Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AD2-023

East Danville (AEP) – Yanceyville Tap (DEP) 230 kV

December 2018

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.

For Local and Network Upgrades which are required due to overloads associated with the System Impact Studies of an individual New Services Queue, and have a cost less than $5,000,000, the cost of the Local and Network Upgrades will be shared by all proposed projects which have been assigned a Queue Position in the New Services Queue in which the need for the Local and Network Upgrades was identified. The Load Flow Cost Allocation methods discussed in this manual, including cutoffs, still apply to the individual projects.

For Local and Network Upgrades which are required due to the overloads associated with the System Impact Studies of an individual New Services Queue, and have a cost of $5,000,000 or greater, the cost of the Local and Network Upgrades will be allocated according to the order of the New Service Requests in the New Services Queue and the MW contribution of each individual Interconnection Request for those projects which cause or contribute to the need for the Local or Network Upgrades. The Load Flow Cost Allocation methods discussed in this manual, including cutoffs, still apply to the individual projects.

Cost allocation rules 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.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment G-2 of Manual 14A. 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 2.2.2. of Manual

14A 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 G-1 of Manual 14A) 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 Interconnection Customer (IC) proposes to install PJM Project #AD2-023, a 54.0 MW (35.0 MW Capacity) solar facility in Pittsylvania County, Virginia (see Figure 2). The primary point of interconnection will be to the East Danville (AEP) - Yanceyville Tap (DEP) 230 kV section of the East Danville (AEP) – Concord (DEP) 230 kV circuit in the AEP area (see Figure 1). The secondary point of interconnection will be to the East Danville (AEP) – Roxborough (DEP) 230 kV circuit in the AEP area (see Figure 3).

The requested in service date is June 1, 2020.

The objective of this Feasibility Study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the AEP transmission system. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required for maintaining the reliability of the AEP transmission system. Stability analysis is not included as part of this study.

Attachment Facilities

Primary Point of Interconnection (East Danville – Yanceyville Tap 230 kV)

To accommodate the interconnection on the East Danville – Yanceyville Tap 230 kV section of the East Danville – Concord 230 kV circuit, a new three (3) circuit breaker 230 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus will be constructed (see Figure 1). Installation of associated protection and control equipment, 230 kV line risers, SCADA, and 230 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.

<u>New Switching Station Work and Cost:</u>

- Construct a new three (3) circuit breaker 230 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus (See Figure 1). Installation of associated protection and control equipment, 230 kV line risers and SCADA will also be required.
    - **Estimated Station Cost: $7,000,000**

Direct Connection Cost Estimate

The total preliminary cost estimate for Direct Connection work is given in the following tables below.

For AEP building Direct Connection cost estimates:

Description	Estimated Cost
East Danville – Yanceyville Tap 230 kV T-Line Cut In	$1,000,000
Total	**$1,000,000**

Table 1

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for Non-Direct Connection work is given in the following table below:

For AEP building Non-Direct Connection cost estimates:

Description	Estimated Cost
230 kV Revenue Metering	$300,000
Upgrade line protection and controls at the East Danville 230 kV substation.	$300,000
Upgrade line protection and controls at the Concord 230 kV substation	To be provided by DEP
Total	**$600,000**

Table 2

Secondary Point of Interconnection (East Danville – Roxborough 230 kV)

To accommodate the interconnection on the East Danville – Roxborough 230 kV line, a new three (3) circuit breaker 230 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus will be constructed (see Figure 3). Installation of associated protection and control equipment, 230 kV line risers, SCADA, and 230 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.

Interconnection Customer Requirements

It is understood that Interconnection Customer is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of Interconnection Customer's generating plant and the costs for the line connecting the generating plant to the East Danville – Yanceyville Tap 230 kV line are not included in this report; these are assumed to be the Interconnection Customer's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for American Electric Power 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.

Requirement from the PJM Open Access Transmission Tariff:

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.

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.

AEP Requirements

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx

Network Impacts – Option 1

The Queue Project AD2-023 was evaluated as a 54.0 MW (Capacity 35.0 MW) injection tapping the East Danville to Yancey Tap 230 kV line in the AEP area. Project AD2-023 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-023 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2021 Case

Contingency Descriptions

The following contingencies resulted in overloads:

Option 1	
Contingency Name	**Description**
'AEP_P4_#7589_05J.FERR 765'	OPEN BRANCH FROM BUS 242514 TO BUS 242520 CKT 1 / 242514 05J.FERR 765 242520 05J.FERR 500 1 OPEN BRANCH FROM BUS 242514 TO BUS 242684 CKT 2 / 242514 05J.FERR 765 242684 05J.FERR 138 2 OPEN BRANCH FROM BUS 242520 TO BUS 306719 CKT 1 / 242520 05J.FERR 500 306719 8ANTIOCH 500 1 END
'AEP_P1-2_#1377'	OPEN BRANCH FROM BUS 242514 TO BUS 242520 CKT 1 / 242514 05J.FERR 765 242520 05J.FERR 500 1 OPEN BRANCH FROM BUS 242520 TO BUS 306719 CKT 1 / 242520 05J.FERR 500 306719 8ANTIOCH 500 1 END

Table 3

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)

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)

AD2-023 Contribution to Previously Identified Overloads – Option 1															
		Contingency	Affected	Facility	Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	LFFB	'AEP_P4_#7589_05J.FERR 765'	AEP - AEP	05EDAN 1-05DANVL2 138 kV	242631	242620	1	DC	131.65	133.95	ER	415	9.56	
2	N-1	'AEP_P1-2_#1377'	AEP - AEP	05EDAN 1-05DANVL2 138 kV	242631	242620	1	DC	109.85	111.34	ER	415	6.2	

Table 4

Steady-State Voltage Requirements

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Affected System Analysis & Mitigation

LGEE Impacts:

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

MISO Impacts:

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

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

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

Delivery of Energy Portion of Interconnection Request

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.
Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

AD2-023 Delivery of Energy Portion of Interconnection Request – Option 1														
	Contingency		Affected		Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	N-1	'AEP_P1-2_#1377'	AEP - AEP	05EDAN 1-05DANVL2 138 kV	242631	242620	1	DC	131.63	133.93	ER	415	9.56	
2	-	None	AEP - AEP	05EDAN 1-05DANVL2 138 kV	242631	242620	1	DC	106.51	109.7	NR	275	8.77	

