



Juliet Solar

Exhibit I

PJM Interconnection Studies

Case No. 20-1760-EL-BGN



**Generation Interconnection  
Feasibility Study Report  
for  
Queue Project AF1-064  
WESTON 69 KV  
33.4 MW Capacity / 50 MW Energy**

January, 2020

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## 1 Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the Feasibility Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is American Transmission Systems, Inc. (ATSI – Toledo Edison zone).

## 2 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.

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.

### 3 General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Wood County, Ohio. The installed facilities will have a total capability of 50 MW with 33.4 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is March 31, 2022. This study does not imply a TO commitment to this in-service date.

<b>Queue Number</b>	<b>AF1-064</b>
<b>Project Name</b>	<b>WESTON 69 KV</b>
<b>State</b>	Ohio
<b>County</b>	Wood
<b>Transmission Owner</b>	ATSI
<b>MFO</b>	50
<b>MWE</b>	50
<b>MWC</b>	33.4
<b>Fuel</b>	Solar
<b>Basecase Study Year</b>	2023

### 3.1 Point of Interconnection

#### 3.1.1 Primary POI

The interconnection of the project at the Primary POI will be accomplished by expanding the FirstEnergy Weston 69 kV substation into a four (4) breaker ring bus station and providing a 69 kV line exit to the Primary POI. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated attachment facilities.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF1-064 generation project to connect to the FirstEnergy ("FE") transmission system. IC will be responsible for constructing all of the facilities on its side of the POI, including the attachment facilities which connect the generator to the FE transmission system's direct connection facilities.

#### 3.1.2 Secondary POI

The interconnection of the project at a Secondary POI can be accomplished by constructing a new 69 kV three (3) breaker ring bus substation and looping the Midway-Bowling Green 69 kV line into the new ring bus substation. A 69 kV line exit would then be extended from the new ring bus substation to the Secondary POI. The new substation would be located approximately 0.16 miles from Weston 69 kV substation and 7.9 miles from Grand Rapids 69 kV substation. A full scope of work or estimated cost is not provided for the proposed Secondary POI.

### 3.2 Cost Summary

The AF1-064 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$470,500
Direct Connection Network Upgrade	\$0
Non Direct Connection Network Upgrades	\$6,696,300
<b>Total Costs</b>	<b>\$7,166,800</b>

In addition, the AF1-064 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	\$23,600,000

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

The Feasibility Study is used to make a preliminary determination of the type and scope of Attachment Facilities, Local Upgrades, and Network Upgrades that will be necessary to accommodate the Interconnection Request and to provide the Interconnection Customer a preliminary estimate of the time that will be required



to construct any necessary facilities and upgrades and the Interconnection Customer's cost responsibility. The System Impact Study provides refined and comprehensive estimates of cost responsibility and construction lead times for new facilities and system upgrades. Facilities Studies will include, commensurate with the degree of engineering specificity as provided in the Facilities Study Agreement, good faith estimates of the cost, determined in accordance with Section 217 of the Tariff,

- (a) to be charged to each affected New Service Customer for the Facilities and System Upgrades that are necessary to accommodate this queue project;
- (b) the time required to complete detailed design and construction of the facilities and upgrades; and
- (c) a description of any site-specific environmental issues or requirements that could reasonably be anticipated to affect the cost or time required to complete construction of such facilities and upgrades.

The costs provided above exclude the Contribution in Aid of Construction ("CIAC") Federal Income Tax Gross Up charge. If at a future date it is determined that the CIAC Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

The required Attachment Facilities and Direct and Non-Direct Connection work for the interconnection of the AF1-064 generation project to the FE Transmission System is detailed in the following sections. The associated one-line with the generation project Attachment Facilities and the Primary Direct and Non-Direct Connection facilities are shown in Attachment 1.

## 4 Transmission Owner Scope of Work

### Primary POI

The interconnection of the project at the Primary POI will be accomplished by expanding the FirstEnergy Weston 69 kV substation into a four (4) breaker ring bus station and providing a 69 kV line exit to the Primary POI. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated attachment facilities.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF1-064 generation project to connect to the FirstEnergy ("FE") transmission system. IC will be responsible for constructing all of the facilities on its side of the POI, including the attachment facilities which connect the generator to the FE transmission system's direct connection facilities

## 5 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
Install SCADA and MOAB for the New Line Exit @ Weston	\$393,700
Customer drawings and Nameplates @ AF1-064	\$76,800
<b>Total Attachment Facility Costs</b>	<b>\$470,500</b>

## 6 Direct Connection Cost Estimate

No Direct Connection work is required.

## 7 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
Reconfigure 69kV to 4-Breaker Ring Bus @ Weston	\$6,377,700
Upgrade Line Relaying @ Midway	\$318,600
<b>Total Non-Direct Connection Facility Costs</b>	<b>\$6,696,300</b>

## 8 Schedule

Based on the scope of work for the Attachment Facilities and the Direct and Non-Direct Connection facilities, it is expected to take a minimum of **24 months** after the signing of an Interconnection Construction Service Agreement to complete the installation. This includes the requirement for the IC to make a preliminary payment that compensates FE for the first three months of the engineering design work that is related to the Attachment Facilities. Full initial deposit will be required for the Non-Direct Connection work. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the interconnection work and network upgrades, and that all transmission system outages will be allowed when requested.

The schedule for the required Network Impact Reinforcements will be more clearly identified in future study phases. The estimate elapsed time to complete each of the required reinforcements is identified in the “System Reinforcements” section of the report.

## 9 Transmission Owner Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AF1-064 project did not contribute to any overloads on the FE transmission system.

## 10 Interconnection Customer Requirements

### 10.1 System Protection

The IC must design its Customer Facilities in accordance with all applicable standards, including the standards in FE's "Requirements for Transmission Connected Facilities" document located at: <http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx>. Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the project enters the construction phase.

The IC has requested a non-standard GSU transformer winding configuration. This transformer is in violation of section 14.2.6 of FE's "Requirements for Transmission Connected Facilities" document and will not be accepted. The GSU transformer must have a grounded wye connection on the high (utility) side and a delta connection on the low (generator) side.

### 10.2 Compliance Issues and Interconnection Customer Requirements

The proposed Customer Facilities must be designed in accordance with FE's "Requirements for Transmission Connected Facilities" document located at: <http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx>. In particular, the IC is responsible for the following:

1. The purchase and installation of a fully rated 69 kV circuit breaker to protect the AF1-064 generator lead line. A single circuit breaker must be used to protect this line; if the project has several GSU transformers, the individual GSU transformer breakers cannot be used to protect this line.
2. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.
3. The purchase and installation of supervisory control and data acquisition ("SCADA") equipment to provide information in a compatible format to the FE Transmission System Control Center.
4. Compliance with the FE and PJM generator power factor and voltage control requirements.
5. The execution of a back-up service agreement to serve the customer load supplied from the AF1-064 generation project metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

The IC will also be required to meet all PJM, ReliabilityFirst, and NERC reliability criteria and operating procedures for standards compliance. For example, the IC will need to properly locate and report the over and under voltage and over and under frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits.

Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE system.

### **10.3 Power Factor Requirements**

The IC shall design its solar Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) measured at the high-side of the facility substation transformer(s) connected to the FE transmission system.

## **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.

#### **11.1.1 Meteorological Data Reporting Requirement**

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

- Temperature (degrees Fahrenheit)
- Atmospheric pressure (hectopascals)
- Irradiance
- Forced outage data

### **11.2 ATSI Requirements**

The IC will be required to comply with all FE revenue metering requirements for generation interconnection customers which can be found in FE's "Requirements for Transmission Connected Facilities" document located at: <http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx>



## 12 Network Impacts – Primary POI

The Queue Project AF1-064 was evaluated as a 50.0 MW (Capacity 33.4 MW) injection at the Weston 69 kV substation in the ATSI area. Project AF1-064 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-064 was studied with a commercial probability of 53%. Potential network impacts were as follows:

## Summer Peak Load Flow

### 12.1 Generation Deliverability

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

None

### 12.2 Multiple Facility Contingency

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

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)

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC/D C	MW IMPACT
40964016	238874	02LAKVEW	138.0	ATSI	238768	02GRNFLD	138.0	ATSI	1	ATSI-P7-1-TE-345-027A	tower	316.0	113.89	114.4	DC	3.53
43720294	243009	05FRMNT	138.0	AEP	243008	05FREMT	138.0	AEP	1	AEP_P2-2_#517_05FOS TOR 345_1	bus	251.0	104.93	105.43	DC	2.76
43720647	243009	05FRMNT	138.0	AEP	243008	05FREMT	138.0	AEP	1	AEP_P4_#517_05FOS TOR 345_A1	breaker	251.0	104.93	105.43	DC	2.76

### 12.4 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

## 12.5 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
43720647,437 20294	2	05FRMNT 138.0 kV - 05FREMCT 138.0 kV Ckt 1	<p>AEPO0020e (364) : Fremont-Fremont CT 138 kV Line: A sag study will be required on the 4.0 miles of ACSR ~ 795 ~ 45/7 ~ TERN - Conductor Section 1 to mitigate the overload. Depending on the sag study results, the cost for this upgrade is expected to be around \$20,000 (no remediation required, just sag study) and \$6 million (complete line reconductor/rebuild). New rating after sag study: S/N:251 S/E: 335 MVA. 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 : \$20,000 Time Estimate : Sag Study : 6 - 12 months Months</p>	\$20,000
40964016	1	02LAKVEW 138.0 kV - 02GRNFLD 138.0 kV Ckt 1	<p>OEC-011-B (665) : Greenfield-Lakeview 138 KV Line: Reconductor roughly 13.1 miles (currently bundled 336 ACSR) with 795 ACSS conductor. Replace two 1200A line switches with 2000A line switches. Upgrade 500 CU substation conductor at Greenfield to exceed line ratings of 795 ACSS. Upgrade RT for B-242 to exceed line ratings of 795 ACSS.</p> <p>Project Type : Facility Cost : \$23,580,000 Time Estimate : 24.0 Months</p>	\$23,580,000
			<b>TOTAL COST</b>	<b>\$23,600,000</b>

