



**Generation Interconnection
Feasibility Study Report
for
Queue Project AG1-092
HICKMAN-RIVER BEND 69 KV
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 AEP.

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 update to a planned Solar generating facility located in Pulaski, Virginia. This project is an increase to the Interconnection Customer's AG1-091 project, which will share the same point of interconnection. The AG1-092 queue position is a 0 MW Storage update (0 MW Capacity update) to the previous project. The total installed facilities will have a capability of 50 MW with 32.4 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this update project is June 30, 2023. This study does not imply a TO commitment to this in-service date.

Queue Number	AG1-092
Project Name	HICKMAN-RIVER BEND 69 KV
State	Virginia
County	Pulaski
Transmission Owner	AEP
MFO	50
MWE	0
MWC	0
Fuel	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

AG1-092 will interconnect with the AEP transmission system as an uprate to AG1-091 tapping the Hickman to River Bend 69 kV line.

5 Cost Summary

The AG1-092 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	\$0
Total System Network Upgrade Costs	\$22,000
Total Costs	\$22,000

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.

6 Transmission Owner Scope of Work

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

Description	Total Cost
Total Physical Interconnection Costs	\$0

7 Transmission Owner Analysis

No violations were identified in the Sub-Transmission load flow analysis and the short circuit analysis for the Sub-Transmission will be conducted in the System Impact Study phase.

8 Schedule

It is anticipated that the time between receipt of executed Agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would generally be between 24 to 36 months after signing Agreement execution.

9 Interconnection Customer Requirements

It is understood that the Interconnection Customer (IC) is responsible for all costs associated with this interconnection. The costs above are reimbursable to the Transmission Owner. The cost of the IC's generating plant and the costs for the line connecting the generating plant to the Point of Interconnection are not included in this report; these are assumed to be the IC's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for the Transmission Owner to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider to determine if a local service agreement is required.

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 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.
2. 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.

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 AG1-092 was evaluated as a 0.0 MW (Capacity 0.0 MW) injection tapping the Hickman to River Bend 69 kV line in the AEP area. Project AG1-092 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-092 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	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC D C	MW IMPACT
161454493	242609	05CLYTR2	138.0	AEP	242721	05MORGAN	138.0	AEP	1	AEP_P7-1_#10877-B	tower	167.0	95.17	100.41	DC	8.76
167051195	937350	AD2-179 TAP	138.0	AEP	242721	05MORGAN	138.0	AEP	1	AEP_P4_#2914_05J.FERR	breaker	167.0	99.08	103.13	DC	6.76
167051196	937350	AD2-179 TAP	138.0	AEP	242721	05MORGAN	138.0	AEP	1	AEP_P4_#311_05CLOVRD	breaker	167.0	99.08	103.13	DC	6.76

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.

ID	FROM BUS#	FROM BUS	KV	FROM BUS AREA	TO BUS#	TO BUS	KV	TO BUS AREA	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC D C	MW IMPACT
169560063	934750	AD1-102 TAP	138.0	AEP	242609	05CLYTR2	138.0	AEP	1	AEP_P1-2_#311_5	operation	251.0	138.11	140.39	DC	5.72
169560065	934750	AD1-102 TAP	138.0	AEP	242609	05CLYTR2	138.0	AEP	1	Base Case	operation	251.0	103.13	105.34	DC	5.56
169560243	937350	AD2-179 TAP	138.0	AEP	242721	05MORGAN	138.0	AEP	1	Base Case	operation	134.0	108.81	113.83	DC	6.72

