Generation Interconnection

Feasibility Study Report

for

Queue Project AG1-136

CLOVERDALE-BURLINGTON HEIGHT 138 KV

40 MW Capacity / 100 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.

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 Storage generating facility located in Botetourt County, Virginia. The installed facilities will have a total capability of 100 MW with 40 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is October 22, 2023. This study does not imply a TO commitment to this in-service date.

Queue Number	**AG1-136**
Project Name	CLOVERDALE-BURLINGTON HEIGHT 138 KV
State	Virginia
County	Botetourt
Transmission Owner	AEP
MFO	100
MWE	100
MWC	40
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

AG1-136 will interconnect with the AEP transmission system via a new switching station cut into the Cloverdale – Burlington Heights 138 kV section of the Cloverdale – Matt Funk 138 kV circuit.

To accommodate the interconnection on the Cloverdale – Burlington Heights 138 kV section of the Cloverdale – Matt Funk 138 kV circuit, a new three (3) circuit breaker 138 kV switching station physically configured and operated as a ring-bus will be constructed (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 AG1-136 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$9,786,000
Total System Network Upgrade Costs	$0
Total Costs	$9,786,000

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.

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.

6 Transmission Owner Scope of Work

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

6.1 Attachment Facilities

The total preliminary cost estimate for the Attachment work is given in the table below. These costs do not include CIAC Tax Gross-up.

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
Total Attachment Facility Costs	**$776,000**

6.2 Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
A new three (3) circuit breaker 138 kV switching station physically configured and operated as a ring-bus will be constructed (see Figure 1). Installation of associated protection and control equipment, 138 kV line risers, and SCADA will also be required.	$8,150,000
Total Direct Connection Facility Costs	**$8,150,000**

6.3 Non-Direct Connection Cost Estimate

The total preliminary cost estimate for the Non-Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Total Cost
Cloverdale – Burlington Heights 138 kV T-Line Cut In	$770,000
Review Protection and Control Settings at the Cloverdale 138 kV substation	$45,000
Review Protection and Control Settings at the Matt Funk 138 kV substation	$45,000
Total Non-Direct Connection Facility Costs	**$860,000**

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 Section 4 of PJM Manual 14D for additional information.

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

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 - Primary POI

The Queue Project AG1-136 was evaluated as a 100.0 MW (Capacity 40.0 MW) injection tapping the Cloverdale to Burlington Height 138 kV line in the AEP area. Project AG1-136 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-136 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)

None

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	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
168112813	242791	05SCHRIS	138.0	AEP	243874	05TECHDR	138.0	AEP	1	AEP_P1-2_#311_5	operation	167.0	119.12	120.86	DC	5.49
168112854	243874	05TECHDR	138.0	AEP	242708	05MFUNK	138.0	AEP	1	AEP_P1-2_#311_5	operation	167.0	115.53	117.27	DC	5.49
169584745	934750	AD1-102 TAP	138.0	AEP	242609	05CLYTR2	138.0	AEP	1	AEP_P1-2_#311_5	operation	251.0	140.39	141.49	DC	5.18

10.5 System Reinforcements - Summer Peak Load Flow - Primary POI

None

10.6 Flow Gate Details - Primary POI

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".

10.7 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.

None

10.8 Contingency Descriptions - Primary POI

Contingency Name	Contingency Definition
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

11 Short Circuit Analysis - Primary POI

The following Breakers are overdutied

None

12 Summer Peak - Load Flow Analysis - Secondary POI

The Queue Project AG1-136 was evaluated as a 100.0 MW (Capacity 40.0 MW) injection tapping the Cloverdale to Catawba 138 kV line in the AEP area. Project AG1-136 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-136 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

12.1 Generation 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)

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
161503549	242607	05CLOVRD	138.0	AEP	962870	AG1-136 TAP	138.0	AEP	1	AEP_P7-1_#10810	tower	205.0	63.61	109.77	DC	94.64
172492213	242607	05CLOVRD	138.0	AEP	962870	AG1-136 TAP	138.0	AEP	1	AEP_P2-2_#10257_05HUNTCT 138_1	bus	205.0	63.68	109.49	DC	93.91
172492214	242607	05CLOVRD	138.0	AEP	962870	AG1-136 TAP	138.0	AEP	1	AEP_P2-2_#11370_05ROANOKE 69.0_1	bus	205.0	63.12	109.11	DC	94.29
172492215	242607	05CLOVRD	138.0	AEP	962870	AG1-136 TAP	138.0	AEP	1	AEP_P2-2_#10324_05ROANO 2 138_2	bus	205.0	63.12	109.11	DC	94.29
172492493	242607	05CLOVRD	138.0	AEP	962870	AG1-136 TAP	138.0	AEP	1	AEP_P7-1_#10819	tower	205.0	65.92	111.48	DC	93.4

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 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

12.5 Flow Gate Details - Secondary POI

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".