## 12.6 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.

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## 12.7 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
40964016	238874	02LAKVEW	ATSI	238768	02GRNFLD	ATSI	1	ATSI-P7-1-TE-345-027A	tower	316.0	113.89	114.4	DC	3.53

Bus #	Bus	MW Impact
238601	02FRMENG 1	2.4779
238602	02FRMENG 2	2.4779
238603	02FRMENG 3	4.4733
238979	02NAPMUN	2.0225
247548	V4-010 C	1.4243
247551	U4-028 C	0.6092
247552	U4-029 C	0.6092
247940	U4-028 E	4.0769
247941	U4-029 E	4.0769
247947	V4-010 E	9.5322
931951	AB1-107 1	20.5456
931961	AB1-107 2	33.5314
934251	AD1-052 C1	0.1839
934252	AD1-052 E1	0.5861
934261	AD1-052 C2	0.1839
934262	AD1-052 E2	0.5861
934461	AD1-070 C O1	1.5612
934462	AD1-070 E O1	7.3290
934891	AD1-118	3.6670
937021	AD2-136 C O1	2.1931
937022	AD2-136 E O1	14.6767
937381	AD2-191 C	1.0356
937382	AD2-191 E	6.9307
938911	AE1-119	28.8120
941741	AE2-174 C	1.0119
941742	AE2-174 E	4.7370
941781	AE2-181 C	1.5331
941782	AE2-181 E	1.0221
942661	AE2-282 C O1	2.3557
942662	AE2-282 E O1	1.2396
943961	AF1-064 C O1	1.0626
943962	AF1-064 E O1	0.5281
944551	AF1-120 C	0.7565
944552	AF1-120 E	0.3811
945401	AF1-205 C O1	0.6953
945402	AF1-205 E O1	0.4635
945411	AF1-206 C O1	3.3957
945412	AF1-206 E O1	2.2638
LGEE	LGEE	0.7188
CPLE	CPLE	0.1528

<b>Bus #</b>	<b>Bus</b>	<b>MW Impact</b>
<b>WEC</b>	WEC	0.5758
<b>CBM-W2</b>	CBM-W2	10.4095
<b>NY</b>	NY	0.6564
<b>CBM-W1</b>	CBM-W1	33.7395
<b>TVA</b>	TVA	1.3510
<b>O-066</b>	O-066	6.8410
<b>CBM-S2</b>	CBM-S2	2.2947
<b>CBM-S1</b>	CBM-S1	8.6904
<b>G-007</b>	G-007	1.0494
<b>MADISON</b>	MADISON	0.6713
<b>MEC</b>	MEC	2.5615

## 12.8 Index 2

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC DC	MW IMPACT
43720647	243009	05FRMNT	AEP	243008	05FREMCT	AEP	1	AEP_P4_#517_05FOSTOR 345_A1	breaker	251.0	104.93	105.43	DC	2.76

Bus #	Bus	MW Impact
238601	02FRMENG 1	4.2033
238602	02FRMENG 2	4.2033
238603	02FRMENG 3	7.5883
244357	05GRANGER EL	-0.1970
931951	AB1-107 1	14.5634
931961	AB1-107 2	26.0324
934251	AD1-052 C1	0.3119
934252	AD1-052 E1	0.9941
934261	AD1-052 C2	0.3119
934262	AD1-052 E2	0.9941
934891	AD1-118	3.0553
938911	AE1-119	24.0061
941761	AE2-176 C	8.1397
941762	AE2-176 E	5.4265
943961	AF1-064 C O1	0.8300
943962	AF1-064 E O1	0.4125
DUCKCREEK	DUCKCREEK	0.2833
NEWTON	NEWTON	0.4255
FARMERCITY	FARMERCITY	0.0175
G-007A	G-007A	0.0743
VFT	VFT	0.2193
CBM-W1	CBM-W1	10.1331
PRAIRIE	PRAIRIE	0.9867
COFFEEN	COFFEEN	0.1866
EDWARDS	EDWARDS	0.0798
CHEOAH	CHEOAH	0.2462
TILTON	TILTON	0.2218
MADISON	MADISON	1.1592
GIBSON	GIBSON	0.2741
CALDERWOOD	CALDERWOOD	0.2455
BLUEG	BLUEG	1.0590
TRIMBLE	TRIMBLE	0.3422
CATAWBA	CATAWBA	0.1561



## Affected Systems

## 12.9 Affected Systems

### 12.9.1 LG&E

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

### 12.9.2 MISO

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

### 12.9.3 TVA

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

### 12.9.4 Duke Energy Progress

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

### 12.9.5 NYISO

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

## 12.10 Contingency Description

Contingency Name	Contingency Definition
<b>AEP_P2-2_#517_05FOSTOR 345_1</b>	CONTINGENCY 'AEP_P2-2_#517_05FOSTOR 345_1' OPEN BRANCH FROM BUS 241901 TO BUS 242936 CKT 1 / 241901 02LALLEND
<b>ATSI-P7-1-TE-345-027A</b>	CONTINGENCY 'ATSI-P7-1-TE-345-027A' /* DB - X1-027A & DB - HAYES 345 DISCONNECT BRANCH FROM BUS 238654 TO BUS 907060 CKT 1 /* 02DAV-BE 345 X1-027A_AT12 345 DISCONNECT BRANCH FROM BUS 238654 TO BUS 239289 CKT 1 /* 02DAV-BE 345 02HAYES 345 END
<b>AEP_P4_#517_05FOSTOR 345_A1</b>	CONTINGENCY 'AEP_P4_#517_05FOSTOR 345_A1' OPEN BRANCH FROM BUS 241901 TO BUS 242936 CKT 1 / 241901 02LALLEND

## Short Circuit

### 12.11 Short Circuit

The following Breakers are overduty:

None

### **13 Network Impacts – Secondary POI**

The Queue Project AF1-064 was evaluated as a 50.0 MW (Capacity 33.4 MW) injection tapping the Midway-Bowling Green 69 kV Line (between Weston and Grand Rapids 69 kV substations) in the ATSI area. Project AF1-064 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-064 was studied with a commercial probability of 53%. Potential network impacts were as follows:

## Summer Peak Load Flow

### 13.1 Generation Deliverability

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

None

### 13.2 Multiple Facility Contingency

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

None

### 13.3 Contribution to Previously Identified Overloads

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC/D C	MW IMPACT
40964016	238874	02LAKVEW	138.0	ATSI	238768	02GRNFLD	138.0	ATSI	1	ATSI-P7-1-TE-345-027A	tower	316.0	113.86	114.37	DC	3.53
43720294	243009	05FRMNT	138.0	AEP	243008	05FREMT	138.0	AEP	1	AEP_P2-2_#517_05FOS TOR 345_1	bus	251.0	104.89	105.39	DC	2.76
43720647	243009	05FRMNT	138.0	AEP	243008	05FREMT	138.0	AEP	1	AEP_P4_#517_05FOS TOR 345_A1	breaker	251.0	104.89	105.39	DC	2.76

### 13.4 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



### 13.5 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.

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## 13.6 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
40964016	238874	02LAKVEW	ATSI	238768	02GRNFLD	ATSI	1	ATSI-P7-1-TE-345-027A	tower	316.0	113.86	114.37	DC	3.53

Bus #	Bus	MW Impact
238601	02FRMENG 1	2.4779
238602	02FRMENG 2	2.4779
238603	02FRMENG 3	4.4733
238979	02NAPMUN	2.0225
247548	V4-010 C	1.4243
247551	U4-028 C	0.6092
247552	U4-029 C	0.6092
247940	U4-028 E	4.0769
247941	U4-029 E	4.0769
247947	V4-010 E	9.5322
931951	AB1-107 1	20.5456
931961	AB1-107 2	33.5314
934251	AD1-052 C1	0.1839
934252	AD1-052 E1	0.5861
934261	AD1-052 C2	0.1839
934262	AD1-052 E2	0.5861
934461	AD1-070 C O1	1.5612
934462	AD1-070 E O1	7.3290
934891	AD1-118	3.6670
937021	AD2-136 C O1	2.1931
937022	AD2-136 E O1	14.6767
937381	AD2-191 C	1.0356
937382	AD2-191 E	6.9307
938911	AE1-119	28.8120
941741	AE2-174 C	1.0119
941742	AE2-174 E	4.7370
941781	AE2-181 C	1.5331
941782	AE2-181 E	1.0221
942661	AE2-282 C O1	2.3557
942662	AE2-282 E O1	1.2396
943961	AF1-064 C O2	1.0626
943962	AF1-064 E O2	0.5281
944551	AF1-120 C	0.7565
944552	AF1-120 E	0.3811
945401	AF1-205 C O2	0.6909
945402	AF1-205 E O2	0.4606
945411	AF1-206 C O2	3.4092
945412	AF1-206 E O2	2.2728
LGEE	LGEE	0.7188
CPLE	CPLE	0.1528

