Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AA1-123

Highland-Sammis 345kV

September 2015

Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, 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 System Impact Study is performed.

The System Impact 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

East Ohio Energy, LLC, the Interconnection Customer (IC), has proposed a natural gas generating facility located in Columbiana County, OH. The installed facilities will have a total capability of 1,152 MW with 1,105 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 2019. **This study does not imply a American Transmission Systems, Inc. (ATSI) commitment to this in-service date.**

Point of Interconnection

AA1-123 will interconnect with the ATSI transmission system along the Highland-Sammis 345kV line.

Cost Summary

The AA1-123 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 11,032,500
Non Direct Connection Network Upgrades	$ 878,700
Allocation for New System Upgrades	$ 13,340,000
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 25,251,200**

Attachment Facilities

There are no Attachment Facilities required to be constructed by the Transmission Owner.

Direct Connection Cost Estimate

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

Description	Cost	Tax (if applicable)	Total Cost
AA1-123 Interconnect SS. 345kV three breaker ring bus substation for AA1-123 generation interconnection. *PJM Network Upgrade Number n4694*	$ 8,363,200	$ 2,151,000	$ 10,514,200
Highland-Sammis 345kV, Loop to 3-Bkr Ring Bus for PJM AA1-123. Install a loop, approx. 600' in length, to a new 345kV 3-breaker ring bus substation. *PJM Network Upgrade Number n4695*	$ 2,669,300	$ 685,700	$ 3,355,000
Total Direct Connection Cost Estimate	**$ 11,032,500**	**$ 2,836,700**	**$ 13,869,200**

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below.

Description	Total Cost	Total Cost	Total Cost
Highland SS. Upgrade 345kV line relaying due to AA1-123 generation interconnect substation. *PJM Network Upgrade Number n4696*	$ 459,400	$ 117,600	$ 577,000
Sammis SS. Upgrade 345kV line relaying due to Aax-123 generation interconnect substation. *PJM Network Upgrade Number n4697*	$ 419,300	$ 107,300	$ 526,600
Total Non-Direct Facilities Cost Estimate	**$ 878,700**	**$ 224,900**	**$ 1,103,600**

Schedule

Based on the extent of the FE primary direct connection and system up-grades (breaker replacements) required to support the AA1-123 generation project, it is expected to take a minimum of forty-eight (48) months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This includes the requirement for the Interconnection Customer to make a preliminary payment to FE which funds the first three months of engineering design that is related to the construction of the Direct Connection facilities. It further assumes that the Interconnection Customer will provide all rights-of-way,

permits, easements, etc. that will be needed. A further assumption is that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and that all system outages will be allowed when requested.

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 Interconnection Customer will be responsible for constructing all of the facilities on its side of the POI including the attachment line. The Interconnection Customer may not install above ground equipment within any FirstEnergy right-of-way unless permission to do so is expressly granted by FirstEnergy. The Interconnection Customer will be responsible for acquiring all easements, properties and permits that may be required to construct both the new 345kV three breaker ring bus substation and the associated attachment facilities. The Interconnection Customer will also be responsible for the rough grade of the property and an access road to the proposed three breaker ring bus site.

In addition to the FE facilities, the Interconnection Customer will also be responsible for meeting all criteria as specified in the applicable sections of the FE “Requirements for Transmission Connected Facilities" document including:

1. The purchase and installation of fully rated 345 kV circuit breakers to permit tripping of each entire unit.
2. 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.
3. 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.
4. The establishment of dedicated communication circuits for SCADA to the FE Transmission System Control Center.
5. A compliance with the FE and PJM generator power factor and voltage control requirements.

6. The execution of a back-up service agreement to serve the customer load supplied from the AA1-123 generation project metering point when the units are out-of-service. This assumes the intent of the Interconnection Customer is to net the generation with the load.
7. The 3 mile 345 kV line from the 345 kV Interconnection Substation to the Generator Connection Substation (shown in Attachment 2) will be built at the cost of the developer and owned by the developer.

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.

ATSI 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

Short Circuit Analysis

Short Circuit Values

The preliminary 345kV fault values for the AA1-123 Ring Bus (3 breaker) interconnection location with all new generation (1152MW, two combined cycle combustion/steam turbines) in service are:

Three phase = 43.5kA
Single line to ground = 42.1kA
Z1= (0.067 + j 0.379)%
Z0= (0.050 + j 0.424)%

The 345kV fault values for the AA1-123 Ring Bus interconnection location with all new generation out of service are:

Three phase = 36.0kA
Single line to ground = 29.1kA
Z1= (0.034 + j 0.463)%
Z0= (0.157 + j 0.785)%

Network Impacts

The Queue Project AA1-123 was studied as a 1105.0 MW (Capacity 1105.0 MW) injection into a tap of the Sammis – Z2-028 (segment of Sammis – Highland) 345 kV line in the ATSI area. Project AA1-123 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AA1-123 was studied with a commercial probability of 100% using a Summer Peak 2018 case. 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

Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

None.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

None.