12.5.1 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
172492493	242607	05CLOVRD	AEP	962870	AG1-136 TAP	AEP	1	AEP_P7-1_#10819	tower	205.0	65.92	111.48	DC	93.4

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
962873	AG1-136 BAT	93.3960	50/50	93.3960
963061	AG1-155 C	0.1856	Adder	0.41
963062	AG1-155 E	0.2784	Adder	0.62
963871	**AG1-240 (Withdrawn : 12/08/2020)**	**2.0881**	**Adder**	**4.64**
G-007A	G-007A	0.3069	Confirmed LTF	0.3069
VFT	VFT	0.8192	Confirmed LTF	0.8192
CALDERWOOD	CALDERWOOD	0.0989	Confirmed LTF	0.0989
PRAIRIE	PRAIRIE	0.5863	Confirmed LTF	0.5863
CHEOAH	CHEOAH	0.0976	Confirmed LTF	0.0976
CBM-N	CBM-N	0.1500	Confirmed LTF	0.1500
COTTONWOOD	COTTONWOOD	0.4242	Confirmed LTF	0.4242
HAMLET	HAMLET	0.0139	Confirmed LTF	0.0139
GIBSON	GIBSON	0.1332	Confirmed LTF	0.1332
BLUEG	BLUEG	0.4444	Confirmed LTF	0.4444
TRIMBLE	TRIMBLE	0.1425	Confirmed LTF	0.1425
CATAWBA	CATAWBA	0.0248	Confirmed LTF	0.0248

12.6 Contingency Descriptions - Secondary POI

Contingency Name	Contingency Definition
AEP_P2-2_#10324_05ROANO2 138_2	CONTINGENCY 'AEP_P2-2_#10324_05ROANO2 138_2' OPEN BRANCH FROM BUS 242676 TO BUS 247631 CKT 1 / 242676 05HUNTCT 138 247631 05BENNINGTON 138 1 OPEN BRANCH FROM BUS 242774 TO BUS 247631 CKT 1 / 242774 05ROANO2 138 247631 05BENNINGTON 138 1 OPEN BRANCH FROM BUS 242601 TO BUS 242774 CKT 1 / 242601 05CLEARB 138 242774 05ROANO2 138 1 OPEN BRANCH FROM BUS 242656 TO BUS 242774 CKT 1 / 242656 05GRASSH 138 242774 05ROANO2 138 1 OPEN BRANCH FROM BUS 242724 TO BUS 242774 CKT 1 / 242724 05MOSELEY 138 242774 05ROANO2 138 1 OPEN BRANCH FROM BUS 242773 TO BUS 242774 CKT Z1 / 242773 05ROANO1 138 242774 05ROANO2 138 Z1 OPEN BRANCH FROM BUS 242774 TO BUS 246981 CKT 1 / 242774 05ROANO2 138 246981 05SUNSCA 138 1 OPEN BRANCH FROM BUS 242774 TO BUS 244073 CKT 1 / 242774 05ROANO2 138 244073 05ROANOKE 69.0 1 OPEN BRANCH FROM BUS 242774 TO BUS 244072 CKT 1 / 242774 05ROANO2 138 244072 05ROANOKE 34.5 1 REMOVE SWSHUNT FROM BUS 242774 / 242774 05ROANO2 138 OPEN BRANCH FROM BUS 244030 TO BUS 244073 CKT 1 / 244030 05CAMPBEL1 69.0 244073 05ROANOKE 69.0 1 OPEN BRANCH FROM BUS 244073 TO BUS 244098 CKT 1 / 244073 05ROANOKE 69.0 244098 05WALNUTA2 69.0 1 END
AEP_P2-2_#10257_05HUNTCT 138_1	CONTINGENCY 'AEP_P2-2_#10257_05HUNTCT 138_1' OPEN BRANCH FROM BUS 242676 TO BUS 244101 CKT 1 / 242676 05HUNTCT 138 244101 05HUNTCTEQ 999 1 OPEN BRANCH FROM BUS 244101 TO BUS 244102 CKT 1 / 244101 05HUNTCTEQ 999 244102 05HUNTCRT1 69.0 1 OPEN BRANCH FROM BUS 244054 TO BUS 244101 CKT 1 / 244054 05HUNTNGTN 34.5 244101 05HUNTCTEQ 999 1 OPEN BRANCH FROM BUS 242676 TO BUS 247631 CKT 1 / 242676 05HUNTCT 138 247631 05BENNINGTON 138 1 OPEN BRANCH FROM BUS 242774 TO BUS 247631 CKT 1 / 242774 05ROANO2 138 247631 05BENNINGTON 138 1 OPEN BRANCH FROM BUS 242607 TO BUS 242676 CKT 1 / 242607 05CLOVRD 138 242676 05HUNTCT 138 1 REMOVE SWSHUNT FROM BUS 242676 / 242676 05HUNTCT 138 END
AEP_P7-1_#10810	CONTINGENCY 'AEP_P7-1_#10810' OPEN BRANCH FROM BUS 242524 TO BUS 242527 CKT 1 / 242524 05CLOVRD 345 242527 05M FUNK 345 1 OPEN BRANCH FROM BUS 242526 TO BUS 242527 CKT 1 / 242526 05KANAWZ 345 242527 05M FUNK 345 1 END

