Revised Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AE1-079

Maysville-Sharon 69 kV

February 2019

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/storage generating facility located in Mercer County, PA. The installed facilities will have a total capability of 19.9 MW with 13.5 MW of this output being recognized by PJM as capacity (Solar: 11.9 MWC | Storage:1.6 MWC). The proposed in-service date for this project is June 1, 2020. **This study does not imply a ATSI commitment to this in-service date.**

Point of Interconnection

AE1-079 will interconnect with the ATSI transmission system along one of the following points of interconnection:

1. Maysville - Sharon 69kV line
2. Maysville - Masury 69kV line

Cost Summary

The AE1-079 project will be responsible for the following costs:

Description	Total Cost	
Attachment Facilities	$	233,200
Direct Connection Network Upgrades	$	0
Non Direct Connection Network Upgrades	$	516,400
Total Costs	**$**	**749,600**

The transmission and substation costs given above exclude the Contribution in Aid of Construction ("CIAC") Federal Income Tax Gross up charge. If at a future date Federal CIAC taxes are deemed necessary by the IRS for this project, ATSI shall be reimbursed by the Interconnection Customer for such taxes. ATSI estimates the tax, if applicable, would be approximately $96,200.

In addition, the AE1-079 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 0
Previously Identified Upgrades	$ 0
Total Costs	**$ 0**

General Information

Queue Position: AE1-079

Interconnected Transmission Owner ("TO"): American Transmission Systems, Incorporated ("ATSI")

Impacted TO(s) (if applicable): American Transmission Systems, Incorporated ("ATSI")

PJM Zone: ATSI

FE Operating Company or Planning Region: Penn Power

Customer Connection Request

Requested Backfeed Date: TBD

Requested Commercial Operation Date: 06/01/2020

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

New Facilities		Existing Facilities	
Capacity:	13.5 MW	Capacity:	NA
Energy:	19.9 MW	Energy:	NA
MFO[1]:	19.9 MW	MFO:	NA
Fuel:	Solar, Storage	Prior Queue Position(s):	NA

Point of Interconnection

Primary Point of Interconnection: Maysville-Sharon 69 kV

Secondary Point of Interconnection: Masury-Maysville 69 kV

[1] Maximum Facility Output

Attachment Facilities

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

Description	Activity Cost
Tap the Maysville-Sharon Y-301 69 kV Line at or near structure 62. Install one span of 795 kcmil ACSR towards the customer substation	$ 233,200
Total Attachment Facility Costs	**$ 233,200**

Direct Connection Cost Estimate

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

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	Activity Cost
Tap the Maysville-Sharon Y-301 69 kV Line at or near structure 62. Install two 69 kV line switches with SCADA	$ 466,400
Adjust remote, relaying, and metering settings at the Maysville 69 kV Substation	$ 25,000
Adjust remote, relaying, and metering settings at the Sharon 69 kV Substation	$ 25,000
Total Non-Direct Connection Facility Costs	**$ 516,400**

Transmission Owner Scope of Work

Primary POI

The interconnection of the project at the Primary POI will be accomplished by tapping the Maysville-Sharon 69 kV line and constructing a one span tap. The line tap will be located approximately 1.25 miles from Maysville substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated attachment facilities. The project will also require non-direct connection upgrades at Maysville and Sharon substations.

Based on this scope of work, it is expected to take a minimum of 9 months after the signing of an Interconnection Construction Service Agreement. This include preliminary payment that compensates FE for the first three months of the engineering design work that is related to the

construction of the AE1-079 interconnection substation. This assumes 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 PJM will allow all transmission system outages when requested.

Secondary POI

The interconnection of the project at the Secondary POI will be accomplished by tapping the Masury-Maysville 69 kV line and constructing a one span tap. The line tap will be located approximately 1.25 miles from Maysville substation. A full scope of work or estimated cost is not provided for the Secondary POI.

Interconnection Customer Requirements

1. 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.

