



**Generation Interconnection
Feasibility Study Report
for
Queue Project AE1-154
LOUISA-SOUTH ANNA 230 KV
10 MW Capacity / 17 MW Energy**

January, 2019

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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 Virginia Electric and Power Company (VEPCO).

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.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a \$10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See Section 4.3 for starting dates) for the Interconnection Request which shall specify the use of the new model.

The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

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.

General

The IC has proposed an update to the existing AB2-158 solar generating facility located in Louisa County, Virginia. AE1-154 requests an increase to the installed capacity of 17 MW with 10 MW of this output being recognized by PJM as Capacity. The installed facilities will have a total capability of 105.2 MW with 71 MW of this output being recognized by PJM as Capacity. The proposed in-service date for the AE1-154 project is 10/30/2020. This study does not imply an ITO commitment to either in-service date.

Queue Number	AE1-154
Project Name	LOUISA-SOUTH ANNA 230 KV
State	Virginia
County	Louisa
Transmission Owner	Dominion
MFO	105.2
MWE	17
MWC	10
Fuel	Solar
Queue Number	AE1-154

Point of Interconnection

AE1-154 will interconnect with the ITO transmission system as a tap of the Louisa to South Anna 230 kV line #255.

Cost Summary

The AE1-154 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$0
Direct Connection Network Upgrade	\$0
Non Direct Connection Network Upgrades	\$0
Total Costs	\$0

In addition, the AE1-154 project may be responsible for a contribution to the following costs

(Reference System Reinforcements in the Network Impacts section for details):

Description	Total Cost
System Upgrades	\$250,000

Cost allocations for these upgrades will be provided in the System Impact Study Report.

Note: 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.

The Feasibility Study is used to make a preliminary determination of the type and scope of Attachment Facilities, Local Upgrades, and Network Upgrades that will be necessary to accommodate the Interconnection Request and to provide the Interconnection Customer a preliminary estimate of the time that will be required to construct any necessary facilities and upgrades and the Interconnection Customer's cost responsibility. The System Impact Study provides refined and comprehensive estimates of cost responsibility and construction lead times for new facilities and system upgrades. Facilities Studies will include, commensurate with the degree of engineering specificity as provided in the Facilities Study Agreement, good faith estimates of the cost, determined in accordance with Section 217 of the Tariff,

- (a) to be charged to each affected New Service Customer for the Facilities and System Upgrades that are necessary to accommodate this queue project;
- (b) the time required to complete detailed design and construction of the facilities and upgrades; and

(c) a description of any site-specific environmental issues or requirements that could reasonably be anticipated to affect the cost or time required to complete construction of such facilities and upgrades.

Transmission Owner Scope of Work

Attachment Facilities

None.

Direct Connection Cost Estimate

None.

Non-Direct Connection Cost Estimate

Remote Terminal Work: During the Facilities Study, ITO's System Protection Engineering Department will review transmission line protection as well as anti-islanding required to accommodate the new generation and interconnection substation. System Protection Engineering will determine the minimal acceptable protection requirements to reliably interconnect the proposed generating facility with the transmission system. The review is based on maintaining system reliability by reviewing ITO's protection requirements with the known transmission system configuration which includes generating facilities in the area. This review may determine that transmission line protection and communication upgrades are required at remote substations.

Interconnection Customer Requirements

ITO's Facility Connection Requirements as posted on PJM's website <http://www.pjm.com/~media/planning/plan-standards/private-dominion/facility-connection-requirements1.ashx>

Voltage Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for voltages and times as specified for the Eastern Interconnection in Attachment 1 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low voltage conditions, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Frequency Ride Through Requirements - The Customer Facility shall be designed to remain in service (not trip) for frequencies and times as specified in Attachment 2 of NERC Reliability Standard PRC-024-1, and successor Reliability Standards, for both high and low frequency condition, irrespective of generator size, subject to the permissive trip exceptions established in PRC-024-1 (and successor Reliability Standards).

Reactive Power - The Generation Interconnection Customer shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading to 0.95 lagging measured at the generator's terminals.

Revenue Metering and SCADA Requirements

PJM Requirements

The IC 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 Appendix 2.

Meteorological Data Reporting Requirement

The solar generation facility shall provide the Transmission Provider with site-specific meteorological data including:

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

Network Impacts

The Queue Project AE1-154 was evaluated as a 17 MW (Capacity 10 MW) injection tapping the Louisa to South Anna 230 kV line in the ITO area. Project AE1-154 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-154 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

Generation Deliverability

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

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
435778	314766	6LOUISA	DVP	314232	6NO ANNA	DVP	1	DVP_P1-2: LN 2088	single	749.18	98.74	100.07	DC	9.96
435773	925020	AB2-158 TAP	DVP	314766	6LOUISA	DVP	1	DVP_P1-2: LN 2088	single	749.18	99.34	100.67	DC	9.96

Multiple Facility Contingency

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

None.

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.

