

Exhibit F

PJM Interconnection Studies

- 1. AE2-214 Generation Interconnection Feasibility Study Report October 2019**
- 2. AE2-214 Generation Interconnection System Impact Study Report February 2020**
- 3. AF1-275 Generation Interconnection Feasibility Study Report January 2020**
- 4. AF1-275 Generation Interconnection System Impact Study Report August 2020**

Exhibit F

PJM Interconnection Studies

- 1. AE2-214 Generation Interconnection Feasibility Study
Report October 2019**



**Generation Interconnection
Feasibility Study Report
for
Queue Project AE2-214
COLE 345 KV
120 MW Capacity / 200 MW Energy**

October, 2019

Table of Contents

1	Preface.....	4
2	General.....	6
2.1	Point of Interconnection	7
2.2	Cost Summary.....	7
3	Transmission Owner Scope of Work.....	8
4	Attachment Facilities	8
5	Direct Connection Cost Estimate.....	9
6	Non-Direct Connection Cost Estimate.....	10
7	Incremental Capacity Transfer Rights (ICTRs)	11
8	Schedule.....	12
9	Transmission Owner Analysis.....	13
10	Interconnection Customer Requirements.....	14
11	Revenue Metering and SCADA Requirements	15
11.1	PJM Requirements	15
11.2	AEP Requirements.....	15
12	Network Impacts.....	16
13	Generation Deliverability	18
14	Multiple Facility Contingency	18
15	Contribution to Previously Identified Overloads	18
16	Potential Congestion due to Local Energy Deliverability.....	18
17	System Reinforcements.....	19
18	Flow Gate Details	20
18.1	Index 1	21
19	Affected Systems	25
19.1	LG&E.....	25
19.2	MISO	25
19.3	TVA.....	25
19.4	Duke Energy Progress.....	25
19.5	NYISO	25
20	Contingency Descriptions.....	26
21	Short Circuit.....	28

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 a Solar generating facility located in Franklin County, Ohio. The installed facilities will have a total capability of 200 MW with 120 MW of this output being recognized by PJM as Capacity. The Point of Interconnection for the solar facilities will be AEP's Cole 345 kV substation.

The proposed in-service date for this project is December 31, 2021. 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	AE2-214
Project Name	COLE 345 KV
State	Ohio
County	Franklin
Transmission Owner	AEP
MFO	200
MWE	200
MWC	120
Fuel	Solar
Basecase Study Year	2022

2.1 Point of Interconnection

AE2-214 will interconnect with the AEP transmission system at Cole 345 kV substation.

To accommodate the interconnection at the Cole 345 kV substation, the substation will have to be expanded requiring the installation of one (1) 345 kV circuit breaker (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 AE2-214 project will be responsible for the following costs:

Based upon the results of this Feasibility Study, the construction of the 200 MW (120 MW Capacity) Solar generating facility of the Interconnection Customer (PJM Project #AE2-214) will require the following additional interconnection charges. This plan of service will interconnect the proposed Solar generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the the Interconnection Customer Development facility.

Description	Total Cost
Attachment Facilities	\$350,000
Direct Connection Network Upgrade	\$0
Non Direct Connection Network Upgrades	\$3,200,000
Total Costs	\$3,550,000

In addition, the AE2-214 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	\$0

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
Total Direct Connection Facility Costs	\$0

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
Expand the Cole 345 kV substation: Install one (1) additional 345 kV circuit breaker. Installation of associated protection and control equipment, 345 kV line risers and SCADA will also be required.	\$2,500,000
Upgrade line protection and controls at the Beatty Road 345 kV substation	\$350,000
Upgrade line protection and controls at the Hayden Road 345 kV substation	\$350,000
Total Non-Direct Connection Facility Costs	\$3,200,000

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 signing Agreement execution.

9 Transmission Owner Analysis

10 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 Cole 345 kV substation 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.

11 Revenue Metering and SCADA Requirements

11.1 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.

11.2 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>

12 Network Impacts

The Queue Project AE2-214 was evaluated as a 200 MW (Capacity 120 MW) injection at Cole 345 kV substation in the AEP area. Project AE2-214 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-214 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

13 Generation Deliverability

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

None

14 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
7193482	243453	05BEATTY	AEP	243454	05BIXBY	AEP	1	AEP_P4_#10715_05COLE 345_C	breaker	1203.0	90.59	98.36	DC	93.34

15 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

16 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

17 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
7193482	1	05BEATTY 345.0 kV - 05BIXBY 345.0 kV Ckt 1	<u>7193482</u> No violation. Post queue loading less than 100%.	\$0
			TOTAL COST	\$0

18 Flow Gate Details

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. 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.

18.1 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
7193482	243453	05BEATTY	AEP	243454	05BIXBY	AEP	1	AEP_P4_#10715_05COLE 345_C	breaker	1203.0	90.59	98.36	DC	93.34

Bus #	Bus	MW Impact
253038	09KILLEN	49.47
253077	09STUART	204.02
253110	09ADKINS	22.89
253261	09MON D	0.2
902531	W2-040 C	0.93
902532	W2-040 E	1.52
904722	V4-073 E	0.2
913222	Y1-054 E	1.54
914372	Y2-111 E	1.55
915582	Y3-080 E	1.03
915662	Y3-099 E	0.15
915672	Y3-100 E	0.15
916182	Z1-065 E	0.48
916272	Z1-080 E	0.47
918802	AA1-099 E	0.31
925242	AB2-178 E	1.44
925921	AC1-068 C	10.77
925922	AC1-068 E	5.04
925931	AC1-069 C	10.77
925932	AC1-069 E	5.04
925981	AC1-074 C O1	4.01
925982	AC1-074 E O1	1.72
926011	AC1-078 C O1	10.5
926012	AC1-078 E O1	17.5
926061	AC1-085 C O1	19.65
926062	AC1-085 E O1	32.05
926101	AC1-089 C O1	3.99
926102	AC1-089 E O1	6.51
926791	AC1-165 C	10.65
926792	AC1-165 E	5.17
926801	AC1-166 C	10.65
926802	AC1-166 E	5.17
930062	AB1-014 E	8.07
931181	AB1-169	128.49
932381	AC2-055 C	1.7
932382	AC2-055 E	2.77
932421	AC2-060 C	6.01
932422	AC2-060 E	3.38
932431	AC2-061 C	4.08
932432	AC2-061 E	4.13

Bus #	Bus	MW Impact
932462	AC2-066 E	0.26
932481	AC2-068 C	3.17
932482	AC2-068 E	5.19
932551	AC2-075 C	0.95
932552	AC2-075 E	0.48
932651	AC2-087 C O1	4.45
932652	AC2-087 E O1	3.53
932661	AC2-088 C O1	4.04
932662	AC2-088 E O1	3.33
934491	AD1-073 C	1.24
934492	AD1-073 E	0.64
934561	AD1-081 C	2.1
934562	AD1-081 E	1.08
935031	AD1-136 C	0.57
935032	AD1-136 E	0.48
935041	AD1-140 C O1	12.37
935042	AD1-140 E O1	10.22
936251	AD2-031 C O1	2.4
936252	AD2-031 E O1	3.91
936281	AD2-036 C	2.87
936282	AD2-036 E	1.43
936381	AD2-048 C	3.27
936382	AD2-048 E	1.63
937111	AD2-147 C O1	13.05
937112	AD2-147 E O1	18.03
937151	AD2-151 C O1	4.44
937152	AD2-151 E O1	6.13
938051	AE1-007 C	0.91
938052	AE1-007 E	1.48
938271	AE1-040 C O1	3.86
938272	AE1-040 E O1	1.94
938921	AE1-120	4.58
939141	AE1-144 C O1	6.8
939142	AE1-144 E O1	3.37
940531	AE2-038 C O1	4.53
940532	AE2-038 E O1	2.25
941411	AE2-138 C	14.05
941412	AE2-138 E	5.19
941511	AE2-148 C	161.57
941512	AE2-148 E	73.08
941771	AE2-180 C	8.88
941772	AE2-180 E	5.92
941981	AE2-210 C O1	4.8
941982	AE2-210 E O1	1.81
942021	AE2-214 C	56.0
942022	AE2-214 E	37.34
942051	AE2-217 C	12.58
942052	AE2-217 E	8.38
942061	AE2-218 C	10.97
942062	AE2-218 E	7.45
942091	AE2-221 C	25.51
942092	AE2-221 E	17.0

