estimated Cost Excluding Tax: $90,600. The estimated time to complete would be 9 months after signing an interconnection agreement.		**$ 976,400**
#31, 32	01KARNSC-01BUTLER 138 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • AP: Convert the existing 6 wire Butler - Shanor Manor - Krendale 138 kV Line into two separate 138 kV lines. New lines will be Butler - Keisters and Butler - Shanor Manor - Krendale 138 kV (PJM Upgrade Id: b2967). The scheduled in-service date is 06/01/2022.	b2967	**$ 0**
			Total New Network Upgrades	**$ 52,999,800**

Attachment 1. Flowgate Details

Appendices

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

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

Appendix 1

(PENELEC - NYISO) The 26E.TWANDA-HILSD230 230 kV line (from bus 200675 to bus 130763 ckt 1) loads from 99.89% to 100.43% (**DC power flow**) of its emergency rating (531 MVA) for the single line contingency outage of 'PJM_P1_ JEFF-LACK 500_B'. This project contributes approximately 2.84 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
203283	26MANOR_T86	0.05
200851	26MEHOOP3	1.54
200823	26MHP_X3-003	6.07
200917	26MTNTP_P28	0.78
200949	26X1-109	39.86
934801	AD1-108	0.24
934811	AD1-109	0.17
934821	AD1-110	0.21
935061	AD1-142	-0.07
936421	AD2-055	2.84
LTF	AMIL	0.28
LTF	BAYOU	0.91
LTF	BIG_CAJUN1	1.39
LTF	BIG_CAJUN2	2.81
LTF	BLUEG	1.67
LTF	CALDERWOOD	0.45
LTF	CANNELTON	0.29
LTF	CARR	6.48
LTF	CATAWBA	0.25

Bus Number	Bus Name	Full Contribution
LTF	RENSSELAER	5.18
LTF	ROSETON	37.55
LTF	ROWAN	0.49
LTF	SANTEETLA	0.12
LTF	SMITHLAND	0.19
LTF	TATANKA	0.6
LTF	TILTON	0.61
LTF	TRIMBLE	0.32
LTF	TVA	0.67
LTF	UNIONPOWER	0.61
LTF	VFT	9.58
913191	Y1-047 OP1	0.4
914041	Y2-042	0.09
914151	Y2-060	0.09
916051	Z1-038	2.86
916541	Z1-110	0.6
917071	Z2-011	0.6
917621	Z2-103	0.03
917631	Z2-104	0.21

Bus Number	Bus Name	Full Contribution
LTF	CELEVELAND	0.74
LTF	CHEOAH	0.41
LTF	CHILHOWEE	0.15
LTF	CHOCTAW	0.92
LTF	CLIFTY	6.9
LTF	COTTONWOOD	3.63
LTF	DEARBORN	1
LTF	EDWARDS	0.51
LTF	ELMERSMITH	0.82
LTF	FARMERCITY	0.33
LTF	G-007A	3.5
LTF	GIBSON	0.57
LTF	HAMLET	0.78
LTF	MORGAN	1.49
LTF	NEWTON	1.27
LTF	PRAIRIE	2.41

Bus Number	Bus Name	Full Contribution
918601	AA1-077 C	2.21
918871	AA1-106	3.16
919201	AA1-144 OP	44.15
919491	AA2-000	37.56
920351	AA2-133	3.27
LTF	AA2-200	25.31
LTF	AA2-300	19.34
LTF	AA2-500	5.81
LTF	AA2-700	4.62
LTF	AA2-800	23.32
930431	AB1-084	1.29
930511	AB1-092	1.38
930641	AB1-108	25.73
931091	AB1-160 C	-0.22
925951	AC1-071 C	0.52

Appendix 2

(PENELEC - PENELEC) The AA2-000 TAP-26CHAPMAN+ 230 kV line (from bus 919490 to bus 200908 ckt 1) loads from 95.37% to 100.32% (**DC power flow**) of its emergency rating (666 MVA) for the single line contingency outage of 'PN-P1-2-PN-230-012B'. This project contributes approximately 32.97 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
203261	26BLOSSBCT	1.01
934801	AD1-108	0.95
934811	AD1-109	0.69
936421	AD2-055	32.97
LTF	AMIL	0.01
LTF	BAYOU	0.04
LTF	BIG_CAJUN1	0.06
LTF	BIG_CAJUN2	0.13
LTF	BLUEG	0.07
LTF	CALDERWOOD	0.02
LTF	CANNELTON	0.01
LTF	CATAWBA	0.01
LTF	CBM-N	0.24
LTF	CELEVELAND	0.04
LTF	CHEOAH	0.02
LTF	CHILHOWEE	< 0.01

