Generation Interconnection

Feasibility Study Report

for

Queue Project AG1-122

LONDON-NATIONAL 138 KV

41.9 MW Capacity / 70 MW Energy

January 2021

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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 ATSI.

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.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

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 a Solar generating facility located in Madison County, Ohio. The installed facilities will have a total capability of 70 MW with 41.9 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 01, 2024. This study does not imply a TO commitment to this in-service date.

Queue Number	AG1-122
Project Name	LONDON-NATIONAL 138 KV
State	Ohio
County	Madison
Transmission Owner	ATSI
MFO	70
MWE	70
MWC	41.9
Fuel	Solar
Basecase Study Year	2024

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

AG1-122 will interconnect with the ATSI system by tapping the London – Tangy 138 kV line between London and National. The interconnection of the project at the Primary POI will be accomplished by constructing a new 138 kV three (3) breaker ring bus substation and looping the London-Tangy 138 kV line into the new station. The new substation will be located approximately 2.3 miles from London Substation.

5 Cost Summary

The AG1-122 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$10,660,000
Total System Network Upgrade Costs	$36,221,600[1]
Total Costs	$46,881,600

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 2016-36, 2016-25 I.R.B. (6/20/2016). If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

Cost allocations for any System Upgrades will be provided in the System Impact Study Report.

[1] This project currently causes and/or contributes to overloads of the Transmission System (see Summer Peak Load Flow Analysis section below) and therefore has potential to have cost allocation for the system reinforcements listed in the report. This will be re-evaluated in the System Impact phase. The results may vary with queue customers withdrawing from the queue and other generators deactivating over time. If a customer is the first to cause the need for a project (causes loading to exceed 100% of rating), then the customer is responsible. If a customer contributes to a facility that is already overloaded by a prior queue, then they may receive cost allocation.

6 Transmission Owner Scope of Work

AG1-122 will interconnect with the ATSI system. The interconnection of the project at the Primary POI will be accomplished by constructing a new 138 kV three (3) breaker ring bus substation and looping the London-Tangy 138 kV line into the new station. The new substation will be located approximately 2.3 miles from London Substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection switching station and the associated facilities. The IC will also be responsible for the rough grade of the property and an access road to the proposed three-breaker ring bus site. The project will also require Non-Direct Connection upgrades at London Substation and Tangy Substation.

Attachment 1 shows a one-line diagram of the proposed primary Direct Connection Facilities for the AG1-122 generation project to connect to the FirstEnergy ("FE") Transmission system. The 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.

The total physical interconnection costs is given in the table below:

Description	**Total Cost**
Install disconnect switch, dead-end structure, and associated facilities for generator lead line exit at interconnection substation	$320,000
Construct 138 kV three breaker ring bus interconnection substation	$5,970,000
Loop the London-Tangy 138 kV Line into the new substation	$820,000
Install OPGW to London substation	$2,030,000
Upgrade relaying at London substation	$760,000
Upgrade relaying at Tangy substation	$760,000
Total Physical Interconnection Costs	$10,660,000

7 Schedule

Based on the scope of work for the Attachment Facilities and the Direct and/or Non-Direct Connection facilities, it is expected to take a minimum of 24 months after the signing of an Interconnection Construction Service Agreement to complete the installation. 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 all transmission system outages will be allowed when requested.

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

If the customer is ultimately responsible for network upgrades, then the schedule for those upgrades will be refined in future study phases. The customer would need to wait for those upgrades to be completed prior to commercial operation unless determined deliverable by an interim deliverability study. The elapsed time to complete any network upgrades is provided in the System Reinforcements table of this report.[1]

8 Transmission Owner Analysis

8.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AG1-122 project did not contribute to any overloads on the FE Transmission System.

9 Interconnection Customer Requirements

9.1 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.

9.2 Compliance Issues and Interconnection Customer Requirements

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 AG1-122 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 AG1-122 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 Transmission System.

9.3 Power Factor Requirements

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.