Bus #	Bus	MW Impact
942231	AE2-235 C O1	3.39
942232	AE2-235 E O1	1.46
942521	AE2-267 C O1	2.75
942522	AE2-267 E O1	1.7
942621	AE2-278 C	7.98
942622	AE2-278 E	5.32
942781	AE2-296 O1	12.78
942861	AE2-305 C O1	3.27
942862	AE2-305 E O1	2.18
942951	AE2-315	3.11
942981	AE2-320 C O1	21.2
942982	AE2-320 E O1	10.49
943191	AE2-318 C	6.63
943192	AE2-318 E	3.23
943201	AE2-319 C O1	21.2
943202	AE2-319 E O1	10.49
CARR	CARR	0.53
CBM-S1	CBM-S1	8.26
CBM-S2	CBM-S2	0.9
CBM-W1	CBM-W1	9.11
CBM-W2	CBM-W2	57.72
CIN	CIN	8.6
CPLE	CPLE	0.13
G-007	G-007	1.43
IPL	IPL	5.91
LGEE	LGEE	3.3
MEC	MEC	9.93
MECS	MECS	1.58
O-066	O-066	9.19
RENSSELAER	RENSSELAER	0.42
WEC	WEC	1.33

Affected Systems

19 Affected Systems

19.1 LG&E

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

19.2 MISO

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

19.3 TVA

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

19.4 Duke Energy Progress

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

19.5 NYISO

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

20 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

Short Circuit

21 Short Circuit

The following Breakers are over-duty

None

Exhibit F

PJM Interconnection Studies

2. AE2-214 Generation Interconnection System Impact Study Report February 2020



**Generation Interconnection
System Impact Study Report
for**

Queue Project AE2-214

COLE 345 KV

120 MW Capacity / 200 MW Energy

February 2020

Table of Contents

1	Preface.....	4
2	General.....	5
2.1	Point of Interconnection	6
2.2	Cost Summary.....	6
3	Transmission Owner Scope of Work.....	7
4	Attachment Facilities	7
5	Direct Connection Cost Estimate.....	7
6	Non-Direct Connection Cost Estimate.....	7
7	Incremental Capacity Transfer Rights (ICTRs)	8
8	Schedule.....	8
9	Interconnection Customer Requirements.....	8
10	Revenue Metering and SCADA Requirements	9
10.1	PJM Requirements	9
10.2	AEP Requirements.....	9
11	Network Impacts.....	10
12	Generation Deliverability	12
13	Multiple Facility Contingency	12
14	Contribution to Previously Identified Overloads	12
15	Potential Congestion due to Local Energy Deliverability.....	12
16	Steady-State Voltage Requirements.....	12
17	Stability and Reactive Power Requirements for Low Voltage Ride Through	12
18	Light Load Analysis	13
19	System Reinforcements.....	14
20	Affected Systems	16
20.1	LG&E.....	16
20.2	MISO	16
20.3	TVA.....	16
20.4	Duke Energy Progress.....	16
20.5	NYISO	16
21	Short Circuit.....	18
22	Figure 1: AE2-214 Point of Interconnection (Cole 345 kV)	19

23 Figure 2: AE2-214 Point of Interconnection (Cole 345 kV)20

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

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

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

2 General

Invenergy Solar Project Development, LLC has proposed a Solar generating facility located in Franklin County, Ohio. The installed facilities will have a total capability of 200 MW with 120 MW of this output being recognized by PJM as Capacity. The Point of Interconnection for the solar facilities will be AEP's Cole 345 kV substation.

The proposed in-service date for this project is December 31, 2021. This study does not imply AEP's 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 AEP transmission system. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required for maintaining the reliability of the AEP transmission system.

Queue Number	AE2-214
Project Name	COLE 345 KV
Interconnection Customer	Invenergy Solar Project Development LLC
State	Ohio
County	Franklin
Transmission Owner	AEP
MFO	200
MWE	200
MWC	120
Fuel	Solar
Basecase Study Year	2022

2.1 Point of Interconnection

AE2-214 will interconnect with the AEP transmission system at Cole 345 kV substation.

To accommodate the interconnection at the Cole 345 kV substation, the substation will have to be expanded requiring the installation of one (1) 345 kV circuit breaker (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 AE2-214 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$1,600,000
Direct Connection Network Upgrade	\$0
Non Direct Connection Network Upgrades	\$3,200,000
Allocation for New System Upgrades	\$0
Contribution for Previously Identified Upgrades	\$0
Total Costs	\$4,800,000

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.

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
Generator lead first span exiting the POI station, including the first structure outside the fence	\$1,250,000
Total Attachment Facility Costs	\$1,600,000

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
Total Direct Connection Facility Costs	\$0

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
Expand the Cole 345 kV substation: Install one (1) additional 345 kV circuit breaker. Installation of associated protection and control equipment, 345 kV line risers and SCADA will also be required.	\$2,500,000
Upgrade line protection and controls at the Beatty Road 345 kV substation	\$350,000
Upgrade line protection and controls at the Hayden Road 345 kV substation	\$350,000
Total Non-Direct Connection Facility Costs	\$3,200,000

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 signing Agreement execution.

9 Interconnection Customer Requirements

It is understood that Invenergy Solar Project Development is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of Invenergy Solar Project Development's generating plant and the costs for the line connecting the generating plant to the Cole 345 kV substation are not included in this report; these are assumed to be Invenergy Solar Project Development'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 AE2-214 was evaluated as a 200.0 MW (Capacity 120.0 MW) injection into the Cole 345 kV substation in the AEP area. Project AE2-214 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-214 was studied with a commercial probability of 1.00. 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)

None

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)

None

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.

None

16 Steady-State Voltage Requirements

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

To be evaluated during the Facilities Study Phase

17 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

18 Light Load Analysis

Light Load Studies (applicable to wind, coal, nuclear, and pumped storage projects).

Not required

19 System Reinforcements

None

Affected Systems

20 Affected Systems

20.1 LG&E

None

20.2 MISO

MISO Impacts to be determined during the Facilities Study.

