Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AD1-151

Hopewell-Surry 230kV 90 MW Capacity / 150 MW Energy

Revision 6/ October 2022
Revision 5/ September 2022
Revision 4/ May 2022
Revision 3 / April 2022
Revision 2 / January 2022
Revision 1 / November 2021
March 2019

Introduction

This System Impact Study (SIS) has been prepared in accordance with the PJM Open Access Transmission Tariff, Section 205, as well as the System Impact Study Agreement between Loblolly Solar, LLC, 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 System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the IC. As a requirement for interconnection, the IC may be responsible for the cost of constructing Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.
In some instances an IC may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. 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 System Impact Study is performed.
The System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The IC 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.

Revision 1 (November 2021) Summary

This revision is being issued to incorporate results of a re-tool performed in November of 2021.

Revision 2 (January 2022) Summary

This revision is being issued to incorporate results of a re-tool performed in January of 2022. This retool was needed to account for the withdrawal of AC1-107.

Revision 3 (April 2022) Summary

This revision is being issued to incorporate results of short circuit impacts of the Prince George – Poe 230 kV line reinforcement.

Revision 4 (May 2022) Summary

This revision is being issued to incorporate results of a re-tool performed in May of 2022. This retool was needed to account for the withdrawal of AD1-023.

Revision 5 (September 2022) Summary

This revision is being issued to reflect costs changes included in the Facilities Study for the project.

Revision 6 (October 2022) Summary

This revision is being issued to reflect updated analysis driven by model corrections.

General

The IC has proposed a solar generating facility located in Surry County, Virginia. The installed AD1-151 facilities will have a total capability of 150 MW with 90 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 31, 2020. **This study does not imply an ITO commitment to this in-service date.**

Point of Interconnection

AD1-151 will interconnect with the ITO transmission system via a new three breaker ring bus switching station that connects the Hopewell-Surry 230kV line.

Cost Summary

The AD1-151 interconnection request will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 641,535
Direct Connection Network Upgrades	$ 6,334,455
Non Direct Connection Network Upgrades	$ 1,473,092
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0
Total Costs	$ 8,449,082

Attachment Facilities

Generation Substation: Install metering and associated protection equipment. Estimated Cost $641,535.

The estimated total cost of the Attachment Facilities is $1,800,000. It is estimated to take 18-24 months to complete this work upon execution of an Interconnection Construction Service Agreement (ICSA). 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.

Direct Connection Cost Estimate

Substation: Establish the new 230 kV AD1-151 Switching Substation (interconnection substation). The estimated cost of this work scope is $6,334,455. It is estimated to take 24-36 months to complete this work upon execution of an Interconnection Construction Service Agreement.

Non-Direct Network Upgrades:

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 $1,361,288 and is estimated to take 24-30 months to complete.

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.
Note: Cost of remote changes at Colonial Trail and Hopewell substations as will be included in the facilities study report is $111,804.

Incremental Capacity Transfer Rights

The network upgrades outlined in this report do not increase the CETL in the 2021/22 BRA case.

Interconnection Customer Requirements

ITO's Facility Interconnection 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.
Meteorological Data Reporting Requirement - The solar generation facility shall, at a minimum, be required to provide the Transmission Provider with site-specific meteorological data including:

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

Revenue Metering and SCADA Requirements

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 Sections 24.1 and 24.2.

Interconnected Transmission Owner Requirements

Metering and SCADA/Communication equipment must meet the requirements outlined in section 3.1.6 Metering and Telecommunications of ITO's Facility Connection Requirement NERC Standard FAC-001 which is publically available at www.dom.com.

Summer Peak Analysis – 2021

The Queue Project AD1-151 was evaluated as a 150.0 MW (Capacity 90.0 MW) injection into Hopewell-Surry 230kV in the ITO area. Project AD1-151 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-151 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
DVP_P1-2: LN 211	CONTINGENCY 'DVP_P1-2: LN 211' OPEN BRANCH FROM BUS 314287 TO BUS 314303 CKT 1 /* 6CHSTF B 230.00 - 6HOPEWLL 230.00 END
DVP_P1-2: LN 217	CONTINGENCY 'DVP_P1-2: LN 217' OPEN BRANCH FROM BUS 314225 TO BUS 314227 CKT 1 /* 6CHARCTY 230.00 - 6LAKESD 230.00 OPEN BRANCH FROM BUS 314225 TO BUS 314287 CKT 1 /* 6CHARCTY 230.00 - 6CHSTF B 230.00 OPEN BUS 314225 /* ISLAND END
DVP_P1-2: LN 228	CONTINGENCY 'DVP_P1-2: LN 228' OPEN BRANCH FROM BUS 314278 TO BUS 314286 CKT 1 /* 6BERMUDA 230.00 - 6CHSTF A 230.00 OPEN BRANCH FROM BUS 314278 TO BUS 314303 CKT 1 /* 6BERMUDA 230.00 - 6HOPEWLL 230.00 OPEN BUS 314278 /* ISLAND END

