

***Generation Interconnection
Feasibility Study Report***

For

***PJM Generation Interconnection Request Queue
Position Y2-086***

Engle 69 kV

March/2013

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

Interconnection Customer (IC) proposes to install PJM Project #Y2-086, a 62.5 MW Biomass fuel generating facility connecting to American Electric Power (AEP) Engle 69 kV Station. The projected in-service date for the facility is January 1, 2015.

The objective of this Feasibility Study is to provide a plan of service for interconnection at Engle Station and an engineering estimate of the associated costs. These reinforcements include the Attachment Facilities and Network Upgrades required to maintain the reliability of the AEP transmission system.

Attachment Facilities

Y2-086 proposes to connect the biomass generation facility directly to AEP's Engle 69kV Station via a 1.4 mile long transmission line. AEP's Engle Station will require the addition of a four breaker 69kV ring bus, a new 69kV transmission line into Engle Station, remote end relaying upgrades, metering, SCADA, land for site expansion, line termination work, and associated station equipment upgrades. IC is expected to obtain, at their cost, the necessary 69kV line connection and right of way (approximately 1.4 miles) required to connect to AEP's Engle Station. In addition, IC shall obtain all necessary permits for this right of way acquisition.

The rebuilt Engle Station will have four 69kV circuit breakers with four 69kV circuits connected to it in a ring bus arrangement. The ring bus orientation was selected to prevent islanding generation on the distribution transformer located at Engle Station. As part of the interconnection, AEP will need to install a new drop-in control house, new RTU, SCADA equipment, surge arresters, and protection equipment at Engle Station. Engle Station will require expansion to the south and east in order to accommodate the new station equipment and maintain proper drive paths to service equipment. Remote end relaying and protection equipment installation will be required at Hazard Station and Bonnyman Station in order to accommodate the proposed generation of 62.5 MW connecting to Engle Station.

A new 4.25 mile 69kV transmission line to Engle Station will be constructed as part of this project to provide proper generation outlets that will allow for routine maintenance and prevent generation islanding at Engle Station following a single contingency. The line will terminate at Engle station's four-position ring bus and will also terminate at the line which presently connects Bonnyman to Shamrock (and will be disconnected at Shamrock) to complete a looped feed to Engle Station. AEP will need to purchase new ROW for the new line from Engle Station to Shamrock Station. AEP will need to make line termination changes at Engle and Shamrock stations to accommodate the proposed line configurations.

Direct Connection Cost Estimate

The total preliminary cost estimate for Direct Connection work is given in the following tables below.

Description	Total Cost
Bonnyman Station: Remote end relaying upgrades	\$304,600
Hazard Station: Remote end relaying upgrades	\$516,100
Engle Station: Construct new 69kV four breaker ring bus	\$2,515,700
Shamrock Station: Relocate Engle line termination	\$68,600
Engle-Bonnyman 69kV line: New 4.25mi 69kV transmission line	\$5,881,100
Engle-Hazard 69kV line: Line termination changes at Engle and Shamrock	\$654,100
Engle-Bonnyman 69kV line: ROW for new 69kV line	\$588,900
Engle Station: Property purchase for site expansion	\$122,000
Total	\$10,651,100

IC is responsible for all costs associated with this connection. Costs for IC's generation station and costs for the line connection from IC's generation station to AEP's Engle Station are not included in this Feasibility Study. The costs detailed above are reimbursable to AEP.

Contributions to Previously Identified Overloads

The “Contributions to Previously Identified Overloads” are summarized in the table below. The Load Flow analysis originally contained thirteen violations which can be found at the end of this report. Further analysis reduced the violations to three with four required reinforcements to mitigate them. Additional details can be found in the flow gate appendices attached at the end of this report. IC will only be responsible for a portion of these costs, as they have not been allocated. Allocation of costs is not calculated until the System Impact Study Phase.

Violations	Contingency	Description	Cost*
7, 13	The 05CLNCHR-05LEBANO 138 kV line	Reconductor 0.09 miles of single circuit 1033 conductor section outside Lebanon Station. Reconductor a single span of 1033 conductor at the Elk Garden Tap.	\$765,000
		Replace a 1200 A switch at Lebanon Station and Elk Garden Station. Replace 1590 AAC 61 Str. Bus at Lebanon Station.	\$28,000
12	The 05LEBANO-05ELKGAZ 138 kV line	Reconductor 0.09 miles of single circuit 1033 conductor section outside Lebanon Station. Reconductor a single span of 1033 conductor at the Elk Garden Tap.	\$344,000
		Replace a 1200 A switch at Lebanon Station and Elk Garden Station. Replace 1590 AAC 61 Str. Bus at Lebanon Station.	\$312,000
Total			\$1,449,000

*The “Contribution to Previously Identified Overloads” estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review, coordination, and allocation with other projects within the Queue to determine final costs.