20.3 TVA

None

20.4 Duke Energy Progress

None

20.5 NYISO

None

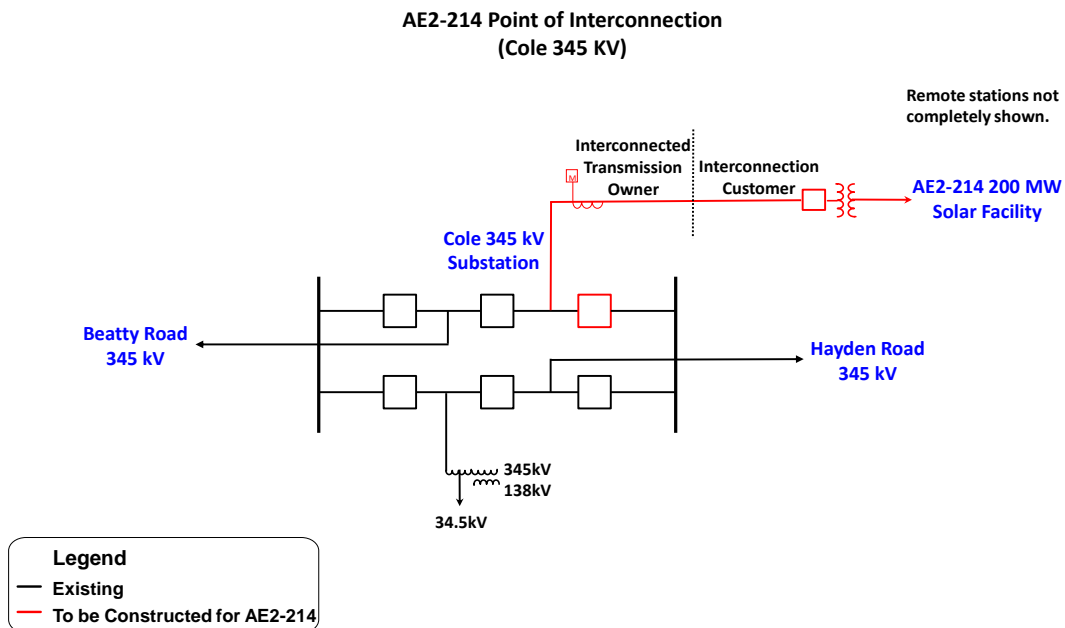
Short Circuit

21 Short Circuit

The following Breakers are over-duty

None

**22 Figure 1: AE2-214 Point of Interconnection (Cole 345 kV)
Single-Line Diagram**



23 Figure 2: AE2-214 Point of Interconnection (Cole 345 kV)

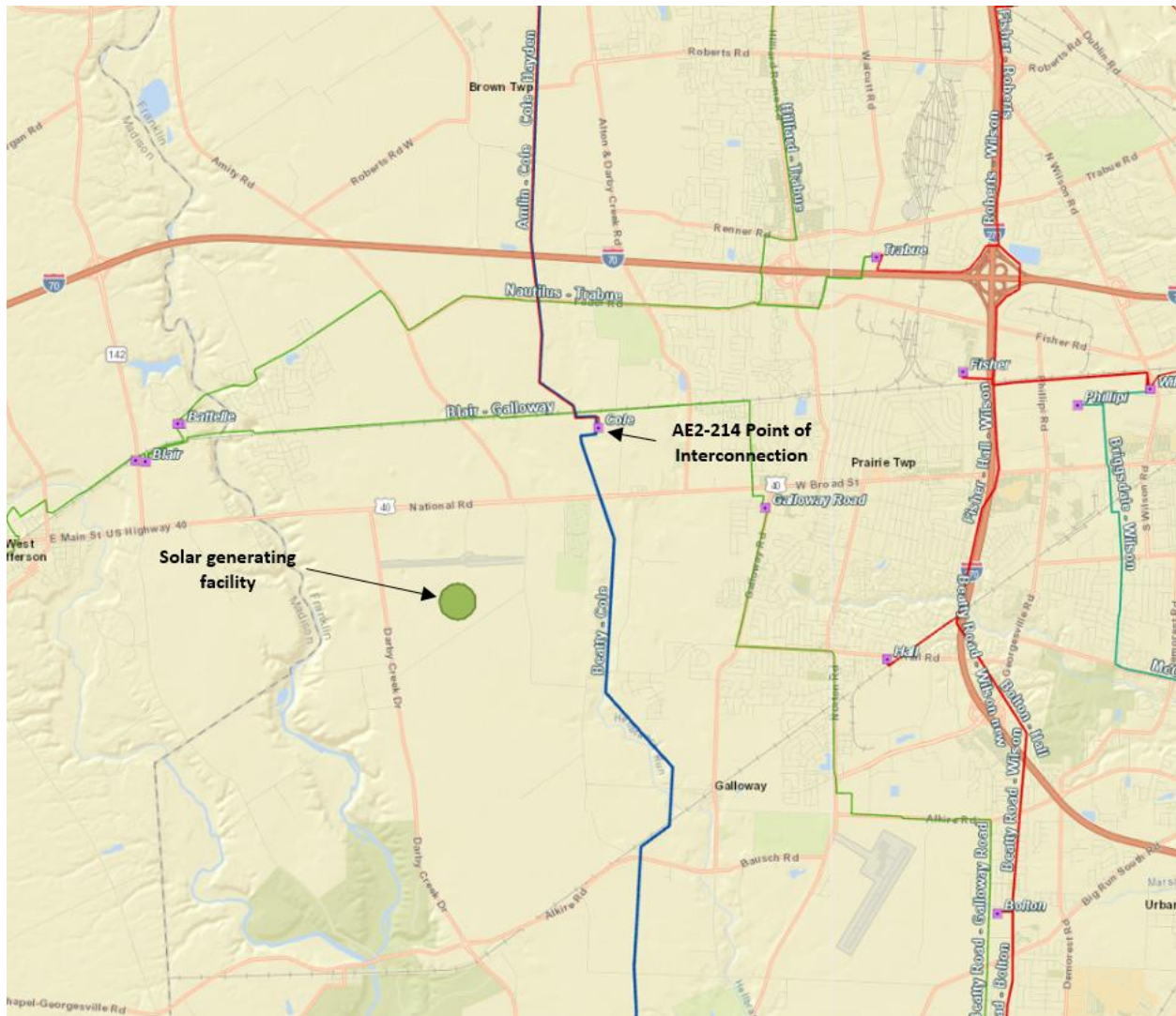


Exhibit F

PJM Interconnection Studies

3. AF1-275 Generation Interconnection Feasibility Study Report January 2020



**Generation Interconnection
Feasibility Study Report
for
Queue Project AF1-275
COLE 345 KV
50 MW Capacity / 50 MW Energy**

January, 2020

Table of Contents

1	Preface.....	3
2	General.....	4
2.1	Point of Interconnection	5
2.2	Cost Summary.....	5
3	Transmission Owner Scope of Work.....	6
4	Attachment Facilities	6
5	Direct Connection Cost Estimate.....	6
6	Non-Direct Connection Cost Estimate.....	6
7	Incremental Capacity Transfer Rights (ICTRs)	7
8	Schedule.....	7
9	Interconnection Customer Requirements.....	7
10	Revenue Metering and SCADA Requirements	7
10.1	PJM Requirements	7
10.2	AEP Requirements.....	8
11	Network Impacts.....	9
12	Generation Deliverability	11
13	Multiple Facility Contingency	11
14	Contribution to Previously Identified Overloads	11
15	Potential Congestion due to Local Energy Deliverability.....	11
16	System Reinforcements.....	13
17	Flow Gate Details	16
17.1	Index 1	17
17.2	Index 2	20
17.3	Index 3	23
17.4	Index 4	26
18	Affected Systems	31
18.1	LG&E.....	31
18.2	MISO	31
18.3	TVA.....	31
18.4	Duke Energy Progress.....	31
18.5	NYISO	31

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.

