Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-120

EAST FAYETTE 2 138 KV

26.6 MW Capacity / 40 MW Energy

January, 2020

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1 Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the Feasibility Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is American Transmission Systems Inc. (ATSI-Toledo Edison).

2 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. Cost allocation rules for network upgrades can be found in PJM Manual 14A, Attachment B. 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.

An Interconnection Customer 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.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See

Section 4.3 for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

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.

3 General

The Interconnection Customer (IC) has proposed an uprate to a planned solar generating facility located in Fulton County, Ohio. This project is an increase to the Interconnection Customer's AE2-282 project, which will share the same property and point of interconnection. The AF1-120 queue position is a 40 MW uprate (26.6 MW Capacity uprate) to the previous project. The total installed facilities will have a capability of 107 MW with 70.5 MW of this output being recognized by PJM as Capacity (see table below for clarity). The proposed in-service date for this uprate project is June 30, 2022. This study does not imply a TO commitment to this in-service date.

Queue	Maximum Facility Output (MFO) (MW)	Energy (MW)	Capacity (MW)
AE2-282	67	67	43.9
AF1-120	107	40	26.6
Total	**107**	**107**	**70.5**

Queue Number	**AF1-120**
Project Name	EAST FAYETTE 2 138 KV
State	Ohio
County	Fulton
Transmission Owner	ATSI
MFO	107
MWE	40
MWC	26.6
Fuel	Solar
Basecase Study Year	2023

3.1 Point of Interconnection

The AF1-120 project is an uprate to the AE2-282 project. The interconnection of the AE2-282 project will be accomplished by installing a new 138 kV breaker at the FirstEnergy East Fayette 138 kV substation and connecting the East Fayette 138 kV ring bus substation and a new line exit to the Primary POI. 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.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-282/AF1-120 generation project to connect to the FirstEnergy ("FE") transmission system. IC will be responsible for constructing the facilities on its side of the POI, including the attachment facilities which connect the generator to the FE transmission system's direct connection facilities.

3.2 Cost Summary

The AF1-120 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$0
Direct Connection Network Upgrade	$0
Non Direct Connection Network Upgrades	$37,000
Total Costs	$37,000

In addition, the AF1-120 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	**$53,463,100**

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

The Feasibility Study is used to make a preliminary determination of the type and scope of Attachment Facilities, Local Upgrades, and Network Upgrades that will be necessary to accommodate the Interconnection Request and to provide the Interconnection Customer a preliminary estimate of the time that will be required to construct any necessary facilities and upgrades and the Interconnection Customer's cost responsibility. The System Impact Study provides refined and comprehensive estimates of cost responsibility and construction lead times for new facilities and system upgrades. Facilities Studies will include, commensurate with the degree of engineering specificity as provided in the Facilities Study Agreement, good faith estimates of the cost, determined in accordance with Section 217 of the Tariff,

(a) to be charged to each affected New Service Customer for the Facilities and System Upgrades that are necessary to accommodate this queue project;

(b) the time required to complete detailed design and construction of the facilities and upgrades; and

(c) a description of any site-specific environmental issues or requirements that could reasonably be anticipated to affect the cost or time required to complete construction of such facilities and upgrades.

The costs provided above exclude the Contribution in Aid of Construction ("CIAC") Federal Income Tax Gross Up charge. If, at a future date, it is determined that the CIAC Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

The required Attachment Facilities and Direct and Non-Direct Connection work for the interconnection of the AF1-120 generation project to the FE Transmission System is detailed in the following sections. The associated one-line with the generation project Attachment Facilities and the Primary Direct and Non-Direct Connection facilities are shown in Attachment 1.

4 Transmission Owner Scope of Work

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The AF1-120 project is an uprate to the AE2-282 project. The interconnection of the AE2-282 project will be accomplished by installing a new 138 kV breaker at the FirstEnergy East Fayette 138 kV substation and connecting the East Fayette 138 kV ring bus substation and a new line exit to the Primary POI. 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

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-282/AF1-120 generation project to connect to the FirstEnergy ("FE") transmission system. IC will be responsible for constructing the facilities on its side of the POI, including the attachment facilities which connect the generator to the FE transmission system's direct connection facilities.

5 Attachment Facilities

There is no Attachment Facility scope of work required.

6 Direct Connection Cost Estimate

There is no Direct Connection scope of work required.

7 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
Engineering Review	$ 10,000
Relay settings updates at East Fayette	$ 27,000
Total Non-Direct Connection Facility Costs	**$ 37,000**

8 Schedule

Based on the scope of work for the Non-Direct Connection facilities, it is expected to take a minimum of **6 months** after the signing of an Interconnection Construction Service Agreement to complete the identified work. If this project is done together with AE2-282, the schedule can be improved.

The schedule for the required Network Impact Reinforcements will be more clearly identified in future study phases. The estimate elapsed time to complete each of the required reinforcements is identified in the "System Reinforcements" section of the report.

9 Transmission Owner Analysis

9.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AF1-120 project did not contribute to any overloads on the FE transmission system.

