Generation Interconnection

System Impact Study Report

for

Queue Project AF1-117

ATLANTA-STUART 345 KV

152.9 MW Capacity / 200 MW Energy

August, 2020

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1 Introduction

This System Impact Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 205, as well as the System Impact Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is AEP.

2 Preface

The intent of the 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 Interconnection Customer. As a requirement for interconnection, the Interconnection Customer 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 Interconnection Customer 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 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.

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.

3 General

The Interconnection Customer (IC), has proposed a Solar; Storage generating facility located in Ross County, Ohio. The installed facilities will have a total capability of 200 MW with 152.9 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this project is June 01, 2023. This study does not imply a TO commitment to this in-service date.

The objective of this System Impact Study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the ITO transmission system. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required for maintaining the reliability of the ITO transmission system.

Queue Number	AF1-117
Project Name	ATLANTA-STUART 345 KV
State	Ohio
County	Ross
Transmission Owner	AEP
MFO	200
MWE	200
MWC	152.9
Fuel	Solar; Storage
Basecase Study Year	2023

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

AF1-117 will interconnect with the AEP transmission system via a new station cut into the (Dayton) Atlanta – (Dayton) Stuart 345 kV circuit.

To accommodate the interconnection on the Atlanta – Stuart 345 kV circuit, a new three (3) circuit breaker 345 kV switching station physically configured and operated as a ring bus will be constructed (see Attachment 1). Installation of associated protection and control equipment, 345 kV line risers, SCADA, and 345 kV revenue metering will also be required. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.

Installation of the generator lead first span exiting the POI station, including the first structure outside the AEP fence, will also be included in AEP's scope. In the case where the generator lead is a single span, the structure in the customer station will be the customer's responsibility.

5 Cost Summary

The AF1-117 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$1,082,000
Direct Connection Network Upgrade	$17,440,000
Non Direct Connection Network Upgrades	$1,210,000
Allocation for New System Upgrades*	$0
Contribution to Previously Identified Upgrades*	$32,632,000
Total Costs	**$52,364,000**

*As your project progresses through the study process and other projects modify their request or withdraw, then your cost allocation could change.

The estimates provided in this report are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements. In addition, Stability analysis will be completed during the Facilities Study stage. It is possible that a need for additional upgrades could be identified by these studies.

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 88-129. If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

Note 1: 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.

Note 2: For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

6 Transmission Owner Scope of Work

6.1 Attachment Facilities

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

Description	Total Cost
345 kV Revenue Metering	$431,000
Generator lead first span exiting the POI station, including the first structure outside the fence	$651,000
Total Attachment Facility Costs	**$1,082,000**

6.2 Direct Connection Cost Estimate

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

Description	Total Cost
Construct a new three (3) circuit breaker 345 kV switching station physically configured and operated as a ring bus (see Attachment 1). Installation of associated protection and control equipment, 345 kV line risers and SCADA will also be required	$17,440,000
Total Direct Connection Facility Costs	**$17,440,000**

6.3 Non-Direct Connection Cost Estimate

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

Description	Total Cost
Review and revise line protections and controls at the Atlanta 345 kV station	$TBD by Dayton
Review and revise line protections and controls at the Stuart 345 kV station	$TBD by Dayton
345 kV Transmission Line Cut In	$1,210,000
Total Non-Direct Connection Facility Costs	**$1,210,000**

7 Incremental Capacity Transfer Rights (ICTRs)

None

8 Schedule

It is anticipated that the time between receipt of executed Agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would generally be between 24 to 36 months after Agreement execution.

9 Interconnection Customer Requirements

It is understood that the Interconnection Customer is responsible for all costs associated with this interconnection. The costs above are reimbursable to the Interconnected Transmission Owner. The cost of the Interconnection Customer's generating plant and the costs for the line connecting the generating plant to the Interconnected Transmission Owner's Transmission circuit 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 the Interconnected Transmission Owner to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider to determine if a local service agreement is required.

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.