DVP_P1-2: LN 563	CONTINGENCY 'DVP_P1-2: LN 563' OPEN BRANCH FROM BUS 314902 TO BUS 314914 CKT 1 /* 8CARSON 500.00 - 8MDLTHAN 500.00 END
DVP_P1-2: LN 574	CONTINGENCY 'DVP_P1-2: LN 574' OPEN BRANCH FROM BUS 314908 TO BUS 314911 CKT 1 /* 8ELMONT 500.00 - 8LDYSMTH 500.00 END
DVP_P1-2: LN 575	CONTINGENCY 'DVP_P1-2: LN 575' OPEN BRANCH FROM BUS 314911 TO BUS 314918 CKT 1 /* 8LDYSMTH 500.00 - 8NO ANNA 500.00 END
DVP_P1-2: LN 576	CONTINGENCY 'DVP_P1-2: LN 576' OPEN BRANCH FROM BUS 314914 TO BUS 314918 CKT 1 /* 8MDLTHAN 500.00 - 8NO ANNA 500.00 END
DVP_P1-2: LN 594	CONTINGENCY 'DVP_P1-2: LN 594' OPEN BRANCH FROM BUS 314916 TO BUS 314934 CKT 1 /* 8MORRSVL 500.00 - 8SPOTSYL 500.00 END
DVP_P4-2: 211T2124	CONTINGENCY 'DVP_P4-2: 211T2124' /*_ HOPEWELL OPEN BRANCH FROM BUS 314303 TO BUS 314287 CKT 1 /*L211 HOPEWELL CHESTERFIELD OPEN BRANCH FROM BUS 314303 TO BUS 314269 CKT 1 /*L2124 END

DVP_P4-2: 562T563	CONTINGENCY 'DVP_P4-2: 562T563' /*CARSON OPEN BRANCH FROM BUS 314902 TO BUS 314923 CKT 1 /*CARSON TO MIDLOTHIAN OPEN BRANCH FROM BUS 314914 TO BUS 314902 CKT 1 /*CARSON 500.00 - 8SEPTA 500.00 END
DVP_P7-1: LN 211-228	CONTINGENCY 'DVP_P7-1: LN 211-228' OPEN BRANCH FROM BUS 314287 TO BUS 314303 CKT 1 /* 6CHSTF B 230.00 - 6HOPEWLL 230.00 OPEN BRANCH FROM BUS 314278 TO BUS 314286 CKT 1 /* 6BERMUDA 230.00 - 6CHSTF A 230.00 OPEN BRANCH FROM BUS 314278 TO BUS 314303 CKT 1 /* 6BERMUDA 230.00 - 6HOPEWLL 230.00 OPEN BUS 314278 /* ISLAND END
DVP_P7-1: LN 212-240_D	CONTINGENCY 'DVP_P7-1: LN 212-240_D' OPEN BRANCH FROM BUS 925330 TO BUS 314538 CKT 2 /* AB2-190 TAP 230.00 - 6SURRY 230.00 OPEN BRANCH FROM BUS 924810 TO BUS 314538 CKT 1 /* AB2-134 TAP 230.00 - 6SURRY 230.00 END

Generator Deliverability

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

None

Multiple Facility Contingency

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

Overload Number	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Flowgate Appendix
1	LFFB	DVP_P4-2: 211T2124	DVP - DVP	6BERMUDA-6CHESTF A 230 kV line	314278	314286	1	AC	99	110.49		549	63.99	1
2	DCTL	DVP_P7-1: LN 212-240_D	DVP - DVP	6BERMUDA-6CHESTF A 230 kV line	314278	314286	1	AC	89.46	101.47		549	67.25	
3	LFFB	DVP_P4-2: 211T2124	DVP - DVP	6HOPEWLL-6BERMUDA 230 kV line	314303	314278	1	AC	99.02	110.52		549	63.99	2
4	DCTL	DVP_P7-1: LN 212-240_D	DVP - DVP	6HOPEWLL-6BERMUDA 230 kV line	314303	314278	1	AC	89.49	101.49		549	67.25	