Table 5

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	Schedule	Estimated Cost

Violation #	Overloaded Facility	Upgrade Description	Schedule	Estimated Cost
	05EDAN 1-05DANVL2 138 kV line	1) Replace bus 1.5" AL Tubular at Danville 2) Replace two 1200 Switches at Danville 3) Replace Five Sub cond 1590 AAC 61 str **Note:** Project B2697.2 will mitigate the constraints identified above (#1, #2 & #3). The in service date for Project B2697.2 is June 1, 2019. 4) 2.78 miles of ACSR ~ 336/556 Six Wire conductor will need to be rebuilt/reconductored. 5) An Engineering study will need to be conducted to determine if the Relay Thermal Limit at East Danville can be adjusted to mitigate the overload. 6) An Engineering study will need to be conducted to determine if the Relay Thermal Limit at Danville can be adjusted to mitigate the overload. 7) An Engineering study will need to be conducted to determine if the Relay Compliance Trip Limit at East Danville can be adjusted to mitigate the overload. 8) An Engineering study will need to be conducted to determine if the Relay Compliance Trip Limit at Danville can be adjusted to mitigate the overload. 9) 0.03 miles of ACSR ~ 1351.5 ~ 45/7 ~ DIPPER - Conductor Section 3 will need to be rebuilt/reconductored. 10) 0.03 miles of ACSR ~ 1351.5 ~ 45/7 ~ DIPPER - Conductor Section 1 will need to be rebuilt/reconductored. 11) Replace 2000A Non-Oil Breaker. 12) Replace five jumpers at East Danville. 13) Replace two risers at Danville. 14) An Engineering study will need to be conducted to determine if the CT Thermal Limit settings at Danville can be adjusted to mitigate the overload. 15) An Engineering study will need to be conducted to determine if the CT Thermal Limit settings at East Danville can be adjusted to mitigate the overload.	An approximate construction time would be 24 to 36 months after signing an interconnection agreement.	$9,475,000
			Total Network Upgrades	**$9,475,000**

Table 6

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 be between 24 to 36 months after signing an interconnection agreement.

Conclusion

Based upon the results of this Feasibility Study, the construction of the Interconnection Customer's (IC) (54.0 MW (35.0 MW Capacity) solar generating facility under PJM Project #AD2-023, will require the following additional interconnection charges. This plan of service will interconnect the proposed solar generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the IC's generating facility.

Cost Breakdown for Primary Point of Interconnection (East Danville – Yanceyville Tap 230 kV)		
Attachment Cost	New 230 kV Switching Station and installation of associated protection and controls equipment	$7,000,000
Direct Connection Cost Estimate	East Danville – Yanceyville Tap 230 kV T-Line Cut In	$1,000,000
Non-Direct Connection Cost Estimate	230 kV Revenue Metering	$300,000
	Upgrade line protection and controls at the East Danville 230 kV substation	$300,000
	Upgrade line protection and controls at the Concord 230 kV substation	To be provided by DEP
	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)*	**$9,475,000**
	Total Estimated Cost for Project AD2-023	**$18,075,000**

Table 7

The estimates 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.

Network Impacts – Option 2

The Queue Project AD2-023 was evaluated as a 54.0 MW (Capacity 35.0 MW) injection tapping the East Danville to Roxborough 230 kV line in the AEP area. Project AD2-023 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD2-023 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2021 Case

Contingency Descriptions

The following contingencies resulted in overloads:

Option 2	
Contingency Name	**Description**
'AEP_P4_#7589_05J.FERR 765	OPEN BRANCH FROM BUS 242514 TO BUS 242520 CKT 1 / 242514 05J.FERR 765 242520 05J.FERR 500 1 OPEN BRANCH FROM BUS 242514 TO BUS 242684 CKT 2 / 242514 05J.FERR 765 242684 05J.FERR 138 2 OPEN BRANCH FROM BUS 242520 TO BUS 306719 CKT 1 / 242520 05J.FERR 500 306719 8ANTIOCH 500 1 END
'AEP_P1-2_#1377'	OPEN BRANCH FROM BUS 242514 TO BUS 242520 CKT 1 / 242514 05J.FERR 765 242520 05J.FERR 500 1 OPEN BRANCH FROM BUS 242520 TO BUS 306719 CKT 1 / 242520 05J.FERR 500 306719 8ANTIOCH 500 1 END
'AEP_P1-2_#344_A'	OPEN BRANCH FROM BUS 242530 TO BUS 936170 CKT 1 / 242530 05EDANV1 230 936170 AD2-022 TAP 230 1 END

Table 8

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)

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)

AD2-023 Contribution to Previously Identified Overloads – Option 2									
Contingency	**Affected**	**Facility**	**Bus**	**Cir.**	**PF**	**Loading**	**Rating**	**MW**	**FG**

#	Type	Name	Area	Description	From	To			Initial	Final	Type	MVA		
1	LFFB	'AEP_P4_#7589_05J.FERR 765'	AEP - AEP	05EDAN 1-05DANVL2 138 kV	242631	242620	1	DC	131.59	133.93	ER	415	9.69	
2	N-1	'AEP_P1-2_#1377'	AEP - AEP	05EDAN 1-05DANVL2 138 kV	242631	242620	1	DC	109.81	111.33	ER	415	6.28	

Table 9

Steady-State Voltage Requirements

None

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Affected System Analysis & Mitigation

LGEE Impacts:

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

MISO Impacts:

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

Duke, Progress & TVA Impacts:

Duke Carolina, Progress, & TVA Impacts to be determined during later study phases (as applicable).

