Generation Interconnection

Feasibility Study Report

for

Queue Project AE1-155

"GARNER-NORTHERN NECK 115 KV"

89.4 MW Capacity / 149 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 a new solar generating facility located in Moon Corner (Richmond County), Virginia. The installed facilities will have a capability of **149 MW** with **89.4 MW** of this output being recognized by PJM as Capacity. The proposed in-service date for the AE1-155 project is **10/23/2020**. **This study does not imply an ITO commitment to this proposed in-service date.**

Queue Number	**AE1-155**
Project Name	GARNER-NORTHERN NECK 115 KV
Interconnection Customer	
State	Virginia
County	City of Richmond
Transmission Owner	Dominion
MFO	149
MWE	149
MWC	89.4
Fuel	Solar
Basecase Study Year	2022

Primary Point of Interconnection

The AE1-155 project will interconnect with the ITO transmission system via a tap off of the Garner DP-Northern Neck 115 kV line. See one line in **Attachment 1**.

Secondary Point of Interconnection

The IC requested that a secondary POI be reviewed for network impacts. The secondary interconnection chosen was a tap off of the Garner-Lancaster 115 kV line.

This report does not provide costs for the physical interconnection of Option 2. PJM Interconnection Analysis indicates that the secondary connection point chosen would essentially be the same as the primary point in the network model so the results for Option 2 will be the same as those for Option 1.

Cost Summary

The AE1-155 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$1,550,000
Direct Connection Network Upgrade	$5,500,000
Non Direct Connection Network Upgrades	$ 800,000
Total Costs	$7,850,000

In addition, the AE1-155 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$114,000,000

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

Generation Substation: Install metering and associated protection equipment. Estimated Cost $550,000.

Transmission: Construct approximately one span of 115 kV Attachment line between the generation substation and a new AE1-155 Switching Station. The estimated cost for this work is $1,000,000.

The estimated total cost of the Attachment Facilities is $1,550,000. It is estimated to take 18-24 months to complete this work. These preliminary cost estimates are based on typical engineering costs. A more detailed engineering cost estimates are normally done when the IC provides an exact site plan location for the generation substation during the Facility Study phase. See **Attachment 1**.

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
Substation	$ 550,000
Transmission	$1,000,000
Total Attachment Facility Costs	$1,550,000

Direct Connection Cost Estimate

Substation: Establish the new 115 kV AE1-155 Switching Substation (interconnection substation). The arrangement of the substation will be as shown below in **Attachment 1: One-Line Diagram**. The estimated cost of this work scope is $5,500,000. It is estimated to take 24-36 months to complete this work.

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
Substation	$5,500,000
Transmission	$ 0
Total Direct Connection Facility Costs	$5,500,000

Non-Direct Connection Cost Estimate

Transmission: Install transmission structure in-line with transmission line to allow the proposed interconnection switching station to be interconnected with the transmission system. Estimated cost is $800,000 and it is estimated to take 24-30 months to complete. See **Attachment 1**.

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.

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
Transmission	$800,000
Substation	Remote relay work TBD in Facilities Study Phase
Total Non-Direct Connection Facility Costs	$800,000

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

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.

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 Sections 24.1 and 24.2.

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 – Option 1

The Queue Project AE1-155 was evaluated as a 149 MW (Capacity 89.4 MW) injection at the Garner 115 kV substation in the ITO area. Project AE1-155 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-155 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
437681	314134	6CRANES	DVP	314142	6STAFORD	DVP	1	DVP_P1-3: 8LADYSMITH-TX#1	single	678.68	95.28	97.66	DC	16.14
437682	314134	6CRANES	DVP	314142	6STAFORD	DVP	1	DVP_P1-2: LN 2089	single	678.68	95.28	97.66	DC	16.14
437683	314134	6CRANES	DVP	314142	6STAFORD	DVP	1	DVP_P1-2: LN 2032-B	single	678.68	95.78	97.67	DC	12.83

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	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