Bus Number	Bus Name	Full Contribution
LTF	G-007A	0.12
LTF	GIBSON	0.02
LTF	HAMLET	0.04
LTF	MORGAN	0.07
LTF	NEWTON	0.05
LTF	NYISO	3.53
LTF	PRAIRIE	0.11
LTF	ROWAN	0.03
LTF	SANTEETLA	< 0.01
LTF	SMITHLAND	< 0.01
LTF	TATANKA	0.03
LTF	TILTON	0.03
LTF	TRIMBLE	0.01
LTF	TVA	0.03
LTF	UNIONPOWER	0.03
LTF	VFT	0.38

Bus Number	Bus Name	Full Contribution
LTF	CHOCTAW	0.04
LTF	CLIFTY	0.3
LTF	COTTONWOOD	0.17
LTF	DEARBORN	0.04
LTF	EDWARDS	0.02
LTF	ELMERSMITH	0.04
LTF	FARMERCITY	0.01

Bus Number	Bus Name	Full Contribution
916541	Z1-110	2.37
917071	Z2-011	2.37
918871	AA1-106	12.55
919201	AA1-144 OP	141.27
919491	AA2-000	436.09
930511	AB1-092	16.01

Appendix 3

(PENELEC - PENELEC) The 26TOWANDA-26NO MESHO 115 kV line (from bus 200674 to bus 200677 ckt 1) loads from 119.28% to 120.51% (**DC power flow**) of its emergency rating (172 MVA) for the single line contingency outage of 'PN-P1-2-PN-230-013'. This project contributes approximately 2.12 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200887	26ARMNA MT	0.43
203261	26BLOSSBCT	0.35
203283	26MANOR_T86	0.04
200949	26X1-109	20.43
932571	AC2-077	1.32
934801	AD1-108	0.18
934811	AD1-109	0.13
935061	AD1-142	0.12
936421	AD2-055	2.12
LTF	CBM-N	1.02
LTF	CBM-S1	1.16
LTF	CBM-S2	0.78
LTF	CBM-W1	5.12
LTF	CBM-W2	7.17
LTF	CIN	1.06
LTF	CPLE	0.17
LTF	IPL	0.68

Bus Number	Bus Name	Full Contribution
LTF	LGEE	0.22
LTF	MEC	1.96
LTF	MECS	1.77
LTF	NYISO	15.28
LTF	WEC	0.29
914041	Y2-042	-0.1
916201	Z1-069 C	0.17
916361	Z1-092	0.42
916541	Z1-110	0.44
917071	Z2-011	0.44
917631	Z2-104	-0.22
918871	AA1-106	2.34
919201	AA1-144 OP	22.73
919491	AA2-000	28.05
930511	AB1-092	1.03
931091	AB1-160 C	0.24
927001	AC1-187 C	0.81

Appendix 4

(PENELEC - PENELEC) The 26E.TWANDA-26CANYON 230 kV line (from bus 200675 to bus 200924 ckt 1) loads from 152.43% to 154.8% (**DC power flow**) of its emergency rating (615 MVA) for the line fault with failed breaker contingency outage of 'AP-P2_3-WP-230-0001-3'. This project contributes approximately 14.55 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200894	26K02	29.61
200949	26X1-109	64.15
932571	AC2-077	3.44
934801	AD1-108	0.57
934811	AD1-109	0.42
935061	AD1-142	0.31
936421	AD2-055	14.55
LTF	CBM-N	4.23
LTF	CBM-S1	2.99
LTF	CBM-S2	1.93
LTF	CBM-W1	13.41
LTF	CBM-W2	18.55
LTF	CIN	2.76
LTF	CPLE	0.42
LTF	G-007	3.62
LTF	IPL	1.78
LTF	LGEE	0.57
LTF	MEC	5.1
LTF	MECS	4.7
LTF	NYISO	62.59
LTF	O-066	24.95
203999	P-047 E	20.78
297050	V2-019 E	0.13