OVEC Impacts:

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

Delivery of Energy Portion of Interconnection Request

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.
Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

AD2-023 Delivery of Energy Portion of Interconnection Request – Option 2														
	Contingency		Affected		Bus				Loading		Rating		MW	FG
#	Type	Name	Area	Facility Description	From	To	Cir.	PF	Initial	Final	Type	MVA	Con.	App.
1	N-1	'AEP_P1-2_#1377'	AEP - AEP	05EDAN 1-05DANVL2 138 kV	242631	242620	1	DC	131.57	133.91	ER	415	9.69	
2	None	None	AEP - AEP	05EDAN 1-05DANVL2 138 kV	242631	242620	1	DC	106.42	109.66	NR	275	8.91	
3	N-1	'AEP_P1-2_#344_A'	AEP - AEP	05EDAN 2-05EDAN 1 138 kV	242632	242631	Z1	DC	99.56	100.31	ER	296	4.9	

Table 10

Figure 1: Primary Point of Interconnection (East Danville – Yanceyville Tap 230 kV)

Single-Line Diagram

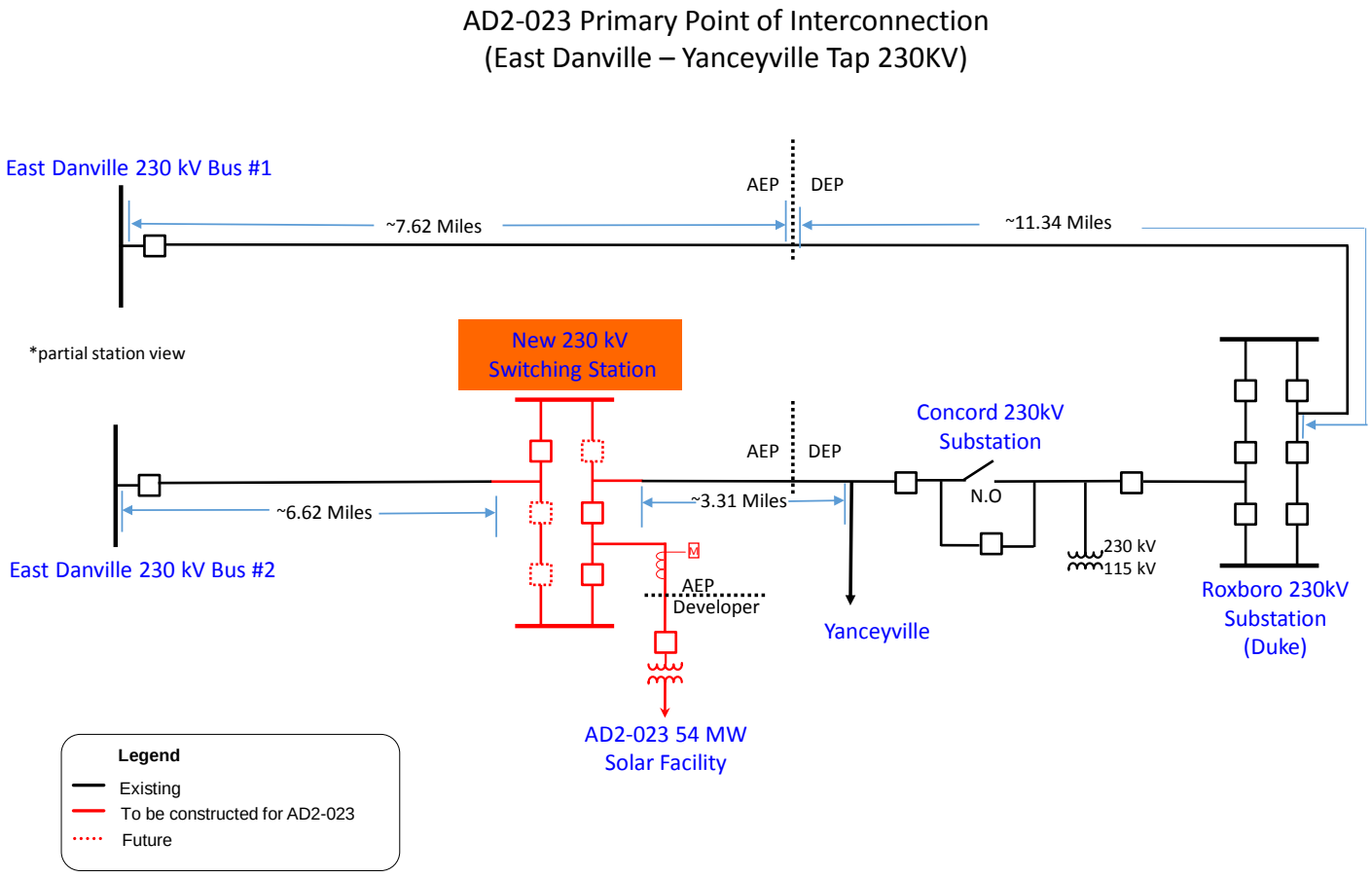


Figure 2: Primary Point of Interconnection (East Danville – Yanceyville Tap 230 kV)