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	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
436397	314218	6ELMONT	DVP	314908	8ELMONT	DVP	1	DVP_P4-2: H2T557	breaker	1050.6	148.66	149.89	DC	28.38
436493	314903	8CHCKAHM	DVP	314908	8ELMONT	DVP	1	DVP_P4-2: 563T576	breaker	3144.0	139.63	140.1	DC	32.91

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
437678	314134	6CRANES	DVP	314142	6STAFORD	DVP	1	DVP_P1-2: LN 2032-B	operation	678.68	96.73	98.15	DC	21.39
437816	314142	6STAFORD	DVP	314145	6AQUI_HARB_B	DVP	1	DVP_P1-2: LN 2032-B	operation	678.68	81.75	83.17	DC	21.39
437795	314173	3GARNER	DVP	314181	3NORNECK	DVP	1	DVP_P1-2: LN 65-B	operation	203.98	31.67	104.72	DC	149.0
437833	314214	6CHCKAHM	DVP	314903	8CHCKAHM	DVP	1	DVP_P1-2: LN 567	operation	828.8	94.15	95.62	DC	26.88
437677	314218	6ELMONT	DVP	314908	8ELMONT	DVP	2	DVP_P1-2: LN 557	operation	879.84	106.64	107.57	DC	18.15
437714	314218	6ELMONT	DVP	314908	8ELMONT	DVP	1	DVP_P1-2: LN 557	operation	920.92	103.39	104.29	DC	18.23
437100	314903	8CHCKAHM	DVP	314908	8ELMONT	DVP	1	DVP_P1-2: LN 563	operation	2442.12	172.45	173.03	DC	31.08
437105	314903	8CHCKAHM	DVP	314908	8ELMONT	DVP	1	Base Case	operation	2442.12	137.22	137.75	DC	28.55
437205	314905	8CHANCE	DVP	314900	8BRISTER	DVP	1	DVP_P1-2: LN 594	operation	2442.12	154.94	155.44	DC	26.79

System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
436397	2	6ELMONT 230.0 kV - 8ELMONT 230.0 kV Ckt 1	Description : Expand Elmont Substation to Add a 3rd 500-230 kV Transformer Time Estimate : 24-30 Months Cost : $30,000,000	$30,000,000
437681,437682,437683	1	6CRANES 230.0 kV - 6STAFORD 230.0 kV Ckt 1	Description : No Violation. Facility loading does not exceed 100%.	$0
436493	3	8CHCKAHM 500.0 kV - 8ELMONT 500.0 kV Ckt 1	Description : Rebuild & Uprate Elmont-Chickahominy 500 kV Line 557 for 28 miles (Va CPCN) Time Estimate : 36-44 Months Cost : $84,000,000	$84,000,000
		TOTAL COST		$114,000,000

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 gage 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
437683	314134	6CRANES	DVP	314142	6STAFORD	DVP	1	DVP_P1-2: LN 2032-B	single	678.68	95.78	97.67	DC	12.83

Bus #	Bus	MW Impact
314131	6ARNOLDS	0.46
314134	6CRANES	0.15
315033	1BIRCHWDA	12.99
315034	1NORNECKC1	0.65
315035	1NORNECKC2	0.62
315037	1LDYSMT1	5.01
315038	1LDYSMT2	5.0
315039	1LDYSMT3	5.29
315040	1LDYSMT4	5.3
315041	1LDYSMT5	5.32
315043	1FOUR RIVERA	3.9
315044	1FOUR RIVERB	3.02
315045	1FOUR RIVERC	3.9
315046	1FOUR RIVERD	3.02
315047	1FOUR RIVERE	3.02
315048	1FOUR RIVERF	3.89
315050	1FOURRIVERG	2.95
919211	AA1-145	11.27
924061	AB2-050	0.66
924281	AB2-072 C	4.05
926471	AC1-118 C	0.44
926551	AC1-134	1.66
933011	AC2-125	3.22
933021	AC2-126	3.24
933031	AC2-127	1.77
933041	AC2-128	1.71
933051	AC2-129	1.6
933271	AC2-138 C	0.13
934141	AD1-041 C	2.16
934191	AD1-046 C	7.58
934781	AD1-105 C	5.66
936241	AD2-030 C	1.0
936341	AD2-044 C	0.25
936581	AD2-073 C	2.62
936591	AD2-074 C	4.44
938961	AE1-124 C	3.28
939241	AE1-155 C	12.83
939261	AE1-157 C O1	16.81
939271	AE1-158 C O1	17.16
939281	AE1-159 C O1	15.59