2. The Interconnection Customer seeking to interconnect a solar 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.

3. The purchase and installation of a fully rated 69 kV circuit breaker to protect the AE1-079 generator lead line. A single circuit breaker must be used to protect this line; if the project has several GSU transformers, the individual GSU transformer breakers cannot be used to protect this line.

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 AE1-079 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. The IC will also be required to meet all PJM, ReliabilityFirst, and NERC reliability criteria and operating procedures for standards compliance. For example, the IC will need to properly locate and report the over and under voltage and over and under frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to

comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE system.

9. The IC shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) measured at the high-side of the facility substation transformer(s) connected to the FE transmission system.

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.

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.

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.

The IC has requested a non-standard GSU transformer winding configuration. This transformer is in violation of section 14.2.6 of FE's "Requirements for Transmission Connected Facilities" document and will not be accepted. Inverter-based generation that is UL1741 certified for anti-islanding protection connected to the FE Transmission System at <100kV shall have delta or ungrounded wye winding on the transmission side.

Network Impacts

Option 1

The Queue Project AE1-079 was evaluated as a 19.9 MW (Capacity 13.5 MW) injection tapping the Maysville to C.P. Reynolds 69 kV line in the ATSI area. Project AE1-079 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-079 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis – 2022

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Contingency Defintion
ATSI-P2-3-OEE-345-043A_FSA	CONTINGENCY 'DVP_P1-3: 6CAROLNA-TX#4' OPEN BRANCH FROM BUS 314559 TO BUS 314561 CKT 1 /* 3CAROLNA 115.00 - 6CAROLNA 230.00 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)

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
134391	930600	AB1-105 TAP	ATSI	238781	02HANNA	ATSI	1	ATSI-P2-3-OEE-345-043A_FSA	breaker	1672.0	99.89	100.01	DC	4.33

Note: Please see Attachment 1 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)

None

Short Circuit

(Summary of impacted circuit breakers)

None

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

Affected System Analysis & Mitigation

MISO Impacts:

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

Light Load Analysis - 2021

Light Load 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

System Reinforcements

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

(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)

ID	Index	Facility	Upgrade Description	Cost
134391	1	AB1-105 TAP 345.0 kV - 02HANNA 345.0 kV Ckt 1	Description : The Hanna-Highland #1 345 kV Line is currently rated at 1413/1743 MVA (SN/STE). Therefore, the AB1-105 Tap-Hanna 345 kV Line will have similar ratings. Based on a STE rating of 1743, the actual loading of this facility would be 95.9% and is therefore not a violation	$0
		TOTAL COST	$0	

Network Impacts

Option 2

The Queue Project AE1-079 was evaluated as a 19.9 MW (Capacity 13.5 MW) injection tapping the Maysville to Y299 Tap 69 kV line in the ATSI area. Project AE1-079 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-079 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis – 2022

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Contingency Defintion
ATSI-P2-3-OEE-345-043A_FSA	CONTINGENCY 'DVP_P1-3: 6CAROLNA-TX#4' OPEN BRANCH FROM BUS 314559 TO BUS 314561 CKT 1 /* 3CAROLNA 115.00 - 6CAROLNA 230.00 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)

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
134876	930600	AB1-105 TAP	ATSI	238781	02HANNA	ATSI	1	ATSI-P2-3-OEE-345-043A_FSA	breaker	1672.0	99.89	100.02	DC	4.33

Note: Please see Attachment 1 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)

None

Short Circuit

(Summary of impacted circuit breakers)

None

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

Affected System Analysis & Mitigation

MISO Impacts:

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

Light Load Analysis - 2021

Light Load 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

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.

Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
134391	930600	AB1-105 TAP	ATSI	238781	02HANNA	ATSI	1	ATSI-P2-3-OEE-345-043A_FSA	breaker	1672.0	99.89	100.01	DC	4.33

Bus #	Bus	MW Impact
200813	26YOUGH	0.71
200834	26SW_E13_K22	3.78
200835	26DSGENWIN	5.66
200840	26DEEPCRK1	1.4
200841	26DEEPCRK2	1.4
200889	26STNY CRK	0.59
200890	26BF_G21_K23	0.48
200891	26CSLMN_L13	0.75
200892	26LOOKOUT	0.71
202225	26SCI_S29B	0.23
292340	K-022	0.07
292350	K-023	17.43
292542	L-013 1	17.43
293432	R-040 E	0.98
293902	O-048 E	15.68
294903	P-060 E	13.69
913141	Y1-033 C OP1	0.56
913142	Y1-033 E OP1	21.79
917672	Z2-108 E	10.89
932981	AC2-122 C	10.35
932982	AC2-122 E	16.88
938351	AE1-053	5.45
BAYOU	BAYOU	0.26
BIG_CAJUN1	BIG_CAJUN1	0.4

Bus #	Bus	MW Impact
BIG_CAJUN2	BIG_CAJUN2	0.81
BLUEG	BLUEG	1.23
CALDERWOOD	CALDERWOOD	0.14
CANNELTON	CANNELTON	0.07
CATAWBA	CATAWBA	0.09
CBM-N	CBM-N	0.41
CHEOAH	CHEOAH	0.13
CHILHOWEE	CHILHOWEE	0.05
CHOCTAW	CHOCTAW	0.27
COFFEEN	COFFEEN	0.13
COTTONWOOD	COTTONWOOD	1.04
DEARBORN	DEARBORN	0.16
DUCKCREEK	DUCKCREEK	0.27
EDWARDS	EDWARDS	0.12
ELMERSMITH	ELMERSMITH	0.13
FARMERCITY	FARMERCITY	0.08
G-007A	G-007A	0.7
GIBSON	GIBSON	0.05
HAMLET	HAMLET	0.3
NEWTON	NEWTON	0.34
NYISO	NYISO	1.78
O-066A	O-066A	0.34
PRAIRIE	PRAIRIE	0.63
SANTEETLA	SANTEETLA	0.04
SMITHLAND	SMITHLAND	0.05
TATANKA	TATANKA	0.15
TILTON	TILTON	0.15
TRIMBLE	TRIMBLE	0.14
TVA	TVA	0.44
UNIONPOWER	UNIONPOWER	0.2
VFT	VFT	1.92

Attachment 2. Flowgate Details – Option 2

Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
134876	930600	AB1-105 TAP	ATSI	238781	02HANNA	ATSI	1	ATSI-P2-3-OEE-345-043A_FSA	breaker	1672.0	99.89	100.02	DC	4.33

Bus #	Bus	MW Impact
314314	3LOCKS	0.26
314539	3UNCAMP	0.96
314541	3WATKINS	0.28
314557	3BETHELC	0.3
314572	3EMPORIA	0.28
314578	3HORNRTN	1.61
314582	3KELFORD	1.44
314603	3SCOT NK	1.37
314617	3TUNIS	0.35
314620	6CASHIE	0.31
314623	3WITAKRS	0.53
315065	1CHESTF6	33.13
315073	1STONECA	5.69
315074	1HOPCGN1	6.86
315075	1HOPCGN2	6.78
315076	1HOPPOLC	1.36
315077	1HOPHCF1	2.12
315078	1HOPHCF2	2.12
315079	1HOPHCF3	2.12
315080	1HOPHCF4	3.22
315131	1EDGECMA	3.54
315132	1EDGECMB	3.54
900672	V4-068 E	0.13
907092	X1-038 E	2.41
917332	Z2-043 E	0.41
917342	Z2-044 E	0.23
918492	AA1-063AE OP	1.84
918512	AA1-065 E OP	1.71
918562	AA1-072 E	0.07
919692	AA2-053 E	1.79
919701	AA2-057 C	2.88
919702	AA2-057 E	1.44
920042	AA2-088 E OP	4.51
920592	AA2-165 E	0.19
920672	AA2-174 E	0.21
923801	AB2-015 C O1	3.48
923802	AB2-015 E O1	2.85
923851	AB2-025 C	0.43

