Generation Interconnection

Feasibility Study Report

for

Queue Project AE2-148

BEATTY-GREENE 345 KV

397.3 MW Capacity / 577 MW Energy

October, 2019

Table of Contents

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 has proposed to install PJM project # AE2-148, a Solar generating facility and DC coupled Storage located in Madison County, Ohio (See Figure 2). The installed facilities will have a total capability of 577 MW with 397.3 MW of this output being recognized by PJM as Capacity. The Point of Interconnection for the Solar and storage facilities will be to the AEP owned section of the Beatty – Greene 345 kV circuit (See Figure 1). The interconnection customer has indicated that the batteries will be charged only from the solar facility. The solar/storage output will be inverter limited. The IC should provide documentation at the Impact Study phase to show that the battery doesn't charge from the grid.

The proposed in-service date for this project is June 01, 2022. This study does not imply AEP's 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	AE2-148
Project Name	BEATTY-GREENE 345 KV
State	Ohio
County	Madison
Transmission Owner	AEP
Affected Transmission Owner	Dayton
MFO	577
MWE	577
MWC	397.3
Fuel	Solar
Base case Study Year	2022

2.1 Point of Interconnection

AE2-148 will interconnect with the AEP transmission system via a new station cut into the AEP owned section of the Beatty – Greene 345 kV AEP-Dayton tieline. To accommodate the interconnection on the AEP owned section of the Beatty – Greene 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 AE2-148 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 AE2-148 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$8,890,000

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 Figure 1). 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
Beatty – Greene 345 kV T-Line Cut In	$1,200,000
Upgrade line protection and controls at the Beatty 345 kV substation	$350,000
Upgrade line protection and controls at the Greene 345 kV substation*	$350,000
Total Non-Direct Connection Facility Costs*	$1,900,000

- Note that Dayton may have additional Non-Direct Connection costs at either the Greene station or (planned) South Charleston station (S0322) in the portion of the tieline owned by Dayton. This scope of work will be evaluated during the Impact Study

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 signing 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 Beatty - Greene 345 kV 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 AE2-148 was evaluated as a 577 MW (Capacity 397.3 MW) injection at the Beatty – Greene 345 kV line in the AEP area. Project AE2-148 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-148 was studied with a commercial probability of 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	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
1531634	243453	05BEATTY	AEP	244022	05COLE	AEP	1	AEP_P4_#3195_05BEATTY 345_304E	breaker	1203.0	87.32	106.18	DC	226.57
1531635	243453	05BEATTY	AEP	244022	05COLE	AEP	1	AEP_P4_#8094_05BIXBY 345_C	breaker	1203.0	87.88	105.59	DC	212.81
1531746	243453	05BEATTY	AEP	243454	05BIXBY	AEP	1	AEP_P4_#3196_05BEATTY 345_302E	breaker	1203.0	78.34	98.89	DC	246.78
7066441	243453	05BEATTY	AEP	243454	05BIXBY	AEP	1	AEP_P4_#10715_05COLE 345_C	breaker	1203.0	69.58	89.11	DC	234.65

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	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
1532744	253038	09KILLEN	DAY	242938	05MARQUI	AEP	1	DAY_P7_BEATTY-S. CHARLESTON 34542_1-A	tower	1372.0	106.89	108.98	DC	63.79

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	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
1532479	243453	05BEATTY	AEP	244022	05COLE	AEP	1	AEP_P1-2_#713	operation	1203.0	79.92	97.72	DC	213.84
7067451	243453	05BEATTY	AEP	243454	05BIXBY	AEP	1	AEP_P1-2_#10137	operation	1203.0	70.12	89.66	DC	234.64
1532478	941510	AE2-148 TAP	DAY	243453	05BEATTY	AEP	1	AEP_P1-2_#762	operation	1374.0	71.63	100.95	DC	402.84

