



Generation Interconnection

Feasibility Study Report

for

Queue Project AG1-194

NUTTALL 138 KV

104 MW Capacity / 200 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.

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.

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; Battery generating facility located in Fayette County, West Virginia. The installed facilities will have a total capability of 200 MW with 104 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 01, 2023. This study does not imply a TO commitment to this in-service date.

Queue Number	AG1-194
Project Name	NUTTALL 138 KV
State	West Virginia
County	Fayette
Transmission Owner	AEP
MFO	200
MWE	200
MWC	104
Fuel	Solar; Battery
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

AG1-194 will interconnect with the AEP transmission system via a direct connection to the Nuttall 138 kV substation.

To accommodate the interconnection to the Nuttall 138 kV substation, one (1) new 138 kV circuit breaker will be installed (Attachment 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.

Installation of the generator lead first span exiting the POI station, including the first structure outside the AEP fence, will also be included in AEP's scope. In the case where the generator lead is a single span, the structure in the customer station will be the customer's responsibility.

5 Cost Summary

The AG1-194 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	\$1,464,000
Total System Network Upgrade Costs	\$13,185,210
Total Costs	\$14,649,210

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
138 kV Revenue Metering	\$376,000
Generator lead first span exiting the POI station, including the first structure outside the fence	\$400,000
One (1) new 138 kV circuit breaker will be installed at the Nuttall 138 kV substation (Attachment 1). Installation of associated protection and control equipment, 138 kV line risers, and SCADA will also be required.	\$643,000
Review line protection and control settings at the Nuttall 138 kV substation	\$45,000
Total Physical Interconnection Costs	\$1,464,000

The estimates provided in this report are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements. In addition, Stability analysis will be completed during the Facilities Study stage. It is possible that a need for additional upgrades could be identified by these studies.

7 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 Agreement execution.

8 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 Revenue Metering and SCADA Requirements

9 Revenue Metering and SCADA Requirements

9.1 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.

9.2 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)

9.3 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/>

10 Summer Peak - Load Flow Analysis

The Queue Project AG1-194 was evaluated as a 200.0 MW (Capacity 104.0 MW) injection at the Nuttall 138 kV substation in the AEP area. Project AG1-194 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-194 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

10.1 Generation Deliverability

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

None

10.2 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 LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPAC T
165550064	235376	01NETTI E	138.0	AP	235318	01CRUPR N	138.0	AP	1	AEP_P2-2_#7801_05BRAD L1 138_1	bus	192.0	74.73	111.24	DC	70.1

10.3 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

10.4 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 LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPAC T
167875451	235296	01BAYS	138.0	AP	235431	01WOLFR N	138.0	AP	1	FE-P1-2-MP-138-063	operatio n	128.0	102.88	108.99	DC	17.37
167875356	235328	01ENONT P	138.0	AP	235389	01POWEL M	138.0	AP	1	FE-P1-2-MP-138-014	operatio n	242.0	106.04	121.62	DC	37.68
167875480	235333	01GILBOA	138.0	AP	235328	01ENONT P	138.0	AP	1	AEP_P1-2_#6140_12	operatio n	229.0	104.75	105.76	DC	4.37
167875363	235376	01NETTIE	138.0	AP	235318	01CRUPR N	138.0	AP	1	FE-P1-2-MP-138-076	operatio n	192.0	86.12	115.75	DC	56.87
167875365	235376	01NETTIE	138.0	AP	235318	01CRUPR N	138.0	AP	1	Base Case	operatio n	160.0	77.98	100.13	DC	35.44