10 Revenue Metering and SCADA Requirements

10.1 PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Section 8 of Attachment O.

10.2 Meteorological Data Reporting Requirements

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

- Back Panel temperature (Fahrenheit)
- Irradiance (Watts/meter^2)
- Ambient air temperature (Fahrenheit) – (Accepted, not required)
- Wind speed (meters/second) – (Accepted, not required)
- Wind direction (decimal degrees from true north) – (Accepted, not required)

10.3 Interconnected Transmission Owner Requirements

The IC will be required to comply with all Interconnected Transmission Owner's revenue metering requirements for generation interconnection customers located at the following link:

http://www.pjm.com/planning/design-engineering/to-tech-standards/

11 Summer Peak Analysis

The Queue Project AF1-117 was evaluated as a 200.0 MW (Capacity 152.9 MW) injection tapping the Atlanta to Stuart 345 kV line in the AEP area. Project AF1-117 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-117 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

11.1 Generation Deliverability

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

None

11.2 Multiple Facility Contingency

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
43444451	243453	05BEATTY	345.0	AEP	243454	05BIXBY	345.0	AEP	1	AEP_P4_#10715_05COLE 345_C	breaker	1203.0	99.24	104.67	AC	65.43
41535938	253110	09ADKINS	345.0	DAY	243453	05BEATTY	345.0	AEP	1	DAY_P4_L34526-3	breaker	1372.0	99.07	106.74	AC	106.26

11.3 Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
43444450	243453	05BEATTY	345.0	AEP	243454	05BIXBY	345.0	AEP	1	AEP_P4_#3196_05BEATTY 345_302E	breaker	1203.0	100.05	105.74	AC	68.35
40985852	253110	09ADKINS	345.0	DAY	243453	05BEATTY	345.0	AEP	1	DAY_P7_495	tower	1372.0	101.88	109.58	AC	106.47

11.4 Steady-State Voltage Requirements

To be determined

11.5 Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed

with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
43444802	243453	05BEATTY	345.0	AEP	243454	05BIXBY	345.0	AEP	1	AEP_P1-2_#714	operation	1203.0	92.62	97.78	AC	62.19
43444927	243453	05BEATTY	345.0	AEP	244022	05COLE	345.0	AEP	1	AEP_P1-2_#713	operation	1203.0	83.03	87.55	AC	54.37
41201287	253110	09ADKINS	345.0	DAY	243453	05BEATTY	345.0	AEP	1	DAY_P1_AC1-085_ST_FSA-B	operation	1372.0	99.02	106.69	AC	106.36
41201289	253110	09ADKINS	345.0	DAY	243453	05BEATTY	345.0	AEP	1	Base Case	operation	1233.0	93.51	102.03	AC	105.04
41201346	945630	AF1-228 TAP	345.0	DAY	243453	05BEATTY	345.0	AEP	1	DAY_P1-2_#762	operation	1374.0	87.66	89.01	AC	21.91

11.6 System Reinforcements

<table>
<tr><th>ID</th><th>Idx</th><th>Facility</th><th>Upgrade Description</th><th>Cost</th><th>Cost Allocated to AF1-117</th><th>Upgrade Number</th></tr>
<tr><td>41201291,41201290,41535938, 40985852</td><td>1</td><td>09ADKINS 345.0 kV - 05BEATTY 345.0 kV Ckt 1</td><td>N6401.1 : Rebuild 13.0 miles of 2-983.1 ACAR 30/7 Rail 5 conductor on Beatty-Adkins circuit (3.7 miles of double circuit construction). Bare minimum conductor is 2-1024.5 ACAR 30/7 Rail1 which provide no additional margin. Upgrade other elements previously rated by DP&L. Ratings validation of this equipment is currently underway. This will require relay upgrades at Beatty and Adkins.
Project Type : FAC
Cost : $ 55,000,000
Time Estimate : 24-36 Months
<table><tr><th>Queue</th><th>MW contribution</th><th>Percentage of Cost</th><th>$ cost ($55 M)</th></tr><tr><td>AE2-319</td><td>27.5</td><td>14.65%</td><td>8.059</td></tr><tr><td>AE2-320</td><td>53.7</td><td>28.61%</td><td>15.738</td></tr><tr><td>AF1-117</td><td>106.5</td><td>56.73%</td><td>31.203</td></tr></table></td><td>$55,000,000</td><td>$31,203,000</td><td>N6401.1</td></tr>
<tr><td>43444450,43444451</td><td>2</td><td>05BEATTY 345.0 kV - 05BIXBY 345.0 kV Ckt 1</td><td>N6741.1 : Upgrade/Replace Three 345kV 1600A switches at Beatty station
Project Type : FAC
Cost : $ 1,500,000
Time Estimate : 12-18 Months
<table><tr><th>Queue</th><th>MW contribution</th><th>Percentage of Cost</th><th>$ cost ($1.5 M)</th></tr><tr><td>AF1-078</td><td>3.4</td><td>4.77%</td><td>0.071</td></tr><tr><td>AF1-117</td><td>68.4</td><td>95.23%</td><td>1.429</td></tr></table></td><td>$1,500,000</td><td>$1,429,000</td><td>N6741.1</td></tr>
<tr><td></td><td></td><td></td><td>TOTAL COST</td><td>$56,500,000</td><td>$32,632,000</td><td></td></tr>
</table>