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

#	Area	Bus No.	Bus	Breaker	Rating Type	Duty Percent Without AA1-123	Duty Percent With AA1-123	Duty Percent Difference
1	ATSI	0	SAMMIS 345 345.kV	780-B-298	S	96.77%	104.46%	7.69%
2	ATSI	0	SAMMIS 345 345.kV	BVR VLY-GEN.	S	96.77%	104.46%	7.69%
3	ATSI	0	SAMMIS 345 345.kV	BVR VLY-W. B	S	96.77%	104.46%	7.69%

#	Area	Bus No.	Bus	Breaker	Rating Type	Duty Percent Without AA1-123	Duty Percent With AA1-123	Duty Percent Difference
4	ATSI	0	SAMMIS 345 345.kV	GEN.3-E. BUS	S	96.77%	104.46%	7.69%
5	ATSI	0	SAMMIS 345 345.kV	GEN.4-E. BUS	S	96.77%	104.46%	7.69%
6	ATSI	0	SAMMIS 345 345.kV	GEN.5-E. BUS	S	96.77%	104.46%	7.69%
7	ATSI	0	SAMMIS 345 345.kV	GEN.6-E. BUS	S	96.77%	104.46%	7.69%
8	ATSI	0	SAMMIS 345 345.kV	GEN.7-E. BUS	S	96.77%	104.46%	7.69%
9	ATSI	0	SAMMIS 345 345.kV	HIGHL-GEN.3	S	96.77%	104.46%	7.69%
10	ATSI	0	SAMMIS 345 345.kV	HIGHL-W. BUS	S	96.77%	104.46%	7.69%
11	ATSI	0	SAMMIS 345 345.kV	S. CAN-W. BU	S	96.77%	104.46%	7.69%
12	ATSI	0	SAMMIS 345 345.kV	S.CAN-GEN.5	S	96.77%	104.46%	7.69%
13	ATSI	0	SAMMIS 345 345.kV	STAR-GEN.4 :	S	96.77%	104.46%	7.69%
14	ATSI	0	SAMMIS 345 345.kV	STAR-W. BUS	S	96.77%	104.46%	7.69%
15	ATSI	0	SAMMIS 345 345.kV	WR-GEN.6 : B	S	96.77%	104.46%	7.69%
16	ATSI	0	SAMMIS 345 345.kV	WR-W. BUS :	S	96.77%	104.46%	7.69%
17	APS	20180	WYLIE RG 138.kV	W-3	T	99.63%	100.15%	0.52%
18	APS	20180	WYLIE RG 138.kV	W-8	T	99.63%	100.15%	0.52%

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)

None.

Steady-State Voltage Requirements

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

None.

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

Will be performed during the Facilities Study stage.

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	AA1-123 Allocation
1	SAMMIS 345 345.kV 780-B-298 circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.1	**$ 765,000**	**$ 765,000**
2	SAMMIS 345 345.kV BVR VLY-GEN circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.2	**$ 765,000**	**$ 765,000**
3	SAMMIS 345 345.kV BVR VLY-W. B circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.3	**$ 765,000**	**$ 765,000**
4	SAMMIS 345 345.kV GEN.3-E. BUS circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.4	**$ 765,000**	**$ 765,000**

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AA1-123 Allocation
5	SAMMIS 345 345.kV GEN.4-E. BUS circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.5	**$ 765,000**	**$ 765,000**
6	SAMMIS 345 345.kV GEN.5-E. BUS circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.6	**$ 765,000**	**$ 765,000**
7	SAMMIS 345 345.kV GEN.6-E. BUS circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.7	**$ 765,000**	**$ 765,000**
8	SAMMIS 345 345.kV GEN.7-E. BUS circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.8	**$ 765,000**	**$ 765,000**
9	SAMMIS 345 345.kV HIGHL-GEN.3 circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.9	**$ 765,000**	**$ 765,000**
10	SAMMIS 345 345.kV HIGHL-W. BUS circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.10	**$ 765,000**	**$ 765,000**
11	SAMMIS 345 345.kV S. CAN-W. BU circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.11	**$ 765,000**	**$ 765,000**
12	SAMMIS 345 345.kV S.CAN-GEN.5circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.12	**$ 765,000**	**$ 765,000**
13	SAMMIS 345 345.kV STAR-GEN.4 circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.13	**$ 765,000**	**$ 765,000**
14	SAMMIS 345 345.kV STAR-W. BUS circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.14	**$ 765,000**	**$ 765,000**