10 Revenue Metering and SCADA Requirements

10.1 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.

10.2 Meteorological Data Reporting Requirements

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

- Back Panel temperature (Fahrenheit) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Irradiance (Watts/meter2) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Ambient air temperature (Fahrenheit) - (Accepted, not required)
- Wind speed (meters/second) - (Accepted, not required)
- Wind direction (decimal degrees from true north) - (Accepted, not required)

10.3 Interconnected Transmission Owner Requirements

The IC will be required to comply with all Interconnected Transmission Owner's revenue metering requirements for generation interconnection customers located at the following link:

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

11 Summer Peak - Load Flow Analysis

The Queue Project AG1-122 was evaluated as a 70.0 MW (Capacity 41.9 MW) injection tapping the London to Tangy 138 kV line in the ATSI area. Project AG1-122 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-122 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

11.1 Generation Deliverability

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

None

11.2 Multiple Facility Contingency

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

None

11.3 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
161485697	926010	AC1-078 TAP	138.0	ATSI	243469	05BEATTY	138.0	AEP	1	ATSI-P2-2-OES-138-054	bus	242.0	125.09	143.53	DC	44.63
161485911	926010	AC1-078 TAP	138.0	ATSI	243469	05BEATTY	138.0	AEP	1	ATSI-P7-1-OES-138-066B-B	tower	242.0	122.97	142.99	DC	48.45
161485912	926010	AC1-078 TAP	138.0	ATSI	243469	05BEATTY	138.0	AEP	1	ATSI-P7-1-OES-138-066A-B	tower	242.0	119.13	139.15	DC	48.45
164285139	926010	AC1-078 TAP	138.0	ATSI	243469	05BEATTY	138.0	AEP	1	ATSI-P2-4-OES-138-047	breaker	242.0	119.14	139.16	DC	48.45

11.4 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.

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONTNAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
16428543 3	926010	AC1-078 TAP	138.0	ATSI	243469	05BEATTY	138.0	AEP	1	Base Case	operation	200.0	124.86	141.64	DC	33.56
16428543 4	926010	AC1-078 TAP	138.0	ATSI	243469	05BEATTY	138.0	AEP	1	ATSI-P1-2-OES-138-022A-A	operation	242.0	116.33	134.05	DC	42.88

11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
161485912,161485697,161485911,164285139	1	**AC1-078 TAP 138.0 kV - 05BEATTY 138.0 kV Ckt 1**	**AEP** **AEPO0002a (260) : AEP Only: Upgrade relaying at Beatty** **Project Type : FAC** **Cost : $200,000** **Time Estimate : 12-18 Months** **AEPO0002b (261) : Upgrade/Replace 138 kV 1200A wave trap at Beatty station** **Project Type : FAC** **Cost : $100,000** **Time Estimate : 12-18 Months** **ATSI** **OES-007C (1094) : Reconductor approx. 14 miles of Beatty-London 138 kV, from AC1-078 to Beatty. Replace Sub Conductor, Replace TL drop, Replace Free standing CT TL Drop, Replace wavetrap, and Replace Sub Conductor.** **Project Type : FAC** **Cost : $35,921,600** **Time Estimate : 66.0 Months**	$36,221,600
			TOTAL COST	**$36,221,600[1]**

11.6 Flow Gate Details

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

11.6.1 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
161485697	926010	AC1-078 TAP	ATSI	243469	05BEATTY	AEP	1	ATSI-P2-2-OES-138-054	bus	242.0	125.09	143.53	DC	44.63