Bus #	Bus	MW Impact
939611	AE1-191 C	4.32
939751	AE1-206 C O1	38.9
CARR	CARR	0.4
CBM-S1	CBM-S1	2.31
CBM-S2	CBM-S2	2.49
CBM-W1	CBM-W1	2.06
CBM-W2	CBM-W2	14.81
CIN	CIN	1.0
CPLE	CPLE	1.24
IPL	IPL	0.62
LGEE	LGEE	0.3
MEC	MEC	2.22
MECS	MECS	0.69
RENSSELAER	RENSSELAER	0.32
WEC	WEC	0.26

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
436397	314218	6ELMONT	DVP	314908	8ELMONT	DVP	1	DVP_P4-2: H2T557	breaker	1050.6	148.66	149.89	DC	28.38

Bus #	Bus	MW Impact
314189	6PAPERMILL	8.74
314229	6MT RD221	0.22
314236	6NRTHEST	0.29
314250	6ROCKVILLE	0.49
314539	3UNCAMP	2.16
314541	3WATKINS	0.61
314648	6SUNBURY	0.8
314651	6WINFALL	1.57
315043	1FOUR RIVERA	5.34
315044	1FOUR RIVERB	4.14
315045	1FOUR RIVERC	5.34
315046	1FOUR RIVERD	4.14
315047	1FOUR RIVERE	4.14
315048	1FOUR RIVERF	5.34
315053	1BELMED1	25.29
315054	1BELMED2	25.29
315055	1BELMED3	20.99
315058	1CHESTF3	26.85
315059	1CHESTF4	43.53
315067	1DARBY 1	3.87
315068	1DARBY 2	3.88
315069	1DARBY 3	3.89
315070	1DARBY 4	3.89
315073	1STONECA	9.29
315074	1HOPCGN1	11.2
315075	1HOPCGN2	11.06
315083	1SPRUNCA	14.79
315084	1SPRUNCB	14.79
315085	1SPRUNCC	10.96
315086	1SPRUNCD	10.96
315090	1YORKTN1	30.64
315091	1YORKTN2	31.8
901082	W1-029 E	41.26
907092	X1-038 E	5.41
913392	Y1-086 E	1.98
916042	Z1-036 E	40.25
916192	Z1-068 E	1.74
917122	Z2-027 E	0.95
919152	AA1-139 E	5.85
919211	AA1-145	15.45

Bus #	Bus	MW Impact
923801	AB2-015 C O1	7.64
923802	AB2-015 E O1	6.26
923832	AB2-022 E	1.12
923842	AB2-024 E	1.47
923852	AB2-025 E	1.07
924061	AB2-050	0.91
924241	AB2-068 O1	176.04
924511	AB2-100 C	10.32
924512	AB2-100 E	5.08
924812	AB2-134 E O1	14.72
925051	AB2-160 C O1	7.08
925052	AB2-160 E O1	11.55
925061	AB2-161 C O1	3.58
925062	AB2-161 E O1	5.84
925281	AB2-186 C	0.55
925282	AB2-186 E	0.23
925331	AB2-190 C	24.56
925332	AB2-190 E	10.52
925522	AC1-027 E	1.06
925861	AC1-065 C	4.33
925862	AC1-065 E	7.07
926291	AC1-107 O1	265.73
926411	AC1-112 C	0.53
926412	AC1-112 E	1.92
926472	AC1-118 E	1.06
926551	AC1-134	2.27
926662	AC1-147 E	1.24
926751	AC1-161 C O1	26.86
926752	AC1-161 E O1	11.47
926781	AC1-164 C	57.98
926782	AC1-164 E	26.05
927041	AC1-191 C O1	17.44
927042	AC1-191 E O1	8.69
927221	AC1-216 C O1	11.83
927222	AC1-216 E O1	9.3
930121	AB1-027 C	0.68
930122	AB1-027 E	1.89
932041	AC2-012 C	9.52
932042	AC2-012 E	15.53
932501	AC2-070 C	0.44
932502	AC2-070 E	1.2
932532	AC2-073 E	1.54
932581	AC2-078 C O1	4.69
932582	AC2-078 E O1	7.66
932591	AC2-079 C O1	5.74
932592	AC2-079 E O1	9.37
932831	AC2-110 C	1.73
932832	AC2-110 E	2.83
933061	AC2-130	3.44
933071	AC2-131 1	2.33
933081	AC2-131 2	1.06
933111	AC2-132 1	1.23