<b>Bus #</b>	<b>Bus</b>	<b>MW Impact</b>
<b>WEC</b>	WEC	0.5758
<b>CBM-W2</b>	CBM-W2	10.4095
<b>NY</b>	NY	0.6564
<b>CBM-W1</b>	CBM-W1	33.7395
<b>TVA</b>	TVA	1.3510
<b>O-066</b>	O-066	6.8410
<b>CBM-S2</b>	CBM-S2	2.2947
<b>CBM-S1</b>	CBM-S1	8.6904
<b>G-007</b>	G-007	1.0494
<b>MADISON</b>	MADISON	0.6713
<b>MEC</b>	MEC	2.5615

## 13.7 Index 2

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC DC	MW IMPACT
43720647	243009	05FRMNT	AEP	243008	05FREMCT	AEP	1	AEP_P4_#517_05FOSTOR 345_A1	breaker	251.0	104.89	105.39	DC	2.76

Bus #	Bus	MW Impact
238601	02FRMENG 1	4.2033
238602	02FRMENG 2	4.2033
238603	02FRMENG 3	7.5883
244357	05GRANGER EL	-0.1970
931951	AB1-107 1	14.5634
931961	AB1-107 2	26.0324
934251	AD1-052 C1	0.3119
934252	AD1-052 E1	0.9941
934261	AD1-052 C2	0.3119
934262	AD1-052 E2	0.9941
934891	AD1-118	3.0553
938911	AE1-119	24.0061
941761	AE2-176 C	8.1397
941762	AE2-176 E	5.4265
943961	AF1-064 C O2	0.8300
943962	AF1-064 E O2	0.4125
DUCKCREEK	DUCKCREEK	0.2833
NEWTON	NEWTON	0.4255
FARMERCITY	FARMERCITY	0.0175
G-007A	G-007A	0.0743
VFT	VFT	0.2193
CBM-W1	CBM-W1	10.1331
PRAIRIE	PRAIRIE	0.9867
COFFEEN	COFFEEN	0.1866
EDWARDS	EDWARDS	0.0798
CHEOAH	CHEOAH	0.2462
TILTON	TILTON	0.2218
MADISON	MADISON	1.1592
GIBSON	GIBSON	0.2741
CALDERWOOD	CALDERWOOD	0.2455
BLUEG	BLUEG	1.0590
TRIMBLE	TRIMBLE	0.3422
CATAWBA	CATAWBA	0.1561

## Affected Systems

## 13.8 Affected Systems

### 13.8.1 LG&E

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

### 13.8.2 MISO

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

### 13.8.3 TVA

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

### 13.8.4 Duke Energy Progress

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

### 13.8.5 NYISO

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

## 13.9 Contingency Description

Contingency Name	Contingency Definition
<b>AEP_P2-2_#517_05FOSTOR 345_1</b>	CONTINGENCY 'AEP_P2-2_#517_05FOSTOR 345_1' OPEN BRANCH FROM BUS 241901 TO BUS 242936 CKT 1 / 241901 02LALLEND
<b>ATSI-P7-1-TE-345-027A</b>	CONTINGENCY 'ATSI-P7-1-TE-345-027A' /* DB - X1-027A & DB - HAYES 345 DISCONNECT BRANCH FROM BUS 238654 TO BUS 907060 CKT 1 /* 02DAV-BE 345 X1-027A_AT12 345 DISCONNECT BRANCH FROM BUS 238654 TO BUS 239289 CKT 1 /* 02DAV-BE 345 02HAYES 345 END
<b>AEP_P4_#517_05FOSTOR 345_A1</b>	CONTINGENCY 'AEP_P4_#517_05FOSTOR 345_A1' OPEN BRANCH FROM BUS 241901 TO BUS 242936 CKT 1 / 241901 02LALLEND

## Short Circuit



### 13.10 Short Circuit

The following Breakers are overduty:

None

## 14 Attachment One: One Line Diagram



**Generation Interconnection  
System Impact Study Report  
for**

**Queue Project AF1-064**

**WESTON 69 KV**

**33.4 MW Capacity / 50 MW Energy**

August 2020

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## 1 Introduction

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

## 2 Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation will be deferred until the System Impact Study is performed.

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

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

### 3 General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Wood County, Ohio. The installed facilities will have a total capability of 50 MW with 33.4 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is March 31, 2022. This study does not imply a TO commitment to this in-service date. The interconnection customer has requested cost to accelerate the supplemental project s1953<sup>1</sup> in order to reduce the direction connection cost for AF1-064. FE will proceed with accelerating the supplemental project s1953 with a signed Interim ISA that is to be developed by PJM and the Interconnection Customer.

<b>Queue Number</b>	<b>AF1-064</b>
<b>Project Name</b>	WESTON 69 KV
<b>State</b>	Ohio
<b>County</b>	Wood
<b>Transmission Owner</b>	ATSI
<b>MFO</b>	50
<b>MWE</b>	50
<b>MWC</b>	33.4
<b>Fuel</b>	Solar
<b>Basecase Study Year</b>	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.

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<sup>1</sup> Supplemental Project s1953 for Richland Substation Upgrades and New Richland-Weston 69 kV line in the ATSI zone is currently scheduled for completion by 12.31.2023. The customer is requesting to accelerate the completion to May 31, 2023.

## 4 Point of Interconnection

AF1-064 will interconnect with the ATSI on transmission system at the Weston 69 kV substation.

The interconnection of the project at the selected POI will be accomplished by expanding Weston 69 kV Substation into a five (5) breaker ring bus substation and loop in the Bowling Green No2-Midway 69 kV Line to eliminate the three terminal line. The ring bus will provide a line exit for the AF1-064 project. The interconnection customer has requested the cost to accelerate the supplemental project s1953 in order to reduce the direct connection cost for AF1-064. FE will proceed with accelerating the supplemental project s1953 with a signed Interim ISA that is to be developed by PJM and the interconnection customer.

Attachment 1 shows a one-line diagram of the proposed primary Direct Connection facilities for the AF1-064 generation project to connect to the FirstEnergy ("FE") Transmission System. The IC will be responsible for constructing the facilities on its side of the POI, including the Attachment Facilities which connect the generator to the FE Transmission System's Direct Connection facilities.

## 5 Cost Summary

The AF1-064 project will be responsible for the following costs:

Description	Total Cost
<b>Total Physical Interconnection Costs</b>	\$4,299,400
<b>Allocation towards System Network Upgrade Costs*</b>	\$0 (See Note 2)
<b>Total Costs</b>	<b>\$4,299,400</b>

**\*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.

**Note 2:** For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates \$0, then please be aware that as changes to the interconnection process occur, such



as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently \$0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

## 6 Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by expanding Weston 69 kV Substation into a five (5) breaker ring bus substation and loop in the Bowling Green No2-Midway 69 kV Line to eliminate the three terminal line. The ring bus will provide a line exit for the AF1-064 project. The interconnection customer has requested the cost to accelerate the supplemental project s1953 in order to reduce the direct connection cost for AF1-064. FE will proceed with accelerating the supplemental project s1953 with a signed Interim ISA that is to be developed by PJM and the interconnection customer.

The total physical interconnection costs is given in the table below:

Description	Total Cost
Install SCADA and MOAB for the New Line Exit at Weston Substation	\$82,600
Provide a 69 kV Line Exit at Weston Substation for AF1-064	\$743,200
Provide assistance to the developer on the customer-owned revenue metering design, perform a remote meter checkout, and facilitate the meter's installation in the FE MV-90 system.	\$2,500
Project Management	\$284,900
Drawing review, nameplates, and CD drawing update; add to HV circuit diagram at AF1-064 Customer Sub	\$30,600
Acceleration of s1953 to accommodate AF1-064.	\$3,155,600
<b>Total Physical Interconnection Costs</b>	<b>\$4,299,400</b>

## 7 Schedule

Based on the scope of work for the interconnection facilities, it is expected to take a minimum of **24 months** after the signing of an Interconnection Construction Service Agreement and construction kickoff call to complete the installation. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined Direct Connection and network upgrades, and that all transmission system outages will be allowed when requested.

The schedule for any required Network Impact Reinforcements will be more clearly identified in future study phases. The estimated time to complete each of the required reinforcements is identified in the “System Reinforcements” section of the report.

## 8 Transmission Owner Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AF1-064 project did not contribute to any overloads on the FE transmission < 100 kV system.

## 9 Interconnection Customer Requirements

### 9.1 System Protection

The IC must design its Customer Facilities in accordance with all applicable standards, including the standards in FE’s “Requirements for Transmission Connected Facilities” document located at: <http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx>. Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the project enters the construction phase.

The IC has requested a non-standard GSU transformer winding configuration. This transformer is in violation of section 14.2.6 of FE’s “Requirements for Transmission Connected Facilities” document and will not be accepted. The GSU transformer must have a grounded wye connection on the high (utility) side and a delta connection on the low (generator) side.

### 9.2 Compliance Issues and Interconnection Customer Requirements

The proposed Customer Facilities must be designed in accordance with FE’s “Requirements for Transmission Connected Facilities” document located at: <http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx>. In particular, the IC is responsible for the following:

1. The purchase and installation of a fully rated 69 kV circuit breaker to protect the AF1-064 generator lead line. A single circuit breaker must be used to protect this line; if the project has several GSU transformers, the individual GSU transformer breakers cannot be used to protect this line.

2. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.
3. The purchase and installation of supervisory control and data acquisition (“SCADA”) equipment to provide information in a compatible format to the FE Transmission System Control Center.
4. Compliance with the FE and PJM generator power factor and voltage control requirements.
5. The execution of a back-up service agreement to serve the customer load supplied from the AF1-064 generation project metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

The IC will also be required to meet all PJM, ReliabilityFirst, and NERC reliability criteria and operating procedures for standards compliance. For example, the IC will need to properly locate and report the over and under voltage and over and under frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE Transmission System.

### **9.3 Power Factor Requirements**

The IC shall design its solar Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) measured at the high-side of the facility substation transformer(s) connected to the FE transmission system.

## **10 Revenue Metering and SCADA Requirements**

### **10.1 PJM Requirements**

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

### **10.2 Meteorological Data Reporting Requirements**

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

- Back Panel temperature (Fahrenheit)
- Irradiance (Watts/meter<sup>2</sup>)
- 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 FE revenue metering requirements for generation interconnection customers which can be found in FE's "Requirements for Transmission Connected Facilities" document located at: <http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx>

## 11 Summer Peak Analysis

The Queue Project AF1-064 was evaluated as a 50.0 MW (Capacity 33.4 MW) injection at the Weston 69 kV substation in the ATSI area. Project AF1-064 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF1-064 was studied with a commercial probability of 100%. 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
43720294	243009	05FRMNT	138.0	AEP	243008	05FREMT	138.0	AEP	1	AEP_P2-2_#517_05FOS TOR 345_1	bus	251.0	106.05	107.65	AC	2.76
43720647	243009	05FRMNT	138.0	AEP	243008	05FREMT	138.0	AEP	1	AEP_P4_#517_05FOS TOR 345_A1	breaker	251.0	106.05	107.65	AC	2.76

### 11.4 Steady-State Voltage Requirements

To be determined in Facilities Study phase.

### 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.

None

## 11.6 System Reinforcements

ID	Idx	Facility	Upgrade Description	Cost	Cost Allocated to AF1-064	Upgrade Number
43720647,43720294	1	05FRMNT 138.0 kV - 05FREMCT 138.0 kV Ckt 1	<p><b>AEP:</b></p> <p>A sag study will be required on the 4.0 miles of ACSR ~ 795 ~ 45/7 ~ TERN - Conductor Section 1 to mitigate the overload. Depending on the sag study results, the cost for this upgrade is expected to be around \$20,000 (no remediation required, just sag study) and \$6 million (complete line reconductor/rebuild).</p> <p>New rating after sag study: S/N:251 S/E: 335 MVA. 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</p> <p>Cost : \$20,000</p> <p>New Ratings : 251/335</p> <p>Time Estimate : 6-12 Months</p>	\$200,000	\$0	N6297.1
			<b>TOTAL COST</b>	<b>\$200,000</b>	<b>\$0</b>	

**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".

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### 11.7.1 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 %	ACID C	MW IMPACT
43720647	243009	05FRMNT	AEP	243008	05FREMC T	AEP	1	AEP_P4_#517_05FOSTO R 345_A1	breaker	251.0	106.05	107.65	AC	2.76

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
238601	02FRMENG 1	5.3360	50/50	5.3360
238602	02FRMENG 2	5.3360	50/50	5.3360
238603	02FRMENG 3	9.6331	50/50	9.6331
244357	05GRANGER EL	-0.1967	Adder	-0.23
931951	AB1-107 1	14.5816	Adder	17.15
931961	AB1-107 2	26.0727	Adder	30.67
934251	AD1-052 C1	0.3960	50/50	0.3960
934252	AD1-052 E1	0.9946	50/50	0.9946
934261	AD1-052 C2	0.3960	50/50	0.3960
934262	AD1-052 E2	0.9946	50/50	0.9946
934891	AD1-118	3.0595	Adder	3.6
938911	AE1-119	24.0388	Adder	28.28
941761	AE2-176 C	8.1465	50/50	8.1465
941762	AE2-176 E	5.4310	50/50	5.4310
943961	AF1-064 C O1	1.5683	Adder	1.85
943962	AF1-064 E O1	0.7794	Adder	0.92
NEWTON	NEWTON	0.4169	Confirmed LTF	0.4169
FARMERCITY	FARMERCITY	0.0171	Confirmed LTF	0.0171
G-007A	G-007A	0.0647	Confirmed LTF	0.0647
VFT	VFT	0.1935	Confirmed LTF	0.1935
PRAIRIE	PRAIRIE	0.9686	Confirmed LTF	0.9686
COFFEEN	COFFEEN	0.0688	Confirmed LTF	0.0688
CHEOAH	CHEOAH	0.2427	Confirmed LTF	0.2427
EDWARDS	EDWARDS	0.0770	Confirmed LTF	0.0770
TILTON	TILTON	0.2167	Confirmed LTF	0.2167
MADISON	MADISON	1.1592	Confirmed LTF	1.1592
GIBSON	GIBSON	0.2697	Confirmed LTF	0.2697
CALDERWOOD	CALDERWOOD	0.2420	Confirmed LTF	0.2420
BLUEG	BLUEG	1.0451	Confirmed LTF	1.0451
TRIMBLE	TRIMBLE	0.3378	Confirmed LTF	0.3378
CATAWBA	CATAWBA	0.1540	Confirmed LTF	0.1540
CBM-W1	CBM-W1	10.1331	Confirmed LTF	10.1331

## 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
AB1-107	Bayshore-GM Powertrain 138 kV & Lallendorf 345kV	Engineering and Procurement
AD1-052	Freemont Energy Center	Under Construction
AD1-118	Lemoyne	Active
AE1-119	Lemoyne 345 kV	Active
AE2-176	Groton 138 kV Solar	Active
AF1-064	Weston 69 kV	Active

## 11.9 Contingency Descriptions

Contingency Name	Contingency Definition
AEP_P2-2_#517_05FOSTOR 345_1	CONTINGENCY 'AEP_P2-2_#517_05FOSTOR 345_1' OPEN BRANCH FROM BUS 241901 TO BUS 242936 CKT 1 / 241901 02LALLEND
AEP_P4_#517_05FOSTOR 345_A1	CONTINGENCY 'AEP_P4_#517_05FOSTOR 345_A1' OPEN BRANCH FROM BUS 241901 TO BUS 242936 CKT 1 / 241901 02LALLEND

## 12 Light Load Analysis

Not required for solar projects.

### 13 Short Circuit Analysis

The following Breakers are overdutied:

None

### 14 Stability and Reactive Power

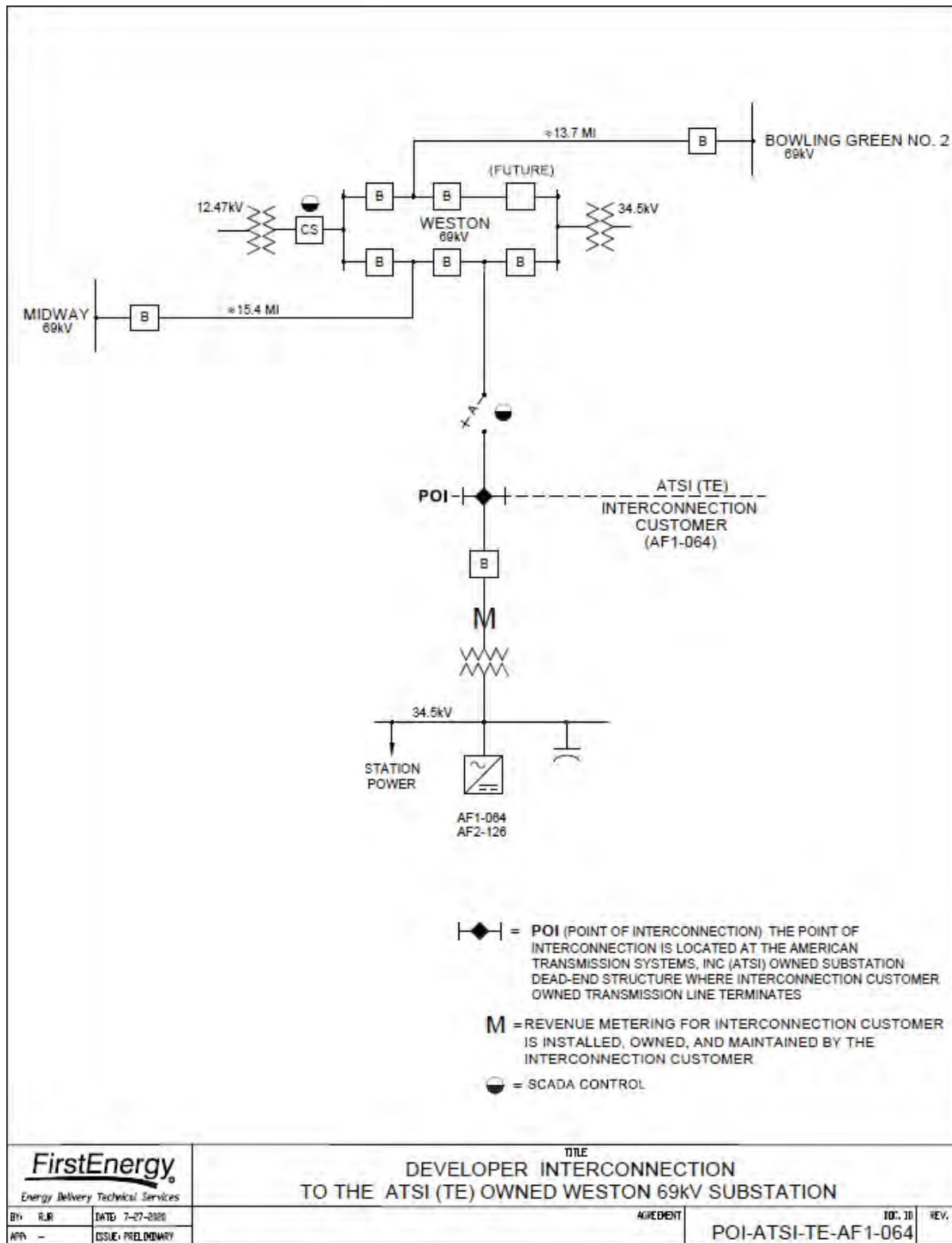
(Summary of the VAR requirements based upon the results of the dynamic studies)

To be determined in the Facilities Study Phase.