16 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
1531634,1531635	1	**05BEATTY 345.0 kV - 05COLE 345.0 kV Ckt 1**	**AEPO0001a (102) : Upgrade/Replace 3-345kV 1600A switches at Beatty station** **Project Type : FAC** **Cost : $1,500,000** **Time Estimate : 12-18 Months**	$1,500,000
7066441,1531746	2	**05BEATTY 345.0 kV - 05BIXBY 345.0 kV Ckt 1**	**1531746,7066441** **No violation. Post queue loading less than 100%.**	$0
1532744	3	**09KILLEN 345.0 kV - 05MARQUI 345.0 kV Ckt 1**	**AEPO0007a (116) : Perform sag study on Don Marquis-Killen 345kV circuit, 32.1 miles of 2-983.1 ACAR 30/7 Rail5 conductor.Since Killen will be retired, the conductor between Don Marquis and Stuart will become a complete circuit and the whole circuit will need to be sag studied.** **Perform sag study on Killen-Stuart 345kV circuit, 15.2 miles of 2-983.1 ACAR 30/7 Rail5 conductor.** **Project Type : FAC** **Cost : $190,000** **Time Estimate : 6-12 Months** **r190008 (397) : Reconductor line with 795 ACCR high temperature conductor in a twin bundle** **Project Type : FAC** **Cost : $6,500,000** **Time Estimate : 18.0 Months** **r190009 (398) : Replace 2000A wave trap with 3000A** **Project Type : FAC** **Cost : $100,000** **Time Estimate : 12.0 Months** **r190010 (399) : Replace substation riser conductor with 2-1024.5 ACAR 30x7** **Project Type : FAC** **Cost : $100,000** **Time Estimate : 12.0 Months**	$6,890,000
			TOTAL COST	**$8,390,000**

17 Flow Gate Details

The following appendices contain additional information about each flow gate presented in the body of the report. For each appendix, a description of the flow gate 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 flow gate 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
1531634	243453	05BEATTY	AEP	244022	05COLE	AEP	1	AEP_P4_#3195_05BEATTY 345_304E	breaker	1203.0	87.32	106.18	DC	226.57

Bus #	Bus	MW Impact
247965	Y1-063 E	0.3
253038	09KILLEN	56.4
253077	09STUART	208.35
253110	09ADKINS	22.23
253261	09MON D	0.18
902531	W2-040 C	0.86
902532	W2-040 E	1.41
904722	V4-073 E	0.19
913222	Y1-054 E	1.51
914372	Y2-111 E	1.42
915582	Y3-080 E	0.95
915662	Y3-099 E	0.15
915672	Y3-100 E	0.15
916182	Z1-065 E	0.46
916272	Z1-080 E	0.48
918802	AA1-099 E	0.32
925242	AB2-178 E	1.44
925921	AC1-068 C	10.53
925922	AC1-068 E	4.92
925931	AC1-069 C	10.53
925932	AC1-069 E	4.92
925981	AC1-074 C O1	4.06
925982	AC1-074 E O1	1.74
926011	AC1-078 C O1	5.87
926012	AC1-078 E O1	9.79
926061	AC1-085 C O1	19.55
926062	AC1-085 E O1	31.89
926101	AC1-089 C O1	4.28
926102	AC1-089 E O1	6.99
926791	AC1-165 C	10.41
926792	AC1-165 E	5.05
926801	AC1-166 C	10.41
926802	AC1-166 E	5.05
930062	AB1-014 E	8.06
931181	AB1-169	131.22
932381	AC2-055 C	2.09
932382	AC2-055 E	3.41
932421	AC2-060 C	7.4
932422	AC2-060 E	4.17
932431	AC2-061 C	4.39

Bus #	Bus	MW Impact
932432	AC2-061 E	4.45
932462	AC2-066 E	0.26
932481	AC2-068 C	2.9
932482	AC2-068 E	4.75
932551	AC2-075 C	0.96
932552	AC2-075 E	0.49
932651	AC2-087 C O1	5.48
932652	AC2-087 E O1	4.35
932661	AC2-088 C O1	4.08
932662	AC2-088 E O1	3.36
934491	AD1-073 C	1.53
934492	AD1-073 E	0.79
934561	AD1-081 C	1.17
934562	AD1-081 E	0.61
935031	AD1-136 C	0.57
935032	AD1-136 E	0.49
935041	AD1-140 C O1	9.97
935042	AD1-140 E O1	8.24
936251	AD2-031 C O1	2.41
936252	AD2-031 E O1	3.93
936281	AD2-036 C	2.9
936282	AD2-036 E	1.45
936381	AD2-048 C	3.31
936382	AD2-048 E	1.65
937111	AD2-147 C O1	12.54
937112	AD2-147 E O1	17.32
937151	AD2-151 C O1	4.43
937152	AD2-151 E O1	6.12
938051	AE1-007 C	0.83
938052	AE1-007 E	1.36
938271	AE1-040 C O1	4.38
938272	AE1-040 E O1	2.2
938921	AE1-120	4.58
939141	AE1-144 C O1	6.94
939142	AE1-144 E O1	3.45
940531	AE2-038 C O1	4.63
940532	AE2-038 E O1	2.29
941411	AE2-138 C	14.23
941412	AE2-138 E	5.26
941511	AE2-148 C	156.01
941512	AE2-148 E	70.56
941771	AE2-180 C	5.29
941772	AE2-180 E	3.53
941981	AE2-210 C O1	4.86
941982	AE2-210 E O1	1.83
942061	AE2-218 C	9.45
942062	AE2-218 E	6.42
942091	AE2-221 C	24.82
942092	AE2-221 E	16.55
942231	AE2-235 C O1	3.46
942232	AE2-235 E O1	1.49
942521	AE2-267 C O1	2.68