Bus Number	Bus Name	Full Contribution
903643	W3-099 C OP1	1.01
903644	W3-099 E OP1	6.75
LTF	WEC	0.76
907462	X1-109 E	37.74
914041	Y2-042	-0.1
916202	Z1-069 E	8.96
916541	Z1-110	1.43
917071	Z2-011	1.43
917631	Z2-104	-0.22
917662	Z2-107 E	0.89
918682	AA1-082 E	25.53
918871	AA1-106	7.57
919201	AA1-144 OP	72.2
919491	AA2-000	192.42
920341	AA2-132	2
920351	AA2-133	3.09
930411	AB1-082	2.53
930511	AB1-092	7.07
931091	AB1-160 C	0.62
931092	AB1-160 E	2.63
927001	AC1-187 C	2.13
927002	AC1-187 E	14.46

Appendix 5

(PENELEC - PENELEC) The 26NO MESHO-26MESH2REA 115 kV line (from bus 200677 to bus 200825 ckt 3) loads from 128.34% to 128.83% (**DC power flow**) of its emergency rating (197 MVA) for the single line contingency outage of 'PN-P1-2-PN-230-013'. This project contributes approximately 2.13 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200887	26ARMNA MT	0.44
203283	26MANOR_T86	0.04
200851	26MEHOOP3	4.31
200823	26MHP_X3-003	17.01
200917	26MTNTP_P28	2.19
200949	26X1-109	18.93
932571	AC2-077	1.59
934801	AD1-108	0.17
934811	AD1-109	0.12
934821	AD1-110	0.58
935061	AD1-142	0.14
936421	AD2-055	2.13
LTF	CBM-N	2.21
LTF	CBM-S1	1.61
LTF	CBM-S2	1.06
LTF	CBM-W1	7.19
LTF	CBM-W2	10.01
LTF	CIN	1.48
LTF	CPLE	0.23
LTF	IPL	0.95

Bus Number	Bus Name	Full Contribution
LTF	LGEE	0.31
LTF	MEC	2.74
LTF	MECS	2.51
LTF	NYISO	32.53
LTF	WEC	0.41
913191	Y1-047 OP1	1.12
914151	Y2-060	0.26
916051	Z1-038	5.74
916351	Z1-091	5.54
916361	Z1-092	0.49
917621	Z2-103	0.07
918871	AA1-106	2.25
919201	AA1-144 OP	21.09
919491	AA2-000	28.16
920341	AA2-132	4.5
920351	AA2-133	4.52
930411	AB1-082	1.23
930511	AB1-092	1.03
931091	AB1-160 C	0.29
927001	AC1-187 C	1.01

Appendix 6

(PENELEC - PENELEC) The 26N.MESHPN-26OXBOW 230 kV line (from bus 200706 to bus 200708 ckt 1) loads from 111.88% to 113.53% (**DC power flow**) of its emergency rating (984 MVA) for the line fault with failed breaker contingency outage of 'AP-P2_3-WP-230-0001-3'. This project contributes approximately 15.65 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200894	26K02	32.03
200851	26MEHOOP3	6.01
200823	26MHP_X3-003	23.74

Bus Number	Bus Name	Full Contribution
203999	P-047 E	27.27
297050	V2-019 E	0.17
903643	W3-099 C OP1	1.37

Bus Number	Bus Name	Full Contribution
200917	26MTNTP_P28	3.06
200949	26X1-109	69.83
932571	AC2-077	4.51
934801	AD1-108	0.65
934811	AD1-109	0.47
934821	AD1-110	0.81
935061	AD1-142	0.41
936421	AD2-055	15.65
LTF	CBM-N	5.97
LTF	CBM-S1	4.02
LTF	CBM-S2	2.6
LTF	CBM-W1	18.03
LTF	CBM-W2	24.96
LTF	CIN	3.71
LTF	CPLE	0.56
LTF	G-007	4.82
LTF	IPL	2.39
LTF	LGEE	0.76
LTF	MEC	6.86
LTF	MECS	6.32
LTF	NYISO	88.04
LTF	O-066	33.21
294573	P-028 E	64.75

