Generation Interconnection

System Impact Study Report

for

Queue Project AF1-275

COLE 345 KV

50 MW Capacity / 50 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.

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 an uprate to a planned Solar generating facility by adding a Storage facility located in Franklin, Ohio. This project is an increase to the Interconnection Customer's AE2-214 project, which will share the same point of interconnection. The AF1-275 queue position is a 50 MW uprate (50 MW Capacity uprate) to the previous project. The total installed facilities will have a capability of 250 MW with 170 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this uprate project is December 31, 2022. 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	AF1-275
Project Name	COLE 345 KV
State	Ohio
County	Franklin
Transmission Owner	AEP
MFO	250
MWE	50
MWC	50
Fuel	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

AF1-275 will interconnect with the AEP transmission system at the Cole 345 kV station utilizing the same generation lead as queue position AE2-214.

Note: It is assumed that the 345 kV revenue metering system, gen lead, and Protection & Control Equipment that will be installed for AE2-214 will be adequate for the additional facility connection requested in AF1-275. Depending on the timing of the completion of the AF1-275 interconnection construction relative to the AE2-214 completion, there may (or may not) be a need to review and revise relay settings for the increased generation of AF1-275.

5 Cost Summary

The AF1-275 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$0
Direct Connection Network Upgrade	$0
Non Direct Connection Network Upgrades	$45,000
Allocation for New System Upgrades	$0
Contribution to Previously Identified Upgrades*	$448,000
Total Costs	**$448,000**

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

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.

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.

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
Total Attachment Facility Costs	**$0**

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
Total Direct Connection Facility Costs	**$0**

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 protections and controls at the Cole 345 kV station	$45,000
Total Non-Direct Connection Facility Costs	**$45,000**

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 (IC) is responsible for all costs associated with this interconnection. The costs above are reimbursable to the Transmission Owner. The cost of the IC's generating plant and the costs for the line connecting the generating plant to the Point of Interconnection are not included in this report; these are assumed to be the IC's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for the 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.

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

Solar generation facilities 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 AF1-275 was evaluated as a 50.0 MW (Capacity 50.0 MW) injection as an uprate to AE2-214 at the Cole 345kV substation in the AEP area. Project AF1-275 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-275 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)

None

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
43592096	243453	05BEATTY	345.0	AEP	243454	05BIXBY	345.0	AEP	1	AEP_P4_#10715_05COLE 345_C	breaker	1203.0	114.86	116.98	AC	25.58
43592155	243453	05BEATTY	345.0	AEP	244022	05COLE	345.0	AEP	1	AEP_P4_#3195_05BEATTY 345_304E	breaker	1203.0	103.37	104.92	AC	18.65
43592156	243453	05BEATTY	345.0	AEP	244022	05COLE	345.0	AEP	1	AEP_P4_#8094_05BIXBY 345_C	breaker	1203.0	102.13	103.75	AC	19.52

11.4 Steady-State Voltage Requirements

None

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
43592447	243453	05BEATTY	345.0	AEP	243454	05BIXBY	345.0	AEP	1	AEP_P1-2_#714	operation	1203.0	107.47	109.39	AC	23.11

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 AF1-275</th><th>Upgrade Number</th></tr>
<tr><td>43592155,43592156</td><td>3</td><td>05BEATTY 345.0 kV - 05COLE 345.0 kV Ckt 1</td><td>N6769.1 : Upgrade/Replace Three 345kV 1600A switches at Beatty station on the Beatty-Cole 345 kV line.
Cost : $ 1,500,000
Time Estimate : 12-18 Months
New Expected SE rating to be 1409 MVA.

The cost allocation is as follows:
<table>
<tr><th>Queue</th><th>MW contribution</th><th>Percentage of Cost</th><th>$ cost ($1.5 M)</th></tr>
<tr><td>AF1-228</td><td>63.8</td><td>53.87%</td><td>0.808</td></tr>
<tr><td>AF1-233</td><td>19.7</td><td>16.62%</td><td>0.249</td></tr>
<tr><td>AF1-251</td><td>16.3</td><td>13.74%</td><td>0.206</td></tr>
<tr><td>AF1-275</td><td>18.7</td><td>15.76%</td><td>0.236</td></tr>
</table></td><td>$1.5 M</td><td>$236 K</td><td>N6769.1</td></tr>
<tr><td>43592096</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 on the Beatty-Bixby 345 kV line.
Cost : $ 1,500,000
Time Estimate : 12-18 Months
New Expected SE rating to be 1409 MVA.