Bus #	Bus	MW Impact
942522	AE2-267 E O1	1.66
942781	AE2-296 O1	11.82
942951	AE2-315	2.89
942981	AE2-320 C O1	20.72
942982	AE2-320 E O1	10.25
943111	AE2-339 C	2.28
943112	AE2-339 E	1.12
943191	AE2-318 C	6.6
943192	AE2-318 E	3.22
943201	AE2-319 C O1	20.72
943202	AE2-319 E O1	10.25
CARR	CARR	0.47
CBM-S1	CBM-S1	8.14
CBM-S2	CBM-S2	1.21
CBM-W1	CBM-W1	5.36
CBM-W2	CBM-W2	51.73
CIN	CIN	7.66
CPLE	CPLE	0.27
G-007	G-007	1.26
IPL	IPL	5.3
LGEE	LGEE	3.24
MEC	MEC	7.47
O-066	O-066	8.14
RENSSELAER	RENSSELAER	0.37
WEC	WEC	0.85

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
1531746	243453	05BEATTY	AEP	243454	05BIXBY	AEP	1	AEP_P4_#3196_05BEATTY 345_302E	breaker	1203.0	78.34	98.89	DC	246.78

Bus #	Bus	MW Impact
253038	09KILLEN	52.29
253077	09STUART	214.43
253110	09ADKINS	24.08
253261	09MON D	0.21
902531	W2-040 C	0.97
902532	W2-040 E	1.58
904722	V4-073 E	0.21
913222	Y1-054 E	1.61
914372	Y2-111 E	1.61
915582	Y3-080 E	1.07
915662	Y3-099 E	0.15
915672	Y3-100 E	0.15
916182	Z1-065 E	0.5
916272	Z1-080 E	0.49
918802	AA1-099 E	0.32
925242	AB2-178 E	1.5
925921	AC1-068 C	11.33
925922	AC1-068 E	5.3
925931	AC1-069 C	11.33
925932	AC1-069 E	5.3
925981	AC1-074 C O1	4.21
925982	AC1-074 E O1	1.8
926011	AC1-078 C O1	8.49
926012	AC1-078 E O1	14.15
926061	AC1-085 C O1	20.6
926062	AC1-085 E O1	33.61
926101	AC1-089 C O1	4.17
926102	AC1-089 E O1	6.8
926791	AC1-165 C	11.2
926792	AC1-165 E	5.43
926801	AC1-166 C	11.2
926802	AC1-166 E	5.43
927182	AC1-212 E	1.27
930062	AB1-014 E	8.46
931181	AB1-169	135.05
932381	AC2-055 C	1.77
932382	AC2-055 E	2.89
932421	AC2-060 C	6.29
932422	AC2-060 E	3.54
932431	AC2-061 C	4.26
932432	AC2-061 E	4.32
932462	AC2-066 E	0.27