Bus Number	Bus Name	Full Contribution
903644	W3-099 E OP1	9.14
LTF	WEC	1.02
907462	X1-109 E	41.08
910522	X3-003 E	10.79
913191	Y1-047 OP1	1.57
914151	Y2-060	0.36
916051	Z1-038	8.36
916202	Z1-069 E	11.78
916351	Z1-091	8.85
917621	Z2-103	0.1
917662	Z2-107 E	1.19
918682	AA1-082 E	27.79
918871	AA1-106	8.56
919201	AA1-144 OP	78.59
919491	AA2-000	207.02
920341	AA2-132	7.94
920351	AA2-133	8.73
930411	AB1-082	3.34
930511	AB1-092	7.6
931091	AB1-160 C	0.81
931092	AB1-160 E	3.45
927001	AC1-187 C	2.8
927002	AC1-187 E	19.06

Appendix 7

(PENELEC - PL) The 26OXBOW-LACK 230 kV line (from bus 200708 to bus 208009 ckt 1) loads from 104.25% to 104.98% (**DC power flow**) of its emergency rating (984 MVA) for the line fault with failed breaker contingency outage of 'AP-P2_3-WP-230-0001-3'. This project contributes approximately 15.82 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200894	26K02	32.39
200851	26MEHOOP3	6.21
200823	26MHP_X3-003	24.52
200917	26MTNTP_P28	3.16
932571	AC2-077	4.58
934801	AD1-108	0.65
934811	AD1-109	0.48
934821	AD1-110	0.84
935061	AD1-142	0.42

Bus Number	Bus Name	Full Contribution
297050	V2-019 E	0.17
LTF	WEC	1.04
907462	X1-109 E	41.55
910522	X3-003 E	11.15
913191	Y1-047 OP1	1.62
914041	Y2-042	0.47
914151	Y2-060	0.37
916051	Z1-038	11.31
916202	Z1-069 E	11.97

Bus Number	Bus Name	Full Contribution
936421	AD2-055	15.82
LTF	CBM-N	6.07
LTF	CBM-S1	4.09
LTF	CBM-S2	2.65
LTF	CBM-W1	18.33
LTF	CBM-W2	25.36
LTF	CIN	3.77
LTF	CPLE	0.57
LTF	G-007	4.89
LTF	IPL	2.43
LTF	LGEE	0.78
LTF	MEC	6.98
LTF	MECS	6.42
LTF	NYISO	89.5
LTF	O-066	33.73
294573	P-028 E	66.87
203999	P-047 E	27.72

Bus Number	Bus Name	Full Contribution
916351	Z1-091	9.11
917621	Z2-103	0.11
917631	Z2-104	1.08
917662	Z2-107 E	1.21
918682	AA1-082 E	28.11
918871	AA1-106	8.67
919201	AA1-144 OP	79.49
919491	AA2-000	209.33
920341	AA2-132	8.14
920351	AA2-133	10.36
930411	AB1-082	3.39
930511	AB1-092	7.69
931091	AB1-160 C	0.82
931092	AB1-160 E	3.51
927001	AC1-187 C	2.85
927002	AC1-187 E	19.37

Appendix 8

(PENELEC - PENELEC) The 26N.MESHPN 230/115 kV transformer (from bus 200825 to bus 200706 ckt 3) loads from 134.48% to 135.0% (**DC power flow**) of its emergency rating (188 MVA) for the single line contingency outage of 'PN-P1-2-PN-230-013'. This project contributes approximately 2.13 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200887	26ARMNA MT	0.44
203283	26MANOR_T86	0.04
200851	26MEHOOP3	4.31
200823	26MHP_X3-003	17.01
200917	26MTNTP_P28	2.19
200949	26X1-109	18.93
932571	AC2-077	1.59
934801	AD1-108	0.17
934811	AD1-109	0.12
934821	AD1-110	0.58
935061	AD1-142	0.14
936421	AD2-055	2.13
LTF	CBM-N	2.21
LTF	CBM-S1	1.61
LTF	CBM-S2	1.06

Bus Number	Bus Name	Full Contribution
LTF	LGEE	0.31
LTF	MEC	2.74
LTF	MECS	2.51
LTF	NYISO	32.53
LTF	WEC	0.41
913191	Y1-047 OP1	1.12
914151	Y2-060	0.26
916051	Z1-038	5.74
916351	Z1-091	5.54
916361	Z1-092	0.49
917621	Z2-103	0.07
918871	AA1-106	2.25
919201	AA1-144 OP	21.09
919491	AA2-000	28.16
920341	AA2-132	4.5

