Generation Interconnection

Feasibility Study Report

for

Queue Project AF1-228

BEATTY-GREENE 345 KV

93 MW Capacity / 155 MW Energy

February, 2020

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1 Preface

The intent of the feasibility study is to determine a plan, with ballpark cost and construction time estimates, to connect the subject generation to the PJM network at a location specified by the Interconnection Customer. The Interconnection Customer may request the interconnection of generation as a capacity resource or as an energy-only resource. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection, may also contribute to the need for the same network reinforcement. Cost allocation rules for network upgrades can be found in PJM Manual 14A, Attachment B. The possibility of sharing the reinforcement costs with other projects may be identified in the feasibility study, but the actual allocation will be deferred until the impact study is performed.

The Interconnection Customer seeking to interconnect a wind or solar generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per Schedule H to the Interconnection Service Agreement and Section 8 of Manual 14D.

An Interconnection Customer with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See

Section 4.3 for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

The Feasibility Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

2 General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Madison County, Ohio. The installed facilities will have a total capability of 155 MW with 93 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is October 31, 2022. This study does not imply a TO commitment to this in-service date.

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.

The Feasibility Study includes Short Circuit and Peak Load steady state power flow analyses. The conduct of power flow studies at other load levels, stability analysis, and coordination with non-PJM Transmission Planners, as required under the PJM planning process, is not performed during the Generation Interconnection Feasibility Study phase of the PJM study process. Additional reinforcement requirements for this Interconnection Request may be defined during the conduct of these additional analyses which shall be performed following execution of the System Impact Study agreement

Queue Number	**AF1-228**
Project Name	BEATTY-GREENE 345 KV
State	Ohio
County	Madison
Transmission Owner	AEP
MFO	155
MWE	155
MWC	93
Fuel	Solar
Basecase Study Year	2023

2.1 Point of Interconnection

AF1-228 will interconnect with the AEP transmission system tapping the Greene to Beatty 345 kV line.

To accommodate the interconnection on the Greene to Beatty 345 kV circuit, a new three (3) circuit breaker 345 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, 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.

2.2 Cost Summary

The AF1-228 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$350,000
Direct Connection Network Upgrade	$8,000,000
Non Direct Connection Network Upgrades	$1,900,000
Total Costs	$10,250,000

In addition, the AF1-228 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$5,556,600

Cost allocations for these upgrades will be provided in the System Impact Study Report.

3 Transmission Owner Scope of Work

4 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	$350,000
Total Attachment Facility Costs	$350,000

5 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 in a breaker and half bus arrangement but operated as a ring-bus (see Single Line Diagram). Installation of associated protection and control equipment, 345 kV line risers and SCADA will also be required.	$8,000,000
Total Direct Connection Facility Costs	$8,000,000

6 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
Upgrade line protections & Controls at the Greene 345kV Substation	$350,000
Upgrade line protections & Controls at the Beatty 345kV Substation	$350,000
345 kV Transmission Line Cut In	$1,200,000
Total Non-Direct Connection Facility Costs	$1,900,000

7 Incremental Capacity Transfer Rights (ICTRs)

Will be determined at a later study phase

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 AEP. The cost of the Interconnection Customer's generating plant and the costs for the line connecting the generating plant to the AEP 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 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.

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 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

11 Network Impacts

The Queue Project AF1-228 was evaluated as a 155.0 MW (Capacity 93.0 MW) injection tapping the Greene to Beatty 345 kV line in the AEP area. Project AF1-228 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-228 was studied with a commercial probability of 0.53. Potential network impacts were as follows:

Summer Peak Load Flow

12 Generation Deliverability

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

None

13 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
4354684 6	24345 4	05BIXB Y	345. 0	AEP	24345 9	05KIR K	345. 0	AEP	1	AEP_P4_#3196_05BEA TTY 345_302E	breake r	1409. 0	96.32	100.0	DC	51.77