11.7 Flow Gate Details

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

11.7.1 Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
40985852	253110	09ADKINS	DAY	243453	05BEATTY	AEP	1	DAY_P7_495	tower	1372.0	101.88	109.58	AC	106.47

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
253110	09ADKINS	62.7784	50/50	62.7784
342960	1SPURLK2G	10.3055	50/50	10.3055
342966	1SPURLK4G	5.4154	50/50	5.4154
923522	AB1-169 C OP	160.2590	50/50	160.2590
925921	AC1-068 C	18.7541	50/50	18.7541
925922	AC1-068 E	8.7703	50/50	8.7703
925931	AC1-069 C	18.7541	50/50	18.7541
925932	AC1-069 E	8.7703	50/50	8.7703
926061	AC1-085 C	22.1449	50/50	22.1449
926062	AC1-085 E	36.1311	50/50	36.1311
926791	AC1-165 C	18.5334	50/50	18.5334
926792	AC1-165 E	8.9909	50/50	8.9909
926801	AC1-166 C	18.5334	50/50	18.5334
926802	AC1-166 E	8.9909	50/50	8.9909
930062	AB1-014 E	5.7786	Adder	6.8
932381	AC2-055 C	1.5111	Adder	1.78
932382	AC2-055 E	2.4655	Adder	2.9
932421	AC2-060 C	5.3579	Adder	6.3
932422	AC2-060 E	3.0138	Adder	3.55
932462	AC2-066 E	3.4671	Adder	4.08
932661	AC2-088 C O1	3.3182	Adder	3.9
932662	AC2-088 E O1	2.7306	Adder	3.21
934491	AD1-073 C	1.1051	Adder	1.3
934492	AD1-073 E	0.5693	Adder	0.67
935031	AD1-136 C	0.4666	Adder	0.55
935032	AD1-136 E	0.3975	Adder	0.47
936251	AD2-031 C O1	1.4180	Adder	1.67
936252	AD2-031 E O1	2.3135	Adder	2.72
938271	AE1-040 C O1	4.0334	50/50	4.0334
938272	AE1-040 E O1	2.0295	50/50	2.0295
938921	AE1-120	3.2807	Adder	3.86
939141	AE1-144 C O1	6.2287	Adder	7.33
939142	AE1-144 E O1	3.0910	Adder	3.64
940531	AE2-038 C O1	4.1551	Adder	4.89
940532	AE2-038 E O1	2.0581	Adder	2.42
941411	AE2-138 C	12.2788	Adder	14.45
941412	AE2-138 E	4.5415	Adder	5.34
941981	AE2-210 C O1	4.2310	Adder	4.98
941982	AE2-210 E O1	1.5915	Adder	1.87
942091	AE2-221 C	26.2242	50/50	26.2242
942092	AE2-221 E	17.4828	50/50	17.4828
942981	AE2-320 C O1	36.9014	50/50	36.9014
942982	AE2-320 E O1	18.2576	50/50	18.2576