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
926014	AC1-078 C	52.5908	50/50	52.5908
926016	AC1-078 E	87.6513	50/50	87.6513
934561	AD1-081 C	10.5182	50/50	10.5182
934562	AD1-081 E	5.4184	50/50	5.4184
935044	AD1-140 C	14.6172	50/50	14.6172
935045	AD1-140 E	12.0843	50/50	12.0843
937240	AD2-163_C1	18.4321	50/50	18.4321
937241	AD2-163_C2	18.4321	50/50	18.4321
937248	AD2-163_E1	9.0557	50/50	9.0557
937249	AD2-163_E2	9.0557	50/50	9.0557
942051	AE2-217 C	57.4398	50/50	57.4398
942052	AE2-217 E	38.2932	50/50	38.2932
942621	AE2-278 C	19.4595	50/50	19.4595
942622	AE2-278 E	12.9802	50/50	12.9802
942861	AE2-305 C	8.8653	50/50	8.8653
942862	AE2-305 E	5.9102	50/50	5.9102
943131	AE2-342 C	2.7524	50/50	2.7524
943132	AE2-342 E	1.3556	50/50	1.3556
943851	AF1-053 C	3.0309	50/50	3.0309
943852	AF1-053 E	4.5463	50/50	4.5463
943861	AF1-054 C	4.3758	50/50	4.3758
943862	AF1-054 E	2.9172	50/50	2.9172
958291	AF2-123 C	13.1333	50/50	13.1333
958292	AF2-123 E	18.1061	50/50	18.1061
962231	AG1-068 C O1	19.4450	50/50	19.4450
962232	AG1-068 E O1	12.3683	50/50	12.3683
962731	AG1-122 C	26.7129	50/50	26.7129
962732	AG1-122 E	17.9149	50/50	17.9149
963961	AG1-249 C	5.7005	50/50	5.7005
963962	AG1-249 E	3.8003	50/50	3.8003
WEC	WEC	0.0813	Confirmed LTF	0.0813
LGEE	LGEE	0.3192	Confirmed LTF	0.3192
CPLE	CPLE	0.0027	Confirmed LTF	0.0027
CBM-W2	CBM-W2	2.4909	Confirmed LTF	2.4909
NY	NY	0.0857	Confirmed LTF	0.0857
TVA	TVA	0.2996	Confirmed LTF	0.2996
O-066	O-066	1.0230	Confirmed LTF	1.0230
SIGE	SIGE	0.0611	Confirmed LTF	0.0611
CBM-S2	CBM-S2	0.4489	Confirmed LTF	0.4489
CBM-S1	CBM-S1	0.1015	Confirmed LTF	0.1015
G-007	G-007	0.1596	Confirmed LTF	0.1596

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
MEC	MEC	0.4179	Confirmed LTF	0.4179
LAGN	LAGN	0.3797	Confirmed LTF	0.3797
CBM-W1	CBM-W1	3.2106	Confirmed LTF	3.2106

11.7 Queue Dependencies

The Queue Projects below are listed in one or more indices for the overloads identified in your report. These projects contribute to the loading of the overloaded facilities identified in your report. The percent overload of a facility and cost allocation you may have towards a particular reinforcement could vary depending on the action of these earlier projects. The status of each project at the time of the analysis is presented in the table. This list may change as earlier projects withdraw or modify their requests.

Queue Number	Project Name	Status
AC1-078	Beatty-London 138kV	Active
AD1-081	Beatty-London 138 kV	Active
AD1-140	Greene-Clark 138 kV	Active
AD2-163	Broadview-Tangy 138 kV	Active
AE2-217	East Springfield-London 138 kV	Active
AE2-278	Urbana 138 kV	Active
AE2-305	Givens-Mechanicsburg 138 kV	Active
AE2-342	Woodstock 69 kV	Active
AF1-053	Givens-Mechanicsburg 138 kV	Active
AF1-054	Givens-Mechanicsburg 138 kV	Active
AF2-123	National-Tangy 138 kV	Active
AG1-068	London-Tangy 69 kV	Active
AG1-122	London-National 138 kV	Active
AG1-249	Mechanicsburg-Darby 138 kV	Active