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)

Overload Number	Contingency Type	Contingency Name	Affected Area	Facility Description	Bus From	Bus To	Circuit	Power Flow	Loading % Initial	Loading % Final	Rating Type	Rating MVA	MW Contribution	Flowgate Appendix
5	LFFB	DVP_P4-2: 562T563	DVP - DVP	6CHESTF B-6BASIN 230 kV line	314287	314276	1	AC	110.59	113.35		549	15.11	3
6	N-1	DVP_P1-2: LN 217	DVP - DVP	6CHESTF B-6BASIN 230 kV line	314287	314276	1	AC	106.86	109.39	ER	449	11.25	

System Reinforcements – Load Flow

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AD1-151 Allocation
#1, 2 #3, 4	6BERMUDA-6CHESTF A 230 kV line	**PJM Baseline Upgrade:** **Upgrade #1** **Project Id:** b2922 **Project Description:** Rebuild 8 of 11 miles of 230kV Lines #211 and #228 to current standard with a summer emergency rating of 1046 MVA for rebuilt section. Proposed conductor is 2-636 ACSR. **Note: This project is already in Service.** **Upgrade #2** **Project Id:** b3694.11 **Project Description:** Reconductor approximately 2.9 miles of 230 kV Line #228 Chesterfield – Hopewell to achieve a minimum summer emergency rating of 1046 MVA. **Type:** FAC **Total Cost:** $7,500,000 **New Rating:** **Rate A:** 1047 MVA **Rate B:** 1047 MVA **Rate C:** 1204 MVA **Projected ISD:** 6/1/2026	b2922 b3694.11 b3694.12 b3694.13	-	**$0**

	6HOPEWLL-6BERMUDA 230 kV line	**Upgrade #3** **Project Id:** b3694.12 **Project Description:** Upgrade equipment at Chesterfield substation to not limit ratings on Lines 211 and 228. **Projected ISD:** 06/01/2026 **Upgrade #4** **Project Id:** b3694.13 **Project Description:** Upgrade equipment at Hopewell substation to not limit ratings on Lines 211 and 228. **Projected ISD:** 06/01/2026 **Note 1**: Although Queue Project AD1-0151 may not have cost responsibility for this upgrade, Queue Project AD1-151 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AD1-151 comes into service prior to completion of the upgrade, Queue Project AD1-151 will need an interim study.			

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AD1-151 Allocation
#5, 6	6CHESTF B-6BASIN 230 kV line	Chesterfield – Basin 230kV line # 259, replace 0.14 miles of 1109 ACAR with a conductor with a conductor which will increase the line rating to approximately 706 MVA (normal), 706 MVA (emergency), and 812 MVA (load dump). Work completed 6/01/2018.	b2990	-	**$0**
Total Cost($)					**$0**

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 IC 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 interconnection request by addressing 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.

Overload	Contingency		Affected		Bus		Circuit	Power	Loading %		Rating		MW	Flowgate
Number	Type	Name	Area	Facility Description	From	To		Flow	Initial	Final	Type	MVA	Contribution	Appendix
5	N-1	DVP_P1-2: LN 211	DVP - DVP	6BERMUDA-6CHESTF A 230 kV line	314278	314286	1	AC	104	116.28	ER	449	55.68	
6	N-1	DVP_P1-2: LN 563	DVP - DVP	6CHESTF B-6BASIN 230 kV line	314287	314276	1	AC	128	131.46	ER	449	15.54	
7	N-1	DVP_P1-2: LN 211	DVP - DVP	6HOPEWLL-6BERMUDA 230 kV line	314303	314278	1	AC	104.03	116.3	ER	449	55.68	
8	N-1	DVP_P1-2: LN 228	DVP - DVP	6HOPEWLL-6CHESTF B 230 kV line	314303	314287	1	AC	95.01	107.81	ER	442	57.31	
9	N-1	DVP_P1-2: LN 594	DVP - DVP	8CHANCE-8BRISTER 500 kV line	314905	314900	1	AC	101.68	102.71	ER	2442	28.95	
10	N-1	DVP_P1-2: LN 576	DVP - DVP	8ELMONT-8LADYSMITH 500 kV line	314908	314911	1	AC	111.8	113.65	ER	2442	48.43	