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
943191	AE2-319 C O1	36.9014	50/50	36.9014
943192	AE2-319 E O1	18.2576	50/50	18.2576
943201	AE2-318 C	4.2429	Adder	4.99
943202	AE2-318 E	2.0709	Adder	2.44
943771	AF1-045	1.9762	Adder	2.32
943773	AF1-045 E	1.3196	Adder	1.55
944521	AF1-117 C	81.3994	50/50	81.3994
944522	AF1-117 E	25.0746	50/50	25.0746
944621	AF1-127 C O1	3.3878	Adder	3.99
944622	AF1-127 E O1	1.6686	Adder	1.96
944941	AF1-159	0.8209	Adder	0.97
945681	AF1-233 C	11.8832	Adder	13.98
945682	AF1-233 E	5.8706	Adder	6.91
945861	AF1-251 C	8.4464	Adder	9.94
945862	AF1-251 E	5.6309	Adder	6.62
945911	AF1-256 C	3.8087	Adder	4.48
945912	AF1-256 E	2.5391	Adder	2.99
946102	AF1-275 BAT	3.7880	Merchant Transmission	3.7880
946171	AF1-282 C	8.7414	50/50	8.7414
946172	AF1-282 E	5.8276	50/50	5.8276
946181	AF1-283 C	11.3638	50/50	11.3638
946182	AF1-283 E	7.5759	50/50	7.5759
946511	AF1-315 C O1	2.3381	Adder	2.75
946512	AF1-315 E O1	1.5588	Adder	1.83
WEC	WEC	0.2107	Confirmed LTF	0.2107
LGEE	LGEE	1.8364	Confirmed LTF	1.8364
CPLE	CPLE	0.2242	Confirmed LTF	0.2242
CBM-W2	CBM-W2	11.4824	Confirmed LTF	11.4824
NY	NY	0.5049	Confirmed LTF	0.5049
TVA	TVA	2.0440	Confirmed LTF	2.0440
O-066	O-066	5.9002	Confirmed LTF	5.9002
CBM-S2	CBM-S2	3.3813	Confirmed LTF	3.3813
CBM-S1	CBM-S1	15.2252	Confirmed LTF	15.2252
G-007	G-007	0.9100	Confirmed LTF	0.9100
MEC	MEC	1.5016	Confirmed LTF	1.5016
CBM-W1	CBM-W1	4.6162	Confirmed LTF	4.6162

11.7.2 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
4344445 0	24345 3	05BEATT Y	AEP	24345 4	05BIXB Y	AEP	1	AEP_P4_#3196_05BEATT Y 345_302E	breake r	1203. 0	100.05	105.74	AC	68.35

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
250164	08BKJDB1	0.1469	Adder	0.17
250165	08BKJDB2	0.1469	Adder	0.17
251827	WILLYESP	0.4712	Adder	0.55
251828	CLNTESP1	0.4769	Adder	0.56
251829	CLNTESP2	0.3179	Adder	0.37
253110	09ADKINS	38.2293	50/50	38.2293
253261	09MON D	0.3295	50/50	0.3295
904722	V4-073 E	0.2008	Adder	0.24
913222	Y1-054 E	1.5361	Adder	1.81
918802	AA1-099 E	0.3179	Adder	0.37
923522	AB1-169 C OP	129.0580	Adder	151.83
925921	AC1-068 C	12.4613	50/50	12.4613
925922	AC1-068 E	5.8275	50/50	5.8275
925931	AC1-069 C	12.4613	50/50	12.4613
925932	AC1-069 E	5.8275	50/50	5.8275
925981	AC1-074 C O1	4.1045	Adder	4.83
925982	AC1-074 E O1	1.7591	Adder	2.07
926011	AC1-078 C O1	7.9028	Adder	9.3
926012	AC1-078 E O1	13.1713	Adder	15.5
926061	AC1-085 C	23.9993	50/50	23.9993
926062	AC1-085 E	39.1567	50/50	39.1567
926101	**AC1-089 C O1 (Suspended)**	**4.2282**	**Adder**	**4.97**
926102	**AC1-089 E O1 (Suspended)**	**6.8987**	**Adder**	**8.12**
926791	AC1-165 C	12.3147	50/50	12.3147
926792	AC1-165 E	5.9741	50/50	5.9741
926801	AC1-166 C	12.3147	50/50	12.3147
926802	AC1-166 E	5.9741	50/50	5.9741
927181	AC1-212 C	0.1259	Adder	0.15
927182	AC1-212 E	1.1923	Adder	1.4
930062	AB1-014 E	8.0743	Adder	9.5
932381	AC2-055 C	1.8563	Adder	2.18
932382	AC2-055 E	3.0287	Adder	3.56
932421	AC2-060 C	6.5819	Adder	7.74
932422	AC2-060 E	3.7023	Adder	4.36
932431	AC2-061 C	4.2970	Adder	5.06
932432	AC2-061 E	4.3562	Adder	5.12
932462	AC2-066 E	4.8446	Adder	5.7
932481	AC2-068 C	3.1055	Adder	3.65
932482	AC2-068 E	5.0860	Adder	5.98
932551	AC2-075 C	0.9748	Adder	1.15

