Generation Interconnection

System Impact Study Report

for

Queue Project AG1-012

MEWDOW BROOK-STRASBURG 138 KV II

0 MW Capacity / 0 MW Energy

August 2021

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1 Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 205, as well as the System Impact 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 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.

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.

3 General

The Interconnection Customer (IC) has proposed an uprate to a planned Solar generating facility located in Frederick, Virginia. This project is a battery storage increase to the Interconnection Customer's AD1-155 solar 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

AG1-012 will interconnect with the APS on 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. No additional interconnection facilities are required to accommodate AG1-012.

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.

5 Cost Summary

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

Description	Total Cost
Total Physical Interconnection Costs	$0
Allocation towards System Network Upgrade Costs (PJM Identified - Summer Peak)*	$0
Allocation towards System Network Upgrade Costs (PJM Identified - Light Load)*	$0
Allocation towards System Network Upgrade Costs (TO Identified)*	$0
Total Costs	$0

*As your project progresses through the study process and other projects modify their request or withdraw, then your cost allocation could change.

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 88-129. 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.

Note 1: PJM Open Access Transmission Tariff (OATT) section 217.3A outline cost allocation rules. The rules are further clarified in PJM Manual 14A Attachment B. The allocation of costs for a network upgrade will start with the first Queue project to cause the need for the upgrade. Later queue projects will receive cost allocation contingent on their contribution to the violation and are allocated to the queues that have not closed less than 5 years following the execution of the first Interconnection Service Agreement which identifies the need for this upgrade.

Note 2: For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a

System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

6 Transmission Owner Scope of Work

AG1-012 is an uprate to the previous queue AD1-155. The interconnection will be completed in the AD1-155 project.

7 Schedule

AG1-012 is an uprate to the previous queue AD1-155. The interconnection will be completed in the AD1-155 project.

8 Transmission Owner 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 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/meter^2) - (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 Analysis

The Queue Project AG1-012 was evaluated as a 0.0 MW (Capacity 0.00 MW) injection 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 100.0 %. 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
16547227 7	23548 3	01MDWBR K	138. 0	AP	93520 0	AD1 -155 TAP	138. 0	AP	1	DVP_P7 -1: LN 2017- 2134-B	towe r	229.0	108.0	122.69	AC	28.55
16547227 8	23548 3	01MDWBR K	138. 0	AP	93520 0	AD1 -155 TAP	138. 0	AP	1	DVP_P7 -1: LN 2017- 2134-A	towe r	229.0	108.02	122.87	AC	28.55

11.4 Steady-State Voltage Requirements

None

11.5 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

11.6 System Reinforcements

ID	Idx	Facility	Upgrade Description	Cost	Cost Allocated to AG1-012	Upgrade Number
165472277,165472278	1	01MDWBRK 138.0 kV - AD1-155 TAP 138.0 kV Ckt 1	**APS** Project Id: n7582 (PE-AG1-S-0005a) Description: "Replace (1) 8 Amp thermal relay at Strasburg. Replace (1) 1200 Amp current transformer at Strasburg." Project Type : FAC Total Cost : $1,557,312 Time Estimate : 12.0 Months Ratings : 275.0/287.0/287.0 Per PJM cost allocation rules, Queue Project AG1-012 presently does not receive cost allocation for this upgrade. Note 1: As changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, Queue Project AG1-012 could receive cost allocation. Note 2: Although Queue Project AG1-012 may not have cost responsibility for this upgrade, Queue Project AG1-012 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AG1-012 comes into service prior to completion of the upgrade, Queue Project AG1-012 will need an interim study.	$1,557,312	$0	n7582
			TOTAL COST	**$1,557,312**	**$0**	

Note : For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

11.7 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".