Bus #	Bus	MW Impact
933121	AC2-132 2	0.63
933261	AC2-137 C	0.48
933262	AC2-137 E	2.03
933272	AC2-138 E	1.08
933291	AC2-141 C	26.86
933292	AC2-141 E	11.47
933732	AC2-196 E	1.09
934011	AD1-025 C	20.33
934012	AD1-025 E	12.04
934061	AD1-033 C	6.89
934062	AD1-033 E	4.59
934141	AD1-041 C	6.72
934142	AD1-041 E	4.48
934211	AD1-048 C	0.58
934212	AD1-048 E	1.91
934392	AD1-063 E	1.38
934571	AD1-082 C	8.16
934572	AD1-082 E	4.66
934781	AD1-105 C	11.45
934782	AD1-105 E	7.96
935112	AD1-144 E	0.91
935161	AD1-151 C O1	19.73
935162	AD1-151 E O1	13.16
935212	AD1-156 E	1.68
936041	AD2-007	2.16
936051	AD2-008 C	3.54
936052	AD2-008 E	7.7
936151	AD2-021	0.36
936241	AD2-030 C	2.87
936242	AD2-030 E	1.47
936301	AD2-039 C	1.73
936302	AD2-039 E	2.83
936341	AD2-044 C	0.27
936342	AD2-044 E	0.3
936391	AD2-049 C	1.86
936392	AD2-049 E	1.86
936581	AD2-073 C	2.22
936582	AD2-073 E	1.1
936591	AD2-074 C	6.33
936592	AD2-074 E	10.33
936661	AD2-085 C	3.46
936662	AD2-085 E	5.64
936711	AD2-090 C O1	6.27
936712	AD2-090 E O1	4.18
937221	AD2-160 C O1	5.34
937222	AD2-160 E O1	2.8
937251	AD2-164	5.09
937541	AD2-215 C	1.68
937542	AD2-215 E	0.89
938031	AE1-004 C	1.73
938032	AE1-004 E	2.83
938181	AE1-027 C	2.14

Bus #	Bus	MW Impact
938182	AE1-027 E	1.13
938191	AE1-028 C	1.24
938192	AE1-028 E	0.72
938461	AE1-065 C O1	26.28
938462	AE1-065 E O1	106.06
938471	AE1-066 C O1	27.01
938472	AE1-066 E O1	105.33
938481	AE1-067 C O1	24.56
938482	AE1-067 E O1	107.78
938531	AE1-072 C O1	15.96
938532	AE1-072 E O1	8.32
938551	AE1-074 C	3.1
938552	AE1-074 E	1.56
938631	AE1-085 C O1	12.47
938632	AE1-085 E O1	8.31
938771	AE1-103 C O1	3.25
938772	AE1-103 E O1	4.48
938841	AE1-109AC O1	9.62
938842	AE1-109AE O1	6.42
939041	AE1-133 C	31.98
939042	AE1-133 E	15.75
939071	AE1-135 C O1	18.72
939072	AE1-135 E O1	12.48
939191	AE1-149 C O1	12.56
939192	AE1-149 E O1	8.37
939241	AE1-155 C	17.03
939242	AE1-155 E	11.35
939281	AE1-159 C O1	12.03
939282	AE1-159 E O1	7.12
939311	AE1-162 C	2.22
939312	AE1-162 E	1.48
939421	AE1-174 C	0.23
939422	AE1-174 E	0.34
939431	AE1-175 C	2.87
939432	AE1-175 E	1.42
939611	AE1-191 C	13.45
939612	AE1-191 E	8.97
939751	AE1-206 C O1	56.75
939752	AE1-206 E O1	37.83
940061	AE1-248 C O1	16.97
940062	AE1-248 E O1	11.31
940071	AE1-249 C	9.34
940072	AE1-249 E	6.97
AA2-074	AA2-074	3.26
CARR	CARR	0.77
CBM-S1	CBM-S1	4.24
CBM-S2	CBM-S2	8.55
CBM-W1	CBM-W1	0.08
CBM-W2	CBM-W2	23.98
CIN	CIN	0.25
CPLE	CPLE	4.79
DEARBORN	DEARBORN	0.48