14 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
4354674 0	24345 3	05BEATT Y	345. 0	AEP	24345 4	05BIXB Y	345. 0	AEP	1	AEP_P4_#3196_05BEA TTY 345_302E	break er	1203. 0	110.36	116.68	DC	76.0
4354674 1	24345 3	05BEATT Y	345. 0	AEP	24345 4	05BIXB Y	345. 0	AEP	1	AEP_P4_#10715_05CO LE 345_C	break er	1203. 0	109.93	115.98	DC	72.71
4354680 0	24345 3	05BEATT Y	345. 0	AEP	24402 2	05COL E	345. 0	AEP	1	AEP_P4_#3195_05BEA TTY 345_304E	break er	1203. 0	100.94	106.24	DC	63.7
4354680 1	24345 3	05BEATT Y	345. 0	AEP	24402 2	05COL E	345. 0	AEP	1	AEP_P4_#8094_05BIXB Y 345_C	break er	1203. 0	100.11	105.08	DC	59.76

15 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

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
43547092	243453	05BEATTY	345.0	AEP	243454	05BIXBY	345.0	AEP	1	AEP_P1-2_#714	operation	1203.0	102.28	108.04	DC	69.17
41321338	945630	AF1-228 TAP	345.0	DAY	243453	05BEATTY	345.0	AEP	1	DAY_P1-2_#762	operation	1374.0	94.82	103.21	DC	115.26

16 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
43546800,43546801	3	05BEATTY 345.0 kV - 05COLE 345.0 kV Ckt 1	**AEPO0001a (229) : Upgrade/Replace 3-345kV 1600A switches at Beatty station** **Project Type : FAC** **Cost : $1,500,000** **Time Estimate : 12-18 Months** **AEPO0001b (230) : 1) A sag study will be required on the 9.7 miles of ACSR ~ 954 ~ 45/7 ~ Bundled - Conductor Section 1 to mitigate the overload. Depending on the sag study results, the cost for this upgrade is expected to be between $42,000 (no remediation required, just sag study) and $40 million (complete line reconductor/rebuild). New rating after sag study: S/N:1409 S/E: 1887 . Time Estimate: a) Sag Study: 6-12 months. b) Rebuild: The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement.** **Project Type : FAC** **Cost : $42,000** **Time Estimate : 6-12 Months**	$1,542,000

ID	Index	Facility	Upgrade Description	Cost
43546846	1	05BIXBY 345.0 kV - 05KIRK 345.0 kV Ckt 1	**AEPO0038a (411) : Replace Kirk Riser, Sub Cond 954 ACSR 45/7** **Project Type : FAC** **Cost : $100,000** **Time Estimate : 12-18 months Months** **AEPO0038b (412) : An engineering study will need to be conducted to determine if the Kirk Relay Thermal limits 1386 Amps settings can be adjusted to mitigate the overload, Estimated Cost $25,000. New relay packages will be required if the settings cannot be adjusted. Estimated Cost: $600,000.** **Project Type : FAC** **Cost : $25,000** **Time Estimate : 12-18 months Months** **AEPO0038c (413) : Replace two Kirk risers, Sub cond 1700 kcm AAC 61 Str.** **Project Type : FAC** **Cost : $200,000** **Time Estimate : 12-18 months Months** **AEPO0038d (414) : Sag Study will be required on 37.9 miles of line between Bixby and kirk .The cost is expected to be 151,600.New Ratings after sag study : S/N: 1409MVA S/E: 1887 MVA.Rebuild/Reconductor, cost : $ 75.8 million** **Project Type : FAC** **Cost : $151,600** **Time Estimate : Sag Study : 6 - 12 months Months** **AEPO0038e (415) : An engineering study will need to be conducted to determine if the Kirk Compliance Thermal limits 2396 Amps settings can be adjusted to mitigate the overload, Estimated Cost $25,000. New relay packages will be required if the settings cannot be adjusted. Estimated Cost: $600,000.** **Project Type : FAC** **Cost : $25,000** **Time Estimate : 12-18 months Months** **AEPO0038f (416) : Replace Bixby switch (2000A)** **Project Type : FAC** **Cost : $100,000** **Time Estimate : 12-18 months Months** **AEPO0038g (417) : Replace Bixby Riser, Sub Cond 954 ACSR 45/7** **Project Type : FAC** **Cost : $100,000** **Time Estimate : 12-18 months Months** **AEPO0038h (418) : Replace Kirk Riser, Sub Cond 954 ACSR 45/7** **Project Type : FAC** **Cost : $100,000** **Time Estimate : 12-18 months Months**	$801,600