Bus #	Bus	MW Impact
923852	AB2-025 E	1.13
923911	AB2-031 C O1	1.35
923912	AB2-031 E O1	0.66
923941	AB2-035 C	0.13
923942	AB2-035 E	0.05
923991	AB2-040 C O1	0.76
923992	AB2-040 E O1	3.61
924152	AB2-059 E O1	2.05
924391	AB2-088 C	0.16
924392	AB2-088 E	0.08
924501	AB2-099 C	0.24
924502	AB2-099 E	0.1
924511	AB2-100 C	9.15
924512	AB2-100 E	4.51
924811	AB2-134 C O1	1.34
924812	AB2-134 E O1	7.39
925051	AB2-160 C O1	4.72
925052	AB2-160 E O1	7.7
925061	AB2-161 C O1	2.27
925062	AB2-161 E O1	3.71
925171	AB2-174 C O1	4.38
925172	AB2-174 E O1	3.96
925331	AB2-190 C	12.73
925332	AB2-190 E	5.45
925591	AC1-034 C	2.58
925592	AC1-034 E	1.94
925821	AC1-061	0.01
926071	AC1-086 C	11.96
926072	AC1-086 E	5.44
926201	AC1-098 C	2.59
926202	AC1-098 E	1.55
926211	AC1-099 C	0.87
926212	AC1-099 E	0.51
927141	AC1-208 C	3.92
927142	AC1-208 E	1.74
927221	AC1-216 C O1	5.94
927222	AC1-216 E O1	4.67
930402	AB1-081 E O1	1.45
930862	AB1-132 E O1	3.48
931231	AB1-173 C	0.23
931232	AB1-173 E	0.63
931241	AB1-173AC	0.23
931242	AB1-173AE	0.63
932581	AC2-078 C O1	3.72
932582	AC2-078 E O1	6.07
932591	AC2-079 C O1	2.99
932592	AC2-079 E O1	4.88
932631	AC2-084 C	3.7
932632	AC2-084 E	1.82
933991	AD1-023 C	4.72
933992	AD1-023 E	2.57
934011	AD1-025 C	10.21
934012	AD1-025 E	6.05
934201	AD1-047 C	4.82
934202	AD1-047 E	3.21
934331	AD1-057 C O1	4.69

Bus #	Bus	MW Impact
934332	AD1-057 E O1	2.5
934571	AD1-082 C	5.18
934572	AD1-082 E	2.95
935161	AD1-151 C O1	10.23
935162	AD1-151 E O1	6.82
935211	AD1-156 C	0.47
935212	AD1-156 E	1.8
936041	AD2-007	1.08
936051	AD2-008 C	1.78
936052	AD2-008 E	3.87
936401	AD2-051 C O1	3.56
936402	AD2-051 E O1	1.53
936661	AD2-085 C	1.82
936662	AD2-085 E	2.98
936701	AD2-089 C	2.72
936702	AD2-089 E	1.81
936711	AD2-090 C O1	2.98
936712	AD2-090 E O1	1.99
937571	AD2-169 C	5.77
937572	AD2-169 E	3.85
938171	AE1-026 C1 O	10.21
938172	AE1-026 C2 O	1.48
938173	AE1-026 E O2	3.08
938221	AE1-035 C	0.87
938222	AE1-035 E	0.43
CARR	CARR	0.27
CBM-S1	CBM-S1	2.59
CBM-S2	CBM-S2	3.59
CBM-W1	CBM-W1	1.81
CBM-W2	CBM-W2	16.22
CIN	CIN	0.87
CPLE	CPLE	1.95
G-007	G-007	0.86
IPL	IPL	0.53
LGEE	LGEE	0.25
MEC	MEC	2.19
MECS	MECS	0.44
O-066	O-066	2.86
RENSSELAER	RENSSELAER	0.21
WEC	WEC	0.23