Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC1-074

Jacksonville 138kV

February 2017

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 solar generating facility located in Harrison County, Kentucky. The installed facilities will have a total capability of 80 MW with 56 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is June 1, 2019. **This study does not imply a EKPC commitment to this in-service date.**

Point of Interconnection

AC1-074 will interconnect with the EKPC Transmission system at one of the two following points of interconnection:

Option 1 will connect along the Jacksonville – Renaker 138kV line

Option 2 will connect at the Jacksonville 138kV substation

Cost Summary

The AC1-074 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 3,200,000
Non Direct Connection Network Upgrades	$ 100,000
Total Costs	**$ 3,300,000**

In addition, the AC1-074 project may be responsible for a contribution to the following costs:

Description	Total Cost	
New System Upgrades	$	100,000
Previously Identified Upgrades	$	2,500,000
Total Costs	**$**	**2,600,000**

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

Attachment Facilities

No Attachment Facilities are required to support this interconnection request.

Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Build 138kv switching station at Jacksonville Tap including associated transmission line work. Estimated Time: 18 months	$ 3,200,000
Total Direct Connection Facility Costs	**$ 3,200,000**

Non-Direct Connection Cost Estimate

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
Adjust remote, relaying, and metering settings.	$ 100,000
Total Non-Direct Connection Facility Costs	**$ 100,000**

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.

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.

EKPC Requirements

The Interconnection Customer will be required to comply with all EKPC Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "EKPC Facility Connection Requirements" document located at the following link:

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

Network Impacts

Option 1

The Queue Project AC1-074 was evaluated as a 80.0 MW (Capacity 56.0 MW) injection tapping the Jacksonville-Renaker 138kV line in the EKPC area. Project AC1-074 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-074 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK	CONTINGENCY 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK' OPEN BRANCH FROM BUS 342838 TO BUS 249581 CKT 1 OPEN BRANCH FROM BUS 253077 TO BUS 342838 CKT 1 END

Generator Deliverability

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

None.

Multiple Facility Contingency

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

	Contingency		Affected		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
1	DCTL	P7-1..C5	AEP	AC1-089 TAP-05HILLSB 138 kV line	926100	243019	1	DC	84.47	85.67	ER	185	4.91	1

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

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
2	DCTL	P7-1..C5	EKPC - LGEE	4SPUR-KENT-R-4KENTON 138 kV line	342661	324267	1	DC	104.33	105.07	ER	281	4.61	2
3	DCTL	P7-1..C5	EKPC	4SPURLOCK-4SPUR-KENT-R 138 kV line	342664	342661	1	DC	104.62	105.36	ER	281	4.61	3

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

Short Circuit

(Summary of impacted circuit breakers)

None.

Light Load Analysis - 2020

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

Stability and Reactive Power Requirement

Stability and Reactive study to be completed during later study phases

Steady-State Voltage Requirements

Steady-State Voltage study to be completed during later study phases

Affected System Analysis & Mitigation

LGEE Impacts:

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

MISO Impacts:

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

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

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

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.

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	AC1-089 TAP-05HILLSB 138 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • Reconductor/Rebuild 100 ft section of line. New ratings will be S/N: 383 S/E: 448 The estimated schedule duration is 24-36 months. Cost: $100,000	TBD	**$** 100,000
			Total New Network Upgrades	**$ 100,000**

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
#2, 3	4SPUR-KENT-R-4KENTON 138 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: • Upgrade Spurlock-KU Kenton 138kv series reactor from 1200A at 5% impedance to 1600A at 6.5% impedance; (note: project submitted to 2016 RTEP Window 2; IDV provided). New ratings will be S/N: 259 MVA, S/E: 291 MVA The estimated schedule duration is 24 months. Cost: $2.5 million	TBD	**$ 2,500,000**
			Total New Network Upgrades	**$ 2,500,000**

Network Impacts

Option 2

The Queue Project AC1-074 was evaluated as a 80.0 MW (Capacity 56.0 MW) injection at the Jacksonville 138kV substation in the EKPC area. Project AC1-074 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-074 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK	CONTINGENCY 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK' OPEN BRANCH FROM BUS 342838 TO BUS 249581 CKT 1 OPEN BRANCH FROM BUS 253077 TO BUS 342838 CKT 1 END

Generator Deliverability

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

None.

Multiple Facility Contingency

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

#	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	DCTL	P7-1..C5	AEP	AC1-089 TAP-05HILLSB 138 kV line	926100	243019	1	DC	84.47	85.66	ER	185	4.9	1

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.