ID	Index	Facility	Upgrade Description	Cost
43546741,43546740	2	05BEATTY 345.0 kV - 05BIXBY 345.0 kV Ckt 1	**AEPO0003a (233) : Upgrade/Replace Three 345kV 1600A switches and 2-954 ACSR risers at Beatty station** **Project Type : FAC** **Cost : $1,500,000** **Time Estimate : 12-18 Months** **AEPO0003b (377) : 1) A sag study will be required on the 9.5 miles of ACSR ~ 954 ~ 45/7 ~ Bundled - Conductor Section 1 to mitigate the overload. Depending on the sag study results, the cost for this upgrade is expected to be between $38,000 (no remediation required, just sag study) and $19 million (complete line reconductor/rebuild). New rating after sag study: S/N:1409 S/E: 1887 . Time Estimate: a) Sag Study: 6-12 months. b) Rebuild: The standard time required for construction differs from state to state. An approximate construction time would be 24 to 36 months after signing an interconnection agreement.** **Project Type : FAC** **Cost : $38,000** **Time Estimate : 12-18 Months** **AEPO0003c (378) : Upgrade/Replace four 345kV 2000A Bixby switches** **Project Type : FAC** **Cost : $1,500,000** **Time Estimate : 12-18 Months** **AEPO0003d (379) : Replace 2-954 ACSR risers at Bixby station** **Project Type : FAC** **Cost : $175,000** **Time Estimate : 12-19 Months**	$3,213,000
			TOTAL COST	**$5,556,600**

17 Flow Gate Details

The following indices contain additional information about each flowgate presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

17.1 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
43546846	243454	05BIXBY	AEP	243459	05KIRK	AEP	1	AEP_P4_#3196_05BEATTY 345_302E	breaker	1409.0	96.32	100.0	DC	51.77

Bus #	Bus	MW Impact
250164	08BKJDB1	0.1401
250165	08BKJDB2	0.1401
251827	WILLYESP	0.4269
251828	CLNTESP1	0.4890
251829	CLNTESP2	0.3260
253110	09ADKINS	20.9360
902531	**W2-040 C (Withdrawn : 01/23/2020)**	**0.7175**
902532	**W2-040 E (Withdrawn : 01/23/2020)**	**1.1707**
904722	V4-073 E	0.1565
913222	Y1-054 E	1.4170
918802	AA1-099 E	0.3260
923522	AB1-169 C OP	118.2868
924351	AB2-083 C O1	4.8226
924352	AB2-083 E O1	2.2694
924371	AB2-085 C O1	5.1516
924372	AB2-085 E O1	2.4243
925242	**AB2-178 E (Withdrawn : 12/10/2019)**	**1.3870**
925341	AC1-001 C O1	9.6451
925342	AC1-001 E O1	4.5389
925921	AC1-068 C	9.0239
925922	AC1-068 E	4.2200
925931	AC1-069 C	9.0239
925932	AC1-069 E	4.2200
925981	AC1-074 C O1	3.9170
925982	AC1-074 E O1	1.6787
926011	AC1-078 C O1	6.5558
926012	AC1-078 E O1	10.9264
926061	AC1-085 C	20.2099
926062	AC1-085 E	32.9741
926101	AC1-089 C O1	4.7127
926102	AC1-089 E O1	7.6892
926791	AC1-165 C	8.9178
926792	AC1-165 E	4.3262
926801	AC1-166 C	8.9178
926802	AC1-166 E	4.3262
926951	AC1-182	1.6402
930062	AB1-014 E	7.2522
932201	AC2-029 C	4.9527
932202	AC2-029 E	8.0806
932381	AC2-055 C	3.1871
932382	AC2-055 E	5.2000
932411	AC2-059 C	13.0337