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
932552	AC2-075 E	0.4911	Adder	0.58
932661	AC2-088 C O1	4.0545	Adder	4.77
932662	AC2-088 E O1	3.3365	Adder	3.93
932841	AC2-111 C O1	2.0631	Adder	2.43
932842	AC2-111 E O1	3.3661	Adder	3.96
934491	AD1-073 C	1.3575	Adder	1.6
934492	AD1-073 E	0.6993	Adder	0.82
934561	AD1-081 C	1.5806	Adder	1.86
934562	AD1-081 E	0.8142	Adder	0.96
935031	AD1-136 C	0.5702	Adder	0.67
935032	AD1-136 E	0.4857	Adder	0.57
935041	AD1-140 C O1	11.5451	Adder	13.58
935042	AD1-140 E O1	9.5446	Adder	11.23
936251	AD2-031 C O1	2.4102	Adder	2.84
936252	AD2-031 E O1	3.9325	Adder	4.63
936381	AD2-048 C	3.3765	Adder	3.97
936382	AD2-048 E	1.6846	Adder	1.98
938051	AE1-007 C	0.8906	Adder	1.05
938052	AE1-007 E	1.4531	Adder	1.71
938271	AE1-040 C O1	4.0682	Adder	4.79
938272	AE1-040 E O1	2.0470	Adder	2.41
938921	AE1-120	4.5841	Adder	5.39
939141	AE1-144 C O1	6.9404	Adder	8.17
939142	AE1-144 E O1	3.4442	Adder	4.05
940531	AE2-038 C O1	4.6298	Adder	5.45
940532	AE2-038 E O1	2.2933	Adder	2.7
941411	AE2-138 C	14.2422	Adder	16.76
941412	AE2-138 E	5.2677	Adder	6.2
941511	AE2-148 C	184.5141	50/50	184.5141
941512	AE2-148 E	83.4563	50/50	83.4563
941941	AE2-206 C O1	2.6857	Adder	3.16
941942	AE2-206 E O1	3.7088	Adder	4.36
941981	AE2-210 C O1	4.9075	Adder	5.77
941982	AE2-210 E O1	1.8459	Adder	2.17
942051	AE2-217 C	9.8217	Adder	11.55
942052	AE2-217 E	6.5478	Adder	7.7
942061	AE2-218 C	10.6381	Adder	12.52
942062	AE2-218 E	7.2259	Adder	8.5
942091	AE2-221 C	30.1482	50/50	30.1482
942092	AE2-221 E	20.0988	50/50	20.0988
942521	AE2-267 C O1	2.7190	Adder	3.2
942522	AE2-267 E O1	1.6806	Adder	1.98
942621	AE2-278 C	6.8019	Adder	8.0
942622	AE2-278 E	4.5371	Adder	5.34
942951	AE2-315	3.0438	Adder	3.58
942981	AE2-320 C O1	24.5195	50/50	24.5195
942982	AE2-320 E O1	12.1315	50/50	12.1315
943111	AE2-339 C	1.8479	Adder	2.17
943112	AE2-339 E	0.9102	Adder	1.07
943191	AE2-319 C O1	24.5195	50/50	24.5195
943192	AE2-319 E O1	12.1315	50/50	12.1315
943201	AE2-318 C	6.6299	Adder	7.8