Schedule

The standard time required for construction is 12 to 18 months from the signing of an interconnection agreement.

Conclusion

Based upon the results of this Feasibility Study, the construction of the IC (PJM Project Y2-086) bio-mass generation project connecting to AEP’s Engle 69kV station will require the associated line, station, and ROW upgrades as outlined in the attachment facilities and “Contribution to Previously Identified Overloads” sections above at an approximate cost of \$12,100,000. This plan of service will interconnect the proposed generation in a manner that will provide operational reliability and flexibility to both the AEP system and the IC’s Generator. The additional outlet at Engle Station will help prevent the generator from islanding on distribution load following a single contingency, and will also prevent the generator from being tripped offline for a distribution fault at Engle and Shamrock Stations. This additional outlet at Engle Station will also significantly decrease outage time for reliability and maintenance since it will

have two outlets from Engle Station. The interconnection plan of service will provide the necessary facilities to operate the proposed generation in a safe and reliable manner to serve area load.

Revenue Metering and SCADA Requirements

For PJM: IC will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

For AEP:

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" document located at the following link:

<http://www.pjm.com/~media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx>

Network Impacts

The Queue Project #Y2-086 was studied as a 62.5MW (Capacity 62.5MW) injection at the Engle 69 kV substation in the AEP area. Project #Y2-086 was evaluated for compliance with reliability criteria for summer peak conditions in 2016. Potential network impacts were as follows:

Generator Deliverability

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

None

Light Load Analysis

Not Applicable

Multiple Facility Contingency

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

None

Short Circuit

(Summary form of Cost allocation for breakers will be inserted here if any)

No Overdutied Breakers Identified

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)

1. The 05CLNCHR-05LEBANO 138 kV line (from bus 242605 to bus 242700 ckt 1) loads from 120.88% to 122.68% (AC power flow) of its normal rating (296 MVA) for non-contingency condition. This project contributes approximately 5.34 MW to the thermal violation.

Please refer to Appendix 8 for a table containing the generators having contribution to this flowgate.

2. The 05LEBANO-05ELKGAZ 138 kV line (from bus 242700 to bus 246766 ckt 1) loads from 135.65% to 135.9% (AC power flow) of its emergency rating (384 MVA) for the line fault with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('1528_C2'). This project contributes approximately 6.01 MW to the thermal violation.

CONTINGENCY '1528_C2'

OPEN BRANCH FROM BUS 242510 TO BUS 242511 CKT 1 / 242510 05BAKER
765 242511 05BROADF 765 1
OPEN BRANCH FROM BUS 242511 TO BUS 242518 CKT 4 / 242511
05BROADF 765 242518 05BROADF 500 4
OPEN BRANCH FROM BUS 242518 TO BUS 360106 CKT 1 / 242518
05BROADF 500 360106 8SULLIVAN TN 500 1
END

Please refer to Appendix 13 for a table containing the generators having contribution to this flowgate.

3. The 05CLNCHR-05LEBANO 138 kV line (from bus 242605 to bus 242700 ckt 1) loads from 138.65% to 138.9% (AC power flow) of its emergency rating (384 MVA) for the line fault with failed breaker contingency outage of CONTINGENCY DESCRIPTION ('1528_C2'). This project contributes approximately 6.01 MW to the thermal violation.

CONTINGENCY '1528_C2'

OPEN BRANCH FROM BUS 242510 TO BUS 242511 CKT 1 / 242510 05BAKER
765 242511 05BROADF 765 1
OPEN BRANCH FROM BUS 242511 TO BUS 242518 CKT 4 / 242511
05BROADF 765 242518 05BROADF 500 4
OPEN BRANCH FROM BUS 242518 TO BUS 360106 CKT 1 / 242518
05BROADF 500 360106 8SULLIVAN TN 500 1
END

Please refer to Appendix 14 for a table containing the generators having contribution to this flowgate.

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

To be determined

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

To be determined

New System Reinforcements

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

None

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

1, 3. The 05CLNCHR-05LEBANO 138 kV line:

Reconductor 0.16 miles of single circuit 1033 conductor section outside of Lebanon Station.

Reconductor 0.06 miles of single circuit 1033 conductor section outside of Clinch River Station.

Replace 1200 A switches at Lebanon Station. Estimated cost: \$765 K (Line), \$28 K (Stations), \$784 K (Total)

2. The 05LEBANO-05ELKGAZ 138 kV line:

Reconductor 0.09 miles of single circuit 1033 conductor section outside Lebanon Station.

Reconductor a single span of 1033 conductor at the Elk Garden Tap. Replace a 1200 A switch at Lebanon Station and Elk Garden Station. Replace 1590 AAC 61 Str. Bus at Lebanon Station.