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.

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 Storage facility located in Franklin County, Ohio. The installed facilities will have a capability of 50 MW with 50 of new request MW of this output being recognized by PJM as capacity. Note that this project is an increase to the Interconnection Customer's AE2-214 project, which will share the same property and connection point.

The proposed in-service date for this project is 12/31/2022. 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	AF1-275
Project Name	COLE 345 KV
State	Ohio
County	Franklin
Transmission Owner	AEP
MFO	250
MWE	50
MWC	50
Fuel	Storage
Basecase Study Year	2023

2.1 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 (Figure 2).

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.

2.2 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	\$0
Total Costs	\$0

In addition, the AF1-275 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	\$5,496,600

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
Total Attachment Facility Costs	\$0

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
Total Direct Connection Facility Costs	\$0

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
Total Non-Direct Connection Facility Costs	\$0

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 AF1-275 was evaluated as a 50.1 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 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	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC/D C	MW IMPACT
43592271	244022	05COL E	345.0	AEP	243457	05HAYDE N	345.0	AEP	1	AEP_P4_#3195_05BE ATTY 345_304E	breaker	1429.0	98.14	100.14	DC	28.57

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	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC/D C	MW IMPACT
43592096	243453	05BEATY	345.0	AEP	243454	05BIXBY	345.0	AEP	1	AEP_P4_#10715_05C OLE 345_C	breaker	1203.0	133.6	135.73	DC	25.57
43592155	243453	05BEATY	345.0	AEP	244022	05COL E	345.0	AEP	1	AEP_P4_#3195_05BE ATTY 345_304E	breaker	1203.0	122.19	123.74	DC	18.67
43592156	243453	05BEATY	345.0	AEP	244022	05COL E	345.0	AEP	1	AEP_P4_#8094_05BIX BY 345_C	breaker	1203.0	120.23	121.86	DC	19.54
43592200	243454	05BIXBY	345.0	AEP	243459	05KIRK	345.0	AEP	1	AEP_P4_#10715_05C OLE 345_C	breaker	1409.0	113.97	115.02	DC	17.49

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	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC/D C	MW IMPACT
4359244 7	24345 3	05BEATT Y	345. 0	AEP	24345 4	05BIXB Y	345. 0	AEP	1	AEP_P1 - 2_#714	operation	1203. 0	124.76	126.68	DC	23.1
4359245 3	24345 3	05BEATT Y	345. 0	AEP	24345 4	05BIXB Y	345. 0	AEP	1	Base Case	operation	1096. 0	99.27	100.42	DC	12.56
4359257 2	24345 3	05BEATT Y	345. 0	AEP	24402 2	05COLE	345. 0	AEP	1	AEP_P1 - 2_#713	operation	1203. 0	113.6	115.22	DC	19.37

16 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
43592271	1	05COLE 345.0 kV - 05HAYDEN 345.0 kV Ckt 1	<p>AEPO0041a : A Sag Study will be required on the 7.7 miles of bundled ACSR ~ 954 ~ 45/7 ~ RAIL- Conductor section 1 to mitigate the overload. Depending on the sag study results, the cost for this upgrade is expected to be between \$40,000 (no remediations required, just sag study) and \$11.55 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.</p> <p>Project Type : FAC Cost : \$40,000 Time Estimate : 6-12 Months</p>	\$40,000
43592155,43592156	3	05BEATTY 345.0 kV - 05COLE 345.0 kV Ckt 1	<p>AEPO0001a : Upgrade/Replace 3-345kV 1600A switches at Beatty station Project Type : FAC Cost : \$1,500,000 Time Estimate : 12-18 Months</p> <p>AEPO0001b : 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.</p> <p>Project Type : FAC Cost : \$42,000 Time Estimate : 6-12 Months</p>	\$1,542,000

ID	Index	Facility	Upgrade Description	Cost
43592200	4	05BIXBY 345.0 kV - 05KIRK 345.0 kV Ckt 1	<p>AEPO0038a : Replace Kirk Riser, Sub Cond 954 ACSR 45/7. Project Type : FAC Cost : \$100,000 Time Estimate : 12-18 Months</p> <p>AEPO0038b : 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</p> <p>AEPO0038c : Replace two Kirk risers, Sub cond 1700 kcm AAC 61 Str.. Project Type : FAC Cost : \$200,000 Time Estimate : 12-18 Months</p> <p>AEPO0038d : 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: 1888MVA.Rebuild/Reconductor, cost : \$ 75.8 million. Project Type : FAC Cost : \$151,600 Time Estimate : 6-12 Months</p> <p>AEPO0038e : 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</p> <p>AEPO0038f : Replace Bixby switch (2000A) Project Type : FAC Cost : \$100,000 Time Estimate : 12-18 Months</p> <p>AEPO0038g : Replace Bixby Riser, Sub Cond 954 ACSR 45/7 Project Type : FAC Cost : \$100,000 Time Estimate : 12-18 Months</p>	\$701,600

ID	Index	Facility	Upgrade Description	Cost
43592096	2	05BEATTY 345.0 kV - 05BIXBY 345.0 kV Ckt 1	<p>AEPO0003a : 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</p> <p>AEPO0003b : 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</p> <p>AEPO0003c : Upgrade/Replace four 345kV 2000A Bixby switches Project Type : FAC Cost : \$1,500,000 Time Estimate : 12-18 Months</p> <p>AEPO0003d : Replace 2-954 ACSR risers at Bixby station Project Type : FAC Cost : \$175,000 Time Estimate : 12-18 Months</p>	\$3,213,000
			TOTAL COST	\$5,496,600

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	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPAC T
4359227 1	24402 2	05COL E	AEP	24345 7	05HAYDE N	AEP	1	AEP_P4_#3195_05BEATT Y 345_304E	breaker	1429. 0	98.14	100.14	DC	28.57

Bus #	Bus	MW Impact
251827	WILLYESP	0.3510
251828	CLNTESP1	0.3672
251829	CLNTESP2	0.2448
253077	09STUART (Deactivation : 09/30/17)	155.2792
253110	09ADKINS	23.0328
253261	09MON D	0.1867
902531	W2-040 C	0.6631
902532	W2-040 E	1.0818
904722	V4-073 E	0.1466
913222	Y1-054 E	1.1502
918802	AA1-099 E	0.2448
923522	AB1-169 C OP	99.8580
925921	AC1-068 C	9.5424
925922	AC1-068 E	4.4625
925931	AC1-069 C	9.5424
925932	AC1-069 E	4.4625
926011	AC1-078 C O1	4.1940
926012	AC1-078 E O1	6.9901
926061	AC1-085 C	18.2005
926062	AC1-085 E	29.6955
926101	AC1-089 C O1	3.3251
926102	AC1-089 E O1	5.4252
926791	AC1-165 C	9.4302
926792	AC1-165 E	4.5748
926801	AC1-166 C	9.4302
926802	AC1-166 E	4.5748
926951	AC1-182	1.3631
930062	AB1-014 E	6.1455
932381	AC2-055 C	1.5746
932382	AC2-055 E	2.5691
932421	AC2-060 C	5.5831
932422	AC2-060 E	3.1405
932431	AC2-061 C	3.3809
932432	AC2-061 E	3.4274
932461	AC2-066 C	2.2600
932462	AC2-066 E	3.6873
932481	AC2-068 C	2.2334
932482	AC2-068 E	3.6576
932651	AC2-087 C O1 (Withdrawn : 01/15/2020)	4.1350
932652	AC2-087 E O1 (Withdrawn : 01/15/2020)	3.2801
932661	AC2-088 C O1	3.1077
932662	AC2-088 E O1	2.5573