### 15 Affected Systems

None

## 16 Attachment 1: One Line Diagram





**Generation Interconnection  
Feasibility Study Report  
for  
Queue Project AF2-126  
WESTON 69 KV II  
40.1 MW Capacity / 60 MW Energy**

July 2020

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## 1 Introduction

This Feasibility Study has been prepared in accordance with the PJM Open Access Transmission Tariff, 36.2, as well as the Feasibility Study Agreement between the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is American Transmission Systems, Inc. (ATSI).

## 2 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.

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.

### 3 General

The Interconnection Customer (IC) has proposed an uprate to a planned/existing Solar generating facility located in Wood, Ohio. This project is an increase to the Interconnection Customer's AF1-064 project, which will share the same point of interconnection. The AF2-126 queue position is a 60 MW uprate (40.1 MW Capacity uprate) to the previous project. The total installed facilities will have a capability of 110 MW with 73.5 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this uprate project is December 31, 2021. This study does not imply a TO commitment to this in-service date.

<b>Queue Number</b>	<b>AF2-126</b>
<b>Project Name</b>	WESTON 69 KV II
<b>State</b>	Ohio
<b>County</b>	Wood
<b>Transmission Owner</b>	ATSI
<b>MFO</b>	110
<b>MWE</b>	60
<b>MWC</b>	40.1
<b>Fuel</b>	Solar
<b>Basecase Study Year</b>	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

The interconnection of the project at the Primary POI will be accomplished by expanding the FirstEnergy Weston 69 kV substation into a five (5) breaker ring bus station and providing a 69 kV line exit to the Primary POI. The interconnection will be completed in the AF1-064 generation project. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated attachment facilities.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AF2-126 generation project to connect to the FirstEnergy ("FE") transmission system. IC will be responsible for constructing all of the facilities on its side of the POI, including the attachment facilities which connect the generator to the FE transmission system's direct connection facilities.

## 5 Cost Summary

The AF2-126 project will be responsible for the following costs:

Description	Total Cost
<b>Total Physical Interconnection Costs</b>	\$ 40,000
<b>Total Transmission Owner Analysis Impacts (&lt;100 kV/Non-BES)</b>	\$ 8,509,569 <sup>1</sup>
<b>Total System Network Upgrade Costs</b>	\$ 36,439,750
<b>Total Costs</b>	\$ 44,989,319

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.

Cost allocations for any System Upgrades will be provided in the System Impact Study Report.

## 6 Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by expanding the FirstEnergy Weston 69 kV substation into a five (5) breaker ring bus station and providing a 69 kV line exit to the Primary POI. The interconnection will be completed in the AF1-064 generation project. The IC will be responsible for

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<sup>1</sup>The transmission owner identified overloads will be reviewed by PJM and FirstEnergy in the Impact Study phase to determine whether the queue customer has a cost responsibility to these overloads.

acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated attachment facilities.

The total physical interconnection costs is given in the table below:

Description	Total Cost
Update relaying settings and testing at Midway 69 kV.	\$ 20,000
Update relaying settings and testing at Bowling Green No2 69 kV (relays are owned by FE).	\$ 20,000
Total Physical Interconnection Costs	\$ 40,000

## 7 Schedule

Based on the scope of work for the Attachment Facilities and the Direct and/or Non-Direct Connection facilities, it is expected to take a minimum of 12 months after the signing of an Interconnection Construction Service Agreement to complete the installation. This includes the requirement for the IC to make a preliminary payment that compensates FE for the first three months of the engineering design work that is related to the construction of the interconnection substation. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined Direct Connection and network upgrades, and that all transmission system outages will be allowed when requested.

If the customer is ultimately responsible for any network upgrades, then the schedule for those upgrades will be refined in future study phases. The customer would need to wait for those upgrades to be completed prior to commercial operation unless determined deliverable by an interim deliverability study.

## 8 Transmission Owner Analysis

At the Primary POI, the AF2-126 project contributes to overloads on the FE Transmission <100 kV System as shown below. The estimated cost of system reinforcements required by FirstEnergy to mitigate these overloads is \$8,509,569. Bowling Green and AMPT will be notified of First Energy's analysis results and will need to conduct their own evaluation of these overloads during the Impact Study Phase.

These transmission owner identified overloads will be reviewed by PJM and First Energy in the Impact Study phase to determine whether the queue customer has a cost responsibility to these overloads.

Contingency Description	Overloaded Element	Rating (MVA)	AF2-126 MW Contrib.	FE Comments/Reinforcements
-------------------------	--------------------	--------------	---------------------	----------------------------

Midway-Weston 69 kV CK 1 Line Outage	Tontogany-Bowling Green No2 69 kV Line Section	64	26.5	The supplemental project s1953 has been included in the model when performing the Gen Deliverability analysis. The mitigation is to reconductor the line section from Tontogany-Bowling Green No2 69 kV and the line drop at Bowling Green No2 69 kV with 556.5 26/7 ACSR, replace the relaying at Bowling Green No2.
Brim-Bowling Green No5 69 kV CK1 Line Outage	Tontogany-Bowling Green No2 69 kV Line Section	64	10.5	PJM will notify Bowling Green and AMPT that First Energy identified overloads on their facilities.
Bowling Green No5-Bowling Green No7 69 kV CK1 Line Outage	Bowling Green No2-Bowling Green No3 69 kV Line	52	3.3	PJM will notify Bowling Green and AMPT that First Energy identified overloads on their facilities.

## 9 Interconnection Customer Requirements

### 9.1 System Protection

The IC must design its Customer Facilities in accordance with all applicable standards, including the standards in FE's "Requirements for Transmission Connected Facilities" document located at: <http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx>. Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the project enters the construction phase.

The IC has requested a non-standard GSU transformer winding configuration. This transformer is in violation of section 14.2.6 of FE's "Requirements for Transmission Connected Facilities" document and will not be accepted. The GSU transformer must have a grounded wye connection on the high (utility) side and a delta connection on the low (generator) side.

### 9.2 Compliance Issues and Interconnection Customer Requirements

The proposed Customer Facilities must be designed in accordance with FE's "Requirements for Transmission Connected Facilities" document located at: <http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx>. In particular, the IC is responsible for the following:

1. The purchase and installation of a fully rated 69 kV circuit breaker to protect the AF2-126 generator lead line. A single circuit breaker must be used to protect this line; if the project has several GSU transformers, the individual GSU transformer breakers cannot be used to protect this line.
2. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.
3. The purchase and installation of supervisory control and data acquisition ("SCADA") equipment to provide information in a compatible format to the FE Transmission System Control Center.
4. Compliance with the FE and PJM generator power factor and voltage control requirements.

5. The execution of a back-up service agreement to serve the customer load supplied from the AF2-126 generation project metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

The IC will also be required to meet all PJM, ReliabilityFirst, and NERC reliability criteria and operating procedures for standards compliance. For example, the IC will need to properly locate and report the over and under voltage and over and under frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE Transmission System.

### **9.3 Power Factor Requirements**

The IC shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) measured at the high-side of the facility substation transformer(s) connected to the FE Transmission System.

## **10 Revenue Metering and SCADA Requirements**

### **10.1 PJM Requirements**

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

### **10.2 Meteorological Data Reporting Requirements**

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

- Back panel temperature (Fahrenheit)
- Irradiance (Watts/meter<sup>2</sup>)
- 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 FE revenue metering requirements for generation interconnection customers which can be found in FE's "Requirements for Transmission Connected Facilities" document located at: <http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx>

## 11 Summer Peak - Load Flow Analysis

The Queue Project AF2-126 was evaluated as a 60.0 MW (Capacity 40.1 MW) uprate to AF1-064 which is an injection at the Weston 69 kV substation in the ATSI area. Project AF2-126 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-126 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

### 11.1 Generation Deliverability

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

None

### 11.2 Multiple Facility Contingency

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

None

### 11.3 Contribution to Previously Identified Overloads

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	ACIDC	MW IMPACT
100548068	238874	02LAKVEW	138.0	ATSI	238768	02GRNFLD	138.0	ATSI	1	ATSI-P7-1-TE-345-027A	tower	316.0	118.31	118.91	DC	4.22
95278127	238889	02LEMOYN	345.0	ATSI	242936	05FOSTOR	345.0	AEP	1	ATSI-P2-3-TE-345-034T	breaker	1409.0	120.81	121.84	DC	14.42
100548075	239030	02OTTAWA	138.0	ATSI	238874	02LAKVEW	138.0	ATSI	1	ATSI-P7-1-TE-345-027A	tower	380.0	115.2	115.7	DC	4.22
95277943	239154	02W.FREEM	138.0	ATSI	243009	05FRMNT	138.0	AEP	1	AEP_P2-2_#517_05FOSTOR 345_1	bus	361.0	117.46	117.97	DC	4.06
95278134	239154	02W.FREEM	138.0	ATSI	243009	05FRMNT	138.0	AEP	1	AEP_P4_#517_05FOSTOR 345_A1	breaker	361.0	117.46	117.97	DC	4.06
95703055	243009	05FRMNT	138.0	AEP	243008	05FREMCT	138.0	AEP	1	AEP_P2-2_#517_05FOSTOR 345_1	bus	251.0	106.0	106.61	DC	3.32
95703255	243009	05FRMNT	138.0	AEP	243008	05FREMCT	138.0	AEP	1	AEP_P4_#517_05FOSTOR 345_A1	breaker	251.0	106.0	106.61	DC	3.32