11	N-1	DVP_P1-2: LN 574	DVP - DVP	8MDLTHAN-8NO ANNA 500 kV line	314914	314918	1	AC	104.39	105.8	ER	2442	39.5	
12	N-1	DVP_P1-2: LN 575	DVP - DVP	8SPOTSYL-8MORRSVL 500 kV line	314934	314916	1	AC	99.6	100.44	ER	3219	22.66	

Short Circuit

(Summary of impacted circuit breakers)
New circuit breakers found to be over-duty:

None.

Contributions to previously identified circuit breakers found to be over-duty:
None.

New System Reinforcements – Short Circuit

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this interconnection request)

None.

Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)
None.

Stability and Reactive Power Requirement for Low Voltage Ride Through

(Summary of the VAR requirements based upon the results of the dynamic studies)

The queue project, AD1-151, does not meet the 0.95 lagging power factor requirement and meets the 0.95 leading power factor requirement. An additional 8.62 Mvar would be required for the plant to meet the 0.95 lagging power factor requirement at the high side of the main transformer.

Power Factor Assessment for the AD1-151 Queue Project

Generator	MFO (MW)	Required Power Factor Range		Maximum Lagging (Mvar)	Minimum Leading (Mvar)
		Lagging	Leading		
AD1-151	150.00	0.95	0.95		
Total Reactive Power Required				49.30	-49.30
Reactive Power from Generator				**Qmax**	**Qmin**
				61.18	-61.18
Customer Planned Compensation				0	0
Reactive Power Losses				-20.5	-20.5
Total Available Reactive Power at High Side of Main Transformer				40.68	-81.68
Deficiency in Reactive Power				8.62	Meet

Light Load Analysis in 2021

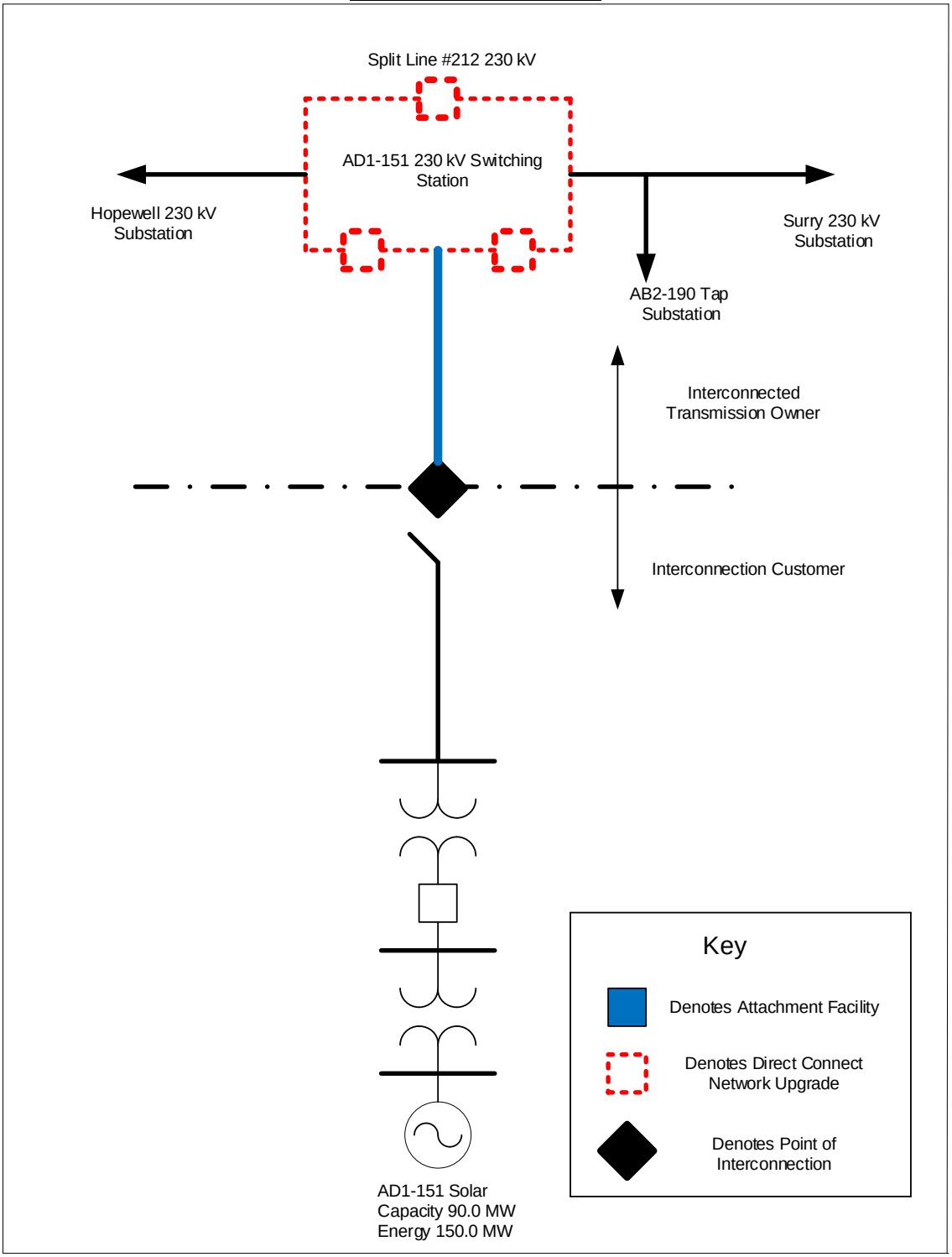
None.