10 Interconnection Customer Requirements

10.1 System Protection

The IC must design its 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.

10.2 Compliance Issues and Interconnection

The proposed Customer Facilities must be designed in accordance with FE's "Requirements for Transmission Connected Facilities" document located at: http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx. In particular, the IC is responsible for the following:

1. The purchase and installation of a fully rated 138 kV circuit breaker to protect the AE2-282 and AF1-120 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.
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. Compliance with the FE and PJM generator power factor and voltage control requirements.
5. The execution of a back-up service agreement to serve the customer load supplied from the AE2-285 and AF1-120 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.

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.

10.3 Power Factor Requirements

The existing proposed AE2-282 Solar-powered 67 MW portion of the Customer Facility shall retain 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. The increase of 40 MW to the Solar-powered Customer Facility associated with AF1-120 project shall be designed with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs).

11 Revenue Metering and SCADA Requirements

11.1 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 Section 8 of Attachment O.

1.1.1 Meteorological Data Reporting Requirement

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

11.2 ATSI Requirements

The IC will be required 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

12 Network Impacts

The Queue Project AF1-120 was evaluated as a 40.0 MW (Capacity 26.6 MW) injection at the East Fayette 138 kV substation in the ATSI area. Project AF1-120 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-120 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

13 Generation Deliverability

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
43447775	256000	18ARGNTA	345.0	METC	243234	05TWIN B	345.0	AEP	1	AEP_P1-2_#7021	single	956.0	99.86	100.02	DC	1.48

14 Multiple Facility Contingency

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

None

15 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)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
40987391	239070	02RICHLD	138.0	ATSI	239165	02WAUSEO	138.0	ATSI	1	AEP_P7-1_#10983-B	tower	190.0	101.28	103.69	DC	4.57

16 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

17 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
43447775	1	**18ARGNTA 345.0 kV - 05TWIN B 345.0 kV Ckt 1**	**AEPI0013a : Argentum-Twin Branch 345 kV Line: 1)A Sag Study will be required on the 51.4mile section of line to mitigate the overload . Depending on the sag study results, cost for this upgrade is expected to be between $205,600 (no remediations required just sag study) and $102.8 million (complete line reconductor/rebuild required).** **Project Type : FAC** **Cost : $205,600** **Time Estimate : 6-12 Months**	$205,600
40987391	2	**02RICHLD 138.0 kV - 02WAUSEO 138.0 kV Ckt 1**	**TE-011A (1385) : Richland-Wauseon 138 kV Line: Reconductor with 336 ACSS (approx 26.3 miles). This project is dependent on the s1698 project Richland-Wauseon-Midway 138 kV Three-Terminal Elimination project (ISD 12/31/2020)** **Project Type : FAC** **Cost : $53,257,500** **Time Estimate : 36.0 Months**	$53,257,500
			TOTAL COST	**$53,463,100**

18 Flow Gate Details

The following indices contain additional information about each flowgate presented in the body of the report. For each index, 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.

18.1 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
43447775	256000	18ARGNTA	METC	243234	05TWIN B	AEP	1	AEP_P1-2_#7021	single	956.0	99.86	100.02	DC	1.48

Bus #	Bus	MW Impact
238564	02BAYSG1	1.2513
238670	**02DVBSG1 (Deativation : 05/31/20)**	**4.7571**
238885	02LEMOG1	1.2913
238886	02LEMOG2	1.2913
238887	02LEMOG3	1.2913
238888	02LEMOG4	1.2913
238979	02NAPMUN	2.0428
239202	02STRYCT	0.0921
239293	02BS-PKR	0.1092
241902	Y1-069 GE	7.0651
247528	05COVRT1	3.3841
247529	05COVRT2	3.3841
247530	05COVRT3	3.3841
247531	05COVRT4	2.0311
247532	05COVRT5	2.0311
247533	05COVRT6	2.0311
925961	AC1-072	0.3139
931951	AB1-107 1	15.7317
931961	AB1-107 2	35.4908
934891	AD1-118	4.0474
936601	AD2-075	16.3053
938911	AE1-119	31.8010
941781	AE2-181 C	1.5491
942661	AE2-282 C O1	2.4470
943961	AF1-064 C O1	1.8878
944551	AF1-120 C	1.4827
945401	AF1-205 C O1	1.3250
945411	AF1-206 C O1	6.6554
950311	G934 C	3.7995
950351	J466	3.1329
950791	J201 C	0.4444
950871	J246 C	0.1728
951531	J533 C	4.9364
951571	J538 C	3.1212
951941	J602 C	3.5527
952161	J571	1.0017
952201	J589 C	3.8039
952401	J752 C	1.6500
952611	J717 C	3.6497
952761	J728 C	3.3942
952881	J758	29.2420
952971	J793	128.0886