Bus Number	Bus Name	Full Contribution
LTF	CBM-W1	7.19
LTF	CBM-W2	10.01
LTF	CIN	1.48
LTF	CPLE	0.23
LTF	IPL	0.95

Bus Number	Bus Name	Full Contribution
920351	AA2-133	4.52
930411	AB1-082	1.23
930511	AB1-092	1.03
931091	AB1-160 C	0.29
927001	AC1-187 C	1.01

Appendix 9

(PENELEC - AP) The 26CHAPMAN+-01MOSHAN 230 kV line (from bus 200908 to bus 235220 ckt 1) loads from 102.24% to 107.55% (**DC power flow**) of its emergency rating (621 MVA) for the single line contingency outage of 'PN-P1-2-PN-230-012B'. This project contributes approximately 32.97 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
203261	26BLOSSBCT	1.01
934801	AD1-108	0.95
934811	AD1-109	0.69
936421	AD2-055	32.97
LTF	AMIL	0.01
LTF	BAYOU	0.04
LTF	BIG_CAJUN1	0.06
LTF	BIG_CAJUN2	0.13
LTF	BLUEG	0.07
LTF	CALDERWOOD	0.02
LTF	CANNELTON	0.01
LTF	CATAWBA	0.01
LTF	CBM-N	0.24
LTF	CELEVELAND	0.04
LTF	CHEOAH	0.02
LTF	CHILHOWEE	< 0.01
LTF	CHOCTAW	0.04
LTF	CLIFTY	0.3
LTF	COTTONWOOD	0.17
LTF	DEARBORN	0.04
LTF	EDWARDS	0.02
LTF	ELMERSMITH	0.04
LTF	FARMERCITY	0.01

Bus Number	Bus Name	Full Contribution
LTF	G-007A	0.12
LTF	GIBSON	0.02
LTF	HAMLET	0.04
LTF	MORGAN	0.07
LTF	NEWTON	0.05
LTF	NYISO	3.53
LTF	PRAIRIE	0.11
LTF	ROWAN	0.03
LTF	SANTEETLA	< 0.01
LTF	SMITHLAND	< 0.01
LTF	TATANKA	0.03
LTF	TILTON	0.03
LTF	TRIMBLE	0.01
LTF	TVA	0.03
LTF	UNIONPOWER	0.03
LTF	VFT	0.38
916541	Z1-110	2.37
917071	Z2-011	2.37
918871	AA1-106	12.55
919201	AA1-144 OP	141.27
919491	AA2-000	436.09
930511	AB1-092	16.01

Appendix 10

(PENELEC - PENELEC) The 26CANYON-26N.MESHPN 230 kV line (from bus 200924 to bus 200706 ckt 1) loads from 138.13% to 140.32% (**DC power flow**) of its emergency rating (666 MVA) for the line fault with failed breaker contingency outage of 'AP-P2_3-WP-230-0001-3'. This project contributes approximately 14.55 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200894	26K02	29.61
200949	26X1-109	64.15
932571	AC2-077	3.44
934801	AD1-108	0.57
934811	AD1-109	0.42
935061	AD1-142	0.31
936421	AD2-055	14.55
LTF	CBM-N	4.23
LTF	CBM-S1	2.99
LTF	CBM-S2	1.93
LTF	CBM-W1	13.41
LTF	CBM-W2	18.55
LTF	CIN	2.76
LTF	CPLE	0.42
LTF	G-007	3.62
LTF	IPL	1.78
LTF	LGEE	0.57
LTF	MEC	5.1
LTF	MECS	4.7
LTF	NYISO	62.59
LTF	O-066	24.95
203999	P-047 E	20.78
297050	V2-019 E	0.13

Bus Number	Bus Name	Full Contribution
903643	W3-099 C OP1	1.01
903644	W3-099 E OP1	6.75
LTF	WEC	0.76
907462	X1-109 E	37.74
914041	Y2-042	-0.1
916202	Z1-069 E	8.96
916541	Z1-110	1.43
917071	Z2-011	1.43
917631	Z2-104	-0.22
917662	Z2-107 E	0.89
918682	AA1-082 E	25.53
918871	AA1-106	7.57
919201	AA1-144 OP	72.2
919491	AA2-000	192.42
920341	AA2-132	2
920351	AA2-133	3.09
930411	AB1-082	2.53
930511	AB1-092	7.07
931091	AB1-160 C	0.62
931092	AB1-160 E	2.63
927001	AC1-187 C	2.13
927002	AC1-187 E	14.46