### 11.4 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	FRO M BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CK T ID	CONT NAME	Type	Ratin g MVA	PRE PROJECT LOADIN G %	POST PROJECT LOADIN G %	AC D C	MW IMPAC T
95278397	238889	02LEMOYN	345.0	ATSI	242936	05FOSTOR	345.0	AEP	1	ATSI-P1-2-TE-345-602T	operatio n	1409.0	119.78	120.8	DC	14.26

## 11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

ID	Idx	Facility	Upgrade Description	Cost
95277943,95278134	4	02W.FREM 138.0 kV - 05FRMNT 138.0 kV Ckt 1	<p><u>AEP</u>            AEPO0026b (450) : Replace 1200 A Switch at Fremont            Project Type : FAC            Cost : \$200,000            Time Estimate : 12-18 months</p> <p>AEPO0026d (452) : Replace three Sub Cond 1590 AAC 61 Str at Fremont            Project Type : FAC            Cost : \$300,000            Time Estimate : 12-18 months</p> <p>AEPO0026f (454) : Rebuild 7 miles of 138 kV line between Fremont Center and First Energy's West Fremont station with a bundled 795 ACSR conductor (Replacing ACSR ~ 1033.5 ~ 45/7 ~ ORTOLAN conductor). First Energy will need to be consulted due to the fact that they own a portion of the line conductor that limits the branch.            Project Type : FAC            Cost : \$10,500,000            Time Estimate : 24-36 months</p> <p><u>ATSI</u>            TE-012A (817) : For the Fremont-West Fremont 138 kV Line, reconductor the line drop at West Fremont with 954 ACSS. Reconductor the existing section of the 954 ACSR 48/7 with 954 ACSS. AEP would need to replace their section of limiting conductor and provide estimates for their replacement.            Project Type : FAC            Cost : \$1,761,750            Time Estimate : 18.0 months</p>	\$12,761,750

ID	Idx	Facility	Upgrade Description	Cost
95278127	2	02LEMOYN 345.0 kV - 05FOSTOR 345.0 kV Ckt 1	<u>AEP</u> AEPO0032a (473) : Sag study is required on 19.5 mile double circuit line between Forstoria Central and Lemoyne. The cost is expected to be 78,000. New ratings after sag Mitigation S/N: 1409 MVA, S/E: 1887MVA. Rebuild/Reconductor cost: \$29.2 million. Project Type : FAC Cost : \$78,000 Time Estimate : Sag Study : 6 - 12 months  <u>ATSI</u> Not a violation for ATSI portion	\$78,000
100548075	3	02OTTAWA 138.0 kV - 02LAKVEW 138.0 kV Ckt 1	<u>ATSI</u> b3033 (737) : Ottawa-Lakeview 138 kV Reconductor and Substation Upgrades. Projected in-service date: 12/01/2023 Months Project Type : FAC Cost : \$0	\$0
95703255,95703055	5	05FRMNT 138.0 kV - 05FREMCT 138.0 kV Ckt 1	<u>AEP</u> AEPO0020e (426) : A sag study will be required on the 4.0 miles of ACSR ~ 795 ~ 45/7 ~ TERN - Conductor Section 1 to mitigate the overload. Depending on the sag study results, the cost for this upgrade is expected to be around \$20,000 (no remediation required, just sag study) and \$6 million (complete line reconductor/rebuild). New rating after sag study: S/N:251 S/E: 335 MVA. 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 : \$20,000 Time Estimate : Sag Study : 6 - 12 months	\$20,000
100548068	1	02LAKVEW 138.0 kV - 02GRNFLD 138.0 kV Ckt 1	<u>ATSI</u> OEC-011-B (773) : Reconductor roughly 13.1 miles of the Greenfield-Lakeview 138 kV Line (currently bundled 336 ACSR) with 795 ACSS conductor. Replace two 1200A line switches with 2000A line switches. Upgrade 500 CU substation conductor at Greenfield to exceed line ratings of 795 ACSS. Upgrade RT for B-242 to exceed line ratings of 795 ACSS. Project Type : Facility Cost : \$23,580,000 Time Estimate : 24.0 months	\$23,580,000
			TOTAL COST	\$36,439,750

## 11.6 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".

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## 11.6.1 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
100548068	238874	02LAKVEW	ATSI	238768	02GRNFLD	ATSI	1	ATSI-P7-1-TE-345-027A	tower	316.0	118.31	118.91	DC	4.22

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
238979	02NAPMUN	2.0137	Adder	2.37
247548	V4-010 C	1.4173	Adder	1.67
247551	U4-028 C (Suspended)	0.6058	Adder	0.71
247552	U4-029 C (Suspended)	0.6058	Adder	0.71
247940	U4-028 E (Suspended)	4.0539	Adder	4.77
247941	U4-029 E (Suspended)	4.0539	Adder	4.77
247947	V4-010 E	9.4848	Adder	11.16
931951	AB1-107 1	20.4819	Adder	24.1
931961	AB1-107 2	33.3903	Adder	39.28
934252	AD1-052 E1	0.4965	Adder	0.58
934262	AD1-052 E2	0.4965	Adder	0.58
934461	AD1-070 C O1	1.5523	Adder	1.83
934462	AD1-070 E O1	7.2874	Adder	8.57
934891	AD1-118	3.6503	Adder	4.29
937021	AD2-136 C O1	2.1807	Adder	2.57
937022	AD2-136 E O1	14.5942	Adder	17.17
937381	AD2-191 C (Withdrawn : 06/03/2020)	1.0298	Adder	1.21
937382	AD2-191 E (Withdrawn : 06/03/2020)	6.8917	Adder	8.11
938911	AE1-119	28.6811	Adder	33.74
941741	AE2-174 C	1.8997	Adder	2.23
941742	AE2-174 E	8.8934	Adder	10.46
941781	AE2-181 C	1.5261	Adder	1.8
941782	AE2-181 E	1.0174	Adder	1.2
942661	AE2-282 C O1	2.3452	Adder	2.76
942662	AE2-282 E O1	1.2341	Adder	1.45
943961	AF1-064 C O1	1.9970	Adder	2.35
943962	AF1-064 E O1	0.9925	Adder	1.17
944551	AF1-120 C	1.4210	Adder	1.67
944552	AF1-120 E	0.7159	Adder	0.84
945401	AF1-205 C O1	1.3062	Adder	1.54
945402	AF1-205 E O1	0.8708	Adder	1.02
945411	AF1-206 C O1	6.3786	Adder	7.5
945412	AF1-206 E O1	4.2524	Adder	5.0
958321	AF2-126 C	1.2707	Adder	2.82
958322	AF2-126 E	0.6306	Adder	1.4
960301	AF2-321 C	2.3259	Adder	5.16
960302	AF2-321 E	1.5506	Adder	3.44
960841	AF2-375 C O1	1.7771	Adder	3.94
960842	AF2-375 E O1	1.1847	Adder	2.63

<b>Bus #</b>	<b>Bus</b>	<b>Gendeliv MW Impact</b>	<b>Type</b>	<b>Full MW Impact</b>
<b>960951</b>	AF2-386 C O1	0.1705	Adder	0.38
<b>960952</b>	AF2-386 E O1	0.2354	Adder	0.52
<b>WEC</b>	WEC	0.5683	Confirmed LTF	0.5683
<b>LGEE</b>	LGEE	0.7057	Confirmed LTF	0.7057
<b>CPL</b>	CPL	0.1449	Confirmed LTF	0.1449
<b>CBM-W2</b>	CBM-W2	10.1802	Confirmed LTF	10.1802
<b>NY</b>	NY	0.6371	Confirmed LTF	0.6371
<b>CBM-W1</b>	CBM-W1	33.3392	Confirmed LTF	33.3392
<b>TVA</b>	TVA	1.3230	Confirmed LTF	1.3230
<b>O-066</b>	O-066	6.5184	Confirmed LTF	6.5184
<b>CBM-S2</b>	CBM-S2	2.2137	Confirmed LTF	2.2137
<b>CBM-S1</b>	CBM-S1	8.5115	Confirmed LTF	8.5115
<b>G-007</b>	G-007	1.0015	Confirmed LTF	1.0015
<b>MADISON</b>	MADISON	0.6733	Confirmed LTF	0.6733
<b>MEC</b>	MEC	2.5249	Confirmed LTF	2.5249

## 11.6.2 Index 2

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC DC	MW IMPACT
95278127	238889	02LEMOYN	ATSI	242936	05FOSTOR	AEP	1	ATSI-P2-3-TE-345-034T	breaker	1409.0	120.81	121.84	DC	14.42