Bus #	Bus	MW Impact
G-007	G-007	2.33
IPL	IPL	0.09
LGEE	LGEE	0.07
MEC	MEC	2.01
O-066	O-066	7.81
RENSSELAER	RENSSELAER	0.61
WEC	WEC	0.06

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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
436493	314903	8CHCKAHM	DVP	314908	8ELMONT	DVP	1	DVP_P4-2: 563T576	breaker	3144.0	139.63	140.1	DC	32.91

Bus #	Bus	MW Impact
314189	6PAPERMILL	10.93
314421	6WINCHST	0.25
314539	3UNCAMP	3.9
314541	3WATKINS	1.09
314554	3BTLEBRO	1.02
314557	3BETHELC	1.08
314566	3CRESWEL	3.91
314572	3EMPORIA	0.55
314574	6EVERETS	5.92
314578	3HORNRTN	4.48
314582	3KELFORD	5.03
314594	6PLYMOTH	1.35
314603	3SCOT NK	4.6
314617	3TUNIS	1.25
314620	6CASHIE	1.31
314623	3WITAKRS	1.76
314648	6SUNBURY	1.55
314651	6WINFALL	3.05
315073	1STONECA	8.71
315074	1HOPCGN1	10.5
315075	1HOPCGN2	10.37
315090	1YORKTN1	53.47
315091	1YORKTN2	55.48
315092	1YORKTN3	40.79
315110	1ELIZAR3	5.54
315131	1EDGECMA	11.91
315132	1EDGECMB	11.91
315233	1SURRY 2	49.18
900672	V4-068 E	0.45
901082	W1-029 E	79.97
907092	X1-038 E	9.74
913392	Y1-086 E	3.89
916042	Z1-036 E	77.57
916192	Z1-068 E	3.42
916302	Z1-086 E	13.63
917122	Z2-027 E	1.86
917332	Z2-043 E	1.43
917342	Z2-044 E	0.75
917512	Z2-088 E OP1	5.37
918492	AA1-063AE OP	5.61

Bus #	Bus	MW Impact
918512	AA1-065 E OP	6.65
918532	AA1-067 E	1.04
918562	AA1-072 E	0.24
919152	AA1-139 E	11.56
919692	AA2-053 E	5.17
919701	AA2-057 C	9.39
919702	AA2-057 E	4.69
920042	AA2-088 E OP	15.96
920592	AA2-165 E	0.62
920672	AA2-174 E	0.6
920692	AA2-178 E	6.71
923801	AB2-015 C O1	13.72
923802	AB2-015 E O1	11.25
923832	AB2-022 E	2.19
923842	AB2-024 E	1.84
923852	AB2-025 E	1.45
923911	AB2-031 C O1	2.98
923912	AB2-031 E O1	1.47
923941	AB2-035 C	0.45
923942	AB2-035 E	0.19
923992	AB2-040 E O1	8.02
924152	AB2-059 E O1	6.97
924241	AB2-068 O1	619.41
924391	AB2-088 C	0.58
924392	AB2-088 E	0.28
924491	AB2-098 C	0.81
924492	AB2-098 E	0.35
924501	AB2-099 C	0.87
924502	AB2-099 E	0.37
924511	AB2-100 C	15.33
924512	AB2-100 E	7.55
924812	AB2-134 E O1	18.11
925051	AB2-160 C O1	6.26
925052	AB2-160 E O1	10.22
925061	AB2-161 C O1	5.12
925062	AB2-161 E O1	8.35
925122	AB2-169 E	8.8
925171	AB2-174 C O1	9.33
925172	AB2-174 E O1	8.44
925281	AB2-186 C	1.06
925282	AB2-186 E	0.45
925291	AB2-188 C O1	3.86
925292	AB2-188 E O1	1.73
925331	AB2-190 C	29.18
925332	AB2-190 E	12.5
925522	AC1-027 E	2.08
925591	AC1-034 C	8.76
925592	AC1-034 E	6.61
925861	AC1-065 C	5.36
925862	AC1-065 E	8.75
926071	AC1-086 C	28.13
926072	AC1-086 E	12.8

