Generation Interconnection

Feasibility Study Report

for

Queue Project AG1-012

MEADOW BROOK-STRASBURG 138 KV II

0 MW Capacity / 0 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 APS.

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 an uprate to a planned/existing Solar; Storage generating facility located in Frederick, Virginia. This project is an increase to the Interconnection Customer's AD1-155 project, which will share the same point of interconnection. The AG1-012 queue position is a 0 MW uprate (0 MW Capacity uprate) to the previous project. The total installed facilities will have a capability of 75 MW with 37.2 MW of this output being recognized by PJM as Capacity. 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 Number	AG1-012
Project Name	MEWDOW BROOK-STRASBURG 138 KV II
State	Virginia
County	Frederick
Transmission Owner	APS
MFO	75
MWE	0
MWC	0
Fuel	Solar; Storage
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

4.1 Primary Point of Interconnection

AG1-012 will interconnect with the APS transmission system as an uprate to AD1-155 which is tapping the Meadow Brook to Strasburg 138 kV line. Battery storage facility will require charging the facility from the transmission system. The IC will be responsible for acquiring all easements, properties, and permits that may be required.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AG1-012 generation project to connect to the FirstEnergy ("FE") transmission system. IC will be responsible for constructing all of the facilities on its side of the POI, including the Attachment facilities which connect the generator to the FE transmission system.

4.2 Secondary Point of Interconnection

There is no secondary point of interconnection specified for AG1-012.

5 Cost Summary

The AG1-012 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$40,000
Total System Network Upgrade Costs	$896,700[1]
Total Costs	$936,700

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

AG1-012 will interconnect with the APS transmission system as an uprate to AD1-155 which is tapping the Meadow Brook to Strasburg 138 kV line. Battery storage facility will require charging the facility from the transmission system.

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

Description	Total Cost
Appropriate terminal equipment upgrades required to accommodate higher generation output.	$20,000
Review of relay settings/ protection settings at AD1-155 138 kV required.	$20,000
Total Physical Interconnection Costs	$40,000

7 Schedule

Based on the scope of work for the interconnection facilities, it is expected to take a minimum of **5 months** after the signing of an Interconnection Construction Service Agreement and construction kickoff call 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.

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 AG1-012 project did not contribute to any overloads on the FE transmission <100 kV system.

9 Interconnection Customer Requirements

9.1 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.

All new generator only and new generator plus load facilities must be isolated from the FE transmission System by a Power Transformer. Section 14.2.6 of FE's "Requirements for Transmission Connected Facilities" document specifies the winding configurations of the transformer connecting to a non-effectively grounded portion of the FE Transmission system shall be determined by FE on a case-by-case basis.

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 AG1-012 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 AG1-012 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.

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 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 AG1-012 was evaluated as a 0.0 MW (Capacity 0.0 MW) injection and 30 MWs of storage chargining as an uprate to AD1-155 which is tapping the Meadow Brook to Strasburg 138 kV line in the APS area. Project AG1-012 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-012 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)

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
165472277	235483	01MDWBRK	138.0	AP	935200	AD1-155 TAP	138.0	AP	1	DVP_P7-1: LN 2017-2134-B	tower	229.0	98.42	110.89	DC	28.54
165472278	235483	01MDWBRK	138.0	AP	935200	AD1-155 TAP	138.0	AP	1	DVP_P7-1: LN 2017-2134-A	tower	229.0	98.38	110.84	DC	28.54

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)

None

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.

None

11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
165472277,165472278	1	01MDWBRK 138.0 kV - AD1-155 TAP 138.0 kV Ckt 1	APS PE-AG1-F-0003a (38) : Replace (1) 8 A ITH thermal relay at Strasburg. Project Type : FAC Cost : $896,700 Time Estimate : 12.0 Months	$896,700
			TOTAL COST	$896,700

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
165472278	235483	01MDWBRK	AP	935200	AD1-155 TAP	AP	1	DVP_P7-1: LN 2017-2134-A	tower	229.0	98.38	110.84	DC	28.54

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
943572	AF1-028 BAT	91.1480	50/50	91.1480
961721	AG1-012 BAT	28.5444	50/50	28.5444
963022	AG1-151 BAT	45.5740	50/50	45.5740
963633	AG1-214 BAT	0.9919	Merchant Transmission	0.9919
G-007A	G-007A	0.4004	Confirmed LTF	0.4004
VFT	VFT	1.0707	Confirmed LTF	1.0707
CALDERWOOD	CALDERWOOD	0.0914	Confirmed LTF	0.0914
PRAIRIE	PRAIRIE	0.3306	Confirmed LTF	0.3306
CHEOAH	CHEOAH	0.0926	Confirmed LTF	0.0926
CBM-N	CBM-N	0.1980	Confirmed LTF	0.1980
COTTONWOOD	COTTONWOOD	0.3276	Confirmed LTF	0.3276
HAMLET	HAMLET	0.1242	Confirmed LTF	0.1242
GIBSON	GIBSON	0.0622	Confirmed LTF	0.0622
BLUEG	BLUEG	0.2014	Confirmed LTF	0.2014
TRIMBLE	TRIMBLE	0.0640	Confirmed LTF	0.0640
CATAWBA	CATAWBA	0.0756	Confirmed LTF	0.0756

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
AF1-028	Endless Caverns 115 kV	Active
AG1-012	Mewdow Brook-Strasburg 138 kV II	Active
AG1-151	Endless Caverns 115 kV	Active
AG1-214	Grottoes 12.5 kV	Active

11.8 Contingency Descriptions

Contingency Name	Contingency Definition
DVP_P7-1: LN 2017-2134-B	CONTINGENCY 'DVP_P7-1: LN 2017-2134-B' /* . OPEN BRANCH FROM BUS 314800 TO BUS 314805 CKT 1 /* 6END
DVP_P7-1: LN 2017-2134-A	CONTINGENCY 'DVP_P7-1: LN 2017-2134-A' /* . OPEN BRANCH FROM BUS 314800 TO BUS 944070 CKT 1 /* 6END

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

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

14 Attachment 1: One Line Diagram