Estimated cost: \$344 K (Line), \$312 K (Stations), \$656 K (Total)

Delivery of Energy Portion of Interconnection Request

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.

Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

Not Applicable

Appendix A - Load Flow Analysis Results

Y2-086 Contribution to Previously Identified Overloads												
#	Contingency		Facility Description	Bus			Loading %		Rating		MW Contrib.	FG App.
	Type	Name		From	To	PF	Initial	Final	Type	MVA		
1	Non	Non	05CLNCHR-05LEBANO 138 kV line	242605	242700	AC	120.88	122.68	NR	296	5.34	8
2	LFFB	1528_C2	05LEBANO-05ELKGAZ 138 kV line	242700	246766	AC	135.65	135.9	ER	384	6.01	13
3	LFFB	1528_C2	05CLNCHR-05LEBANO 138 kV line	242605	242700	AC	138.65	138.9	ER	384	6.01	14

Contingencies

Contingency Name	Option 1	Description
1528_C2	CONTINGENCY '1528_C2'	
		OPEN BRANCH FROM BUS 242510 TO BUS 242511 CKT 1 / 242510 05BAKER 765 242511 05BROADF 765 1
		OPEN BRANCH FROM BUS 242511 TO BUS 242518 CKT 4 / 242511 05BROADF 765 242518 05BROADF 500 4
		OPEN BRANCH FROM BUS 242518 TO BUS 360106 CKT 1 / 242518 05BROADF 500 360106 8SULLIVAN TN 500 1
	END	

FG Appendix 1

Bus Number	Bus Name	Full Contribution
242570	05BUCHAN	.2
242900	05CRG1L	1.48
242902	05CRG2L	1.48
242904	05CRG3L	62.57
246895	05VACITY	3.95
242851	05WOLF2	.25
244221	INDDRVL	.07
LTF	V3-012	8.2
LTF	X2-042	3.46
LTF	X3-096	2.95
LTF	X3-097	4.19
LTF	X3-098	3.97
LTF	X4-041	3.92
LTF	Y1-004	11.86
LTF	Y1-007	8.24
LTF	Y2-004	2.02
LTF	Y2-005	2.02
LTF	Y2-007	4.03
LTF	Y2-008	3.46
LTF	Y2-033	6.18
LTF	Y2-056	2.12
LTF	Y2-068	21.02
LTF	Y2-082	2.29
914341	Y2-086	5.34

FG Appendix 2

Bus Number	Bus Name	Full Contribution
242900	05CRG1L	1.52
242902	05CRG2L	1.52
242904	05CRG3L	64.24
246895	05VACITY	4.05
244159	BUCK	-.5
244160	BYLLESBY	-1.33
884780	S-058 C	4.85
884781	S-058 E	15.99
LTF	V3-012	17.65
LTF	X2-042	7.95
LTF	X3-020	2.84
LTF	X3-021	2.62
900404	X3-028 C	30.52
LTF	X3-096	6.82
LTF	X3-097	9.67
LTF	X3-098	9.17
LTF	X4-041	9.06
LTF	Y1-002	4.88
LTF	Y1-004	25.29
LTF	Y1-007	17.56
LTF	Y2-004	4.65
LTF	Y2-005	4.65
LTF	Y2-006	3.71
LTF	Y2-007	9.3
LTF	Y2-008	7.84
LTF	Y2-030	3.05
LTF	Y2-031	3.05
LTF	Y2-032	3.05
LTF	Y2-033	13.12
LTF	Y2-040	2.62
LTF	Y2-056	5.34
LTF	Y2-068	48.53
LTF	Y2-082	7.61
914341	Y2-086	6.01

FG Appendix 3

Bus Number	Bus Name	Full Contribution
242900	05CRG1L	1.52
242902	05CRG2L	1.52
242904	05CRG3L	64.24
246895	05VACITY	4.05
244159	BUCK	-.5
244160	BYLLESBY	-1.33
884780	S-058 C	4.85
884781	S-058 E	15.99
LTF	V3-012	17.65
LTF	X2-042	7.95
LTF	X3-020	2.84
LTF	X3-021	2.62
900404	X3-028 C	30.52
LTF	X3-096	6.82
LTF	X3-097	9.67
LTF	X3-098	9.17
LTF	X4-041	9.06
LTF	Y1-002	4.88
LTF	Y1-004	25.29
LTF	Y1-007	17.56
LTF	Y2-004	4.65
LTF	Y2-005	4.65
LTF	Y2-006	3.71
LTF	Y2-007	9.3
LTF	Y2-008	7.84
LTF	Y2-030	3.05
LTF	Y2-031	3.05
LTF	Y2-032	3.05
LTF	Y2-033	13.12
LTF	Y2-040	2.62
LTF	Y2-056	5.34
LTF	Y2-068	48.53
LTF	Y2-082	7.61
914341	Y2-086	6.01