Bus #	Bus	MW Impact
926201	AC1-098 C	8.44
926202	AC1-098 E	5.03
926211	AC1-099 C	2.83
926212	AC1-099 E	1.66
926291	AC1-107 O1	934.96
926662	AC1-147 E	2.41
926751	AC1-161 C O1	59.48
926752	AC1-161 E O1	25.39
926781	AC1-164 C	67.95
926782	AC1-164 E	30.53
927021	AC1-189 C	12.09
927022	AC1-189 E	6.02
927141	AC1-208 C	12.18
927142	AC1-208 E	5.41
927221	AC1-216 C O1	14.56
927222	AC1-216 E O1	11.45
930402	AB1-081 E O1	4.92
930862	AB1-132 E O1	8.19
931232	AB1-173 E	1.4
931242	AB1-173AE	1.4
932041	AC2-012 C	18.55
932042	AC2-012 E	30.26
932532	AC2-073 E	1.95
932581	AC2-078 C O1	5.51
932582	AC2-078 E O1	9.0
932591	AC2-079 C O1	9.25
932592	AC2-079 E O1	15.1
932631	AC2-084 C	12.04
932632	AC2-084 E	5.93
932831	AC2-110 C	2.15
932832	AC2-110 E	3.5
933061	AC2-130	3.1
933071	AC2-131 1	2.1
933081	AC2-131 2	0.95
933111	AC2-132 1	1.1
933121	AC2-132 2	0.56
933262	AC2-137 E	1.87
933272	AC2-138 E	1.18
933291	AC2-141 C	59.48
933292	AC2-141 E	25.39
933732	AC2-196 E	2.17
933991	AD1-023 C	20.57
933992	AD1-023 E	11.2
934011	AD1-025 C	25.02
934012	AD1-025 E	14.82
934061	AD1-033 C	13.69
934062	AD1-033 E	9.13
934141	AD1-041 C	8.49
934142	AD1-041 E	5.66
934201	AD1-047 C	10.69
934202	AD1-047 E	7.13
934212	AD1-048 E	1.38

Bus #	Bus	MW Impact
934331	AD1-057 C O1	13.17
934332	AD1-057 E O1	7.03
934392	AD1-063 E	1.75
934521	AD1-076 C	86.33
934522	AD1-076 E	43.96
934571	AD1-082 C	11.67
934572	AD1-082 E	6.65
934611	AD1-087 C O1	9.63
934612	AD1-087 E O1	4.53
935112	AD1-144 E	1.67
935161	AD1-151 C O1	23.45
935162	AD1-151 E O1	15.63
935171	AD1-152 C O1	9.57
935172	AD1-152 E O1	6.38
935212	AD1-156 E	1.73
936041	AD2-007	2.66
936051	AD2-008 C	4.36
936052	AD2-008 E	9.48
936151	AD2-021	0.33
936241	AD2-030 C	3.71
936242	AD2-030 E	1.9
936301	AD2-039 C	2.15
936302	AD2-039 E	3.5
936341	AD2-044 C	0.29
936342	AD2-044 E	0.33
936391	AD2-049 C	3.25
936392	AD2-049 E	3.25
936401	AD2-051 C O1	12.92
936402	AD2-051 E O1	5.55
936531	AD2-068 C	6.83
936532	AD2-068 E	3.52
936591	AD2-074 C	7.45
936592	AD2-074 E	12.16
936661	AD2-085 C	5.53
936662	AD2-085 E	9.03
936701	AD2-089 C	9.68
936702	AD2-089 E	6.45
936711	AD2-090 C O1	11.2
936712	AD2-090 E O1	7.47
937221	AD2-160 C O1	10.58
937222	AD2-160 E O1	5.55
937251	AD2-164	8.86
937481	AD2-202 C O1	2.65
937482	AD2-202 E O1	1.34
937541	AD2-215 C	3.09
937542	AD2-215 E	1.64
937571	AD2-169 C	13.39
937572	AD2-169 E	8.93
938031	AE1-004 C	2.15
938032	AE1-004 E	3.5
938171	AE1-026 C1 O	43.48
938172	AE1-026 C2 O	6.29