Affected System Analysis & Mitigation

Duke Energy:

None.

System Configuration



Appendices

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. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the Appendices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the Appendices. 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 and appendices sections are full contributions, whereas the loading percentages reported in the body of the report, take into consideration the commercial probability of each project as well as the ramping impact of "Adder" contributions.

Appendix 1

(DVP - DVP) The 6BERMUDA-6CHESTF A 230 kV line (from bus 314278 to bus 314286 ckt 1) loads from 99.0% to 110.49% (AC power flow) of its load dump rating (549 MVA) for the line fault with failed breaker contingency outage of 'DVP_P4-2: 211T2124'. This project contributes approximately 63.99 MW to the thermal violation.

CONTINGENCY 'DVP_P4-2: 211T2124' /*_ HOPEWELL
OPEN BRANCH FROM BUS 314303 TO BUS 314287 CKT 1 /*L211 HOPEWELL CHESTERFIELD
OPEN BRANCH FROM BUS 314303 TO BUS 314269 CKT 1 /*L2124
END

Bus Number	*Bus Name*	*Full Contribution*
315119	*1GRAVEL3*	*3.95*
315120	*1GRAVEL4*	*4.*
315121	*1GRAVEL5*	*3.95*
315122	*1GRAVEL6*	*4.*
315074	*1HOPCGN1*	*27.86*
315075	*1HOPCGN2*	*27.5*
315077	*1HOPHCF1*	*8.22*
315078	*1HOPHCF2*	*8.22*
315079	*1HOPHCF3*	*8.22*
315080	*1HOPHCF4*	*12.48*
315076	*1HOPPOLC*	*5.85*
315073	*1STONECA*	*23.11*
315116	*1SURRY 1*	*39.6*
934011	*AD1-025 C O1*	*40.18*
934012	*AD1-025 E O1*	*23.8*
935161	*AD1-151 C O1*	*38.39*
935162	*AD1-151 E O1*	*25.59*
LTF	*CARR*	*0.16*
LTF	*CBM-S1*	*1.*
LTF	*CBM-S2*	*3.07*
LTF	*CBM-W1*	*0.65*
LTF	*CBM-W2*	*4.79*
LTF	*CIN*	*0.17*
LTF	*CPLE*	*1.05*
LTF	*G-007*	*0.62*
LTF	*IPL*	*0.1*
LTF	*LGEE*	*0.04*
LTF	*MEC*	*0.68*
LTF	*O-066*	*3.93*
LTF	*RENSSELAER*	*0.13*
LTF	*WEC*	*0.05*
914231	*Y2-077*	*3.31*

924811	*AB2-134 C O1*	*30.63*
924812	*AB2-134 E O1*	*30.12*
925331	*AB2-190 C*	*47.78*
925332	*AB2-190 E*	*20.48*
927221	*AC1-216 C O1*	*23.38*
927222	*AC1-216 E O1*	*18.39*

Appendix 2

(DVP - DVP) The 6HOPEWLL-6BERMUDA 230 kV line (from bus 314303 to bus 314278 ckt 1) loads from 99.02% to 110.52% (AC power flow) of its load dump rating (549 MVA) for the line fault with failed breaker contingency outage of 'DVP_P4-2: 211T2124'. This project contributes approximately 63.99 MW to the thermal violation.