11.5 System Reinforcements - Summer Peak Load Flow

ID	Idx	Facility	Upgrade Description	Cost
161454493	1	05CLYTR2 138.0 kV - 05MORGAN 138.0 kV Ckt 1	<p><u>AEP</u> AEPA0028a (108) : A sag study will be required on the 4.75 miles of ACSR ~ 397.5 ~ 30/7 ~ LARK - Conductor to determine what mitigation would be required (if any) to operate at the conductor's MOT. New ratings after sag study SN: 167MVA< SE: 245MVA. Depending on the sag study results, the cost for this upgrade is expected to be between \$20,000 (no remediation required, just sag study) and \$7.05 million (complete line reconductor/rebuild). Time Estimate: a) Sag Study: 6-12 months b) Rebuild: The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement</p> <p>Project Type : FAC Cost : \$20,000 Time Estimate : 6 - 12 Months</p>	\$20,000
167051195,167051196	2	AD2-179 TAP 138.0 kV - 05MORGAN 138.0 kV Ckt 1	<p><u>AEP</u> AEPA0026a (57) : A Sag Study will be required for the 0.5 miles of overhead conductor (ACSR ~ 397.5 ~ 30/7 ~ LARK ~ Fe Clamps 9 d) to mitigate the overload. Depending on the sag study results, the cost for this upgrade is expected to be between \$2,000 (no remediation required, just sag study) and \$0.75 million (complete line reconductor/rebuild). Time Estimate: a) Sag Study: 6-12 months b) Rebuild: The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement.</p> <p>Project Type : FAC Cost : \$2,000 Time Estimate : 6 - 12 Months</p>	\$2,000
			TOTAL COST	\$22,000

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
161454493	242609	05CLYTR2	AEP	242721	05MORGAN	AEP	1	AEP_P7-1_#10877-B	tower	167.0	95.17	100.41	DC	8.76

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
242906	05CLAY-1	1.3487	50/50	1.3487
242907	05CLAY-2	1.3421	50/50	1.3421
247619	Y1-049	0.0945	50/50	0.0945
934756	AD1-102 C	4.4521	50/50	4.4521
934757	AD1-102 E	29.7966	50/50	29.7966
937341	AD2-178 C O1	10.5199	50/50	10.5199
937342	AD2-178 E O1	7.0133	50/50	7.0133
942641	AE2-280 C O1	17.3303	50/50	17.3303
942642	AE2-280 E O1	11.5535	50/50	11.5535
958121	AF2-106 C	15.2352	50/50	15.2352
958122	AF2-106 E	10.1568	50/50	10.1568
962433	AG1-092 BAT	8.7591	50/50	8.7591
CPLE	CPLE	0.2614	Confirmed LTF	0.2614
G-007A	G-007A	0.0192	Confirmed LTF	0.0192
VFT	VFT	0.0452	Confirmed LTF	0.0452
CBM-W2	CBM-W2	0.2598	Confirmed LTF	0.2598
NY	NY	0.0011	Confirmed LTF	0.0011
TVA	TVA	0.1008	Confirmed LTF	0.1008
CBM-S2	CBM-S2	3.4034	Confirmed LTF	3.4034
CBM-S1	CBM-S1	0.0190	Confirmed LTF	0.0190
CBM-N	CBM-N	0.0084	Confirmed LTF	0.0084
GIBSON	GIBSON	0.0229	Confirmed LTF	0.0229
BLUEG	BLUEG	0.0920	Confirmed LTF	0.0920
TRIMBLE	TRIMBLE	0.0301	Confirmed LTF	0.0301
LAGN	LAGN	0.1242	Confirmed LTF	0.1242

11.6.2 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
167051196	937350	AD2-179 TAP	AEP	242721	05MORGAN	AEP	1	AEP_P4_#311_05CLOVRD	breaker	167.0	99.08	103.13	DC	6.76