Bus #	Bus	MW Impact
953071	J794 C	0.2331
953271	J701 C	0.8116
953291	J796	27.3583
953321	J799	16.1708
953361	J806	20.1567
953421	J841	80.2667
953771	J832	12.5070
953781	J833	8.4720
953811	J839	9.9020
953941	J857	17.5642
954111	J875	14.9790
954381	J906 C	2.2094
954591	J937	98.3705
955021	J978 C	2.0458
955071	J984 C	3.9515
955121	J989	8.6840
955181	J996	6.8296
955261	J1005	22.8880
955341	J1013	9.4360
955351	J1014 C	5.9140
955591	J1043 C	2.6076
955621	J1046	3.5670
955721	J1056 C	2.4685
955781	J1062	14.2680
955801	J1064 C	4.1755
955811	J1065 C	3.9512
955831	J1068 C	2.7459
955861	J1071	14.0350
955961	J1083	8.9824
956011	J1088	17.4090
956021	J1089	19.5925
956031	J1090	10.9260
956161	J1103	2.1236
956291	J1117	9.9536
956301	J1119	72.8880
956741	J1172	5.5100
956751	J1173	7.7128
956801	J1178	8.3408
DUCKCREEK	DUCKCREEK	2.8960
NEWTON	NEWTON	1.8857
FARMERCITY	FARMERCITY	0.1171
G-007A	G-007A	1.4265
VFT	VFT	3.8571
CBM-W1	CBM-W1	28.3351
PRAIRIE	PRAIRIE	4.4970
COFFEEN	COFFEEN	1.0327
EDWARDS	EDWARDS	0.9149
CHEOAH	CHEOAH	0.3569
TILTON	TILTON	1.2304
GIBSON	GIBSON	0.7759
CALDERWOOD	CALDERWOOD	0.3598
BLUEG	BLUEG	1.8940

Bus #	Bus	MW Impact
TRIMBLE	TRIMBLE	0.6021
CATAWBA	CATAWBA	0.1386

18.2 Index 2

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
40987391	239070	02RICHLD	ATSI	239165	02WAUSEO	ATSI	1	AEP_P7-1_#10983-B	tower	190.0	101.28	103.69	DC	4.57

Bus #	Bus	MW Impact
238979	02NAPMUN	2.1002
239064	02RICHG1	0.6855
239065	02RICHG2&3	1.3657
239067	02RICHG4	7.3530
239068	02RICHG5	7.3530
239069	02RICHG6	7.3530
239202	02STRYCT	0.2457
926941	AC1-181	0.3116
940841	AE2-072 C	40.0275
940842	AE2-072 E	26.6850
941781	AE2-181 C	3.6253
941782	AE2-181 E	2.4169
942661	AE2-282 C O1	5.0204
942662	AE2-282 E O1	2.6417
944551	AF1-120 C	3.0420
944552	AF1-120 E	1.5324
945401	AF1-205 C O1	0.7220
945402	AF1-205 E O1	0.4814
945411	AF1-206 C O1	13.6546
945412	AF1-206 E O1	9.1031
DUCKCREEK	DUCKCREEK	0.1128
NEWTON	NEWTON	0.1053
FARMERCITY	FARMERCITY	0.0055
NY	NY	0.0531
PRAIRIE	PRAIRIE	0.2531
O-066	O-066	0.6384
COFFEEN	COFFEEN	0.0518
EDWARDS	EDWARDS	0.0343
CHEOAH	CHEOAH	0.0485
TILTON	TILTON	0.0617
G-007	G-007	0.0988
GIBSON	GIBSON	0.0535
CALDERWOOD	CALDERWOOD	0.0482
BLUEG	BLUEG	0.1684
TRIMBLE	TRIMBLE	0.0540
CATAWBA	CATAWBA	0.0336

Affected Systems

19 Affected Systems

19.1 LG&E

LG&E Impacts to be determined during later study phases (as applicable).

19.2 MISO

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

19.3 TVA

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

19.4 Duke Energy Progress

Duke Energy Progress Impacts to be determined during later study phases (as applicable).

19.5 NYISO

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

20 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P1-2_#7021	CONTINGENCY 'AEP_P1-2_#7021' OPEN BRANCH FROM BUS 243212 TO BUS 247803 CKT 1 / 243212 05BENTON 345 247803 05SEGRETO 345 1 END
AEP_P7-1_#10983-B	CONTINGENCY 'AEP_P7-1_#10983-B' OPEN BRANCH FROM BUS 239070 TO BUS 243029 CKT 1 / 239070 02RICHLD 138 243029 05LCKWRD 138 1 OPEN BRANCH FROM BUS 940840 TO BUS 242993 CKT 1 / 239269 AE2-072 TAP 138 242993 05E.LPSC 138 1 OPEN BRANCH FROM BUS 242993 TO BUS 893021 CKT 1 / 242993 05E.LPSC 138 893021 V2-006 C 138 1 OPEN BRANCH FROM BUS 242971 TO BUS 243029 CKT 1 / 242971 05BRYAN 138 243029 05LCKWRD 138 1 REMOVE SWSHUNT FROM BUS 243029 / 243029 05LCKWRD 138 END

Short Circuit

21 Short Circuit

The following Breakers are overduty:

None

22 Attachment One: One Line Diagram