The cost allocation is as follows:
<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>1.48%</td><td>0.022</td></tr>
<tr><td>AF1-117</td><td>68.4</td><td>29.71%</td><td>0.446</td></tr>
<tr><td>AF1-221</td><td>14.2</td><td>6.19%</td><td>0.093</td></tr>
<tr><td>AF1-228</td><td>76.0</td><td>33.05%</td><td>0.496</td></tr>
<tr><td>AF1-233</td><td>23.1</td><td>10.06%</td><td>0.151</td></tr>
<tr><td>AF1-251</td><td>19.3</td><td>8.38%</td><td>0.126</td></tr>
<tr><td>AF1-275</td><td>25.6</td><td>11.13%</td><td>0.167</td></tr>
</table></td><td>$1.5 M</td><td>$167 K</td><td>N6741.1</td></tr>
<tr><td></td><td></td><td></td><td>Total Cost</td><td>$3,000,000</td><td>$403,000</td><td></td></tr>
</table>

Note : 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.

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

None

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
4359209 6	24345 3	05BEATTY	AEP	24345 4	05BIXBY	AEP	1	AEP_P4_#10715_05COLE 345_C	breaker	1203.0	114.86	116.98	AC	25.58

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
250164	08BKJDB1	0.1418	Adder	0.17
250165	08BKJDB2	0.1418	Adder	0.17
251827	WILLYESP	0.4548	Adder	0.54
251828	CLNTESP1	0.4613	Adder	0.54
251829	CLNTESP2	0.3076	Adder	0.36
253110	09ADKINS	36.5741	50/50	36.5741
904722	V4-073 E	0.1944	Adder	0.23
913222	Y1-054 E	1.4824	Adder	1.74
918802	AA1-099 E	0.3076	Adder	0.36
923522	AB1-169 C OP	124.0184	Adder	145.9
925921	AC1-068 C	11.9330	50/50	11.9330
925922	AC1-068 E	5.5804	50/50	5.5804
925931	AC1-069 C	11.9330	50/50	11.9330
925932	AC1-069 E	5.5804	50/50	5.5804
925981	AC1-074 C O1	3.9541	Adder	4.65
925982	AC1-074 E O1	1.6946	Adder	1.99
926011	AC1-078 C O1	11.5368	50/50	11.5368
926012	AC1-078 E O1	19.2280	50/50	19.2280
926061	AC1-085 C	23.0994	50/50	23.0994
926062	AC1-085 E	37.6886	50/50	37.6886
926101	**AC1-089 C O1 (Suspended)**	**4.0945**	**Adder**	**4.82**
926102	**AC1-089 E O1 (Suspended)**	**6.6805**	**Adder**	**7.86**
926791	AC1-165 C	11.7926	50/50	11.7926
926792	AC1-165 E	5.7208	50/50	5.7208
926801	AC1-166 C	11.7926	50/50	11.7926
926802	AC1-166 E	5.7208	50/50	5.7208
930062	AB1-014 E	7.7752	Adder	9.15
932381	AC2-055 C	1.8070	Adder	2.13
932382	AC2-055 E	2.9483	Adder	3.47
932421	AC2-060 C	6.4072	Adder	7.54
932422	AC2-060 E	3.6041	Adder	4.24
932431	AC2-061 C	4.1651	Adder	4.9
932432	AC2-061 E	4.2225	Adder	4.97
932462	AC2-066 E	4.6651	Adder	5.49
932481	AC2-068 C	3.0098	Adder	3.54
932482	AC2-068 E	4.9292	Adder	5.8
932551	AC2-075 C	0.9391	Adder	1.1
932552	AC2-075 E	0.4731	Adder	0.56
932661	AC2-088 C O1	3.9031	Adder	4.59
932662	AC2-088 E O1	3.2119	Adder	3.78