ID	FROM BUS#	FROM BUS	kV	FRO M BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CK T ID	CONT NAME	Type	Ratin g MVA	PRE PROJEC T LOADIN G %	POST PROJEC T LOADIN G %	AC D C	MW IMPAC T
167875410	235389	01POWEL M	138.0	AP	235296	01BAYS	138.0	AP	1	FE-P1-2-MP-138-063	operatio n	128.0	108.42	114.54	DC	17.37
167875457	235431	01WOLFR N	138.0	AP	235437	01SUTT T	138.0	AP	1	FE-P1-2-MP-138-063	operatio n	128.0	102.41	108.52	DC	17.37
167875501	235437	01SUTT T	138.0	AP	235411	01SUTTO N	138.0	AP	1	FE-P1-2-MP-138-063	operatio n	111.0	94.91	101.02	DC	15.04
168138641	247826	05MOLLYS CRK	138.0	AEP	242564	05BRADL1	138.0	AEP	1	Base Case	operatio n	136.0	48.99	115.87	DC	90.96
168138642	247826	05MOLLYS CRK	138.0	AEP	242564	05BRADL1	138.0	AEP	1	AEP_P1-2_#13120	operatio n	167.0	50.15	114.71	DC	107.82

10.5 System Reinforcements - Summer Peak Load Flow

ID	Idx	Facility	Upgrade Description	Cost
165550064	1	01NETTIE 138.0 kV - 01CRUPRN 138.0 kV Ckt 1	<u>AP</u> MP-2020-12-001 (606) : Reconductor 4.6 miles of 336 ACSR Line Conductor with 795 ACSR Project Type : FAC Cost : \$13,185,210 Time Estimate : 36.0 Months	\$13,185,210
			TOTAL COST	\$13,185,210

10.6 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".

10.6.1 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
165550064	235376	01NETTIE	AP	235318	01CRUPRN	AP	1	AEP_P2-2_#7801_05BRADL1138_1	bus	192.0	74.73	111.24	DC	70.1

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
235780	01BEECHRIDGE	1.0256	50/50	1.0256
236845	01BR_BAT_M24	13.8682	50/50	13.8682
244467	05SUMMERVL	3.6272	50/50	3.6272
923384	M24 E	37.0540	50/50	37.0540
931011	AB1-150 C	0.4581	50/50	0.4581
931012	AB1-150 E	19.0254	50/50	19.0254
938641	AE1-086 C	0.0410	50/50	0.0410
938642	AE1-086 E	2.1669	50/50	2.1669
960201	AF2-311 C	3.6951	Adder	4.35
960202	AF2-311 E	3.0233	Adder	3.56
960251	AF2-316 C	5.5561	Adder	6.54
960252	AF2-316 E	4.5215	Adder	5.32
963451	AG1-194 C	36.4520	50/50	36.4520
963452	AG1-194 E	33.6480	50/50	33.6480
963671	AG1-219 C	14.6577	50/50	14.6577
963672	AG1-219 E	13.1733	50/50	13.1733
WEC	WEC	0.0828	Confirmed LTF	0.0828
LGEE	LGEE	0.1910	Confirmed LTF	0.1910
CPLE	CPLE	0.1112	Confirmed LTF	0.1112
CBM-W2	CBM-W2	2.4998	Confirmed LTF	2.4998
NY	NY	0.1266	Confirmed LTF	0.1266
TVA	TVA	0.4004	Confirmed LTF	0.4004
O-066	O-066	1.5748	Confirmed LTF	1.5748
SIGE	SIGE	0.0552	Confirmed LTF	0.0552
CBM-S2	CBM-S2	2.2550	Confirmed LTF	2.2550
CBM-S1	CBM-S1	0.1098	Confirmed LTF	0.1098
G-007	G-007	0.2457	Confirmed LTF	0.2457
MEC	MEC	0.4290	Confirmed LTF	0.4290
LAGN	LAGN	0.4847	Confirmed LTF	0.4847
CBM-W1	CBM-W1	3.4069	Confirmed LTF	3.4069

10.7 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
AB1-150	Grassy Falls 138kV	In Service
AE1-086	Grassy Falls 138 kV	In Service
AF2-311	Jones Branch 138 kV	Active
AF2-316	Jones Branch 138 kV	Active
AG1-194	Nuttall 138 kV	Active
AG1-219	Layland 69 kV	Active