Bus #	Bus	MW Impact
934491	AD1-073 C	1.1515
934492	AD1-073 E	0.5932
934561	AD1-081 C	0.8388
934562	AD1-081 E	0.4321
935031	AD1-136 C	0.4370
935032	AD1-136 E	0.3723
935041	AD1-140 C O1	7.6951
935042	AD1-140 E O1	6.3617
936251	AD2-031 C O1	2.1707
936252	AD2-031 E O1	3.5417
938051	AE1-007 C	0.6405
938052	AE1-007 E	1.0450
938271	AE1-040 C O1	3.9105
938272	AE1-040 E O1	1.9676
938921	AE1-120	3.4890
939141	AE1-144 C O1	5.3411
939142	AE1-144 E O1	2.6506
940531	AE2-038 C O1	3.5630
940532	AE2-038 E O1	1.7648
941411	AE2-138 C	10.8656
941412	AE2-138 E	4.0188
941511	AE2-148 C	140.5608
941512	AE2-148 E	63.5761
941981	AE2-210 C O1	3.7440
941982	AE2-210 E O1	1.4083
942021	AE2-214 C	68.5728
942022	AE2-214 E	45.7152
942061	AE2-218 C	7.2404
942062	AE2-218 E	4.9180
942091	AE2-221 C	22.6782
942092	AE2-221 E	15.1188
942521	AE2-267 C O1	1.0735
942522	AE2-267 E O1	0.6636
942951	AE2-315	2.2226
942981	AE2-320 C O1	18.7762
942982	AE2-320 E O1	9.2898
943191	AE2-319 C O1	18.7762
943192	AE2-319 E O1	9.2898
943201	AE2-318 C	5.0283
943202	AE2-318 E	2.4543
943771	AF1-045	2.0701
944521	AF1-117 C	40.0109
944522	AF1-117 E	12.3251
944941	AF1-159	1.2567
945631	AF1-228 C	34.7894
945632	AF1-228 E	23.1930
945681	AF1-233 C O1	5.3367
945682	AF1-233 E O1	2.6365
945821	AF1-247 C	1.0735
945822	AF1-247 E	0.6636
945841	AF1-249 C	0.4657
945842	AF1-249 E	0.2192

Bus #	Bus	MW Impact
945911	AF1-256 C	1.7195
945912	AF1-256 E	1.1464
946101	AF1-275	28.5720
946171	AF1-282 C	7.1844
946172	AF1-282 E	4.7896
946181	AF1-283 C	9.3397
946182	AF1-283 E	6.2265
946511	AF1-315 C O1	1.4387
946512	AF1-315 E O1	0.9591
LGEE	LGEE	2.3744
CPL	CPL	0.2315
WEC	WEC	0.3745
CBM-W2	CBM-W2	16.1916
NY	NY	0.6564
CBM-W1	CBM-W1	10.1456
TVA	TVA	2.5368
O-066	O-066	7.8154
CBM-S2	CBM-S2	3.7917
CBM-S1	CBM-S1	19.1615
G-007	G-007	1.2043
MEC	MEC	2.3533

17.2 Index 2

ID	FROM BUS#	FROM BUS	FRO M BUS AREA	TO BUS#	TO BUS	TO BUS ARE A	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC/D C	MW IMPAC T
43592096	243453	05BEATTY	AEP	243454	05BIXBY	AEP	1	AEP_P4_#10715_05COL E 345_C	break er	1203.0	133.6	135.73	DC	25.57

Bus #	Bus	MW Impact
250164	08BKJDB1	0.1414
250165	08BKJDB2	0.1414
251827	WILLYESP	0.4536
251828	CLNTESP1	0.4602
251829	CLNTESP2	0.3068
253077	09STUART (Deactivation : 09/30/17)	192.5288
253110	09ADKINS	28.8099
253261	09MON D	0.2517
902531	W2-040 C	0.8837
902532	W2-040 E	1.4419
904722	V4-073 E	0.1941
913222	Y1-054 E	1.4787
918802	AA1-099 E	0.3068
923522	AB1-169 C OP	123.8127
925242	AB2-178 E (Withdrawn : 12/10/2019)	1.3999
925921	AC1-068 C	11.9258
925922	AC1-068 E	5.5771
925931	AC1-069 C	11.9258
925932	AC1-069 E	5.5771
926011	AC1-078 C O1	11.5229
926012	AC1-078 E O1	19.2049
926061	AC1-085 C	23.0675
926062	AC1-085 E	37.6365
926101	AC1-089 C O1	4.0839
926102	AC1-089 E O1	6.6631
926791	AC1-165 C	11.7855
926792	AC1-165 E	5.7174
926801	AC1-166 C	11.7855
926802	AC1-166 E	5.7174
926951	AC1-182	1.7315
930062	AB1-014 E	7.7607
932381	AC2-055 C	1.8038
932382	AC2-055 E	2.9431
932421	AC2-060 C	6.3958
932422	AC2-060 E	3.5976
932431	AC2-061 C	4.1543
932432	AC2-061 E	4.2115
932461	AC2-066 C	2.8539
932462	AC2-066 E	4.6564
932481	AC2-068 C	3.0051
932482	AC2-068 E	4.9215
932651	AC2-087 C O1 (Withdrawn : 01/15/2020)	4.7369

Bus #	Bus	MW Impact
932652	AC2-087 E O1 (Withdrawn : 01/15/2020)	3.7575
932661	AC2-088 C O1	3.8959
932662	AC2-088 E O1	3.2060
934491	AD1-073 C	1.3191
934492	AD1-073 E	0.6796
934561	AD1-081 C	2.3046
934562	AD1-081 E	1.1872
935031	AD1-136 C	0.5479
935032	AD1-136 E	0.4667
935041	AD1-140 C O1	11.5655
935042	AD1-140 E O1	9.5615
936251	AD2-031 C O1	2.3235
936252	AD2-031 E O1	3.7910
938051	AE1-007 C	0.8618
938052	AE1-007 E	1.4061
938271	AE1-040 C O1	3.9353
938272	AE1-040 E O1	1.9801
938921	AE1-120	4.4061
939141	AE1-144 C O1	6.6650
939142	AE1-144 E O1	3.3076
940531	AE2-038 C O1	4.4461
940532	AE2-038 E O1	2.2023
941411	AE2-138 C	13.6759
941412	AE2-138 E	5.0582
941511	AE2-148 C	176.4926
941512	AE2-148 E	79.8281
941981	AE2-210 C O1	4.7124
941982	AE2-210 E O1	1.7725
942021	AE2-214 C	61.3740
942022	AE2-214 E	40.9160
942051	AE2-217 C	11.5099
942052	AE2-217 E	7.6733
942061	AE2-218 C	10.3155
942062	AE2-218 E	7.0068
942091	AE2-221 C	28.9998
942092	AE2-221 E	19.3332
942521	AE2-267 C O1	1.3877
942522	AE2-267 E O1	0.8578
942621	AE2-278 C	7.2522
942622	AE2-278 E	4.8374
942951	AE2-315	2.9429
942981	AE2-320 C O1	23.4658
942982	AE2-320 E O1	11.6102
943191	AE2-319 C O1	23.4658
943192	AE2-319 E O1	11.6102
943201	AE2-318 C	6.3757
943202	AE2-318 E	3.1120
943771	AF1-045	2.6249
943943	AF1-062 BAT	20.0860
944521	AF1-117 C	49.9861
944522	AF1-117 E	15.3979
944621	AF1-127 C O1	2.0165