Bus #	Bus	MW Impact
932412	AC2-059 E	13.4508
932421	AC2-060 C	11.3005
932422	AC2-060 E	6.3565
932431	AC2-061 C	4.8452
932432	AC2-061 E	4.9119
932451	**AC2-064 C (Withdrawn : 12/09/2019)**	**5.1413**
932452	**AC2-064 E (Withdrawn : 12/09/2019)**	**3.4275**
932461	AC2-066 C	2.6669
932462	AC2-066 E	4.3513
932481	AC2-068 C	2.4113
932482	AC2-068 E	3.9491
932551	AC2-075 C	0.9303
932552	AC2-075 E	0.4686
932651	**AC2-087 C O1 (Withdrawn : 01/15/2020)**	**8.3694**
932652	**AC2-087 E O1 (Withdrawn : 01/15/2020)**	**6.6390**
932661	AC2-088 C O1	3.7164
932662	AC2-088 E O1	3.0583
934481	AD1-072 C	2.8633
934482	AD1-072 E	1.3075
934491	AD1-073 C	2.3307
934492	AD1-073 E	1.2007
934561	AD1-081 C	1.3112
934562	AD1-081 E	0.6755
935031	AD1-136 C	0.5226
935032	AD1-136 E	0.4452
935041	AD1-140 C O1	8.4190
935042	AD1-140 E O1	6.9602
935051	AD1-141 C O1	2.2080
935052	AD1-141 E O1	1.4720
936111	AD2-016 C	13.0337
936112	AD2-016 E	13.4508
936251	AD2-031 C O1	2.5846
936252	AD2-031 E O1	4.2169
936381	AD2-048 C	3.2494
936382	AD2-048 E	1.6212
937231	AD2-162 C	14.8845
937232	AD2-162 E	7.2981
938051	AE1-007 C	0.6915
938052	AE1-007 E	1.1283
938271	AE1-040 C O1	5.7781
938272	AE1-040 E O1	2.9073
938921	AE1-120	4.1174
939141	AE1-144 C O1	6.5927
939142	AE1-144 E O1	3.2717
940531	AE2-038 C O1	4.3979
940532	AE2-038 E O1	2.1784
941411	AE2-138 C	13.5130
941412	AE2-138 E	4.9980
941511	AE2-148 C	126.1070
941512	AE2-148 E	57.0386
941521	AE2-149 C	100.8623
941522	AE2-149 E	37.5897

Bus #	Bus	MW Impact
941981	AE2-210 C O1	4.6562
941982	AE2-210 E O1	1.7514
942051	AE2-217 C	7.0365
942052	AE2-217 E	4.6910
942061	AE2-218 C	7.8387
942062	AE2-218 E	5.3244
942091	AE2-221 C	24.4944
942092	AE2-221 E	16.3296
942521	AE2-267 C O1	1.2694
942522	AE2-267 E O1	0.7846
942831	AE2-302 C O1	1.4413
942832	AE2-302 E O1	0.9609
942951	AE2-315	2.3734
942981	AE2-320 C O1	17.7559
942982	AE2-320 E O1	8.7851
943041	AE2-327 C	6.3220
943042	AE2-327 E	4.2046
943111	AE2-339 C	1.7702
943112	AE2-339 E	0.8719
943191	AE2-319 C O1	17.7559
943192	AE2-319 E O1	8.7851
943201	AE2-318 C	5.9765
943202	AE2-318 E	2.9171
943771	AF1-045	2.4605
943943	AF1-062 BAT	43.2400
944521	AF1-117 C	37.8993
944522	AF1-117 E	11.6747
944621	AF1-127 C O1	1.9955
944622	AF1-127 E O1	0.9829
944941	AF1-159	1.4963
945631	AF1-228 C	31.0620
945632	AF1-228 E	20.7080
945681	AF1-233 C O1	6.5824
945682	AF1-233 E O1	3.2518
945821	**AF1-247 C (Withdrawn : 01/27/2020)**	**1.2694**
945822	**AF1-247 E (Withdrawn : 01/27/2020)**	**0.7846**
945841	AF1-249 C	0.5606
945842	AF1-249 E	0.2638
945861	AF1-251 C	4.9494
945862	AF1-251 E	3.2996
945911	AF1-256 C	2.1168
945912	AF1-256 E	1.4112
946171	AF1-282 C	7.9776
946172	AF1-282 E	5.3184
946181	AF1-283 C	10.3709
946182	AF1-283 E	6.9139
946441	AF1-308 C O1	1.8690
946442	AF1-308 E O1	1.2460
946511	AF1-315 C O1	1.7095
946512	AF1-315 E O1	1.1397
LGEE	LGEE	3.1788
CPLE	CPLE	0.6211