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
934491	AD1-073 C	1.3215	Adder	1.55
934492	AD1-073 E	0.6808	Adder	0.8
934561	AD1-081 C	2.3074	50/50	2.3074
934562	AD1-081 E	1.1886	50/50	1.1886
935031	AD1-136 C	0.5489	Adder	0.65
935032	AD1-136 E	0.4676	Adder	0.55
935041	AD1-140 C O1	11.5826	Adder	13.63
935042	AD1-140 E O1	9.5756	Adder	11.27
936251	AD2-031 C O1	2.3271	Adder	2.74
936252	AD2-031 E O1	3.7968	Adder	4.47
936381	AD2-048 C	3.2534	Adder	3.83
936382	AD2-048 E	1.6232	Adder	1.91
938051	AE1-007 C	0.8632	Adder	1.02
938052	AE1-007 E	1.4084	Adder	1.66
938271	AE1-040 C O1	3.9409	Adder	4.64
938272	AE1-040 E O1	1.9829	Adder	2.33
938921	AE1-120	4.4143	Adder	5.19
939141	AE1-144 C O1	6.6807	Adder	7.86
939142	AE1-144 E O1	3.3153	Adder	3.9
940531	AE2-038 C O1	4.4566	Adder	5.24
940532	AE2-038 E O1	2.2074	Adder	2.6
941411	AE2-138 C	13.7131	Adder	16.13
941412	AE2-138 E	5.0719	Adder	5.97
941511	AE2-148 C	176.5760	50/50	176.5760
941512	AE2-148 E	79.8659	50/50	79.8659
941981	AE2-210 C O1	4.7252	Adder	5.56
941982	AE2-210 E O1	1.7774	Adder	2.09
942021	AE2-214 C	61.3992	50/50	61.3992
942022	AE2-214 E	40.9328	50/50	40.9328
942051	AE2-217 C	11.5292	Adder	13.56
942052	AE2-217 E	7.6861	Adder	9.04
942061	AE2-218 C	10.3345	Adder	12.16
942062	AE2-218 E	7.0196	Adder	8.26
942091	AE2-221 C	29.0394	50/50	29.0394
942092	AE2-221 E	19.3596	50/50	19.3596
942521	AE2-267 C O1	2.6239	Adder	3.09
942522	AE2-267 E O1	1.6219	Adder	1.91
942621	AE2-278 C	7.2675	Adder	8.55
942622	AE2-278 E	4.8477	Adder	5.7
942951	AE2-315	2.9471	Adder	3.47
942981	AE2-320 C O1	23.4799	50/50	23.4799
942982	AE2-320 E O1	11.6171	50/50	11.6171
943191	AE2-319 C O1	23.4799	50/50	23.4799
943192	AE2-319 E O1	11.6171	50/50	11.6171
943201	AE2-318 C	6.3883	Adder	7.52
943202	AE2-318 E	3.1181	Adder	3.67
943771	AF1-045	2.9755	Adder	3.5
943773	AF1-045 E	1.9868	Adder	2.34
943943	AF1-062 BAT	20.0460	Merchant Transmission	20.0460
944521	AF1-117 C	50.0197	50/50	50.0197
944522	AF1-117 E	15.4083	50/50	15.4083
944621	AF1-127 C O1	3.8152	Adder	4.49

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
944622	AF1-127 E O1	1.8791	Adder	2.21
944941	AF1-159	1.3472	Adder	1.58
945631	AF1-228 C	43.6468	50/50	43.6468
945632	AF1-228 E	29.0978	50/50	29.0978
945681	AF1-233 C	12.6730	Adder	14.91
945682	AF1-233 E	6.2608	Adder	7.37
945841	AF1-249 C	1.1718	Adder	1.38
945842	AF1-249 E	0.4352	Adder	0.51
945861	AF1-251 C	9.4697	Adder	11.14
945862	AF1-251 E	6.3131	Adder	7.43
945911	AF1-256 C	4.0572	Adder	4.77
945912	AF1-256 E	2.7048	Adder	3.18
946101	AF1-275	25.5830	50/50	25.5830
946171	AF1-282 C	9.1182	50/50	9.1182
946172	AF1-282 E	6.0788	50/50	6.0788
946181	AF1-283 C	11.8537	50/50	11.8537
946182	AF1-283 E	7.9024	50/50	7.9024
946511	AF1-315 C O1	3.4456	Adder	4.05
946512	AF1-315 E O1	2.2970	Adder	2.7
WEC	WEC	0.7286	Confirmed LTF	0.7286
LGEE	LGEE	3.1269	Confirmed LTF	3.1269
CPLE	CPLE	0.2302	Confirmed LTF	0.2302
CBM-W2	CBM-W2	23.5954	Confirmed LTF	23.5954
NY	NY	0.9064	Confirmed LTF	0.9064
TVA	TVA	3.4412	Confirmed LTF	3.4412
O-066	O-066	10.7722	Confirmed LTF	10.7722
CBM-S2	CBM-S2	4.4275	Confirmed LTF	4.4275
CBM-S1	CBM-S1	25.7304	Confirmed LTF	25.7304
G-007	G-007	1.6609	Confirmed LTF	1.6609
MEC	MEC	3.9916	Confirmed LTF	3.9916
CBM-W1	CBM-W1	22.6306	Confirmed LTF	22.6306