Bus #	Bus	MW Impact
944622	AF1-127 E O1	0.9932
944941	AF1-159	0.7129
945631	AF1-228 C	43.6282
945632	AF1-228 E	29.0854
945681	AF1-233 C O1	6.6577
945682	AF1-233 E O1	3.2890
945821	AF1-247 C	1.3877
945822	AF1-247 E	0.8578
945841	AF1-249 C	0.5989
945842	AF1-249 E	0.2819
945861	AF1-251 C	5.0053
945862	AF1-251 E	3.3368
945911	AF1-256 C	2.1455
945912	AF1-256 E	1.4304
946101	AF1-275	25.5725
946171	AF1-282 C	9.1056
946172	AF1-282 E	6.0704
946181	AF1-283 C	11.8373
946182	AF1-283 E	7.8915
946511	AF1-315 C O1	1.8226
946512	AF1-315 E O1	1.2151
LGEE	LGEE	3.1144
CPL	CPL	0.2097
WEC	WEC	0.7217
CBM-W2	CBM-W2	23.3743
NY	NY	0.9445
CBM-W1	CBM-W1	22.3304
TVA	TVA	3.4062
O-066	O-066	11.2896
CBM-S2	CBM-S2	4.2599
CBM-S1	CBM-S1	25.5174
G-007	G-007	1.7410
MEC	MEC	3.9566

17.3 Index 3

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC/D C	MW IMPACT
43592155	243453	05BEATTY	AEP	244022	05COL E	AEP	1	AEP_P4_#3195_05BEATTY 345_304E	breaker	1203.0	122.19	123.74	DC	18.67

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
253077	09STUART (Deactivation : 09/30/17)	170.8071
253110	09ADKINS	25.3067
253261	09MON D	0.2050
902531	W2-040 C	0.7288
902532	W2-040 E	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

Bus #	Bus	MW Impact
932481	AC2-068 C	2.4559
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
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
944621	AF1-127 C O1	1.7620

Bus #	Bus	MW Impact
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	1.1814
945822	AF1-247 E	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
CPL	CPL	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

17.4 Index 4

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
43592200	243454	05BIXBY	AEP	243459	05KIRK	AEP	1	AEP_P4_#10715_05COLE 345_C	breaker	1409.0	113.97	115.02	DC	17.49

Bus #	Bus	MW Impact
250164	08BKJDB1	0.1374
250165	08BKJDB2	0.1374
251827	WILLYESP	0.4183
251828	CLNTESP1	0.4809
251829	CLNTESP2	0.3206
253077	09STUART (Deactivation : 09/30/17)	179.8069
253110	09ADKINS	20.2467
902531	W2-040 C	0.7025
902532	W2-040 E	1.1461
904722	V4-073 E	0.1532
913222	Y1-054 E	1.3887
918802	AA1-099 E	0.3206
923522	AB1-169 C OP	115.6314
924351	AB2-083 C O1	4.1984
924352	AB2-083 E O1	1.9757
924371	AB2-085 C O1	5.1285
924372	AB2-085 E O1	2.4134
925242	AB2-178 E (Withdrawn : 12/10/2019)	1.3600
925341	AC1-001 C O1	8.3967
925342	AC1-001 E O1	3.9514
925921	AC1-068 C	8.7451
925922	AC1-068 E	4.0896
925931	AC1-069 C	8.7451
925932	AC1-069 E	4.0896
925981	AC1-074 C O1	3.8380
925982	AC1-074 E O1	1.6449
926011	AC1-078 C O1	7.5645
926012	AC1-078 E O1	12.6075
926061	AC1-085 C	16.7753
926062	AC1-085 E	27.3703
926101	AC1-089 C O1	4.6425
926102	AC1-089 E O1	7.5746
926791	AC1-165 C	8.6423
926792	AC1-165 E	4.1925
926801	AC1-166 C	8.6423
926802	AC1-166 E	4.1925
926951	AC1-182	1.6056
930062	AB1-014 E	7.0947
932201	AC2-029 C	4.4503
932202	AC2-029 E	7.2611
932381	AC2-055 C	2.6832
932382	AC2-055 E	4.3779

Bus #	Bus	MW Impact
932411	AC2-059 C	13.4238
932412	AC2-059 E	13.8533
932421	AC2-060 C	9.5140
932422	AC2-060 E	5.3516
932431	AC2-061 C	4.7760
932432	AC2-061 E	4.8418
932451	AC2-064 C (Withdrawn : 12/09/2019)	5.0838
932452	AC2-064 E (Withdrawn : 12/09/2019)	3.3892
932461	AC2-066 C	2.6090
932462	AC2-066 E	4.2568
932481	AC2-068 C	2.3611
932482	AC2-068 E	3.8668
932551	AC2-075 C	0.9115
932552	AC2-075 E	0.4592
932651	AC2-087 C O1 (Withdrawn : 01/15/2020)	7.0463
932652	AC2-087 E O1 (Withdrawn : 01/15/2020)	5.5895
932661	AC2-088 C O1	3.6364
932662	AC2-088 E O1	2.9925
934481	AD1-072 C	2.9489
934482	AD1-072 E	1.3467
934491	AD1-073 C	1.9623
934492	AD1-073 E	1.0109
934561	AD1-081 C	1.5129
934562	AD1-081 E	0.7794
935031	AD1-136 C	0.5114
935032	AD1-136 E	0.4356
935041	AD1-140 C O1	8.4394
935042	AD1-140 E O1	6.9770
935051	AD1-141 C O1	2.2065
935052	AD1-141 E O1	1.4710
936111	AD2-016 C	13.4238
936112	AD2-016 E	13.8533
936251	AD2-031 C O1	2.1531
936252	AD2-031 E O1	3.5130
936381	AD2-048 C	3.1847
936382	AD2-048 E	1.5890
937231	AD2-162 C	15.4455
937232	AD2-162 E	7.5731
938051	AE1-007 C	0.6771
938052	AE1-007 E	1.1048
938271	AE1-040 C O1	4.8442
938272	AE1-040 E O1	2.4374
938921	AE1-120	4.0280
939141	AE1-144 C O1	6.4557
939142	AE1-144 E O1	3.2037
940531	AE2-038 C O1	4.3065
940532	AE2-038 E O1	2.1331
941411	AE2-138 C	13.2355
941412	AE2-138 E	4.8953
941511	AE2-148 C	121.9115
941512	AE2-148 E	55.1409
941521	AE2-149 C	100.7020