CONTINGENCY 'DVP_P4-2: 211T2124' /*_ HOPEWELL
OPEN BRANCH FROM BUS 314303 TO BUS 314287 CKT 1 /*L211 HOPEWELL CHESTERFIELD
OPEN BRANCH FROM BUS 314303 TO BUS 314269 CKT 1 /*L2124
END

Bus Number	*Bus Name*	*Full Contribution*
315119	*1GRAVEL3*	*3.95*
315120	*1GRAVEL4*	*4.*
315121	*1GRAVEL5*	*3.95*
315122	*1GRAVEL6*	*4.*
315074	*1HOPCGN1*	*27.86*
315075	*1HOPCGN2*	*27.5*
315077	*1HOPHCF1*	*8.22*
315078	*1HOPHCF2*	*8.22*
315079	*1HOPHCF3*	*8.22*
315080	*1HOPHCF4*	*12.48*
315076	*1HOPPOLC*	*5.85*
315073	*1STONECA*	*23.11*
315116	*1SURRY 1*	*39.6*
934011	*AD1-025 C O1*	*40.18*
934012	*AD1-025 E O1*	*23.8*
935161	*AD1-151 C O1*	*38.39*
935162	*AD1-151 E O1*	*25.59*
LTF	*CARR*	*0.16*
LTF	*CBM-S1*	*1.*
LTF	*CBM-S2*	*3.07*
LTF	*CBM-W1*	*0.65*
LTF	*CBM-W2*	*4.79*
LTF	*CIN*	*0.17*
LTF	*CPLE*	*1.05*
LTF	*G-007*	*0.62*
LTF	*IPL*	*0.1*
LTF	*LGEE*	*0.04*
LTF	*MEC*	*0.68*
LTF	*O-066*	*3.93*
LTF	*RENSSELAER*	*0.13*
LTF	*WEC*	*0.05*

914231	*Y2-077*	*3.31*
924811	*AB2-134 C O1*	*30.63*
924812	*AB2-134 E O1*	*30.12*
925331	*AB2-190 C*	*47.78*
925332	*AB2-190 E*	*20.48*
927221	*AC1-216 C O1*	*23.38*
927222	*AC1-216 E O1*	*18.39*

Appendix 3

(DVP - DVP) The 6CHESTF B-6BASIN 230 kV line (from bus 314287 to bus 314276 ckt 1) loads from 110.59% to 113.35% (AC power flow) of its load dump rating (549 MVA) for the line fault with failed breaker contingency outage of 'DVP_P4-2: 562T563'. This project contributes approximately 15.11 MW to the thermal violation.

CONTINGENCY 'DVP_P4-2: 562T563' /*CARSON
OPEN BRANCH FROM BUS 314902 TO BUS 314923 CKT 1 /*CARSON TO MIDLOTHIAN
OPEN BRANCH FROM BUS 314914 TO BUS 314902 CKT 1 /*CARSON 500.00 - 8SEPTA 500.00
END

Bus Number	*Bus Name*	*Full Contribution*
315065	*1CHESTF6*	*32.84*
315131	*1EDGECMA*	*3.05*
315132	*1EDGECMB*	*3.05*
315074	*1HOPCGN1*	*5.89*
315075	*1HOPCGN2*	*5.81*
315077	*1HOPHCF1*	*1.74*
315078	*1HOPHCF2*	*1.74*
315079	*1HOPHCF3*	*1.74*
315080	*1HOPHCF4*	*2.64*
315076	*1HOPPOLC*	*1.24*
315073	*1STONECA*	*4.88*
314557	*3BETHELC*	*0.3*
314554	*3BTLEBRO*	*0.3*
314572	*3EMPORIA*	*0.22*
314578	*3HORNRTN*	*1.43*
314314	*3LOCKS*	*0.06*
314315	*3LOCKS E*	*0.83*
314603	*3SCOT NK*	*1.31*
314541	*3WATKINS*	*0.27*
314620	*6CASHIE*	*0.31*
314594	*6PLYMOTH*	*0.3*
932591	*AC2-079 C*	*2.7*
932592	*AC2-079 E*	*4.41*
932631	*AC2-084 C*	*2.64*
932632	*AC2-084 E*	*1.3*
933991	*AD1-022 C*	*3.17*
933992	*AD1-022 E*	*1.72*
934011	*AD1-025 C O1*	*9.49*
934012	*AD1-025 E O1*	*5.62*
934331	*AD1-057 C O1*	*4.26*