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
937351	AD2-179 C O1	42.6972	50/50	42.6972
937352	AD2-179 E O1	28.4648	50/50	28.4648
939804	AE1-212 C O1	2.6123	Adder	3.07
939805	AE1-212 E O1	1.7976	Adder	2.11
958111	AF2-105 C	39.8844	50/50	39.8844
958112	AF2-105 E	26.5896	50/50	26.5896
962401	AG1-089 C	0.2816	Adder	0.63
962402	AG1-089 E	0.4224	Adder	0.94
962433	AG1-092 BAT	6.7602	50/50	6.7602
963811	AG1-234 C O1	1.1312	Adder	2.51
963812	AG1-234 E O1	0.7541	Adder	1.67
WEC	WEC	0.0885	Confirmed LTF	0.0885
LGEE	LGEE	0.2004	Confirmed LTF	0.2004
CBM-W2	CBM-W2	2.2310	Confirmed LTF	2.2310
NY	NY	0.0564	Confirmed LTF	0.0564
TVA	TVA	0.3346	Confirmed LTF	0.3346
O-066	O-066	0.9018	Confirmed LTF	0.9018
SIGE	SIGE	0.0456	Confirmed LTF	0.0456
CBM-S1	CBM-S1	0.0965	Confirmed LTF	0.0965
G-007	G-007	0.1418	Confirmed LTF	0.1418
HAMLET	HAMLET	0.1011	Confirmed LTF	0.1011
MEC	MEC	0.4306	Confirmed LTF	0.4306
LAGN	LAGN	0.3832	Confirmed LTF	0.3832
CATAWBA	CATAWBA	0.0228	Confirmed LTF	0.0228
CBM-W1	CBM-W1	3.7854	Confirmed LTF	3.7854

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
AD1-102	Wurno-Claytor Lake 138 KV	Active
AD2-178	Wurno 138kV	Active
AD2-179	Morgans Cut-Glen Lyn 138kV	Active
AE1-212	Grandview-Clifftop 138 kV	Active
AE2-280	Claytor Lake-Edgemont 138 kV	Active
AF2-105	Morgans Cut 138 kV	Active
AF2-106	Hazel Hollow 138 kV	Active
AG1-089	Grandview-Clifftop 138 kV	Active
AG1-092	Hickman-River Bend 69 kV	Active
AG1-234	Hinton-Ronceverte 115 kV	Active
Y1-049	Wurno 34.5kV	In Service

11.8 Contingency Descriptions

Contingency Name	Contingency Definition
Base Case	
AEP_P7-1_#10877-B	CONTINGENCY 'AEP_P7-1_#10877-B' OPEN BRANCH FROM BUS 242608 TO BUS 242791 CKT 1 / 242608 05CLYTR1 138 242791 05SCHRIS 138 1 OPEN BRANCH FROM BUS 942640 TO BUS 242634 CKT 1 / 942640 AE2-280 TAP 138 242634 05EDGEMO 138 1 OPEN BRANCH FROM BUS 242708 TO BUS 243874 CKT 1 / 242708 05M FUNK 138 243874 05TECHDR 138 1 OPEN BRANCH FROM BUS 242791 TO BUS 243874 CKT 1 / 242791 05SCHRIS 138 243874 05TECHDR 138 1 OPEN BRANCH FROM BUS 242791 TO BUS 244118 CKT 1 / 242791 05SCHRIS 138 244118 05SCHRISTB 69.0 1 OPEN BRANCH FROM BUS 244107 TO BUS 244118 CKT 1 / 244107 05CAMBRIA 69.0 244118 05SCHRISTB 69.0 1 END
AEP_P1-2_#311_5	CONTINGENCY 'AEP_P1-2_#311_5' OPEN BRANCH FROM BUS 242512 TO BUS 242514 CKT 1 / 242512 05CLOVRD 765 242514 05J.FERR 765 1 END
AEP_P4_#311_05CLOVRD	CONTINGENCY "'AEP_P4_#311_05CLOVRD' 765_CC2" / 1395 OPEN BRANCH FROM BUS 242512 TO BUS 242514 CKT 1 / 242512 05CLOVRD 765 242514 05J.FERR 765 1 END
AEP_P4_#2914_05J.FERR	CONTINGENCY "'AEP_P4_#2914_05J.FERR' 765_B2" / 1487 OPEN BRANCH FROM BUS 242512 TO BUS 242514 CKT 1 / 242512 05CLOVRD 765 242514 05J.FERR 765 1 OPEN BRANCH FROM BUS 242514 TO BUS 245993 CKT 4 / 242514 05J.FERR 765 245993 05J.FERR SVS 20.6 4 REMOVE SWSHUNT FROM BUS 242514 /* 242514 05J.FERR 765 END

12 Short Circuit Analysis

The following Breakers are overdutied

None

13 Affected Systems

None