Bus #	Bus	MW Impact
941522	AE2-149 E	37.5300
941981	AE2-210 C O1	4.5606
941982	AE2-210 E O1	1.7155
942021	AE2-214 C	41.9868
942022	AE2-214 E	27.9912
942051	AE2-217 C	7.9416
942052	AE2-217 E	5.2944
942061	AE2-218 C	7.6783
942062	AE2-218 E	5.2155
942091	AE2-221 C	20.3230
942092	AE2-221 E	13.5487
942521	AE2-267 C O1	1.2430
942522	AE2-267 E O1	0.7683
942831	AE2-302 C O1	1.4527
942832	AE2-302 E O1	0.9685
942951	AE2-315	2.3225
942981	AE2-320 C O1	17.2073
942982	AE2-320 E O1	8.5137
943041	AE2-327 C	6.5603
943042	AE2-327 E	1.9656
943111	AE2-339 C	1.7347
943112	AE2-339 E	0.8544
943191	AE2-319 C O1	17.2073
943192	AE2-319 E O1	8.5137
943201	AE2-318 C	5.8491
943202	AE2-318 E	2.8549
943771	AF1-045	2.4080
943943	AF1-062 BAT	43.0180
944521	AF1-117 C	36.7205
944522	AF1-117 E	11.3115
944621	AF1-127 C O1	1.9547
944622	AF1-127 E O1	0.9628
944941	AF1-159	0.6607
945631	AF1-228 C	30.0195
945632	AF1-228 E	20.0130
945681	AF1-233 C O1	6.4453
945682	AF1-233 E O1	3.1841
945821	AF1-247 C	1.2430
945822	AF1-247 E	0.7683
945841	AF1-249 C	0.5492
945842	AF1-249 E	0.2584
945861	AF1-251 C	4.8477
945862	AF1-251 E	3.2318
945911	AF1-256 C	2.0727
945912	AF1-256 E	1.3818
946101	AF1-275	17.4945
946171	AF1-282 C	3.5096
946172	AF1-282 E	2.3397
946181	AF1-283 C	4.5624
946182	AF1-283 E	3.0416
946441	AF1-308 C O1	1.8806
946442	AF1-308 E O1	1.2538

Bus #	Bus	MW Impact
946511	AF1-315 C O1	1.6730
946512	AF1-315 E O1	1.1154
LGEE	LGEE	3.1218
CPL	CPL	0.6185
WEC	WEC	0.5840
CBM-W2	CBM-W2	23.8575
NY	NY	0.9395
CBM-W1	CBM-W1	19.3154
TVA	TVA	3.9200
O-066	O-066	11.2493
CBM-S2	CBM-S2	8.0284
CBM-S1	CBM-S1	28.0904
G-007	G-007	1.7316
MEC	MEC	3.5832

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
Base Case	
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
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_#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
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

19 Short Circuit

The following Breakers are overduty

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

Exhibit F

PJM Interconnection Studies

4. AF1-275 Generation Interconnection System Impact Study Report August 2020



**Generation Interconnection
System Impact Study Report
for
Queue Project AF1-275
COLE 345 KV
50 MW Capacity / 50 MW Energy**

August, 2020

Table of Contents

1	Introduction.....	4
2	Preface.....	4
3	General	5
4	Point of Interconnection.....	6
5	Cost Summary	6
6	Transmission Owner Scope of Work	7
6.1	Attachment Facilities.....	7
6.2	Direct Connection Cost Estimate.....	7
6.3	Non-Direct Connection Cost Estimate.....	7
7	Incremental Capacity Transfer Rights (ICTRs)	8
8	Schedule.....	8
9	Interconnection Customer Requirements.....	8
10	Revenue Metering and SCADA Requirements	8
10.1	PJM Requirements	8
10.2	Meteorological Data Reporting Requirements	9
10.3	Interconnected Transmission Owner Requirements.....	9
11	Summer Peak Analysis	10
11.1	Generation Deliverability	10
11.2	Multiple Facility Contingency	10
11.3	Contribution to Previously Identified Overloads.....	10
11.4	Steady-State Voltage Requirements	10
11.5	Potential Congestion due to Local Energy Deliverability.....	10
11.6	System Reinforcements.....	12
11.7	Flow Gate Details.....	14
11.7.1	Index 1	15
11.7.2	Index 2	16
11.7.3	Index 3	19
11.8	Queue Dependencies	22
11.9	Contingency Descriptions.....	24
12	Light Load Analysis	25
12.1	Generation Deliverability	25

12.2	Multiple Facility Contingency.....	25
12.3	Contribution to Previously Identified Overloads	25
12.4	Steady-State Voltage Requirements.....	25
12.5	Potential Congestion due to Local Energy Deliverability	25
12.6	System Reinforcements	26
13	Short Circuit Analysis.....	27
14	Stability and Reactive Power Requirements for Low Voltage Ride Through	27
15	Affected Systems	27
15.1	TVA.....	27
15.2	Duke Energy Progress.....	27
15.3	MISO.....	27
15.4	LG&E.....	27
16	Attachment 1: One-Line Diagram and Location Map.....	28

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/meter²)
- 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	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC/D C	MW IMPACT
43592096	243453	05BEATY	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	05BEATY	345.0	AEP	244022	05COLLE	345.0	AEP	1	AEP_P4_#3195_05BEATTY 345_304E	breaker	1203.0	103.37	104.92	AC	18.65
43592156	243453	05BEATY	345.0	AEP	244022	05COLLE	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	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC/D C	MW IMPACT
4359244 7	24345 3	05BEATT Y	345. 0	AEP	24345 4	05BIXB Y	345. 0	AEP	1	AEP_P1 - 2_#714	operation	1203. 0	107.47	109.39	AC	23.11

11.6 System Reinforcements

ID	Idx	Facility	Upgrade Description	Cost	Cost Allocated to AF1-275	Upgrade Number																																
43592155,43592156	3	05BEATTY 345.0 kV - 05COLE 345.0 kV Ckt 1	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.	\$1.5 M	\$236 K	N6769.1																																
			The cost allocation is as follows:																																			
			<table><tr><td>Queue</td><td>MW contribution</td><td>Percentage of Cost</td><td>\$ cost (\$1.5 M)</td></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>				Queue	MW contribution	Percentage of Cost	\$ cost (\$1.5 M)	AF1-228	63.8	53.87%	0.808	AF1-233	19.7	16.62%	0.249	AF1-251	16.3	13.74%	0.206	AF1-275	18.7	15.76%	0.236												
			Queue				MW contribution	Percentage of Cost	\$ cost (\$1.5 M)																													
			AF1-228				63.8	53.87%	0.808																													
			AF1-233				19.7	16.62%	0.249																													
			AF1-251				16.3	13.74%	0.206																													
AF1-275	18.7	15.76%	0.236																																			
43592096	2	05BEATTY 345.0 kV - 05BIXBY 345.0 kV Ckt 1	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.	\$1.5 M	\$167 K	N6741.1																																
			The cost allocation is as follows:																																			
			<table><tr><td>Queue</td><td>MW contribution</td><td>Percentage of Cost</td><td>\$ cost (\$1.5 M)</td></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>				Queue	MW contribution	Percentage of Cost	\$ cost (\$1.5 M)	AF1-078	3.4	1.48%	0.022	AF1-117	68.4	29.71%	0.446	AF1-221	14.2	6.19%	0.093	AF1-228	76.0	33.05%	0.496	AF1-233	23.1	10.06%	0.151	AF1-251	19.3	8.38%	0.126	AF1-275	25.6	11.13%	0.167
			Queue				MW contribution	Percentage of Cost	\$ cost (\$1.5 M)																													
			AF1-078				3.4	1.48%	0.022																													
			AF1-117				68.4	29.71%	0.446																													
			AF1-221				14.2	6.19%	0.093																													
			AF1-228				76.0	33.05%	0.496																													
			AF1-233				23.1	10.06%	0.151																													
			AF1-251				19.3	8.38%	0.126																													
AF1-275	25.6	11.13%	0.167																																			
			Total Cost	\$3,000,000	\$403,000																																	

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	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPAC T
43592096	243453	05BEATTY	AEP	243454	05BIXBY	AEP	1	AEP_P4_#10715_05COL E 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
CPL	CPL	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	CK T ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPAC T
43592155	243453	05BEATTY	AEP	244022	05COL E	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
CPL	CPL	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-Plumville 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).