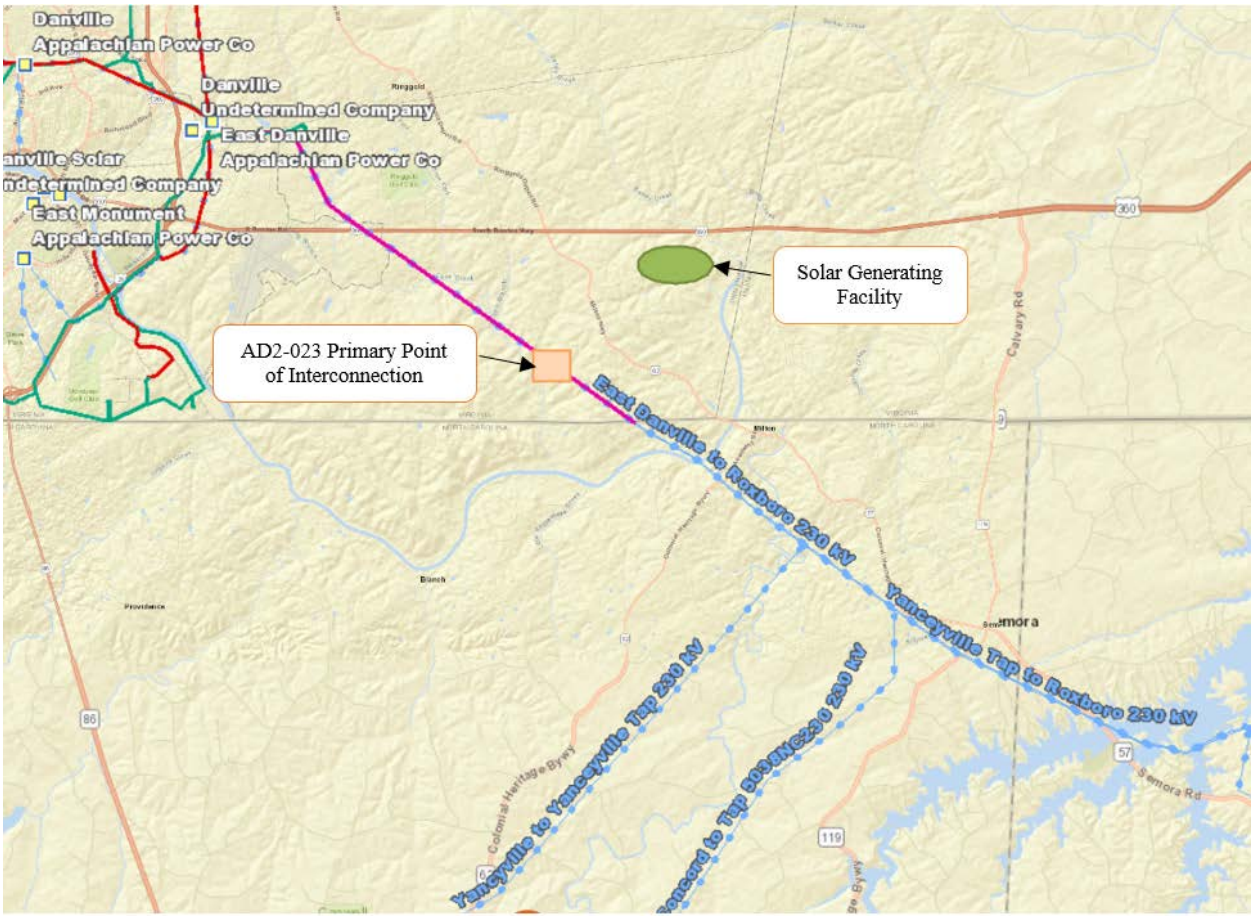


Figure 3: Secondary Point of Interconnection (East Danville - Roxborough 230 kV)

Single-Line Diagram

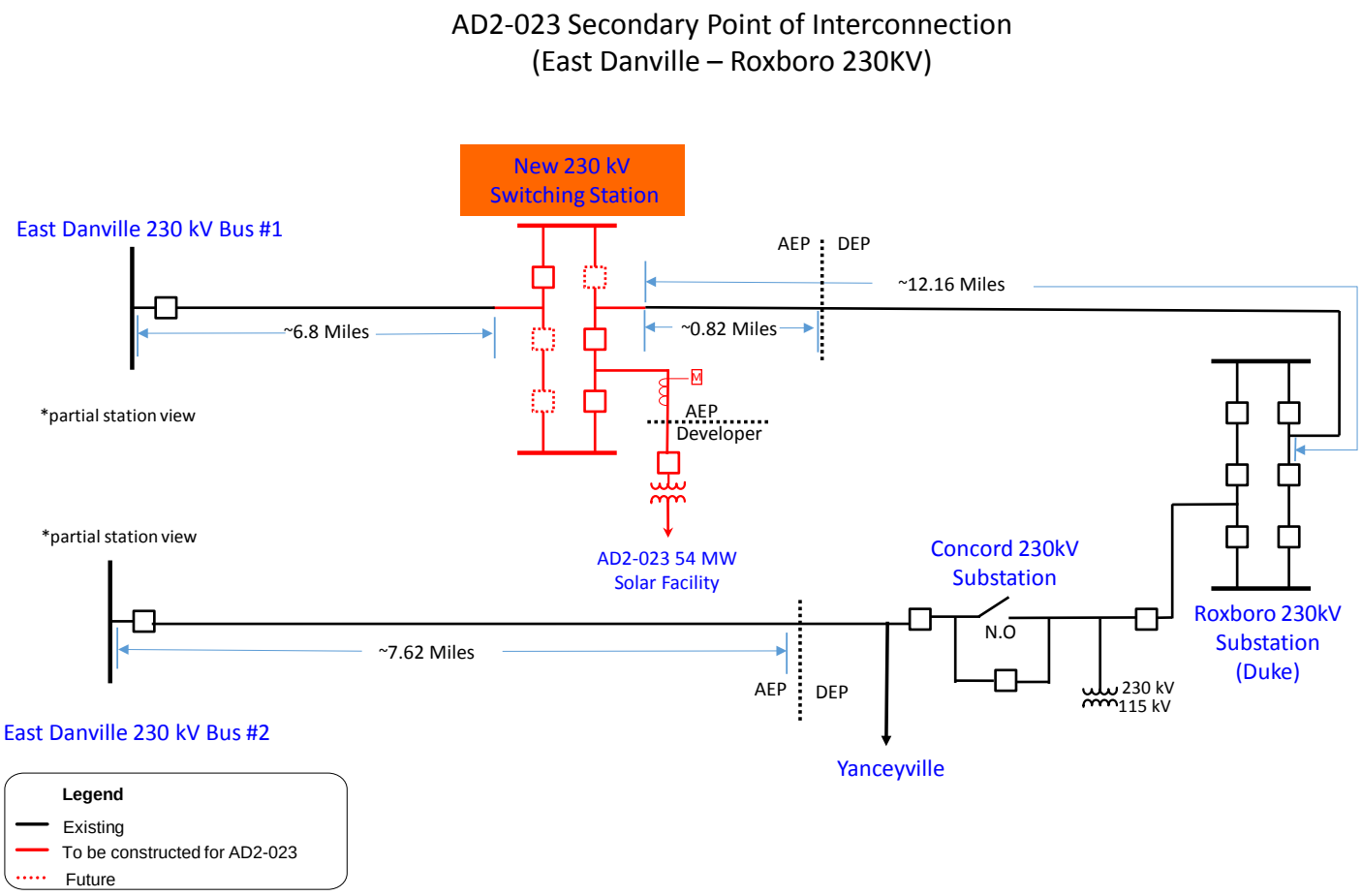
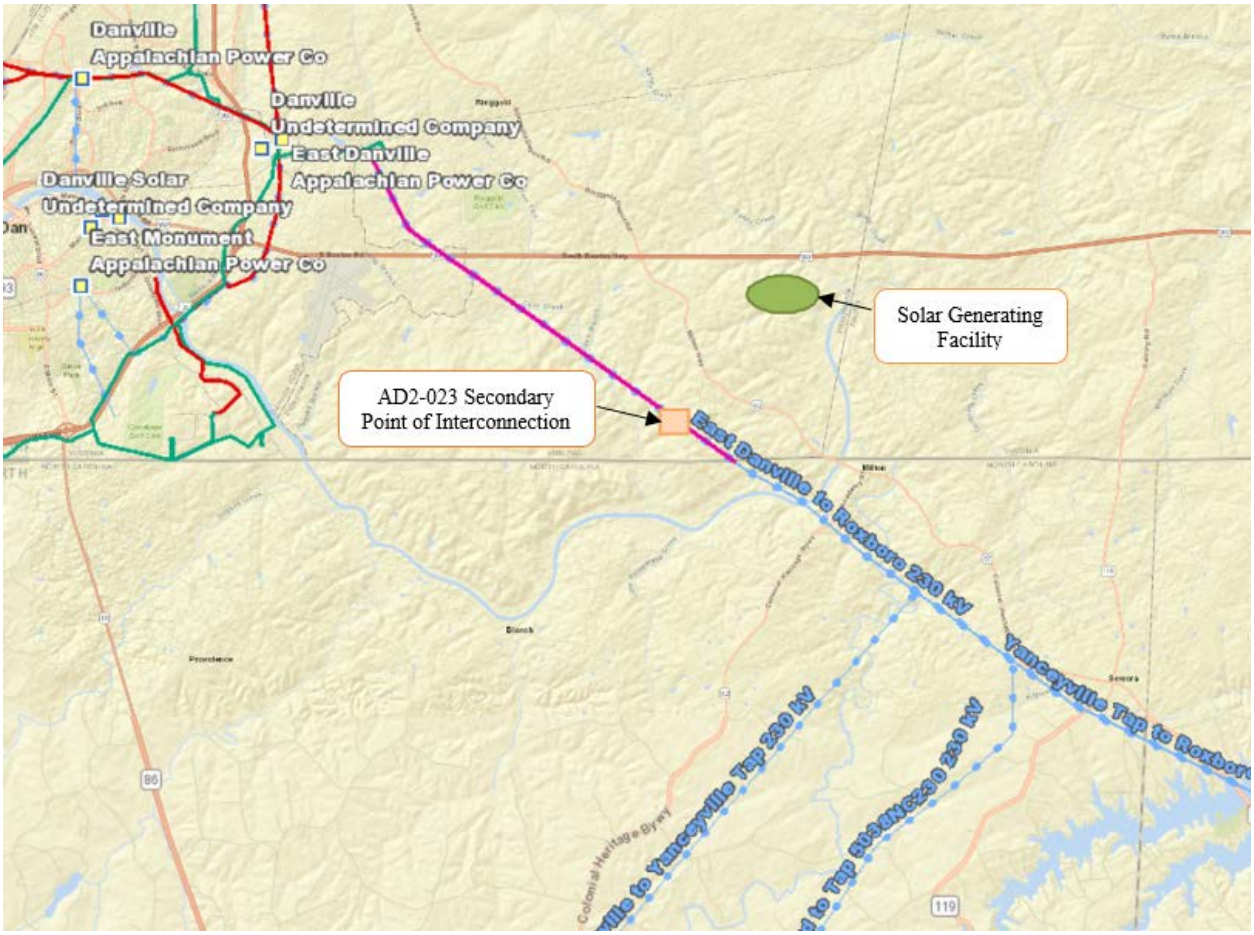