10.8 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P1-2_#6140_12	CONTINGENCY 'AEP_P1-2_#6140_12' OPEN BRANCH FROM BUS 242920 TO BUS 242925 CKT 1 / 242920 05BELMON 765 242925 05KAMMER 765 1 OPEN BRANCH FROM BUS 242516 TO BUS 242920 CKT 1 / 242516 05MOUNTN 765 242920 05BELMON 765 1 OPEN BRANCH FROM BUS 235102 TO BUS 242920 CKT 5 / 235102 01BELMNT 500 242920 05BELMON 765 5 OPEN BRANCH FROM BUS 247319 TO BUS 247370 CKT 1 / 247319 05WOLFCK 138 247370 05MUSKNG1A 138 1 END
AEP_P1-2_#13120	CONTINGENCY 'AEP_P1-2_#13120' OPEN BRANCH FROM BUS 244453 TO BUS 247825 CKT 1 / 244453 05TOWER117 69.0 247825 05NUTALL 69.0 1 END
FE-P1-2-MP-138-076	CONTINGENCY 'FE-P1-2-MP-138-076' /* GRASSY FALLS-SUMMERSVILLE 138KV DISCONNECT BRANCH FROM BUS 235340 TO BUS 235410 CKT 1 /* 01GRASSY 138 01SUMMRV 138 END
FE-P1-2-MP-138-063	CONTINGENCY 'FE-P1-2-MP-138-063' /* COWEN-CRUPPERNECK 138KV DISCONNECT BRANCH FROM BUS 235316 TO BUS 235318 CKT 1 /* 01COWEN 138 01CRUPRN 138 END
FE-P1-2-MP-138-014	CONTINGENCY 'FE-P1-2-MP-138-014' /* CRUPPERNECK-NETTIE-GRASSY FALLS 138KV DISCONNECT BRANCH FROM BUS 235318 TO BUS 235376 CKT 1 /* 01CRUPRN 138 01NETTIE 138 DISCONNECT BRANCH FROM BUS 235340 TO BUS 235376 CKT 1 /* 01GRASSY 138 01NETTIE 138 DISCONNECT BRANCH FROM BUS 235376 TO BUS 236974 CKT 1 /* 01NETTIE 138 01NETTIE 23 END
Base Case	

Contingency Name	Contingency Definition
AEP_P2-2_#7801_05BRADL1 138_1	CONTINGENCY 'AEP_P2-2_#7801_05BRADL1 138_1'
	OPEN BRANCH FROM BUS 242564 TO BUS 244877 CKT 1 / 242564 05BRADL1 138 244877 05BRDLEYEQ 999 1
	OPEN BRANCH FROM BUS 244380 TO BUS 244877 CKT 1 / 244380 05BRADLEY 69.0 244877 05BRDLEYEQ 999 1
	OPEN BRANCH FROM BUS 244876 TO BUS 244877 CKT 1 / 244876 05BRADLEY 46.0 244877 05BRDLEYEQ 999 1
	OPEN BRANCH FROM BUS 242564 TO BUS 242565 CKT Z1 / 242564 05BRADL1 138 242565 05BRADL2 138 Z1
	OPEN BRANCH FROM BUS 242564 TO BUS 242653 CKT 1 / 242564 05BRADL1 138 242653 05GRANDV 138 1
	OPEN BRANCH FROM BUS 242564 TO BUS 247826 CKT 1 / 242564 05BRADL1 138 247826 05MOLLYS CRK 138 1
	OPEN BRANCH FROM BUS 242564 TO BUS 247333 CKT 1 / 242564 05BRADL1 138 247333 05PAX BRANCH 138 1
	OPEN BRANCH FROM BUS 242564 TO BUS 242758 CKT 1 / 242564 05BRADL1 138 242758 05POLEYD 138 1
	REMOVE SWSHUNT FROM BUS 242564 / 242564 05BRADL1 138
	OPEN BRANCH FROM BUS 244380 TO BUS 244442 CKT 1 / 244380 05BRADLEY 69.0 244442 05PRINCE 69.0 1
	END

11 Short Circuit Analysis

The following Breakers are overdutied

None

12 Affected Systems

12.1 TVA

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

12.2 Duke Energy Progress

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

12.3 MISO

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

12.4 LG&E

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