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

#	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Ref
2	DCTL	P7-1..C5	EKPC - LGEE	4SPUR-KENT-R-4KENTON 138 kV line	342661	324267	1	DC	104.33	105.07	ER	281	4.59	2
3	DCTL	P7-1..C5	EKPC	4SPURLOCK-4SPUR-KENT-R 138 kV line	342664	342661	1	DC	104.62	105.35	ER	281	4.59	3

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.

Light Load Analysis - 2020

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

Stability and Reactive Power Requirement

Stability and Reactive study to be completed during later study phases

Steady-State Voltage Requirements

Steady-State Voltage study to be completed during later study phases

Affected System Analysis & Mitigation

LGEE Impacts:

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

MISO Impacts:

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

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

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

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.

Attachment 1. Single Line Diagram

Attachment 2. Flowgate Details (Option 1)

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

(AEP - AEP) The AC1-089 TAP-05HILLSB 138 kV line (from bus 926100 to bus 243019 ckt 1) loads from 84.47% to 85.67% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.91 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342910	1DALE 3G	3.78
342911	1DALE 4G	3.88
342957	1SPURLK1G	5.73
916272	Z1-080 E	0.58
924101	AB2-054	26.3

Bus Number	Bus Name	Full Contribution
925981	AC1-074 C OP	3.44
925982	AC1-074 E OP	1.47
926101	AC1-089 C	42.72
926102	AC1-089 E	69.71

Appendix 2

(EKPC - LGEE) The 4SPUR-KENT-R-4KENTON 138 kV line (from bus 342661 to bus 324267 ckt 1) loads from 104.33% to 105.07% (**DC power flow**) of its emergency rating (281 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.61 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342957	1SPURLK1G	9.88
342960	1SPURLK2G	14.39
342963	1SPURLK3G	7.56
342966	1SPURLK4G	7.56

Bus Number	Bus Name	Full Contribution
924101	AB2-054	30.14
925981	AC1-074 C OP	3.23
925982	AC1-074 E OP	1.38

Appendix 3

(EKPC - EKPC) The 4SPURLOCK-4SPUR-KENT-R 138 kV line (from bus 342664 to bus 342661 ckt 1) loads from 104.62% to 105.36% (**DC power flow**) of its emergency rating (281 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.61 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342957	1SPURLK1G	9.88
342960	1SPURLK2G	14.39
342963	1SPURLK3G	7.56
342966	1SPURLK4G	7.56

Bus Number	Bus Name	Full Contribution
924101	AB2-054	30.14
925981	AC1-074 C OP	3.23
925982	AC1-074 E OP	1.38

Attachment 3. Flowgate Details (Option 2)

Appendix 1

(AEP - AEP) The AC1-089 TAP-05HILLSB 138 kV line (from bus 926100 to bus 243019 ckt 1) loads from 84.47% to 85.66% (**DC power flow**) of its emergency rating (185 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.9 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342910	1DALE 3G	3.78
342911	1DALE 4G	3.88
342957	1SPURLK1G	5.73
916272	Z1-080 E	0.58
924101	AB2-054	26.3

Bus Number	Bus Name	Full Contribution
925981	AC1-074 C OP	3.43
925982	AC1-074 E OP	1.47
926101	AC1-089 C	42.72
926102	AC1-089 E	69.71

Appendix 2

(EKPC - LGEE) The 4SPUR-KENT-R-4KENTON 138 kV line (from bus 342661 to bus 324267 ckt 1) loads from 104.33% to 105.07% (**DC power flow**) of its emergency rating (281 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.59 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
342957	1SPURLK1G	9.88
342960	1SPURLK2G	14.39
342963	1SPURLK3G	7.56
342966	1SPURLK4G	7.56

Bus Number	Bus Name	Full Contribution
924101	AB2-054	30.14
925981	AC1-074 C OP	3.21
925982	AC1-074 E OP	1.38

Appendix 3

(EKPC - EKPC) The 4SPURLOCK-4SPUR-KENT-R 138 kV line (from bus 342664 to bus 342661 ckt 1) loads from 104.62% to 105.35% (**DC power flow**) of its emergency rating (281 MVA) for the tower line contingency outage of 'P7-1..C5 4541MELDAHLSPRLCKSTUARTSPURLOCKDPLEK'. This project contributes approximately 4.59 MW to the thermal violation.

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342957	1SPURLK1G	9.88
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342966	1SPURLK4G	7.56

Bus Number	Bus Name	Full Contribution
924101	AB2-054	30.14
925981	AC1-074 C OP	3.21
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