934332	AD1-057 E O1	2.27
934521	AD1-076 C O1	19.37
934522	AD1-076 E O1	9.86
934571	AD1-082 C O1	5.2
934572	AD1-082 E O1	2.97
935161	AD1-151 C O1	9.07
935162	AD1-151 E O1	6.05
LTF	CARR	0.23
LTF	CBM-S1	3.99
LTF	CBM-S2	8.63
LTF	CBM-W1	7.45
LTF	CBM-W2	20.89
LTF	CIN	1.7
LTF	CPLE	2.76
LTF	G-007	1.04
LTF	IPL	1.08
LTF	LGEE	0.37
LTF	MEC	4.07
LTF	MECS	1.38
LTF	O-066	6.63
LTF	RENSSELAER	0.18
900672	V4-068 E	0.12
LTF	WEC	0.47
907092	X1-038 E	2.34
914231	Y2-077	0.7
916302	Z1-086 E	3.71
917332	Z2-043 E	0.39
917342	Z2-044 E	0.22
917512	Z2-088 E OP1	1.45
918492	AA1-063AE OP	1.7
918512	AA1-065 E OP	1.69
918562	AA1-072 E	0.07
919692	AA2-053 E	1.6
919701	AA2-057 C	2.8
919702	AA2-057 E	1.4
LTF	AA2-074	1.88
920042	AA2-088 E	4.24
920592	AA2-165 E	0.18
920672	AA2-174 E	0.18
930402	AB1-081 E	1.46
930861	AB1-132 C	6.74
930862	AB1-132 E	2.89
931231	AB1-173 C	1.1
931232	AB1-173 E	0.52
931241	AB1-173AC	1.1

931242	*AB1-173AE*	*0.52*
923851	*AB2-025 C*	*0.32*
923852	*AB2-025 E*	*0.78*
923911	*AB2-031 C O1*	*1.1*
923912	*AB2-031 E O1*	*0.54*
923991	*AB2-040 C O1*	*3.6*
923992	*AB2-040 E O1*	*2.94*
924151	*AB2-059 C O1*	*4.01*
924152	*AB2-059 E O1*	*2.06*
924501	*AB2-099 C*	*0.23*
924502	*AB2-099 E*	*0.1*
924511	*AB2-100 C*	*6.79*
924512	*AB2-100 E*	*3.35*
924811	*AB2-134 C O1*	*7.23*
924812	*AB2-134 E O1*	*7.11*
925051	*AB2-160 C O1*	*3.59*
925052	*AB2-160 E O1*	*5.86*
925061	*AB2-161 C O1*	*2.28*
925062	*AB2-161 E O1*	*3.72*
925121	*AB2-169 C*	*2.34*
925122	*AB2-169 E*	*2.1*
925171	*AB2-174 C O1*	*3.52*
925172	*AB2-174 E O1*	*3.18*
925331	*AB2-190 C*	*11.28*
925332	*AB2-190 E*	*4.84*
925591	*AC1-034 C*	*2.6*
925592	*AC1-034 E*	*1.96*
925821	*AC1-061*	*< 0.01*
926071	*AC1-086 C*	*9.93*
926072	*AC1-086 E*	*4.52*
926201	*AC1-098 C*	*2.46*
926202	*AC1-098 E*	*1.47*
926211	*AC1-099 C*	*0.83*
926212	*AC1-099 E*	*0.49*
927021	*AC1-189 C*	*3.2*
927022	*AC1-189 E*	*1.59*
927141	*AC1-208 C*	*3.74*
927142	*AC1-208 E*	*1.66*
927221	*AC1-216 C O1*	*5.52*
927222	*AC1-216 E O1*	*4.34*