11.8 Contingency Descriptions

Contingency Name	Contingency Definition
ATSI-P1-2-OES-138-022A-A	CONTINGENCY 'ATSI-P1-2-OES-138-022A-A' /* LONDON - TANGY 138KV LINE FAULT DISCONNECT BRANCH FROM BUS 958290 TO BUS 239134 CKT 1 /* AF2-123 TAP 138 02TANGY 138 END
ATSI-P7-1-OES-138-066B-B	CONTINGENCY 'ATSI-P7-1-OES-138-066B-B' /* E. SPFD-LONDON 1 & N TITUS-LONDON COMMON TOWER DISCONNECT BRANCH FROM BUS 942050 TO BUS 238703 CKT 1 /* AE2-217 TAP 138 02ESPRNG 138 DISCONNECT BRANCH FROM BUS 240709 TO BUS 238908 CKT 1 /* 02N TITUS 138 02LONDON 138 END
ATSI-P2-2-OES-138-054	CONTINGENCY 'ATSI-P2-2-OES-138-054' /* TANGY 138 BUS FAULT DISCONNECT BRANCH FROM BUS 239134 TO BUS 239264 CKT 1 /* 02TANGY 138 02DBP 138 DISCONNECT BRANCH FROM BUS 239134 TO BUS 239218 CKT 1 /* 02TANGY 138 02SSCIOT 138 DISCONNECT BRANCH FROM BUS 239134 TO BUS 238574 CKT 1 /* 02TANGY 138 02BELPT+ 138 DISCONNECT BRANCH FROM BUS 239134 TO BUS 958290 CKT 1 /* 02TANGY 138 AF2-123 TAP 138 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 3 /* 02TANGY 345 02TANGY 138 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 4 /* 02TANGY 345 02TANGY 138 DISCONNECT BRANCH FROM BUS 239133 TO BUS 239134 CKT 5 /* 02TANGY 345 02TANGY 138 DISCONNECT BRANCH FROM BUS 239134 TO BUS 239135 CKT 1 /* 02TANGY 138 02TANGY 69 DISCONNECT BRANCH FROM BUS 239134 TO BUS 239135 CKT 2 /* 02TANGY 138 02TANGY 69 END

Contingency Name	Contingency Definition
ATSI-P2-4-OES-138-047	CONTINGENCY 'ATSI-P2-4-OES-138-047' /* EAST SPRINGFIELD TIE BREAKER B-265 DISCONNECT BRANCH FROM BUS 238703 TO BUS 238529 CKT 1 /* 02ESPRNG 138 02AIRPK+ 138 DISCONNECT BRANCH FROM BUS 238703 TO BUS 942050 CKT 1 /* 02ESPRNG 138 AE2-217 TAP 138 DISCONNECT BRANCH FROM BUS 238703 TO BUS 240709 CKT 1 /* 02ESPRNG 138 02N TITUS 138 DISCONNECT BRANCH FROM BUS 238703 TO BUS 238677 CKT 4 /* 02ESPRNG 138 02E.SPFL 69 DISCONNECT BRANCH FROM BUS 238703 TO BUS 238677 CKT 5 /* 02ESPRNG 138 02E.SPFL 69 DISCONNECT BRANCH FROM BUS 238703 TO BUS 238677 CKT 6 /* 02ESPRNG 138 02E.SPFL 69 REDUCE BUS 238703 SHUNT BY 100 PERCENT /* 02ESPRNG 138 DISCONNECT BUS 238703 /* 02ESPRNG 138 END
Base Case	
ATSI-P7-1-OES-138-066A-B	CONTINGENCY 'ATSI-P7-1-OES-138-066A-B' /* E. SPFD-LONDON 1 & E. SPFD-N TITUS COMMON TOWER DISCONNECT BRANCH FROM BUS 942050 TO BUS 238703 CKT 1 /* AE2-217 TAP 138 02ESPRNG 138 DISCONNECT BRANCH FROM BUS 238703 TO BUS 240709 CKT 1 /* 02ESPRNG 138 02N TITUS 138 END

12 Short Circuit Analysis

The following Breakers are overdutied:

None

12.1 System Reinforcements - Short Circuit

None

13 Affected Systems

13.1 NYISO

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

13.2 MISO

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