Bus #	Bus	MW Impact
932481	AC2-068 C	3.29
932482	AC2-068 E	5.39
932551	AC2-075 C	1.0
932552	AC2-075 E	0.5
932651	AC2-087 C O1	4.66
932652	AC2-087 E O1	3.7
932661	AC2-088 C O1	4.24
932662	AC2-088 E O1	3.49
932841	AC2-111 C O1	2.16
932842	AC2-111 E O1	3.52
934491	AD1-073 C	1.3
934492	AD1-073 E	0.67
934561	AD1-081 C	1.7
934562	AD1-081 E	0.87
935031	AD1-136 C	0.6
935032	AD1-136 E	0.51
935041	AD1-140 C O1	12.37
935042	AD1-140 E O1	10.23
936251	AD2-031 C O1	2.51
936252	AD2-031 E O1	4.09
936281	AD2-036 C	3.01
936282	AD2-036 E	1.5
936381	AD2-048 C	3.42
936382	AD2-048 E	1.71
937111	AD2-147 C O1	13.71
937112	AD2-147 E O1	18.93
937151	AD2-151 C O1	4.66
937152	AD2-151 E O1	6.43
938051	AE1-007 C	0.94
938052	AE1-007 E	1.54
938061	AE1-008 C	0.54
938062	AE1-008 E	0.88
938271	AE1-040 C O1	4.04
938272	AE1-040 E O1	2.03
938921	AE1-120	4.8
939141	AE1-144 C O1	7.14
939142	AE1-144 E O1	3.54
940531	AE2-038 C O1	4.76
940532	AE2-038 E O1	2.36
941411	AE2-138 C	14.74
941412	AE2-138 E	5.45
941511	AE2-148 C	169.93
941512	AE2-148 E	76.86
941771	AE2-180 C	7.08
941772	AE2-180 E	4.72
941941	AE2-206 C O1	2.91
941942	AE2-206 E O1	4.02
941981	AE2-210 C O1	5.04
941982	AE2-210 E O1	1.89
942051	AE2-217 C	10.75
942052	AE2-217 E	7.17
942061	AE2-218 C	11.36

Bus #	Bus	MW Impact
942062	AE2-218 E	7.72
942091	AE2-221 C	26.7
942092	AE2-221 E	17.8
942231	AE2-235 C O1	3.55
942232	AE2-235 E O1	1.54
942521	AE2-267 C O1	2.88
942522	AE2-267 E O1	1.78
942621	AE2-278 C	7.48
942622	AE2-278 E	4.99
942781	AE2-296 O1	13.29
942951	AE2-315	3.23
942981	AE2-320 C O1	22.29
942982	AE2-320 E O1	11.03
943111	AE2-339 C	2.36
943112	AE2-339 E	1.16
943191	AE2-318 C	6.94
943192	AE2-318 E	3.39
943201	AE2-319 C O1	22.29
943202	AE2-319 E O1	11.03
CARR	CARR	0.55
CBM-S1	CBM-S1	8.63
CBM-S2	CBM-S2	0.95
CBM-W1	CBM-W1	9.32
CBM-W2	CBM-W2	59.99
CIN	CIN	8.94
CPLE	CPLE	0.14
G-007	G-007	1.49
IPL	IPL	6.15
LGEE	LGEE	3.45
MEC	MEC	10.24
MECS	MECS	1.52
O-066	O-066	9.56
RENSSELAER	RENSSELAER	0.43
WEC	WEC	1.36

17.3 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
1532744	253038	09KILLEN	DAY	242938	05MARQUI	AEP	1	DAY_P7_BEATTY-S. CHARLESTON 34542_1-A	tower	1372.0	106.89	108.98	DC	63.79

Bus #	Bus	MW Impact
253038	09KILLEN	298.51
253077	09STUART	478.92
902531	W2-040 C	0.7
902532	W2-040 E	1.13
904722	V4-073 E	0.15
913222	Y1-054 E	1.77
914372	Y2-111 E	1.12
915582	Y3-080 E	0.75
915662	Y3-099 E	0.16
915672	Y3-100 E	0.16
916182	Z1-065 E	0.54
916272	Z1-080 E	0.47
918802	AA1-099 E	0.31
925242	AB2-178 E	1.56
925921	AC1-068 C	7.92
925922	AC1-068 E	3.71
925931	AC1-069 C	7.92
925932	AC1-069 E	3.71
925981	AC1-074 C O1	7.04
925982	AC1-074 E O1	3.02
926061	AC1-085 C O1	34.6
926062	AC1-085 E O1	56.44
926101	AC1-089 C O1	4.35
926102	AC1-089 E O1	7.1
926791	AC1-165 C	7.83
926792	AC1-165 E	3.8
926801	AC1-166 C	7.83
926802	AC1-166 E	3.8
930062	AB1-014 E	13.64
931181	AB1-169	301.62
932462	AC2-066 E	0.44
932481	AC2-068 C	2.36
932482	AC2-068 E	3.86
932551	AC2-075 C	1.67
932552	AC2-075 E	0.84
932661	AC2-088 C O1	7.58
932662	AC2-088 E O1	6.24
935011	AD1-134	7.68
935031	AD1-136 C	1.07
935032	AD1-136 E	0.91
935041	AD1-140 C O1	7.32