Figure 4: Secondary Point of Interconnection (East Danville - Roxborough 230 kV)



Appendices for Primary POI

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

(AEP - AEP) The 05EDAN 1-05DANVL2 138 kV line (from bus 242631 to bus 242620 ckt 1) loads from 131.65% to 133.95% (**DC power flow**) of its emergency rating (415 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7589_05J.FERR 765'. This project contributes approximately 9.56 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#7589_05J.FERR 765'
OPEN BRANCH FROM BUS 242514 TO BUS 242520 CKT 1 / 242514 05J.FERR 765 242520 05J.FERR 500 1
OPEN BRANCH FROM BUS 242514 TO BUS 242684 CKT 2 / 242514 05J.FERR 765 242684 05J.FERR 138 2
OPEN BRANCH FROM BUS 242520 TO BUS 306719 CKT 1 / 242520 05J.FERR 500 306719 8ANTIOCH 500 1
END

Bus Number	*Bus Name*	*Full Contribution*
244012	*05PINNACLE*	*-2.08*
315131	*1EDGECMA*	*4.25*
315132	*1EDGECMB*	*4.25*
314557	*3BETHELC*	*0.35*
314554	*3BTLEBRO*	*0.37*
314572	*3EMPORIA*	*0.14*
314578	*3HORNRTN*	*1.21*
314582	*3KELFORD*	*0.3*
314603	*3SCOT NK*	*1.24*
314617	*3TUNIS*	*0.28*
314620	*6CASHIE*	*0.27*
314574	*6EVERETS*	*0.98*
314594	*6PLYMOTH*	*0.26*
932631	*AC2-084 C*	*3.42*
932632	*AC2-084 E*	*1.68*
932701	*AC2-093 C*	*24.41*
932702	*AC2-093 E*	*13.96*
932761	*AC2-100 C*	*3.66*
932762	*AC2-100 E*	*1.79*
932821	*AC2-107 C*	*3.48*
932822	*AC2-107 E*	*1.63*
933941	*AD1-017 C*	*0.84*
933942	*AD1-017 E*	*1.36*
933991	*AD1-023 C*	*4.1*
933992	*AD1-023 E*	*2.23*
934201	*AD1-047 C*	*2.75*