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
943202	AE2-318 E	3.2360	Adder	3.81
943771	AF1-045	3.0880	Adder	3.63
943773	AF1-045 E	2.0620	Adder	2.43
943943	AF1-062 BAT	20.4660	Merchant Transmission	20.4660
944031	AF1-071 C	0.5158	Adder	0.61
944032	AF1-071 E	0.8415	Adder	0.99
944101	AF1-078 C	1.2208	Adder	1.44
944102	AF1-078 E	1.6858	Adder	1.98
944521	AF1-117 C	52.2505	50/50	52.2505
944522	AF1-117 E	16.0955	50/50	16.0955
944621	AF1-127 C O1	3.9619	Adder	4.66
944622	AF1-127 E O1	1.9514	Adder	2.3
944941	AF1-159	1.3954	Adder	1.64
945561	AF1-221 C O1	9.3053	Adder	10.95
945562	AF1-221 E O1	2.7970	Adder	3.29
945631	AF1-228 C	45.6212	50/50	45.6212
945632	AF1-228 E	30.4141	50/50	30.4141
945681	AF1-233 C	13.1671	Adder	15.49
945682	AF1-233 E	6.5049	Adder	7.65
945841	AF1-249 C	1.2139	Adder	1.43
945842	AF1-249 E	0.4509	Adder	0.53
945861	AF1-251 C	9.8343	Adder	11.57
945862	AF1-251 E	6.5562	Adder	7.71
945911	AF1-256 C	4.2155	Adder	4.96
945912	AF1-256 E	2.8103	Adder	3.31
946171	AF1-282 C	9.4734	50/50	9.4734
946172	AF1-282 E	6.3156	50/50	6.3156
946181	AF1-283 C	12.3154	50/50	12.3154
946182	AF1-283 E	8.2103	50/50	8.2103
946511	AF1-315 C O1	3.5762	Adder	4.21
946512	AF1-315 E O1	2.3841	Adder	2.8
WEC	WEC	0.7421	Confirmed LTF	0.7421
LGEE	LGEE	3.2353	Confirmed LTF	3.2353
CPLE	CPLE	0.2375	Confirmed LTF	0.2375
CBM-W2	CBM-W2	24.2915	Confirmed LTF	24.2915
NY	NY	0.9329	Confirmed LTF	0.9329
TVA	TVA	3.5490	Confirmed LTF	3.5490
O-066	O-066	11.0880	Confirmed LTF	11.0880
CBM-S2	CBM-S2	4.5720	Confirmed LTF	4.5720
CBM-S1	CBM-S1	26.5654	Confirmed LTF	26.5654
G-007	G-007	1.7098	Confirmed LTF	1.7098
MEC	MEC	4.0853	Confirmed LTF	4.0853
CBM-W1	CBM-W1	23.0059	Confirmed LTF	23.0059

11.8 Queue Dependencies

The Queue Projects below are listed in one or more indices for the overloads identified in your report. These projects contribute to the loading of the overloaded facilities identified in your report. The percent overload of a facility and cost allocation you may have towards a particular reinforcement could vary depending on the action of these earlier projects. The status of each project at the time of the analysis is presented in the table. This list may change as earlier projects withdraw or modify their requests.

Queue Number	Project Name	Status
AA1-099	Clinton Co. 34.5kV	In Service
AB1-014	Hillcrest 138kV	Under Construction
AB1-169	Stuart 345kV	Engineering and Procurement
AB2-083	Delano 138kV	Active
AB2-085	Adams 138kV	Active
AC1-001	Delano 138kV	Active
AC1-068	Atlanta 69kV I	Engineering and Procurement
AC1-069	Atlanta 69kV II	Engineering and Procurement
AC1-074	Jacksonville-Renaker 138kV I	Active
AC1-078	Beatty-London 138kV	Active
AC1-085	Stuart-Clinton 345kV	Engineering and Procurement
AC1-089	Hillsboro-Wildcat 138kV	Suspended
AC1-165	Atlanta 69kV III	Engineering and Procurement
AC1-166	Atlanta 69kV IV	Engineering and Procurement
AC1-194	Elk 138kV	Active
AC1-212	Minster 69kV	Engineering and Procurement
AC2-029	Circleville 138kV	Active
AC2-055	Buckskin 69kV	Active
AC2-059	Biers Run-Circleville 138kV	Active
AC2-060	Buckskin 69kV	Active
AC2-061	Hillsboro-Clinton 138kV	Active
AC2-066	Hillcrest 138kV	Under Construction
AC2-068	Camden-Crystal II 69kV	Engineering and Procurement
AC2-075	Great Blue Heron Solar	Active
AC2-088	S. Bethel-Brown 69kV	Engineering and Procurement
AC2-111	College Corner 138kV	Active
AD1-072	Biers Run-Circleville 138 kV	Active
AD1-073	Buckskin 69 kV	Active
AD1-081	Beatty-London 138 kV	Active
AD1-136	South Bethel-Brown 69 kV	Engineering and Procurement
AD1-140	Greene-Clark 138 kV	Active
AD2-016	Biers Run-Circleville 138 kV	Active
AD2-031	Martinsville-Wilmington 69 kV	Active
AD2-048	Cynthia-Headquarters 69 kV	Active
AD2-162	Biers Run-Circleville 138kV	Active
AE1-007	Camden-Crystal III 69 kV	Active
AE1-040	Greenfield 69 kV	Active
AE1-093	Elk 138 kV	Active
AE1-120	Hillcrest 138 kV	Engineering and Procurement