Contingency Name	Contingency Definition
AEP_P7-1_#10819	CONTINGENCY 'AEP_P7-1_#10819' OPEN BRANCH FROM BUS 242607 TO BUS 242676 CKT 1 / 242607 05CLOVRD 138 242676 05HUNTCT 138 1 OPEN BRANCH FROM BUS 244040 TO BUS 244057 CKT 1 / 244040 05CLOV 1 69.0 244057 05ING RAND 69.0 1 OPEN BRANCH FROM BUS 244067 TO BUS 244097 CKT 1 / 244067 05MONTERAV 69.0 244097 05HUNTCRT2 69.0 1 OPEN BRANCH FROM BUS 244057 TO BUS 244067 CKT 1 / 244057 05ING RAND 69.0 244067 05MONTERAV 69.0 1 END
AEP_P2-2_#11370_05ROANOKE 69.0_1	CONTINGENCY 'AEP_P2-2_#11370_05ROANOKE 69.0_1' OPEN BRANCH FROM BUS 242774 TO BUS 247631 CKT 1 / 242774 05ROANO2 138 247631 05BENNINGTON 138 1 OPEN BRANCH FROM BUS 242601 TO BUS 242774 CKT 1 / 242601 05CLEARB 138 242774 05ROANO2 138 1 OPEN BRANCH FROM BUS 242656 TO BUS 242774 CKT 1 / 242656 05GRASSH 138 242774 05ROANO2 138 1 OPEN BRANCH FROM BUS 242724 TO BUS 242774 CKT 1 / 242724 05MOSELEY 138 242774 05ROANO2 138 1 OPEN BRANCH FROM BUS 242773 TO BUS 242774 CKT Z1 / 242773 05ROANO1 138 242774 05ROANO2 138 Z1 OPEN BRANCH FROM BUS 242774 TO BUS 246981 CKT 1 / 242774 05ROANO2 138 246981 05SUNSCA 138 1 OPEN BRANCH FROM BUS 242774 TO BUS 244073 CKT 1 / 242774 05ROANO2 138 244073 05ROANOKE 69.0 1 OPEN BRANCH FROM BUS 242774 TO BUS 244072 CKT 1 / 242774 05ROANO2 138 244072 05ROANOKE 34.5 1 OPEN BRANCH FROM BUS 244030 TO BUS 244073 CKT 1 / 244030 05CAMPBEL1 69.0 244073 05ROANOKE 69.0 1 OPEN BRANCH FROM BUS 244073 TO BUS 244098 CKT 1 / 244073 05ROANOKE 69.0 244098 05WALNUTA2 69.0 1 OPEN BRANCH FROM BUS 244072 TO BUS 244084 CKT 1 / 244072 05ROANOKE 34.5 244084 05VTNMILLZ 34.5 1 END

13 Affected Systems

13.1 TVA

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

13.2 Duke Energy Progress

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

13.3 MISO

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

13.4 LG&E

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