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AA1-123 Allocation
15	SAMMIS 345 345.kV WR-GEN.6 : B circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.15	**$ 765,000**	**$ 765,000**
16	SAMMIS 345 345.kV WR-W. BUS :circuit breaker	Replace with an 80kV rated circuit breaker.	N4680.16	**$ 765,000**	**$ 765,000**
17 18	WYLIE RG 138.kV W-3 circuit breaker WYLIE RG 138.kV W-8 circuit breaker	Replace circuit breakers. The replacement is expected to take 18 months to complete.	Pending	**$ 1,100,000**	**$ 1,100,000**
				Total New Network Upgrades	**$ 13,340,000**

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)

None.

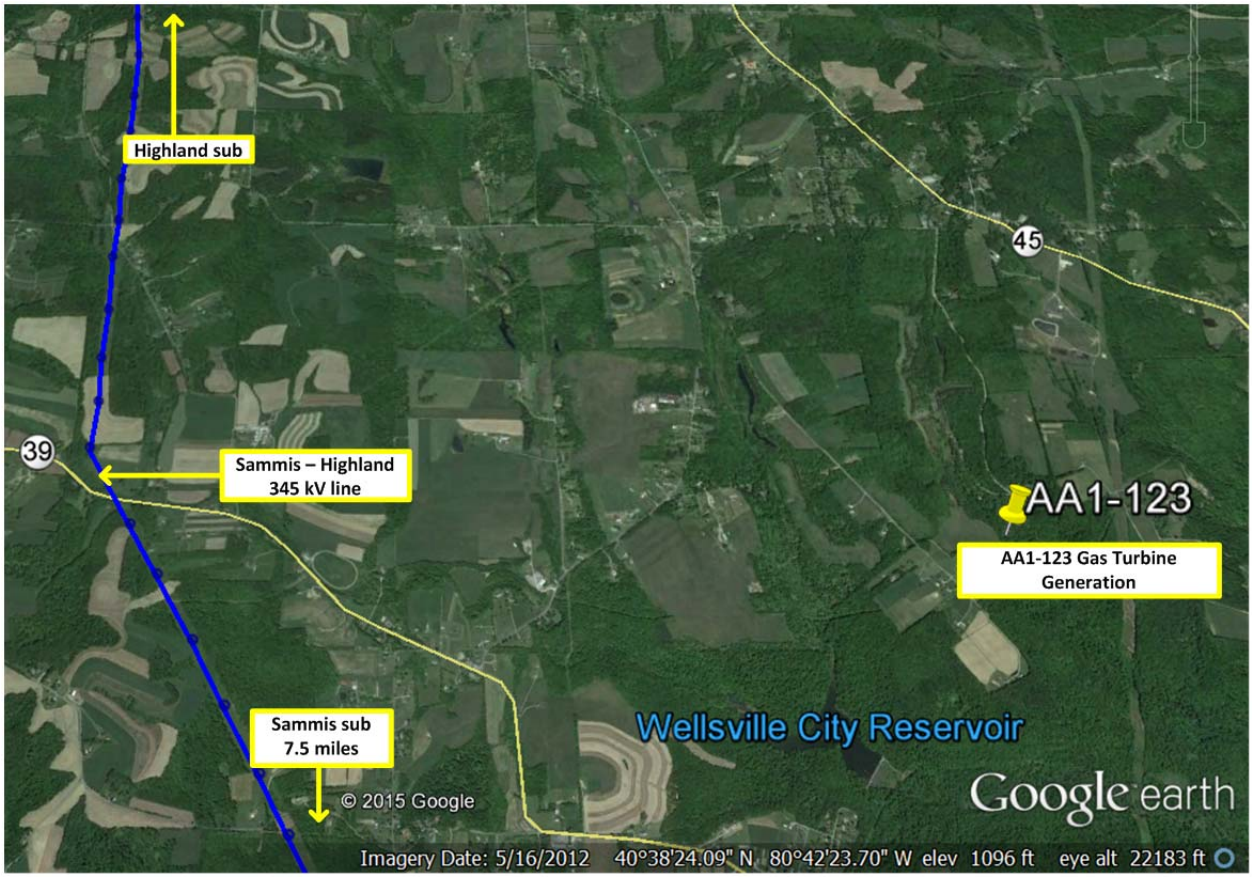
Potential Congestion due to Local Energy Deliverability

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.

None.

Attachment 1. Project Location



Attachment 2. Single Line Diagram