Queue Number	Project Name	Status
AE1-144	Goddard-Plumville 138 kV	Active
AE2-038	Goddard-Plumsville 138 kV II	Active
AE2-138	Avon-North Clark 345 kV	Active
AE2-148	Beatty-Greene 345 kV	Active
AE2-149	Biers Run-Bixby 345 kV	Active
AE2-206	East Sidney-Quincy 138 kV	Active
AE2-210	Avon-North Clark 345 kV	Active
AE2-214	Cole 345 kV	Active
AE2-217	East Springfield-London 138 kV	Active
AE2-218	Eldean 138 kV	Active
AE2-221	Clinton-Stuart 345 kV	Active
AE2-267	Woodsdale 345 kV	Active
AE2-278	Urbana 138 kV	Active
AE2-302	East Beaver-Lick 138 kV	Active
AE2-315	Yankee Tap 69 kV	Active
AE2-318	Ford-Cedarville 138 kV	Active
AE2-319	Atlanta 69kV I	Active
AE2-320	Atlanta 69 kV II	Active
AE2-339	Avon 138 kV	Active
AF1-045	Cedarville-Ford 138 kV	Active
AF1-062	Jug Street 138 kV	Active
AF1-071	College Corner 138 kV	Active
AF1-078	East Sidney-Quincy 138 kV	Active
AF1-117	Atlanta-Stuart 345 kV	Active
AF1-127	Avon 345 kV	Active
AF1-159	Martinsville-Wilmington 69 kV	Active
AF1-221	College Corner-Drewersburg 138 kV	Active
AF1-228	Beatty-Greene 345 kV	Active
AF1-233	Flemingsburg 138 kV	Active
AF1-249	Nickel 12.47 kV	Active
AF1-251	Avon-North Clark 345 kV	Active
AF1-256	Flemingsburg-Spurlock 138 kV	Active
AF1-275	Cole 345 kV	Active
AF1-282	Stuart-Clinton 345 kV	Active
AF1-283	Stuart-Clinton 345 kV	Active
AF1-315	Cedarville-Ford 138 kV	Active
V4-073	Yankee 12.5kV	In Service
Y1-054	Rochelle 138kV	In Service
Y1-063	Trenton 34.5kV	In Service