11.7.1 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	108.02	122.87	AC	28.55

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
943572	AF1-028 BAT	91.15	50|50	91.15
961721	AG1-012 BAT	28.55	50|50	28.55
963022	AG1-151 BAT	45.58	50|50	45.58
963472	AG1-196 BAT	14.78	Adder	17.39
963633	AG1-214 BAT	1.87	Adder	2.2
LTFEXP_AC1-056	LTFEXP_AC1-056->LTFIMP_AC1-056	0.1218	Confirmed LTF	0.1218
LTFEXP_AC1-131	LTFEXP_AC1-131->LTFIMP_AC1-131	0.1663	Confirmed LTF	0.1663
LTFEXP_BlueG	LTFEXP_BlueG->LTFIMP_BlueG	0.2058	Confirmed LTF	0.2058
LTFEXP_CALDERWOOD	LTFEXP_CALDERWOOD->LTFIMP_CALDERWOOD	0.0927	Confirmed LTF	0.0927
LTFEXP_CATAWBA	LTFEXP_CATAWBA->LTFIMP_CATAWBA	0.0766	Confirmed LTF	0.0766
LTFEXP_CBM-N	LTFEXP_CBM-N->LTFIMP_CBM-N	0.1948	LTF/CBM	0.1948
LTFEXP_CHEOAH	LTFEXP_CHEOAH->LTFIMP_CHEOAH	0.0939	Confirmed LTF	0.0939
LTFEXP_COTTONWOOD	LTFEXP_COTTONWOOD->LTFIMP_COTTONWOOD	0.3343	Confirmed LTF	0.3343
LTFEXP_G-007A	LTFEXP_G-007A->LTFIMP_G-007A	0.393	LTF/CMTX	0.393
LTFEXP_GIBSON	LTFEXP_GIBSON->LTFIMP_GIBSON	0.0639	Confirmed LTF	0.0639
LTFEXP_HAMLET	LTFEXP_HAMLET->LTFIMP_HAMLET	0.1258	Confirmed LTF	0.1258
LTFEXP_PRAIRIE	LTFEXP_PRAIRIE->LTFIMP_PRAIRIE	0.3383	Confirmed LTF	0.3383
LTFEXP_TRIMBLE	LTFEXP_TRIMBLE->LTFIMP_TRIMBLE	0.0655	Confirmed LTF	0.0655
LTFEXP_VFT	LTFEXP_VFT->LTFIMP_VFT	1.0541	Confirmed LTF	1.0541

11.8 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
AC1-056	PJM-AMIL	Confirmed
AC1-131	PJM-CPLE	Confirmed
AF1-028	Endless Caverns 115 kV	Active
AG1-012	Mewdow Brook-Strasburg 138 kV II	Active
AG1-151	Endless Caverns 115 kV	Active
AG1-196	Grottoes 115 kV	Active
AG1-214	Grottoes 12.5 kV	Active

11.9 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 Light Load Analysis

The Queue Project AG1-012 was evaluated as a 30.1 MW (Capacity 30.1 MW) injection 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 100.0 %. Potential network impacts were as follows:

12.1 Light Load Deliverability

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

None

12.2 Multiple Facility Contingency

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

None

12.3 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

12.4 Steady-State Voltage Requirements

None

12.5 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

12.6 System Reinforcements

None

12.7 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".

None

12.8 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
AG1-137	Harrisonburg 230 kV	Active
AG1-151	Endless Caverns 115 kV	Active
AG1-195	Valley 230 kV	Active
AG1-196	Grottoes 115 kV	Active
AG1-214	Grottoes 12.5 kV	Active

12.9 Contingency Descriptions

Contingency Name	Contingency Definition
DVP_P1-2: LN 550	CONTINGENCY 'DVP_P1-2: LN 550' OPEN BRANCH FROM BUS 314917 TO BUS 314926 CKT 1 /* 8MT STM 500.00 - 8VALLEY 500.00 END
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_P4-2: H1T550	CONTINGENCY 'DVP_P4-2: H1T550' /* VALLEY 500 KV OPEN BRANCH FROM BUS 314917 TO BUS 314926 CKT 1 /* 8MT STM 500.00 - 8VALLEY 500.00 OPEN BRANCH FROM BUS 314817 TO BUS 314926 CKT 1 /* 6VALLEY 230.00 - 8VALLEY 500.00 END
DVP_P4-2: H2T550	CONTINGENCY 'DVP_P4-2: H2T550' /* VALLEY 500 KV OPEN BRANCH FROM BUS 314917 TO BUS 314926 CKT 1 /* 8MT STM 500.00 - 8VALLEY 500.00 OPEN BRANCH FROM BUS 314817 TO BUS 314926 CKT 2 /* 6VALLEY 230.00 - 8VALLEY 500.00 END
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

13 Short Circuit Analysis

The following Breakers are overdutied:

None

14 Stability and Reactive Power

To be determined in the Facilities Study Phase.

15 Affected Systems

None

16 Attachment 1: One Line Diagram