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
238564	02BAYSG1	6.0928	50/50	6.0928
238670	02DVBSG1 (Deactivation : 31/05/2020)	26.8333	50/50	26.8333
238885	02LEMOG1	9.2520	50/50	9.2520
238886	02LEMOG2	9.2520	50/50	9.2520
238887	02LEMOG3	9.2520	50/50	9.2520
238888	02LEMOG4	9.2520	50/50	9.2520
238979	02NAPMUN	7.2307	Adder	8.51
239293	02BS-PKR	0.5319	50/50	0.5319
241902	Y1-069 GE	34.5794	50/50	34.5794
244357	05GRANGER EL	-0.4435	Adder	-0.52
247549	V3-028 C	-0.7293	Adder	-0.86
925131	AB2-170 C O1	-4.7407	Adder	-5.58
927181	AC1-212 C	-0.1107	Adder	-0.13
927183	AC1-212 BAT	1.3643	Merchant Transmission	1.3643
931951	AB1-107 1	61.8433	50/50	61.8433
931961	AB1-107 2	140.5647	50/50	140.5647
932791	AC2-103 C	5.9676	Adder	7.02
932792	AC2-103 E	39.9438	Adder	46.99
934252	AD1-052 E1	0.6594	Adder	0.78
934262	AD1-052 E2	0.6594	Adder	0.78
934761	AD1-103 C O1	10.0337	Adder	11.8
934762	AD1-103 E O1	67.1485	Adder	79.0
934891	AD1-118	23.4661	50/50	23.4661
936722	AD2-091 BAT	5.6450	Merchant Transmission	5.6450
938911	AE1-119	184.3765	50/50	184.3765
941761	AE2-176 C	8.8173	Adder	10.37
941762	AE2-176 E	5.8782	Adder	6.92
941781	AE2-181 C	5.0290	Adder	5.92
941782	AE2-181 E	3.3527	Adder	3.94
942042	AE2-216 BAT	6.2095	Merchant Transmission	6.2095
942661	AE2-282 C O1	7.8429	Adder	9.23
942662	AE2-282 E O1	4.1269	Adder	4.86
943012	AE2-324 BAT	2.2397	Merchant Transmission	2.2397
943951	AF1-063 C O1	1.1198	Adder	1.32
943952	AF1-063 E O1	0.6208	Adder	0.73
943961	AF1-064 C O1	8.0247	50/50	8.0247
943962	AF1-064 E O1	3.9883	50/50	3.9883
944551	AF1-120 C	4.7522	Adder	5.59
944552	AF1-120 E	2.3940	Adder	2.82
945341	AF1-199	0.2948	Adder	0.35

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
945401	AF1-205 C O1	4.6902	Adder	5.52
945402	AF1-205 E O1	3.1268	Adder	3.68
945411	AF1-206 C O1	21.3312	Adder	25.1
945412	AF1-206 E O1	14.2208	Adder	16.73
945623	AF1-227 BAT	7.6910	Merchant Transmission	7.6910
946052	AF1-270 BAT	4.2155	Merchant Transmission	4.2155
946141	AF1-279 C	7.4213	Adder	8.73
946142	AF1-279 E	4.9475	Adder	5.82
946203	AF1-285 BAT	2.0972	Merchant Transmission	2.0972
950311	G934 C	2.4678	PJM External (MISO)	2.4678
950312	G934 E	9.8712	PJM External (MISO)	9.8712
950351	J466	3.8355	PJM External (MISO)	3.8355
950791	J201 C	0.4628	PJM External (MISO)	0.4628
950792	J201 E	1.8510	PJM External (MISO)	1.8510
950871	J246 C	0.1249	PJM External (MISO)	0.1249
950872	J246 E	0.4995	PJM External (MISO)	0.4995
950942	J325 E	0.5268	PJM External (MISO)	0.5268
951531	J533 C	3.5680	PJM External (MISO)	3.5680
951532	J533 E	14.2720	PJM External (MISO)	14.2720
951571	J538 C	3.9219	PJM External (MISO)	3.9219
951572	J538 E	15.6876	PJM External (MISO)	15.6876
951941	J602 C	3.4554	PJM External (MISO)	3.4554
951942	J602 E	18.6946	PJM External (MISO)	18.6946
952201	J589 C	2.9456	PJM External (MISO)	2.9456
952202	J589 E	15.9364	PJM External (MISO)	15.9364
952312	J646 E	0.2274	PJM External (MISO)	0.2274
952401	J752 C	1.9542	PJM External (MISO)	1.9542
952402	J752 E	10.5728	PJM External (MISO)	10.5728
952611	J717 C	3.2570	PJM External (MISO)	3.2570
952612	J717 E	17.6214	PJM External (MISO)	17.6214
952761	J728 C	3.0290	PJM External (MISO)	3.0290
952762	J728 E	16.4096	PJM External (MISO)	16.4096
952881	J758	15.7180	PJM External (MISO)	15.7180
952971	J793	187.6579	PJM External (MISO)	187.6579
953071	J794 C	0.1930	PJM External (MISO)	0.1930
953072	J794 E	1.0442	PJM External (MISO)	1.0442
953271	J701 C	0.9516	PJM External (MISO)	0.9516
953272	J701 E	5.1484	PJM External (MISO)	5.1484
953291	J796	25.9028	PJM External (MISO)	25.9028
953321	J799	32.2585	PJM External (MISO)	32.2585
953361	J806	14.3860	PJM External (MISO)	14.3860
953771	J832	9.0250	PJM External (MISO)	9.0250
953781	J833	17.4510	PJM External (MISO)	17.4510
953811	J839	13.8170	PJM External (MISO)	13.8170
953941	J857	10.9781	PJM External (MISO)	10.9781
954111	J875	23.2140	PJM External (MISO)	23.2140
955071	J984 C	2.5665	PJM External (MISO)	2.5665
955072	J984 E	13.8855	PJM External (MISO)	13.8855
955121	J989	9.8408	PJM External (MISO)	9.8408
955181	J996	14.4680	PJM External (MISO)	14.4680
955261	J1005	21.6620	PJM External (MISO)	21.6620
955591	J1043 C	1.3966	PJM External (MISO)	1.3966

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
955592	J1043 E	24.7478	PJM External (MISO)	24.7478
955781	J1062	35.4870	PJM External (MISO)	35.4870
955861	J1071	6.2790	PJM External (MISO)	6.2790
956011	J1088	16.4145	PJM External (MISO)	16.4145
956021	J1089	18.7544	PJM External (MISO)	18.7544
956031	J1090	10.9080	PJM External (MISO)	10.9080
956161	J1103	2.4898	PJM External (MISO)	2.4898
956741	J1172	5.8955	PJM External (MISO)	5.8955
956751	J1173	12.8360	PJM External (MISO)	12.8360
956801	J1178	7.1201	PJM External (MISO)	7.1201
957031	AF2-004 1	0.4413	Adder	0.98
957041	AF2-004 2	0.4413	Adder	0.98
957051	AF2-004 3	0.4413	Adder	0.98
957061	AF2-004 4	0.4413	Adder	0.98
957111	AF2-005	0.3743	Adder	0.83
958321	AF2-126 C	9.6344	50/50	9.6344
958322	AF2-126 E	4.7812	50/50	4.7812
958331	AF2-127 C	0.7657	Adder	1.7
958332	AF2-127 E	0.4028	Adder	0.89
960301	AF2-321 C	7.2712	Adder	16.14
960302	AF2-321 E	4.8475	Adder	10.76
960951	AF2-386 C O1	0.5568	Adder	1.24
960952	AF2-386 E O1	0.7690	Adder	1.71
NEWTON	NEWTON	1.3163	Confirmed LTF	1.3163
FARMERCITY	FARMERCITY	0.0477	Confirmed LTF	0.0477
G-007A	G-007A	0.1534	Confirmed LTF	0.1534
VFT	VFT	0.4709	Confirmed LTF	0.4709
CALDERWOOD	CALDERWOOD	0.8563	Confirmed LTF	0.8563
CBM-W1	CBM-W1	52.7922	Confirmed LTF	52.7922
PRAIRIE	PRAIRIE	3.0273	Confirmed LTF	3.0273
CHEOAH	CHEOAH	0.8594	Confirmed LTF	0.8594
EDWARDS	EDWARDS	0.1589	Confirmed LTF	0.1589
TILTON	TILTON	0.6439	Confirmed LTF	0.6439
MADISON	MADISON	5.2154	Confirmed LTF	5.2154
GIBSON	GIBSON	0.9315	Confirmed LTF	0.9315
BLUEG	BLUEG	3.7862	Confirmed LTF	3.7862
TRIMBLE	TRIMBLE	1.2265	Confirmed LTF	1.2265
CATAWBA	CATAWBA	0.5492	Confirmed LTF	0.5492



### 11.6.3 Index 3

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC DC	MW IMPACT
100548075	239030	02OTTAWA	ATSI	238874	02LAKVEW	ATSI	1	ATSI-P7-1-TE-345-027A	tower	380.0	115.2	115.7	DC	4.22