11.9 Contingency Descriptions

Contingency Name	Contingency Definition
DAY_P1-2_#762	CONTINGENCY 'DAY_P1-2_#762' OPEN BRANCH FROM BUS 243453 TO BUS 253110 CKT 1 / 243453 05BEATTY 345 253110 09ADKINS 345 1 END
AEP_P4_#8094_05BIXBY 345_C	CONTINGENCY 'AEP_P4_#8094_05BIXBY 345_C' OPEN BRANCH FROM BUS 243453 TO BUS 243454 CKT 1 / 243453 05BEATTY 345 243454 05BIXBY 345 1 OPEN BRANCH FROM BUS 941520 TO BUS 243454 CKT 1 / 941520 AE2-149 TAP 345 243454 05BIXBY 345 1 END
DAY_P7_495	CONTINGENCY 'DAY_P7_495' OPEN BRANCH FROM BUS 249566 TO BUS 253006 CKT 1 / 249566 08FOSTER 345 253006 09BATH 345 1 OPEN BRANCH FROM BUS 253014 TO BUS 253027 CKT 1 / 253014 09CLINTO 345 253027 09GREENE 345 1 OPEN BRANCH FROM BUS 253014 TO BUS 253013 CKT 1 / 253014 09CLINTO 345 253013 09CLINTO 69.0 1 OPEN BRANCH FROM BUS 253014 TO BUS 253013 CKT 2 / 253014 09CLINTO 345 253013 09CLINTO 69.0 1 END
AEP_P1-2_#714	CONTINGENCY 'AEP_P1-2_#714' OPEN BRANCH FROM BUS 244022 TO BUS 243457 CKT 1 / 244022 05COLE 345 243457 05HAYDEN 345 1 END
DAY_P1_AC1-085_ST_FSA-B	CONTINGENCY 'DAY_P1_AC1-085_ST_FSA-B' OPEN BRANCH FROM BUS 253014 TO BUS 942090 CKT 1 END
DAY_P4_L34526-3	CONTINGENCY 'DAY_P4_L34526-3' OPEN LINE FROM BUS 253027 TO BUS 253006 CKT 1 /* 09GREENE 345 - 09BATH 345 OPEN LINE FROM BUS 253027 TO BUS 253014 CKT 1 /* 09GREENE 345 - 09CLINTO 345 OPEN LINE FROM BUS 253014 TO BUS 253013 CKT 1 /* 09CLINTON 69 - 09CLINTO 345 OPEN LINE FROM BUS 253014 TO BUS 253013 CKT 2 /* 09CLINTON 69 - 09CLINTO 345 END

Contingency Name	Contingency Definition
AEP_P4_#10715_05COLE 345_C	CONTINGENCY 'AEP_P4_#10715_05COLE 345_C' OPEN BRANCH FROM BUS 244022 TO BUS 243457 CKT 1 / 244022 05COLE 345 243457 05HAYDEN 345 1 OPEN BRANCH FROM BUS 244022 TO BUS 244023 CKT 1 / 244022 05COLE 345 244023 05COLE 138 1 END
Base Case	
AEP_P1-2_#713	CONTINGENCY 'AEP_P1-2_#713' OPEN BRANCH FROM BUS 243453 TO BUS 243454 CKT 1 / 243453 05BEATTY 345 243454 05BIXBY 345 1 END
AEP_P4_#3196_05BEATTY 345_302E	CONTINGENCY 'AEP_P4_#3196_05BEATTY 345_302E' OPEN BRANCH FROM BUS 243453 TO BUS 244022 CKT 1 / 243453 05BEATTY 345 244022 05COLE 345 1 OPEN BRANCH FROM BUS 243453 TO BUS 243468 CKT 4 / 243453 05BEATTY 345 243468 05BEATTX 138 4 END
AEP_P4_#3195_05BEATTY 345_304E	CONTINGENCY 'AEP_P4_#3195_05BEATTY 345_304E' OPEN BRANCH FROM BUS 243453 TO BUS 243454 CKT 1 / 243453 05BEATTY 345 243454 05BIXBY 345 1 OPEN BRANCH FROM BUS 243453 TO BUS 243468 CKT 4 / 243453 05BEATTY 345 243468 05BEATTX 138 4 END

12 Light Load Analysis

The Queue Project AF1-117 was evaluated as a 200.0 MW injection tapping the Atlanta to Stuart 345 kV line in the AEP area. Project AF1-117 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-117 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

12.1 Light Load Deliverability

(Single or N-1 contingencies)

None

12.2 Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies)

None

12.3 Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

None

12.4 Steady-State Voltage Requirements

To be determined

12.5 Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

None

12.6 System Reinforcements

None

13 Short Circuit Analysis

The following breakers are overdutied:

None

14 Stability and Reactive Power Requirements for Low Voltage Ride Through

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

To be evaluated during the Facilities Study Phase

15 Affected Systems

15.1 MISO

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

15.2 LG&E

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

16 Attachment 1: One Line Diagram and Point of Interconnection Map