934202	*AD1-047 E*	*1.83*
934231	*AD1-050 C*	*2.01*
934232	*AD1-050 E*	*1.1*
934311	*AD1-055 C*	*1.07*
934312	*AD1-055 E*	*0.28*
934331	*AD1-057 C O1*	*4.1*
934332	*AD1-057 E O1*	*2.19*
934341	*AD1-058 C*	*3.99*
934342	*AD1-058 E*	*1.01*
934521	*AD1-076 C O1*	*16.71*
934522	*AD1-076 E O1*	*8.51*
934611	*AD1-087 C O1*	*3.38*
934612	*AD1-087 E O1*	*1.59*
934621	*AD1-088 C*	*4.*
934622	*AD1-088 E*	*1.88*
LTF	*AD1-120*	*7.55*
LTF	*AD1-121*	*7.6*
934911	*AD1-123 C*	*0.47*
934912	*AD1-123 E*	*0.24*
934991	*AD1-131 C*	*1.31*
934992	*AD1-131 E*	*0.87*
935171	*AD1-152 C O1*	*3.36*
935172	*AD1-152 E O1*	*2.24*
935221	*AD1-157 C*	*0.46*
935222	*AD1-157 E*	*0.31*
935231	*AD1-160 C*	*0.34*
935232	*AD1-160 E*	*0.47*
936161	*AD2-022 C O1*	*10.77*
936162	*AD2-022 E O1*	*6.46*
936171	*AD2-023 C O1*	*6.2*
936172	*AD2-023 E O1*	*3.36*
936261	*AD2-033 C*	*4.75*
936262	*AD2-033 E*	*3.17*
936331	*AD2-043 C*	*2.*
936332	*AD2-043 E*	*2.36*
936361	*AD2-046 C O1*	*3.83*
936362	*AD2-046 E O1*	*1.76*
936401	*AD2-051 C O1*	*2.96*
936402	*AD2-051 E O1*	*1.27*
936481	*AD2-063 C O1*	*5.54*
936482	*AD2-063 E O1*	*3.69*
936531	*AD2-068 C*	*2.28*
936532	*AD2-068 E*	*1.17*
936641	*AD2-081 C*	*2.55*

936642	*AD2-081 E*	*1.15*
936651	*AD2-082 C*	*0.52*
936652	*AD2-082 E*	*0.25*
936701	*AD2-089 C*	*3.17*
936702	*AD2-089 E*	*2.11*
936711	*AD2-090 C O1*	*2.12*
936712	*AD2-090 E O1*	*1.42*
LTF	*AD2-099*	*4.98*
937441	*AD2-195 C*	*3.14*
937442	*AD2-195 E*	*1.35*
937461	*AD2-200 C*	*0.5*
937462	*AD2-200 E*	*0.24*
937481	*AD2-202 C O1*	*0.93*
937482	*AD2-202 E O1*	*0.47*
LTF	*AMIL*	*0.17*
LTF	*BLUEG*	*2.07*
LTF	*CANNELTON*	*0.27*
LTF	*CARR*	*0.07*
LTF	*CBM-S1*	*1.13*
LTF	*CBM-S2*	*16.92*
LTF	*CBM-W2*	*3.07*
LTF	*CLIFTY*	*10.77*
LTF	*CPLE*	*5.57*
LTF	*DEARBORN*	*0.98*
LTF	*EDWARDS*	*0.45*
LTF	*ELMERSMITH*	*0.71*
LTF	*FARMERCITY*	*0.12*
LTF	*G-007A*	*0.79*
LTF	*GIBSON*	*0.59*
LTF	*NEWTON*	*0.97*
LTF	*O-066A*	*0.36*
LTF	*PRAIRIE*	*0.86*
LTF	*RENSSELAER*	*0.05*
LTF	*ROSETON*	*0.38*
LTF	*SMITHLAND*	*< 0.01*
LTF	*TATANKA*	*0.34*
LTF	*TILTON*	*0.61*
LTF	*TRIMBLE*	*0.41*
900672	*V4-068 E*	*0.1*
LTF	*VFT*	*2.1*
917332	*Z2-043 E*	*0.36*
917342	*Z2-044 E*	*0.25*
917512	*Z2-088 E OP1*	*1.66*
918492	*AA1-063AE OP*	*1.37*

918512	*AA1-065 E OP*	*1.46*
918532	*AA1-067 E*	*0.29*
918562	*AA1-072 E*	*0.06*
919692	*AA2-053 E*	*1.33*
919702	*AA2-057 E*	*1.51*
LTF	*AA2-074*	*3.79*
920042	*AA2-088 E*	*3.27*
920592	*AA2-165 E*	*0.2*
920672	*AA2-174 E*	*0.15*
930401	*AB1-081 C*	*4.09*
930402	*AB1-081 E*	*1.75*
930861	*AB1-132 C*	*4.93*
930862	*AB1-132 E*	*2.11*
931231	*AB1-173 C*	*0.77*
931232	*AB1-173 E*	*0.36*
931241	*AB1-173AC*	*0.77*
931242	*AB1-173AE*	*0.36*
923911	*AB2-031 C O1*	*0.77*
923912	*AB2-031 E O1*	*0.38*
923941	*AB2-035 C*	*0.15*
923942	*AB2-035 E*	*0.06*
923991	*AB2-040 C O1*	*2.52*
923992	*AB2-040 E O1*	*2.06*
924021	*AB2-043 C O1*	*1.21*
924022	*AB2-043 E O1*	*1.99*
924151	*AB2-059 C O1*	*4.82*
924152	*AB2-059 E O1*	*2.49*
924161	*AB2-060 C O1*	*3.48*
924162	*AB2-060 E O1*	*1.64*
924301	*AB2-077 C O1*	*0.78*
924302	*AB2-077 E O1*	*0.52*
924311	*AB2-078 C O1*	*0.78*
924312	*AB2-078 E O1*	*0.52*
924321	*AB2-079 C O1*	*0.78*
924322	*AB2-079 E O1*	*0.52*
924391	*AB2-088 C*	*0.19*
924392	*AB2-088 E*	*0.09*
924401	*AB2-089 C*	*0.91*
924402	*AB2-089 E*	*0.47*
924411	*AB2-090 C*	*1.53*
924412	*AB2-090 E*	*0.78*
924491	*AB2-098 C*	*0.23*
924492	*AB2-098 E*	*0.1*
924501	*AB2-099 C*	*0.2*