Bus #	Bus	MW Impact
WEC	WEC	0.5906
CBM-W2	CBM-W2	24.2014
NY	NY	0.9545
CBM-W1	CBM-W1	19.4906
TVA	TVA	3.9746
O-066	O-066	11.4240
CBM-S2	CBM-S2	8.0920
CBM-S1	CBM-S1	28.5164
G-007	G-007	1.7597
MEC	MEC	3.6293

17.2 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
43546740	243453	05BEATTY	AEP	243454	05BIXBY	AEP	1	AEP_P4_#3196_05BEATTY 345_302E	breaker	1203.0	110.36	116.68	DC	76.0

Bus #	Bus	MW Impact
250164	08BKJDB1	0.1465
250165	08BKJDB2	0.1465
251827	WILLYESP	0.4700
251828	CLNTESP1	0.4757
251829	CLNTESP2	0.3171
253110	09ADKINS	30.1137
253261	09MON D	0.2593
902531	**W2-040 C (Withdrawn : 01/23/2020)**	**0.9122**
902532	**W2-040 E (Withdrawn : 01/23/2020)**	**1.4882**
904722	V4-073 E	0.2005
913222	Y1-054 E	1.5322
918802	AA1-099 E	0.3171
923522	AB1-169 C OP	128.8336
925242	**AB2-178 E (Withdrawn : 12/10/2019)**	**1.4507**
925921	AC1-068 C	12.4535
925922	AC1-068 E	5.8239
925931	AC1-069 C	12.4535
925932	AC1-069 E	5.8239
925981	AC1-074 C O1	4.0931
925982	AC1-074 E O1	1.7542
926011	AC1-078 C O1	7.8899
926012	AC1-078 E O1	13.1498
926061	AC1-085 C	23.9628
926062	AC1-085 E	39.0972
926101	AC1-089 C O1	4.2166
926102	AC1-089 E O1	6.8797
926791	AC1-165 C	12.3070
926792	AC1-165 E	5.9704
926801	AC1-166 C	12.3070
926802	AC1-166 E	5.9704
926951	AC1-182	1.7969
930062	AB1-014 E	8.0585
932381	AC2-055 C	1.8528
932382	AC2-055 E	3.0229
932421	AC2-060 C	6.5693
932422	AC2-060 E	3.6953
932431	AC2-061 C	4.2851
932432	AC2-061 E	4.3441
932461	AC2-066 C	2.9634
932462	AC2-066 E	4.8351
932481	AC2-068 C	3.1003
932482	AC2-068 E	5.0775

Bus #	Bus	MW Impact
932551	AC2-075 C	0.9721
932552	AC2-075 E	0.4897
932651	**AC2-087 C O1 (Withdrawn : 01/15/2020)**	**4.8654**
932652	**AC2-087 E O1 (Withdrawn : 01/15/2020)**	**3.8595**
932661	AC2-088 C O1	4.0470
932662	AC2-088 E O1	3.3304
934491	AD1-073 C	1.3549
934492	AD1-073 E	0.6980
934561	AD1-081 C	1.5780
934562	AD1-081 E	0.8129
935031	AD1-136 C	0.5691
935032	AD1-136 E	0.4848
935041	AD1-140 C O1	11.5264
935042	AD1-140 E O1	9.5291
936251	AD2-031 C O1	2.4065
936252	AD2-031 E O1	3.9264
936381	AD2-048 C	3.3665
936382	AD2-048 E	1.6797
938051	AE1-007 C	0.8892
938052	AE1-007 E	1.4507
938271	AE1-040 C O1	4.0620
938272	AE1-040 E O1	2.0439
938921	AE1-120	4.5751
939141	AE1-144 C O1	6.9240
939142	AE1-144 E O1	3.4361
940531	AE2-038 C O1	4.6189
940532	AE2-038 E O1	2.2879
941411	AE2-138 C	14.2019
941412	AE2-138 E	5.2528
941511	AE2-148 C	184.4227
941512	AE2-148 E	83.4149
941981	AE2-210 C O1	4.8936
941982	AE2-210 E O1	1.8407
942051	AE2-217 C	9.8015
942052	AE2-217 E	6.5343
942061	AE2-218 C	10.6174
942062	AE2-218 E	7.2118
942091	AE2-221 C	30.1050
942092	AE2-221 E	20.0700
942521	AE2-267 C O1	1.4378
942522	AE2-267 E O1	0.8888
942621	AE2-278 C	6.7842
942622	AE2-278 E	4.5253
942951	AE2-315	3.0392
942981	AE2-320 C O1	24.5041
942982	AE2-320 E O1	12.1239
943111	AE2-339 C	1.8424
943112	AE2-339 E	0.9075
943191	AE2-319 C O1	24.5041
943192	AE2-319 E O1	12.1239
943201	AE2-318 C	6.6168
943202	AE2-318 E	3.2296