Appendix 11

(PENELEC - PENELEC) The 26SCOTCHHLLW-26E.TWANDA 230 kV line (from bus 200940 to bus 200675 ckt 1) loads from 123.16% to 129.04% (**DC power flow**) of its emergency rating (570 MVA) for the line fault with failed breaker contingency outage of 'AP-P2_3-WP-230-0001-3'. This project contributes approximately 33.51 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200894	26K02	67.03
934801	AD1-108	1.04
934811	AD1-109	0.76
936421	AD2-055	33.51
LTF	CBM-N	0.01
LTF	CBM-S1	0.06
LTF	CBM-S2	0.03
LTF	CBM-W1	0.28
LTF	CBM-W2	0.38
LTF	CIN	0.06
LTF	CPLE	< 0.01
LTF	G-007	0.11
LTF	IPL	0.04

Bus Number	Bus Name	Full Contribution
LTF	LGEE	0.01
LTF	MEC	0.11
LTF	MECS	0.1
LTF	NYISO	0.22
LTF	O-066	0.75
LTF	WEC	0.02
916541	Z1-110	2.6
917071	Z2-011	2.6
918871	AA1-106	13.78
919201	AA1-144 OP	160.41
919491	AA2-000	443.35
930511	AB1-092	16.28

Appendix 12

(AP - PENELEC) The 01SHINGL-26LEWISTWN 230 kV line (from bus 235248 to bus 200513 ckt 1) loads from 103.53% to 105.34% (**DC power flow**) of its emergency rating (554 MVA) for the line fault with failed breaker contingency outage of 'PN-P2-3-PN-115-46FT'. This project contributes approximately 10.0 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
236828	01GRAYMONT	1.99
200805	26COLVER13	7.57
200894	26K02	16.13
200823	26MHP_X3-003	4.99
200913	26SHAW-D	0.3
200715	26SHAWVL 1	1.59
200722	26SHAWVL 2	1.63
200665	26SHAWVL 3	2.54
200666	26SHAWVL 4	2.54
932571	AC2-077	2.1
934801	AD1-108	0.21

Bus Number	Bus Name	Full Contribution
LTF	O-066	14.39
294573	P-028 E	13.6
203999	P-047 E	8.05
290086	Q-036 E	6.14
297050	V2-019 E	0.05
293393	V3-030E	1.88
903643	W3-099 C OP1	0.96
903644	W3-099 E OP1	6.42
LTF	WEC	0.52
907462	X1-109 E	10.18
910522	X3-003 E	2.27

Bus Number	Bus Name	Full Contribution
934811	AD1-109	0.16
934821	AD1-110	0.17
935061	AD1-142	0.11
935191	AD1-154	1.42
936421	AD2-055	10
936941	AD2-119 C	16.04
936942	AD2-119 E	22.15
936991	AD2-133 C	2.76
936992	AD2-133 E	12.63
LTF	CBM-N	1.93
LTF	CBM-S1	1.81
LTF	CBM-S2	0.79
LTF	CBM-W1	9.35
LTF	CBM-W2	11.65
LTF	CIN	1.84
LTF	CPLE	0.12
LTF	G-007	2.25
LTF	IPL	1.19
LTF	LGEE	0.37
LTF	MEC	3.36
LTF	MECS	3.53
LTF	NYISO	28.96

Bus Number	Bus Name	Full Contribution
914041	Y2-042	0.07
914101	Y2-055	3.72
916051	Z1-038	2.16
916202	Z1-069 E	5.94
916351	Z1-091	1.38
917631	Z2-104	0.16
918682	AA1-082 E	6.88
918701	AA1-085 C	4.59
918702	AA1-085 E	30.61
918871	AA1-106	2.85
919201	AA1-144 OP	20.12
919491	AA2-000	132.3
920341	AA2-132	1.5
920351	AA2-133	2.22
930411	AB1-082	2.32
930511	AB1-092	4.86
931091	AB1-160 C	0.41
931092	AB1-160 E	1.74
925512	AC1-025 E	0.77
927001	AC1-187 C	1.69
927002	AC1-187 E	11.49