Bus #	Bus	MW Impact
938173	AE1-026 E O1	13.13
938181	AE1-027 C	4.25
938182	AE1-027 E	2.24
938191	AE1-028 C	2.47
938192	AE1-028 E	1.43
938221	AE1-035 C	3.38
938222	AE1-035 E	1.66
938461	AE1-065 C O1	51.72
938462	AE1-065 E O1	208.71
938471	AE1-066 C O1	53.15
938472	AE1-066 E O1	207.28
938481	AE1-067 C O1	48.34
938482	AE1-067 E O1	212.1
938491	AE1-068 C O1	86.96
938492	AE1-068 E O1	48.03
938501	AE1-069 C O1	68.0
938502	AE1-069 E O1	38.87
938531	AE1-072 C O1	31.52
938532	AE1-072 E O1	16.43
938631	AE1-085 C O1	15.01
938632	AE1-085 E O1	10.01
938661	AE1-088	2.67
938771	AE1-103 C O1	5.85
938772	AE1-103 E O1	8.07
938841	AE1-109AC O1	13.73
938842	AE1-109AE O1	9.15
939041	AE1-133 C	62.46
939042	AE1-133 E	30.76
939071	AE1-135 C O1	27.48
939072	AE1-135 E O1	18.32
939191	AE1-149 C O1	14.18
939192	AE1-149 E O1	9.45
939241	AE1-155 C	19.75
939242	AE1-155 E	13.16
939311	AE1-162 C	3.68
939312	AE1-162 E	2.45
939411	AE1-173 C	146.92
939412	AE1-173 E	97.95
939421	AE1-174 C	0.66
939422	AE1-174 E	1.0
939431	AE1-175 C	4.42
939432	AE1-175 E	2.19
939611	AE1-191 C	16.97
939612	AE1-191 E	11.32
940061	AE1-248 C O1	24.25
940062	AE1-248 E O1	16.17
940071	AE1-249 C	8.26
940072	AE1-249 E	6.16
AA2-074	AA2-074	6.78
AE1-042	AE1-042	9.38
CARR	CARR	1.33
CBM-S1	CBM-S1	13.77

Bus #	Bus	MW Impact
CBM-S2	CBM-S2	18.81
CBM-W1	CBM-W1	9.82
CBM-W2	CBM-W2	86.63
CIN	CIN	4.7
CPLE	CPLE	9.96
G-007	G-007	4.24
IPL	IPL	2.88
LGEE	LGEE	1.37
MEC	MEC	11.75
MECS	MECS	2.52
O-066	O-066	14.17
RENSSELAER	RENSSELAER	1.05
WEC	WEC	1.24