924502	*AB2-099 E*	*0.08*
924511	*AB2-100 C*	*3.5*
924512	*AB2-100 E*	*1.72*
925121	*AB2-169 C*	*2.26*
925122	*AB2-169 E*	*2.03*
925171	*AB2-174 C O1*	*2.38*
925172	*AB2-174 E O1*	*2.15*
925221	*AB2-176 C*	*0.63*
925222	*AB2-176 E*	*0.27*
925591	*AC1-034 C*	*3.12*
925592	*AC1-034 E*	*2.36*
925611	*AC1-036 C*	*0.33*
925612	*AC1-036 E*	*0.54*
925781	*AC1-054 C*	*3.03*
925782	*AC1-054 E*	*1.4*
925991	*AC1-075 C*	*1.96*
925992	*AC1-075 E*	*1.11*
926021	*AC1-080 C*	*0.65*
926022	*AC1-080 E*	*0.37*
926051	*AC1-083 C*	*4.18*
926052	*AC1-083 E*	*6.82*
926071	*AC1-086 C*	*7.26*
926072	*AC1-086 E*	*3.31*
926201	*AC1-098 C*	*2.4*
926202	*AC1-098 E*	*1.43*
926211	*AC1-099 C*	*0.8*
926212	*AC1-099 E*	*0.47*
926271	*AC1-105 C*	*2.39*
926272	*AC1-105 E*	*1.19*
926771	*AC1-163 C*	*0.65*
926772	*AC1-163 E*	*0.3*
927021	*AC1-189 C*	*3.63*
927022	*AC1-189 E*	*1.81*
927141	*AC1-208 C*	*3.54*
927142	*AC1-208 E*	*1.57*
927251	*AC1-221 C*	*1.59*
927252	*AC1-221 E*	*1.59*
927261	*AC1-222 C*	*1.54*
927262	*AC1-222 E*	*1.46*

Appendices for Alternate POI

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

(AEP - AEP) The 05EDAN 1-05DANVL2 138 kV line (from bus 242631 to bus 242620 ckt 1) loads from 131.59% to 133.93% (**DC power flow**) of its emergency rating (415 MVA) for the line fault with failed breaker contingency outage of 'AEP_P4_#7589_05J.FERR 765'. This project contributes approximately 9.69 MW to the thermal violation.

CONTINGENCY 'AEP_P4_#7589_05J.FERR 765'
OPEN BRANCH FROM BUS 242514 TO BUS 242520 CKT 1 / 242514 05J.FERR 765 242520 05J.FERR 500 1
OPEN BRANCH FROM BUS 242514 TO BUS 242684 CKT 2 / 242514 05J.FERR 765 242684 05J.FERR 138 2
OPEN BRANCH FROM BUS 242520 TO BUS 306719 CKT 1 / 242520 05J.FERR 500 306719 8ANTIOCH 500 1
END

Bus Number	*Bus Name*	*Full Contribution*
244012	*05PINNACLE*	*-2.08*
315131	*1EDGECMA*	*4.25*
315132	*1EDGECMB*	*4.25*
314557	*3BETHELC*	*0.35*
314554	*3BTLEBRO*	*0.37*
314572	*3EMPORIA*	*0.14*
314578	*3HORNRTN*	*1.21*
314582	*3KELFORD*	*0.3*
314603	*3SCOT NK*	*1.24*
314617	*3TUNIS*	*0.28*
314620	*6CASHIE*	*0.27*
314574	*6EVERETS*	*0.98*
314594	*6PLYMOTH*	*0.26*
932631	*AC2-084 C*	*3.42*
932632	*AC2-084 E*	*1.68*
932701	*AC2-093 C*	*24.41*
932702	*AC2-093 E*	*13.96*
932761	*AC2-100 C*	*3.66*
932762	*AC2-100 E*	*1.79*
932821	*AC2-107 C*	*3.48*
932822	*AC2-107 E*	*1.63*
933941	*AD1-017 C*	*0.84*
933942	*AD1-017 E*	*1.36*
933991	*AD1-023 C*	*4.1*
933992	*AD1-023 E*	*2.23*
934201	*AD1-047 C*	*2.75*

934202	*AD1-047 E*	*1.83*
934231	*AD1-050 C*	*2.01*
934232	*AD1-050 E*	*1.1*
934311	*AD1-055 C*	*1.07*
934312	*AD1-055 E*	*0.28*
934331	*AD1-057 C O1*	*4.1*
934332	*AD1-057 E O1*	*2.19*
934341	*AD1-058 C*	*3.99*
934342	*AD1-058 E*	*1.01*
934521	*AD1-076 C O1*	*16.71*
934522	*AD1-076 E O1*	*8.51*
934611	*AD1-087 C O1*	*3.38*
934612	*AD1-087 E O1*	*1.59*
934621	*AD1-088 C*	*4.*
934622	*AD1-088 E*	*1.88*
LTF	*AD1-120*	*7.55*
LTF	*AD1-121*	*7.6*
934911	*AD1-123 C*	*0.47*
934912	*AD1-123 E*	*0.24*
934991	*AD1-131 C*	*1.31*
934992	*AD1-131 E*	*0.87*
935171	*AD1-152 C O1*	*3.36*
935172	*AD1-152 E O1*	*2.24*
935221	*AD1-157 C*	*0.46*
935222	*AD1-157 E*	*0.31*
935231	*AD1-160 C*	*0.34*
935232	*AD1-160 E*	*0.47*
936161	*AD2-022 C O2*	*10.62*
936162	*AD2-022 E O2*	*6.37*
936171	*AD2-023 C O2*	*6.28*
936172	*AD2-023 E O2*	*3.41*
936261	*AD2-033 C*	*4.75*
936262	*AD2-033 E*	*3.17*
936331	*AD2-043 C*	*2.*
936332	*AD2-043 E*	*2.36*
936361	*AD2-046 C O2*	*3.8*
936362	*AD2-046 E O2*	*1.75*
936401	*AD2-051 C O2*	*2.92*
936402	*AD2-051 E O2*	*1.25*
936481	*AD2-063 C O2*	*4.78*
936482	*AD2-063 E O2*	*3.19*
936531	*AD2-068 C*	*2.28*
936532	*AD2-068 E*	*1.17*
936641	*AD2-081 C*	*2.55*