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	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
435777	314766	6LOUISA	DVP	314232	6NO ANNA	DVP	1	DVP_P1-2: LN 2088	operation	749.18	102.36	104.62	DC	16.93
435772	925020	AB2-158 TAP	DVP	314766	6LOUISA	DVP	1	DVP_P1-2: LN 2088	operation	749.18	102.96	105.22	DC	16.93

System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
435773	2	AB2-158 TAP 230.0 kV - 6LOUISA 230.0 kV Ckt 1	Description : Replace Wave Trap Time Estimate : 16-20 Months Cost : \$250,000	\$250,000
435778	1	6LOUISA 230.0 kV - 6NO ANNA 230.0 kV Ckt 1		
TOTAL COST			\$250,000	

Flow Gate Details

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gauge other generators impact. It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

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
435778	314766	6LOUISA	DVP	314232	6NO ANNA	DVP	1	DVP_P1-2: LN 2088	single	749.18	98.74	100.07	DC	9.96

Bus #	Bus	MW Impact
315172	1LOISA A	11.77
315173	1LOISA B	11.84
315174	1LOISA C	11.84
315175	1LOISA D	11.84
315176	1LOISA E	24.13
315177	1S ANNAG1	7.76
315178	1S ANNAS1	3.99
315179	1S ANNAG2	7.76
315180	1S ANNAS2	3.99
925021	AB2-158 C	9.32
939231	AE1-154 C	9.96
BAYOU	BAYOU	0.43
BIG_CAJUN1	BIG_CAJUN1	0.66
BIG_CAJUN2	BIG_CAJUN2	1.32
BLUEG	BLUEG	2.04
CALDERWOOD	CALDERWOOD	0.22
CANNELTON	CANNELTON	0.12
CARR	CARR	0.15
CATAWBA	CATAWBA	0.14
CHEOAH	CHEOAH	0.2
CHILHOWEE	CHILHOWEE	0.07
CHOCTAW	CHOCTAW	0.44
COFFEEN	COFFEEN	0.22
COTTONWOOD	COTTONWOOD	1.7
DEARBORN	DEARBORN	0.36
DUCKCREEK	DUCKCREEK	0.47
EDWARDS	EDWARDS	0.21
ELMERSMITH	ELMERSMITH	0.21
FARMERCITY	FARMERCITY	0.14
GIBSON	GIBSON	0.08
HAMLET	HAMLET	0.47
NEWTON	NEWTON	0.56
PRAIRIE	PRAIRIE	1.05
RENSELAER	RENSELAER	0.12
SANTEETLA	SANTEETLA	0.06
SMITHLAND	SMITHLAND	0.08
TATANKA	TATANKA	0.26
TILTON	TILTON	0.26
TRIMBLE	TRIMBLE	0.23
TVA	TVA	0.71
UNIONPOWER	UNIONPOWER	0.32

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
435773	925020	AB2-158 TAP	DVP	314766	6LOUISA	DVP	1	DVP_P1-2: LN 2088	single	749.18	99.34	100.67	DC	9.96

Bus #	Bus	MW Impact
315172	1LOISA A	11.77
315173	1LOISA B	11.84
315174	1LOISA C	11.84
315175	1LOISA D	11.84
315176	1LOISA E	24.13
315177	1S ANNAG1	7.76
315178	1S ANNAS1	3.99
315179	1S ANNAG2	7.76
315180	1S ANNAS2	3.99
925021	AB2-158 C	9.32
939231	AE1-154 C	9.96
BAYOU	BAYOU	0.43
BIG_CAJUN1	BIG_CAJUN1	0.66
BIG_CAJUN2	BIG_CAJUN2	1.32
BLUEG	BLUEG	2.04
CALDERWOOD	CALDERWOOD	0.22
CANNELTON	CANNELTON	0.12
CARR	CARR	0.15
CATAWBA	CATAWBA	0.14
CHEOAH	CHEOAH	0.2
CHILHOWEE	CHILHOWEE	0.07
CHOCTAW	CHOCTAW	0.44
COFFEEN	COFFEEN	0.22
COTTONWOOD	COTTONWOOD	1.7
DEARBORN	DEARBORN	0.36
DUCKCREEK	DUCKCREEK	0.47
EDWARDS	EDWARDS	0.21
ELMERSMITH	ELMERSMITH	0.21
FARMERCITY	FARMERCITY	0.14
GIBSON	GIBSON	0.08
HAMLET	HAMLET	0.47
NEWTON	NEWTON	0.56
PRAIRIE	PRAIRIE	1.05
RENSELAER	RENSELAER	0.12
SANTEETLA	SANTEETLA	0.06
SMITHLAND	SMITHLAND	0.08
TATANKA	TATANKA	0.26
TILTON	TILTON	0.26
TRIMBLE	TRIMBLE	0.23
TVA	TVA	0.71
UNIONPOWER	UNIONPOWER	0.32

Contingency Name	Contingency Definition
DVP_P1-2: LN 2088	CONTINGENCY 'DVP_P1-2: LN 2088' OPEN BRANCH FROM BUS 314745 TO BUS 314758 CKT 1 /* 6LOISACT 230.00 - 6GORDNVL 230.00 END

Short Circuit

Short Circuit

The following Breakers are overduty:

None.