Bus #	Bus	MW Impact
943771	AF1-045	2.7241
943943	AF1-062 BAT	20.5100
944521	AF1-117 C	52.2154
944522	AF1-117 E	16.0847
944621	AF1-127 C O1	2.0938
944622	AF1-127 E O1	1.0313
944941	AF1-159	0.7384
945631	AF1-228 C	45.6007
945632	AF1-228 E	30.4005
945681	AF1-233 C O1	6.9168
945682	AF1-233 E O1	3.4171
945821	**AF1-247 C (Withdrawn : 01/27/2020)**	**1.4378**
945822	**AF1-247 E (Withdrawn : 01/27/2020)**	**0.8888**
945841	AF1-249 C	0.6205
945842	AF1-249 E	0.2920
945861	AF1-251 C	5.1973
945862	AF1-251 E	3.4649
945911	AF1-256 C	2.2292
945912	AF1-256 E	1.4861
946171	AF1-282 C	9.4590
946172	AF1-282 E	6.3060
946181	AF1-283 C	12.2967
946182	AF1-283 E	8.1978
946511	AF1-315 C O1	1.8917
946512	AF1-315 E O1	1.2611
LGEE	LGEE	3.2216
CPLE	CPLE	0.2156
WEC	WEC	0.7349
CBM-W2	CBM-W2	24.0458
NY	NY	0.9727
CBM-W1	CBM-W1	22.6681
TVA	TVA	3.5112
O-066	O-066	11.6256
CBM-S2	CBM-S2	4.3870
CBM-S1	CBM-S1	26.3353
G-007	G-007	1.7919
MEC	MEC	4.0472

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ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
43546800	243453	05BEATTY	AEP	244022	05COLE	AEP	1	AEP_P4_#3195_05BEATTY 345_304E	breaker	1203.0	100.94	106.24	DC	63.7

Bus #	Bus	MW Impact
247964	Y1-063 BAT	0.3062
250164	08BKJDB1	0.1221
250165	08BKJDB2	0.1221
251827	WILLYESP	0.3864
251828	CLNTESP1	0.4043
251829	CLNTESP2	0.2696
253110	09ADKINS	25.3067
253261	09MON D	0.2050
902531	**W2-040 C (Withdrawn : 01/23/2020)**	**0.7288**
902532	**W2-040 E (Withdrawn : 01/23/2020)**	**1.1891**
904722	V4-073 E	0.1611
913222	Y1-054 E	1.2662
918802	AA1-099 E	0.2696
923522	AB1-169 C OP	109.8438
925242	**AB2-178 E (Withdrawn : 12/10/2019)**	**1.2092**
925921	AC1-068 C	10.4859
925922	AC1-068 E	4.9037
925931	AC1-069 C	10.4859
925932	AC1-069 E	4.9037
925981	AC1-074 C O1	3.4396
925982	AC1-074 E O1	1.4741
926011	AC1-078 C O1	4.7584
926012	AC1-078 E O1	7.9307
926061	AC1-085 C	20.0108
926062	AC1-085 E	32.6492
926101	AC1-089 C O1	3.6623
926102	AC1-089 E O1	5.9754
926791	AC1-165 C	10.3626
926792	AC1-165 E	5.0271
926801	AC1-166 C	10.3626
926802	AC1-166 E	5.0271
926951	AC1-182	1.4999
930062	AB1-014 E	6.7608
932381	AC2-055 C	1.7366
932382	AC2-055 E	2.8334
932421	AC2-060 C	6.1575
932422	AC2-060 E	3.4636
932431	AC2-061 C	3.7241
932432	AC2-061 E	3.7754
932461	AC2-066 C	2.4862
932462	AC2-066 E	4.0565
932481	AC2-068 C	2.4559