936642	*AD2-081 E*	*1.15*
936651	*AD2-082 C*	*0.52*
936652	*AD2-082 E*	*0.25*
936701	*AD2-089 C*	*3.17*
936702	*AD2-089 E*	*2.11*
936711	*AD2-090 C O2*	*2.14*
936712	*AD2-090 E O2*	*1.43*
LTF	*AD2-099*	*4.98*
937441	*AD2-195 C*	*3.14*
937442	*AD2-195 E*	*1.35*
937461	*AD2-200 C*	*0.5*
937462	*AD2-200 E*	*0.24*
937481	*AD2-202 C O2*	*0.9*
937482	*AD2-202 E O2*	*0.45*
LTF	*AMIL*	*0.17*
LTF	*BLUEG*	*2.07*
LTF	*CANNELTON*	*0.27*
LTF	*CARR*	*0.07*
LTF	*CBM-S1*	*1.13*
LTF	*CBM-S2*	*16.92*
LTF	*CBM-W2*	*3.07*
LTF	*CLIFTY*	*10.77*
LTF	*CPLE*	*5.57*
LTF	*DEARBORN*	*0.98*
LTF	*EDWARDS*	*0.45*
LTF	*ELMERSMITH*	*0.71*
LTF	*FARMERCITY*	*0.12*
LTF	*G-007A*	*0.79*
LTF	*GIBSON*	*0.59*
LTF	*NEWTON*	*0.97*
LTF	*O-066A*	*0.36*
LTF	*PRAIRIE*	*0.86*
LTF	*RENSSELAER*	*0.05*
LTF	*ROSETON*	*0.38*
LTF	*SMITHLAND*	*< 0.01*
LTF	*TATANKA*	*0.34*
LTF	*TILTON*	*0.61*
LTF	*TRIMBLE*	*0.41*
900672	*V4-068 E*	*0.1*
LTF	*VFT*	*2.1*
917332	*Z2-043 E*	*0.36*
917342	*Z2-044 E*	*0.25*
917512	*Z2-088 E OP1*	*1.66*
918492	*AA1-063AE OP*	*1.37*

918512	*AA1-065 E OP*	*1.46*
918532	*AA1-067 E*	*0.29*
918562	*AA1-072 E*	*0.06*
919692	*AA2-053 E*	*1.33*
919702	*AA2-057 E*	*1.51*
LTF	*AA2-074*	*3.79*
920042	*AA2-088 E*	*3.27*
920592	*AA2-165 E*	*0.2*
920672	*AA2-174 E*	*0.15*
930401	*AB1-081 C*	*4.09*
930402	*AB1-081 E*	*1.75*
930861	*AB1-132 C*	*4.93*
930862	*AB1-132 E*	*2.11*
931231	*AB1-173 C*	*0.77*
931232	*AB1-173 E*	*0.36*
931241	*AB1-173AC*	*0.77*
931242	*AB1-173AE*	*0.36*
923911	*AB2-031 C O1*	*0.77*
923912	*AB2-031 E O1*	*0.38*
923941	*AB2-035 C*	*0.15*
923942	*AB2-035 E*	*0.06*
923991	*AB2-040 C O1*	*2.52*
923992	*AB2-040 E O1*	*2.06*
924021	*AB2-043 C O1*	*1.21*
924022	*AB2-043 E O1*	*1.99*
924151	*AB2-059 C O1*	*4.82*
924152	*AB2-059 E O1*	*2.49*
924161	*AB2-060 C O1*	*3.48*
924162	*AB2-060 E O1*	*1.64*
924301	*AB2-077 C O1*	*0.78*
924302	*AB2-077 E O1*	*0.52*
924311	*AB2-078 C O1*	*0.78*
924312	*AB2-078 E O1*	*0.52*
924321	*AB2-079 C O1*	*0.78*
924322	*AB2-079 E O1*	*0.52*
924391	*AB2-088 C*	*0.19*
924392	*AB2-088 E*	*0.09*
924401	*AB2-089 C*	*0.91*
924402	*AB2-089 E*	*0.47*
924411	*AB2-090 C*	*1.53*
924412	*AB2-090 E*	*0.78*
924491	*AB2-098 C*	*0.23*
924492	*AB2-098 E*	*0.1*
924501	*AB2-099 C*	*0.2*

924502	*AB2-099 E*	*0.08*
924511	*AB2-100 C*	*3.5*
924512	*AB2-100 E*	*1.72*
925121	*AB2-169 C*	*2.26*
925122	*AB2-169 E*	*2.03*
925171	*AB2-174 C O1*	*2.38*
925172	*AB2-174 E O1*	*2.15*
925221	*AB2-176 C*	*0.63*
925222	*AB2-176 E*	*0.27*
925591	*AC1-034 C*	*3.12*
925592	*AC1-034 E*	*2.36*
925611	*AC1-036 C*	*0.33*
925612	*AC1-036 E*	*0.54*
925781	*AC1-054 C*	*3.03*
925782	*AC1-054 E*	*1.4*
925991	*AC1-075 C*	*1.96*
925992	*AC1-075 E*	*1.11*
926021	*AC1-080 C*	*0.65*
926022	*AC1-080 E*	*0.37*
926051	*AC1-083 C*	*4.18*
926052	*AC1-083 E*	*6.82*
926071	*AC1-086 C*	*7.26*
926072	*AC1-086 E*	*3.31*
926201	*AC1-098 C*	*2.4*
926202	*AC1-098 E*	*1.43*
926211	*AC1-099 C*	*0.8*
926212	*AC1-099 E*	*0.47*
926271	*AC1-105 C*	*2.39*
926272	*AC1-105 E*	*1.19*
926771	*AC1-163 C*	*0.65*
926772	*AC1-163 E*	*0.3*
927021	*AC1-189 C*	*3.63*
927022	*AC1-189 E*	*1.81*
927141	*AC1-208 C*	*3.54*
927142	*AC1-208 E*	*1.57*
927251	*AC1-221 C*	*1.59*
927252	*AC1-221 E*	*1.59*
927261	*AC1-222 C*	*1.54*
927262	*AC1-222 E*	*1.46*