Contingency Name	Contingency Defintion
DVP_P1-2: LN 2032-B	CONTINGENCY 'EKPC_P4-5_OWEN N44-808' /* SPURLOCK OPEN BRANCH FROM BUS 324293 TO BUS 342007 CKT 1 /* 324293 4OWEN C 138.00 342007 2OWEN CO 69.000 OPEN BRANCH FROM BUS 324290 TO BUS 324293 CKT 1 /* 324290 4OWC TAP 138.00 324293 4OWEN C 138.00 OPEN BRANCH FROM BUS 324253 TO BUS 324290 CKT 1 /* 324253 4GHENT 138.00 324290 4OWC TAP 138.00 OPEN BRANCH FROM BUS 324290 TO BUS 324305 CKT 1 /* 324290 4OWC TAP 138.00 324305 4SCOTTKU 138.00 END
DVP_P1-3: 8LADYSMITH-TX#1	CONTINGENCY 'EKPC_P4-5_OWEN N44-808' /* SPURLOCK OPEN BRANCH FROM BUS 324293 TO BUS 342007 CKT 1 /* 324293 4OWEN C 138.00 342007 2OWEN CO 69.000 OPEN BRANCH FROM BUS 324290 TO BUS 324293 CKT 1 /* 324290 4OWC TAP 138.00 324293 4OWEN C 138.00 OPEN BRANCH FROM BUS 324253 TO BUS 324290 CKT 1 /* 324253 4GHENT 138.00 324290 4OWC TAP 138.00 OPEN BRANCH FROM BUS 324290 TO BUS 324305 CKT 1 /* 324290 4OWC TAP 138.00 324305 4SCOTTKU 138.00 END
DVP_P4-2: H2T557	CONTINGENCY 'EKPC_P4-5_OWEN N44-808' /* SPURLOCK OPEN BRANCH FROM BUS 324293 TO BUS 342007 CKT 1 /* 324293 4OWEN C 138.00 342007 2OWEN CO 69.000 OPEN BRANCH FROM BUS 324290 TO BUS 324293 CKT 1 /* 324290 4OWC TAP 138.00 324293 4OWEN C 138.00 OPEN BRANCH FROM BUS 324253 TO BUS 324290 CKT 1 /* 324253 4GHENT 138.00 324290 4OWC TAP 138.00 OPEN BRANCH FROM BUS 324290 TO BUS 324305 CKT 1 /* 324290 4OWC TAP 138.00 324305 4SCOTTKU 138.00 END
DVP_P4-2: 563T576	CONTINGENCY 'EKPC_P4-5_OWEN N44-808' /* SPURLOCK OPEN BRANCH FROM BUS 324293 TO BUS 342007 CKT 1 /* 324293 4OWEN C 138.00 342007 2OWEN CO 69.000 OPEN BRANCH FROM BUS 324290 TO BUS 324293 CKT 1 /* 324290 4OWC TAP 138.00 324293 4OWEN C 138.00 OPEN BRANCH FROM BUS 324253 TO BUS 324290 CKT 1 /* 324253 4GHENT 138.00 324290 4OWC TAP 138.00 OPEN BRANCH FROM BUS 324290 TO BUS 324305 CKT 1 /* 324290 4OWC TAP 138.00 324305 4SCOTTKU 138.00 END
DVP_P1-2: LN 2089	CONTINGENCY 'EKPC_P4-5_OWEN N44-808' /* SPURLOCK OPEN BRANCH FROM BUS 324293 TO BUS 342007 CKT 1 /* 324293 4OWEN C 138.00 342007 2OWEN CO 69.000 OPEN BRANCH FROM BUS 324290 TO BUS 324293 CKT 1 /* 324290 4OWC TAP 138.00 324293 4OWEN C 138.00 OPEN BRANCH FROM BUS 324253 TO BUS 324290 CKT 1 /* 324253 4GHENT 138.00 324290 4OWC TAP 138.00 OPEN BRANCH FROM BUS 324290 TO BUS 324305 CKT 1 /* 324290 4OWC TAP 138.00 324305 4SCOTTKU 138.00 END

Short Circuit

Short Circuit

The following Breakers are overduty:

None

Network Impacts – Option 2

Option 2 was for a connection to the Garner-Lancaster 115 kV line. The physical interconnection point for this option would be on the opposite side of Garner Substation from the Option 1 connection. The Option 2 connection would be modeled as injection at the Garner 115 kV substation which is the same as Option 1. Therefore, there was no need to model the Secondary POI in this case. ***The results for Option 2 are the same as Option 1.***

Appendix 1: One Line Diagram