11.7.3 Index 3

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
43592155	243453	05BEATTY	AEP	244022	05COLE	AEP	1	AEP_P4_#3195_05BEATTY 345_304E	breaker	1203.0	103.37	104.92	AC	18.65

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
247964	Y1-063 BAT	0.3049	Merchant Transmission	0.3049
250164	08BKJDB1	0.1227	Adder	0.14
250165	08BKJDB2	0.1227	Adder	0.14
251827	WILLYESP	0.3881	Adder	0.46
251828	CLNTESP1	0.4060	Adder	0.48
251829	CLNTESP2	0.2706	Adder	0.32
253110	09ADKINS	32.1377	50/50	32.1377
253261	09MON D	0.2608	50/50	0.2608
904722	V4-073 E	0.1615	Adder	0.19
913222	Y1-054 E	1.2716	Adder	1.5
918802	AA1-099 E	0.2706	Adder	0.32
923522	AB1-169 C OP	110.1430	Adder	129.58
925921	AC1-068 C	10.4968	50/50	10.4968
925922	AC1-068 E	4.9088	50/50	4.9088
925931	AC1-069 C	10.4968	50/50	10.4968
925932	AC1-069 E	4.9088	50/50	4.9088
925981	AC1-074 C O1	3.4548	Adder	4.06
925982	AC1-074 E O1	1.4806	Adder	1.74
926011	AC1-078 C O1	4.7758	Adder	5.62
926012	AC1-078 E O1	7.9597	Adder	9.36
926061	AC1-085 C	20.0594	50/50	20.0594
926062	AC1-085 E	32.7286	50/50	32.7286
926101	**AC1-089 C O1 (Suspended)**	**3.6778**	**Adder**	**4.33**
926102	**AC1-089 E O1 (Suspended)**	**6.0007**	**Adder**	**7.06**
926791	AC1-165 C	10.3733	50/50	10.3733
926792	AC1-165 E	5.0323	50/50	5.0323
926801	AC1-166 C	10.3733	50/50	10.3733
926802	AC1-166 E	5.0323	50/50	5.0323
930062	AB1-014 E	6.7818	Adder	7.98
932381	AC2-055 C	1.7415	Adder	2.05
932382	AC2-055 E	2.8414	Adder	3.34
932421	AC2-060 C	6.1749	Adder	7.26
932422	AC2-060 E	3.4734	Adder	4.09
932431	AC2-061 C	3.7399	Adder	4.4
932432	AC2-061 E	3.7914	Adder	4.46
932462	AC2-066 E	4.0691	Adder	4.79
932481	AC2-068 C	2.4631	Adder	2.9
932482	AC2-068 E	4.0339	Adder	4.75
932551	AC2-075 C	0.8205	Adder	0.97
932552	AC2-075 E	0.4133	Adder	0.49