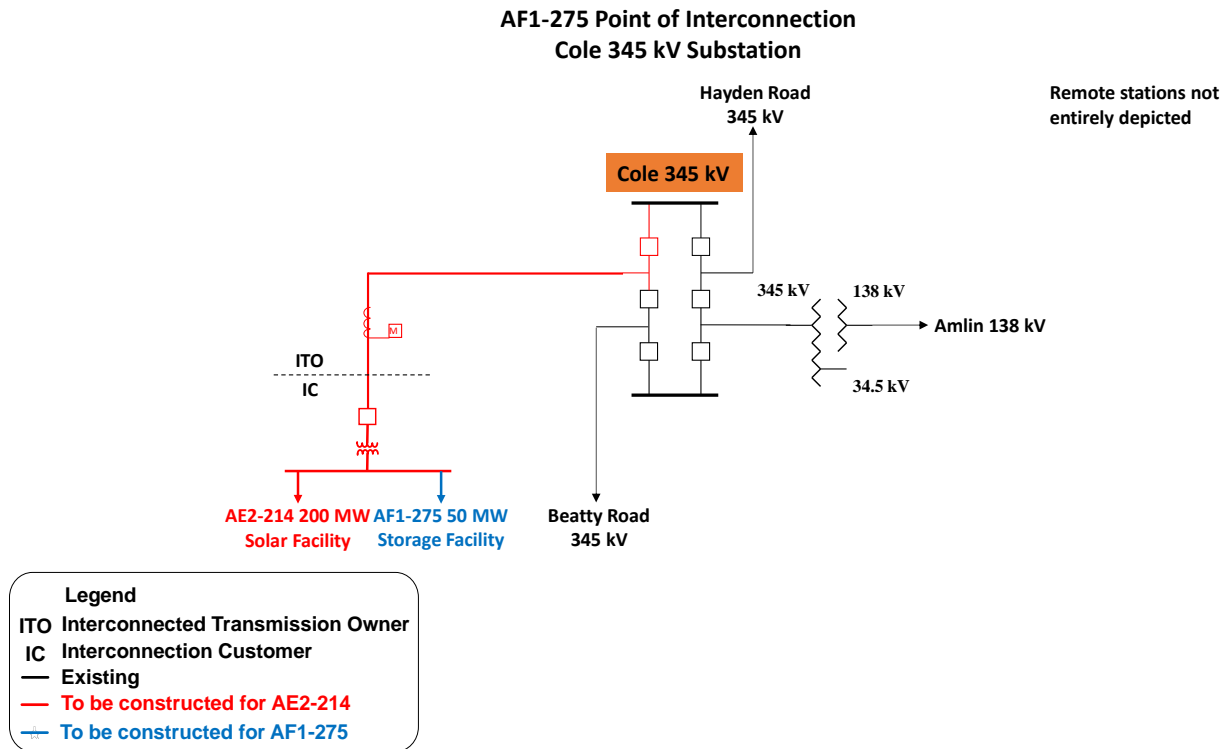
15.3 MISO

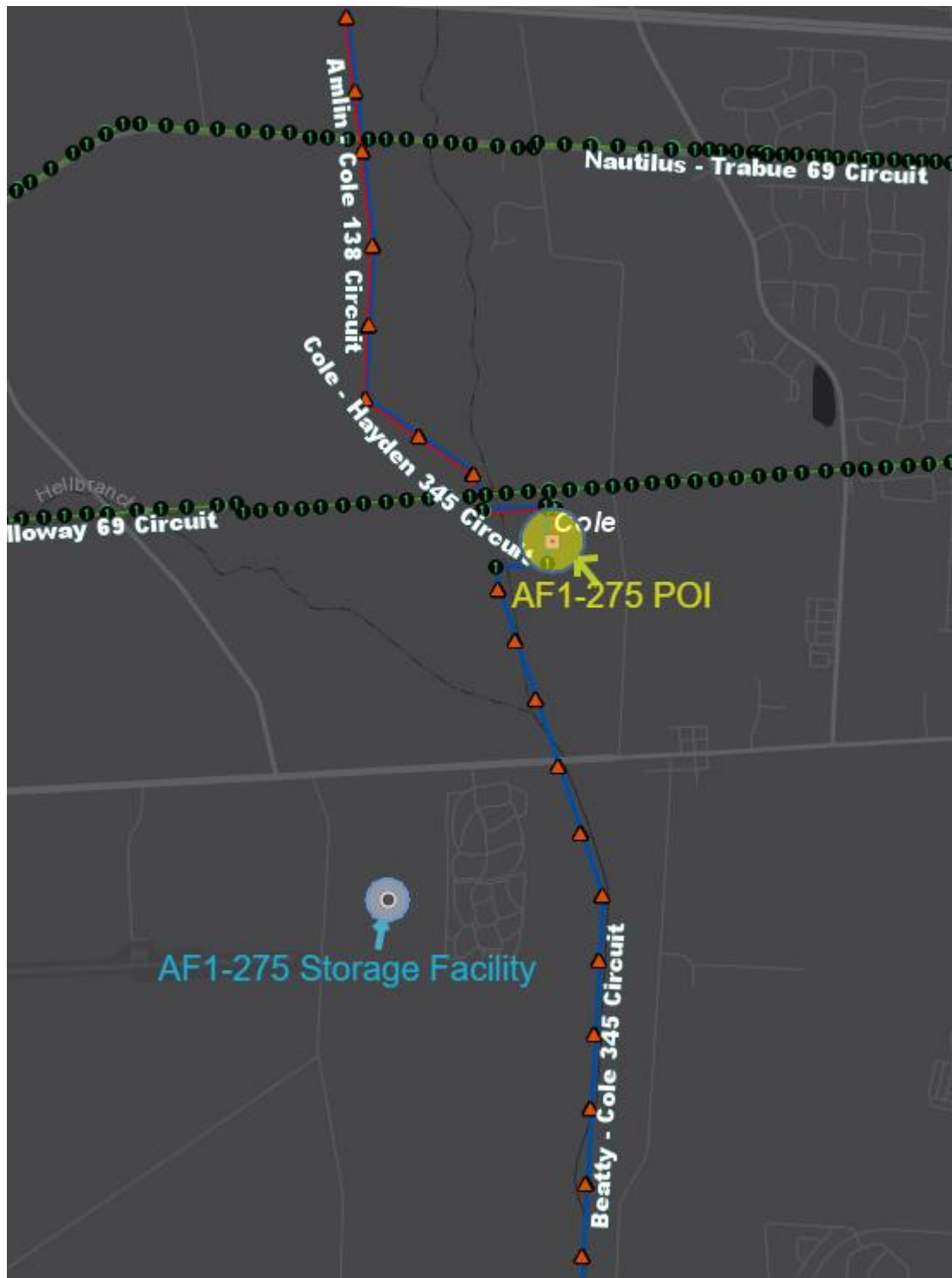
MISO Impacts to be determined during later study phases (as applicable).

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





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in

Case No(s). 20-1679-EL-BGN

Summary: Application - 8 of 25 (Exhibit F - PJM Interconnection Studies)
electronically filed by Christine M.T. Pirik on behalf of Pleasant Prairie Solar Energy LLC