Bus #	Bus	MW Impact
932482	AC2-068 E	4.0221
932551	AC2-075 C	0.8169
932552	AC2-075 E	0.4115
932651	**AC2-087 C O1 (Withdrawn : 01/15/2020)**	**4.5604**
932652	**AC2-087 E O1 (Withdrawn : 01/15/2020)**	**3.6176**
932661	AC2-088 C O1	3.4190
932662	AC2-088 E O1	2.8136
934491	AD1-073 C	1.2700
934492	AD1-073 E	0.6542
934561	AD1-081 C	0.9517
934562	AD1-081 E	0.4903
935031	AD1-136 C	0.4808
935032	AD1-136 E	0.4096
935041	AD1-140 C O1	8.3962
935042	AD1-140 E O1	6.9414
936251	AD2-031 C O1	2.3877
936252	AD2-031 E O1	3.8958
936381	AD2-048 C	2.8334
936382	AD2-048 E	1.4137
938051	AE1-007 C	0.7043
938052	AE1-007 E	1.1492
938271	AE1-040 C O1	4.3077
938272	AE1-040 E O1	2.1675
938921	AE1-120	3.8384
939141	AE1-144 C O1	5.8769
939142	AE1-144 E O1	2.9165
940531	AE2-038 C O1	3.9204
940532	AE2-038 E O1	1.9419
941411	AE2-138 C	11.9578
941412	AE2-138 E	4.4227
941511	AE2-148 C	154.4305
941512	AE2-148 E	69.8494
941981	AE2-210 C O1	4.1203
941982	AE2-210 E O1	1.5498
942061	AE2-218 C	7.9874
942062	AE2-218 E	5.4254
942091	AE2-221 C	24.9318
942092	AE2-221 E	16.6212
942521	AE2-267 C O1	1.1814
942522	AE2-267 E O1	0.7303
942951	AE2-315	2.4419
942981	AE2-320 C O1	20.6326
942982	AE2-320 E O1	10.2084
943111	AE2-339 C	1.5465
943112	AE2-339 E	0.7617
943191	AE2-319 C O1	20.6326
943192	AE2-319 E O1	10.2084
943201	AE2-318 C	5.5321
943202	AE2-318 E	2.7002
943771	AF1-045	2.2775
944521	AF1-117 C	43.9679
944522	AF1-117 E	13.5441

Bus #	Bus	MW Impact
944621	AF1-127 C O1	1.7620
944622	AF1-127 E O1	0.8678
944941	AF1-159	1.3824
945631	AF1-228 C	38.2221
945632	AF1-228 E	25.4814
945681	AF1-233 C O1	5.8720
945682	AF1-233 E O1	2.9009
945821	**AF1-247 C (Withdrawn : 01/27/2020)**	**1.1814**
945822	**AF1-247 E (Withdrawn : 01/27/2020)**	**0.7303**
945841	AF1-249 C	0.5126
945842	AF1-249 E	0.2412
945861	AF1-251 C	4.3749
945862	AF1-251 E	2.9166
945911	AF1-256 C	1.8921
945912	AF1-256 E	1.2614
946102	AF1-275 BAT	18.6700
946171	AF1-282 C	7.8990
946172	AF1-282 E	5.2660
946181	AF1-283 C	10.2687
946182	AF1-283 E	6.8458
946511	AF1-315 C O1	1.5829
946512	AF1-315 E O1	1.0553
LGEE	LGEE	2.6157
CPLE	CPLE	0.2514
WEC	WEC	0.4158
CBM-W2	CBM-W2	17.8624
NY	NY	0.7250
CBM-W1	CBM-W1	11.5217
TVA	TVA	2.7944
O-066	O-066	8.6486
CBM-S2	CBM-S2	4.1443
CBM-S1	CBM-S1	21.1040
G-007	G-007	1.3322
MEC	MEC	2.6028

Affected Systems

18 Affected Systems

18.1 LG&E

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

18.2 MISO

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

18.3 TVA

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

18.4 Duke Energy Progress

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

18.5 NYISO

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

Contingency Name	Contingency Definition
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_#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_P1-2_#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_#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_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

Short Circuit

19 Short Circuit

The following Breakers are overduty

Bus Number	Bus Name	BREAKER	Type	Capacity (Amps)	Duty Percentage Post Queue	Duty Percentage Pre Queue