Appendix 13

(PENELEC - PENELEC) The AA1-144 TAP-26SCOTCHHLLW 230 kV line (from bus 919200 to bus 200940 ckt 1) loads from 114.3% to 119.7% (**DC power flow**) of its emergency rating (621 MVA) for the line fault with failed breaker contingency outage of 'AP-P2_3-WP-230-0001-3'. This project contributes approximately 33.51 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
200894	26K02	67.03
934801	AD1-108	1.04
934811	AD1-109	0.76
936421	AD2-055	33.51
LTF	CBM-N	0.01
LTF	CBM-S1	0.06
LTF	CBM-S2	0.03
LTF	CBM-W1	0.28
LTF	CBM-W2	0.38
LTF	CIN	0.06
LTF	CPLE	< 0.01
LTF	G-007	0.11
LTF	IPL	0.04

Bus Number	Bus Name	Full Contribution
LTF	LGEE	0.01
LTF	MEC	0.11
LTF	MECS	0.1
LTF	NYISO	0.22
LTF	O-066	0.75
LTF	WEC	0.02
916541	Z1-110	2.6
917071	Z2-011	2.6
918871	AA1-106	13.78
919201	AA1-144 OP	160.41
919491	AA2-000	443.35
930511	AB1-092	16.28

Appendix 14

(AP - AP) The 01KARNSC-01BUTLER 138 kV line (from bus 235197 to bus 235152 ckt 1) loads from 126.29% to 126.82% (**DC power flow**) of its emergency rating (179 MVA) for the single line contingency outage of 'PN-P1-2-PN-345-107T'. This project contributes approximately 2.07 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
235134	01AL&D6	0.19
235030	01MHNG-T155	0.21
200805	26COLVER13	7.42
200828	26HNSMLK 1	0.96
200829	26HNSMLK 2	0.96
200830	26HNSMLK 3	0.96
200831	26HNSMLK 4	0.96
200832	26HNSMLK 5	0.96
200849	26LAKVU GN	0.08
200649	26PENNTECH	0.58
200608	26PINEY #1	0.97
200662	26SCRUB GR	2.05
200642	26SENECA#1	3.51
200643	26SENECA#2	1.65
200644	26SENECA#3	0.42
200665	26SHAWVL 3	0.48
200666	26SHAWVL 4	0.49
201201	26WRREN CT	0.82
932571	AC2-077	1.14
935191	AD1-154	2.39
936421	AD2-055	2.07
936941	AD2-119 C	1.62
936991	AD2-133 C	0.93
LTF	AMIL	0.19
LTF	BAYOU	0.63
LTF	BIG_CAJUN1	0.97
LTF	BIG_CAJUN2	1.95
LTF	BLUEG	1.18
LTF	CALDERWOOD	0.31
LTF	CANNELTON	0.2
LTF	CATAWBA	0.17
LTF	CBM-N	1.22
LTF	CELEVELAND	0.5
LTF	CHEOAH	0.28
LTF	CHILHOWEE	0.1

Bus Number	Bus Name	Full Contribution
LTF	CHOCTAW	0.64
LTF	CLIFTY	4.9
LTF	COTTONWOOD	2.52
LTF	DEARBORN	0.68
LTF	EDWARDS	0.36
LTF	ELMERSMITH	0.58
LTF	FARMERCITY	0.23
LTF	G-007A	1.78
LTF	GIBSON	0.4
LTF	HAMLET	0.52
LTF	MORGAN	1.04
LTF	NEWTON	0.89
LTF	NYISO	18.38
LTF	PRAIRIE	1.69
LTF	ROWAN	0.33
LTF	SANTEETLA	0.08
LTF	SMITHLAND	0.13
LTF	TATANKA	0.42
LTF	TILTON	0.43
LTF	TRIMBLE	0.23
LTF	TVA	0.47
LTF	UNIONPOWER	0.42
LTF	VFT	4.93
903643	W3-099 C OP1	1.03
914101	Y2-055	2.21
915951	Y3-092 FTIR	85.58
916321	Z1-088	0.07
916331	Z1-089	0.07
918701	AA1-085 C	0.61
919491	AA2-000	27.4
930411	AB1-082	1.23
930511	AB1-092	1.01
931091	AB1-160 C	0.22
927001	AC1-187 C	0.9