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
932661	AC2-088 C O1	3.4295	Adder	4.03
932662	AC2-088 E O1	2.8222	Adder	3.32
934491	AD1-073 C	1.2736	Adder	1.5
934492	AD1-073 E	0.6561	Adder	0.77
934561	AD1-081 C	0.9552	Adder	1.12
934562	AD1-081 E	0.4921	Adder	0.58
935031	AD1-136 C	0.4823	Adder	0.57
935032	AD1-136 E	0.4108	Adder	0.48
935041	AD1-140 C O1	8.4215	Adder	9.91
935042	AD1-140 E O1	6.9622	Adder	8.19
936251	AD2-031 C O1	2.3938	50/50	2.3938
936252	AD2-031 E O1	3.9057	50/50	3.9057
936381	AD2-048 C	2.8461	Adder	3.35
936382	AD2-048 E	1.4200	Adder	1.67
938051	AE1-007 C	0.7064	Adder	0.83
938052	AE1-007 E	1.1525	Adder	1.36
938271	AE1-040 C O1	4.3178	50/50	4.3178
938272	AE1-040 E O1	2.1726	50/50	2.1726
938921	AE1-120	3.8503	Adder	4.53
939141	AE1-144 C O1	5.8994	Adder	6.94
939142	AE1-144 E O1	2.9276	Adder	3.44
940531	AE2-038 C O1	3.9354	Adder	4.63
940532	AE2-038 E O1	1.9493	Adder	2.29
941411	AE2-138 C	12.0110	Adder	14.13
941412	AE2-138 E	4.4424	Adder	5.23
941511	AE2-148 C	154.5537	50/50	154.5537
941512	AE2-148 E	69.9051	50/50	69.9051
941981	AE2-210 C O1	4.1387	Adder	4.87
941982	AE2-210 E O1	1.5567	Adder	1.83
942061	AE2-218 C	8.0153	Adder	9.43
942062	AE2-218 E	5.4444	Adder	6.41
942091	AE2-221 C	24.9876	50/50	24.9876
942092	AE2-221 E	16.6584	50/50	16.6584
942521	AE2-267 C O1	2.2375	Adder	2.63
942522	AE2-267 E O1	1.3831	Adder	1.63
942951	AE2-315	2.4483	Adder	2.88
942981	AE2-320 C O1	20.6540	50/50	20.6540
942982	AE2-320 E O1	10.2190	50/50	10.2190
943111	AE2-339 C	1.5541	Adder	1.83
943112	AE2-339 E	0.7654	Adder	0.9
943191	AE2-319 C O1	20.6540	50/50	20.6540
943192	AE2-319 E O1	10.2190	50/50	10.2190
943201	AE2-318 C	5.5504	Adder	6.53
943202	AE2-318 E	2.7091	Adder	3.19
943771	AF1-045	2.5852	Adder	3.04
943773	AF1-045 E	1.7262	Adder	2.03
944521	AF1-117 C	44.0169	50/50	44.0169
944522	AF1-117 E	13.5591	50/50	13.5591
944621	AF1-127 C O1	3.3395	Adder	3.93
944622	AF1-127 E O1	1.6449	Adder	1.94
944941	AF1-159	1.3859	50/50	1.3859
945631	AF1-228 C	38.2509	50/50	38.2509

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
945632	AF1-228 E	25.5006	50/50	25.5006
945681	AF1-233 C	11.1919	Adder	13.17
945682	AF1-233 E	5.5291	Adder	6.5
945841	AF1-249 C	1.0045	Adder	1.18
945842	AF1-249 E	0.3731	Adder	0.44
945861	AF1-251 C	8.2916	Adder	9.75
945862	AF1-251 E	5.5277	Adder	6.5
945911	AF1-256 C	3.5831	Adder	4.22
945912	AF1-256 E	2.3887	Adder	2.81
946102	AF1-275 BAT	18.6545	50/50	18.6545
946171	AF1-282 C	7.9182	50/50	7.9182
946172	AF1-282 E	5.2788	50/50	5.2788
946181	AF1-283 C	10.2937	50/50	10.2937
946182	AF1-283 E	6.8624	50/50	6.8624
946511	AF1-315 C O1	2.9960	Adder	3.52
946512	AF1-315 E O1	1.9974	Adder	2.35
WEC	WEC	0.4256	Confirmed LTF	0.4256
LGEE	LGEE	2.6340	Confirmed LTF	2.6340
CPLE	CPLE	0.2765	Confirmed LTF	0.2765
CBM-W2	CBM-W2	18.1900	Confirmed LTF	18.1900
NY	NY	0.6885	Confirmed LTF	0.6885
TVA	TVA	2.8420	Confirmed LTF	2.8420
O-066	O-066	8.1715	Confirmed LTF	8.1715
CBM-S2	CBM-S2	4.3581	Confirmed LTF	4.3581
CBM-S1	CBM-S1	21.3937	Confirmed LTF	21.3937
G-007	G-007	1.2594	Confirmed LTF	1.2594
MEC	MEC	2.6552	Confirmed LTF	2.6552
CBM-W1	CBM-W1	11.9470	Confirmed LTF	11.9470

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
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
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
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

Queue Number	Project Name	Status
AE2-149	Biers Run-Bixby 345 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
AF1-117	Atlanta-Stuart 345 kV	Active
AF1-127	Avon 345 kV	Active
AF1-159	Martinsville-Wilmington 69 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
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
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
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
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_#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 AF1-275 was evaluated as a 50.0 MW injection as an uprate to AE2-214 at the Cole 345kV substation in the AEP area. Project AF1-275 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-275 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

12.1 Generation 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

None

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 TVA

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

15.2 Duke Energy Progress

Duke Energy Progress Impacts to be determined during later study phases (as applicable).

15.3 MISO

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

15.4 LG&E

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

16 Attachment 1: One-Line Diagram and Location Map