Bus #	Bus	MW Impact
935042	AD1-140 E O1	6.06
936251	AD2-031 C O1	2.3
936252	AD2-031 E O1	3.76
936281	AD2-036 C	5.03
936282	AD2-036 E	2.51
936381	AD2-048 C	5.59
936382	AD2-048 E	2.79
936571	AD2-072 C O1	4.96
936572	AD2-072 E O1	2.43
937111	AD2-147 C O1	4.65
937112	AD2-147 E O1	6.41
937151	AD2-151 C O1	7.55
937152	AD2-151 E O1	10.43
938051	AE1-007 C	0.68
938052	AE1-007 E	1.1
938271	AE1-040 C O1	2.56
938272	AE1-040 E O1	1.29
938921	AE1-120	7.75
939141	AE1-144 C O1	13.3
939142	AE1-144 E O1	6.6
940531	AE2-038 C O1	8.87
940532	AE2-038 E O1	4.39
941411	AE2-138 C	26.57
941412	AE2-138 E	9.83
941511	AE2-148 C	43.93
941512	AE2-148 E	19.87
941981	AE2-210 C O1	9.04
941982	AE2-210 E O1	3.4
942061	AE2-218 C	8.21
942062	AE2-218 E	5.58
942091	AE2-221 C	32.57
942092	AE2-221 E	21.71
942231	AE2-235 C O1	6.33
942232	AE2-235 E O1	2.73
942411	AE2-254 C O1	2.36
942412	AE2-254 E O1	1.57
942521	AE2-267 C O1	2.99
942522	AE2-267 E O1	1.85
942591	AE2-275 C O1	6.97
942592	AE2-275 E O1	2.62
942781	AE2-296 O1	9.52
942891	AE2-308 C O1	11.94
942892	AE2-308 E O1	4.34
942951	AE2-315	2.31
942981	AE2-320 C O1	15.59
942982	AE2-320 E O1	7.71
943111	AE2-339 C	4.02
943112	AE2-339 E	1.98
943191	AE2-318 C	10.18
943192	AE2-318 E	4.97
943201	AE2-319 C O1	15.59
943202	AE2-319 E O1	7.71

Bus #	Bus	MW Impact
CARR	CARR	0.47
CATAWBA	CATAWBA	0.07
CBM-S1	CBM-S1	8.51
CBM-W1	CBM-W1	10.07
CBM-W2	CBM-W2	56.95
CIN	CIN	9.04
G-007	G-007	1.37
HAMLET	HAMLET	0.22
IPL	IPL	6.18
LGEE	LGEE	3.95
MEC	MEC	9.91
MECS	MECS	3.8
O-066	O-066	8.76
RENSSELAER	RENSSELAER	0.37
WEC	WEC	1.35

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).

19 Contingency Descriptions

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 /* CONTINGENCY LINE ADDED FOR AE2 BUILD 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
DAY_P7_BEATTY-S. CHARLESTON 34542_1-A	CONTINGENCY 'DAY_P7_BEATTY-S. CHARLESTON 34542_1-A' OPEN BRANCH FROM BUS 243453 TO BUS 253110 CKT 1 / 243453 05BEATTY 345 253110 09ADKINS 345 1 OPEN BRANCH FROM BUS 243453 TO BUS 941510 CKT 1 / 243453 05BEATTY 345 941510 AE2-148 TAP 345 1 END
AEP_P1-2_#762	CONTINGENCY 'AEP_P1-2_#762' OPEN BRANCH FROM BUS 243453 TO BUS 253110 CKT 1 / 243453 05BEATTY 345 253110 09ADKINS 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_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

Short Circuit

20 Short Circuit

The following Breakers are over-duty

Bus Number	Bus Name	BREAKER	Type	Capacity (Amps)	Duty Percentage Post Queue	Duty Percentage Pre Queue
243529	05KENNY 138.kV	106		40000	100.11%	99.93%
243529	05KENNY 138.kV	102		40000	100.11%	99.93%

Description	Total Cost
Upgrade of two over duty 138 kV breakers	$500,000