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
238979	02NAPMUN	2.0137	Adder	2.37
247548	V4-010 C	1.4173	Adder	1.67
247551	U4-028 C (Suspended)	0.6058	Adder	0.71
247552	U4-029 C (Suspended)	0.6058	Adder	0.71
247940	U4-028 E (Suspended)	4.0539	Adder	4.77
247941	U4-029 E (Suspended)	4.0539	Adder	4.77
247947	V4-010 E	9.4848	Adder	11.16
931951	AB1-107 1	20.4819	Adder	24.1
931961	AB1-107 2	33.3903	Adder	39.28
934252	AD1-052 E1	0.4965	Adder	0.58
934262	AD1-052 E2	0.4965	Adder	0.58
934461	AD1-070 C O1	1.5523	Adder	1.83
934462	AD1-070 E O1	7.2874	Adder	8.57
934891	AD1-118	3.6503	Adder	4.29
937021	AD2-136 C O1	2.1807	Adder	2.57
937022	AD2-136 E O1	14.5942	Adder	17.17
937381	AD2-191 C (Withdrawn : 06/03/2020)	1.0298	Adder	1.21
937382	AD2-191 E (Withdrawn : 06/03/2020)	6.8917	Adder	8.11
938911	AE1-119	28.6811	Adder	33.74
941741	AE2-174 C	1.8997	Adder	2.23
941742	AE2-174 E	8.8934	Adder	10.46
941781	AE2-181 C	1.5261	Adder	1.8
941782	AE2-181 E	1.0174	Adder	1.2
942661	AE2-282 C O1	2.3452	Adder	2.76
942662	AE2-282 E O1	1.2341	Adder	1.45
943961	AF1-064 C O1	1.9970	Adder	2.35
943962	AF1-064 E O1	0.9925	Adder	1.17
944551	AF1-120 C	1.4210	Adder	1.67
944552	AF1-120 E	0.7159	Adder	0.84
945401	AF1-205 C O1	1.3062	Adder	1.54
945402	AF1-205 E O1	0.8708	Adder	1.02
945411	AF1-206 C O1	6.3786	Adder	7.5
945412	AF1-206 E O1	4.2524	Adder	5.0
958321	AF2-126 C	1.2707	Adder	2.82
958322	AF2-126 E	0.6306	Adder	1.4
960301	AF2-321 C	2.3259	Adder	5.16
960302	AF2-321 E	1.5506	Adder	3.44
960841	AF2-375 C O1	1.7771	Adder	3.94
960842	AF2-375 E O1	1.1847	Adder	2.63

<b>Bus #</b>	<b>Bus</b>	<b>Gendeliv MW Impact</b>	<b>Type</b>	<b>Full MW Impact</b>
<b>960951</b>	AF2-386 C O1	0.1705	Adder	0.38
<b>960952</b>	AF2-386 E O1	0.2354	Adder	0.52
<b>WEC</b>	WEC	0.5683	Confirmed LTF	0.5683
<b>LGEE</b>	LGEE	0.7057	Confirmed LTF	0.7057
<b>CPL</b>	CPL	0.1449	Confirmed LTF	0.1449
<b>CBM-W2</b>	CBM-W2	10.1802	Confirmed LTF	10.1802
<b>NY</b>	NY	0.6371	Confirmed LTF	0.6371
<b>CBM-W1</b>	CBM-W1	33.3392	Confirmed LTF	33.3392
<b>TVA</b>	TVA	1.3230	Confirmed LTF	1.3230
<b>O-066</b>	O-066	6.5184	Confirmed LTF	6.5184
<b>CBM-S2</b>	CBM-S2	2.2137	Confirmed LTF	2.2137
<b>CBM-S1</b>	CBM-S1	8.5115	Confirmed LTF	8.5115
<b>G-007</b>	G-007	1.0015	Confirmed LTF	1.0015
<b>MADISON</b>	MADISON	0.6733	Confirmed LTF	0.6733
<b>MEC</b>	MEC	2.5249	Confirmed LTF	2.5249

#### 11.6.4 Index 4

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 %	ACID C	MW IMPACT
95278134	239154	02W.FRE M	ATSI	243009	05FRMN T	AEP	1	AEP_P4_#517_05FOSTO R 345_A1	breaker	361.0	117.46	117.97	DC	4.06

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
238601	02FRMENG 1	6.3641	50/50	6.3641
238602	02FRMENG 2	6.3641	50/50	6.3641
238603	02FRMENG 3	11.4892	50/50	11.4892
238979	02NAPMUN	1.8059	Adder	2.12
244357	05GRANGER EL	-0.2410	Adder	-0.28
931951	AB1-107 1	17.8671	Adder	21.02
931961	AB1-107 2	31.9600	Adder	37.6
932791	AC2-103 C	1.6818	Adder	1.98
932792	AC2-103 E	11.2572	Adder	13.24
934251	AD1-052 C1	0.4723	50/50	0.4723
934252	AD1-052 E1	1.2180	50/50	1.2180
934261	AD1-052 C2	0.4723	50/50	0.4723
934262	AD1-052 E2	1.2180	50/50	1.2180
934761	AD1-103 C O1	2.8277	Adder	3.33
934762	AD1-103 E O1	18.9241	Adder	22.26
934891	AD1-118	3.7497	Adder	4.41
938911	AE1-119	29.4618	Adder	34.66
941761	AE2-176 C	9.9818	50/50	9.9818
941762	AE2-176 E	6.6545	50/50	6.6545
941781	AE2-181 C	1.2507	Adder	1.47
941782	AE2-181 E	0.8338	Adder	0.98
942661	AE2-282 C O1	1.9699	Adder	2.32
942662	AE2-282 E O1	1.0365	Adder	1.22
943961	AF1-064 C O1	1.9214	Adder	2.26
943962	AF1-064 E O1	0.9550	Adder	1.12
944551	AF1-120 C	1.1936	Adder	1.4
944552	AF1-120 E	0.6013	Adder	0.71
945401	AF1-205 C O1	1.1714	Adder	1.38
945402	AF1-205 E O1	0.7809	Adder	0.92
945411	AF1-206 C O1	5.3577	Adder	6.3
945412	AF1-206 E O1	3.5718	Adder	4.2
958321	AF2-126 C	1.2226	Adder	2.71
958322	AF2-126 E	0.6067	Adder	1.35
NEWTON	NEWTON	0.5093	Confirmed LTF	0.5093
FARMERCITY	FARMERCITY	0.0208	Confirmed LTF	0.0208
G-007A	G-007A	0.0456	Confirmed LTF	0.0456
VFT	VFT	0.1354	Confirmed LTF	0.1354
CALDERWOOD	CALDERWOOD	0.2952	Confirmed LTF	0.2952
CBM-W1	CBM-W1	12.4224	Confirmed LTF	12.4224
PRAIRIE	PRAIRIE	1.1830	Confirmed LTF	1.1830
CHEOAH	CHEOAH	0.2963	Confirmed LTF	0.2963
EDWARDS	EDWARDS	0.0941	Confirmed LTF	0.0941

<b>Bus #</b>	<b>Bus</b>	<b>Gendeliv MW Impact</b>	<b>Type</b>	<b>Full MW Impact</b>
<b>TILTON</b>	TILTON	0.2652	Confirmed LTF	0.2652
<b>MADISON</b>	MADISON	1.4193	Confirmed LTF	1.4193
<b>GIBSON</b>	GIBSON	0.3298	Confirmed LTF	0.3298
<b>BLUEG</b>	BLUEG	1.2760	Confirmed LTF	1.2760
<b>TRIMBLE</b>	TRIMBLE	0.4129	Confirmed LTF	0.4129
<b>CATAWBA</b>	CATAWBA	0.1879	Confirmed LTF	0.1879

## 11.6.5 Index 5

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 %	ACID C	MW IMPACT
95703255	243009	05FRMNT	AEP	243008	05FREMC T	AEP	1	AEP_P4_#517_05FOSTOR 345_A1	breaker	251.0	106.0	106.61	DC	3.32

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
238601	02FRMENG 1	5.1993	50/50	5.1993
238602	02FRMENG 2	5.1993	50/50	5.1993
238603	02FRMENG 3	9.3862	50/50	9.3862
244357	05GRANGER EL	-0.1965	Adder	-0.23
931951	AB1-107 1	14.5975	Adder	17.17
931961	AB1-107 2	26.1079	Adder	30.72
934251	AD1-052 C1	0.3858	50/50	0.3858
934252	AD1-052 E1	0.9951	50/50	0.9951
934261	AD1-052 C2	0.3858	50/50	0.3858
934262	AD1-052 E2	0.9951	50/50	0.9951
934891	AD1-118	3.0643	Adder	3.61
938911	AE1-119	24.0763	Adder	28.33
941761	AE2-176 C	8.1525	50/50	8.1525
941762	AE2-176 E	5.4350	50/50	5.4350
943961	AF1-064 C O1	1.5703	Adder	1.85
943962	AF1-064 E O1	0.7804	Adder	0.92
958321	AF2-126 C	0.9992	Adder	2.22
958322	AF2-126 E	0.4959	Adder	1.1
NEWTON	NEWTON	0.4115	Confirmed LTF	0.4115
FARMERCITY	FARMERCITY	0.0168	Confirmed LTF	0.0168
G-007A	G-007A	0.0336	Confirmed LTF	0.0336
VFT	VFT	0.1032	Confirmed LTF	0.1032
CALDERWOOD	CALDERWOOD	0.2401	Confirmed LTF	0.2401
CBM-W1	CBM-W1	10.1957	Confirmed LTF	10.1957
PRAIRIE	PRAIRIE	0.9557	Confirmed LTF	0.9557
CHEOAH	CHEOAH	0.2407	Confirmed LTF	0.2407
EDWARDS	EDWARDS	0.0753	Confirmed LTF	0.0753
TILTON	TILTON	0.2136	Confirmed LTF	0.2136
MADISON	MADISON	1.1592	Confirmed LTF	1.1592
GIBSON	GIBSON	0.2670	Confirmed LTF	0.2670
BLUEG	BLUEG	1.0364	Confirmed LTF	1.0364
TRIMBLE	TRIMBLE	0.3350	Confirmed LTF	0.3350
CATAWBA	CATAWBA	0.1530	Confirmed LTF	0.1530

## 11.7 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
AB1-107	Bayshore-GM Powertrain 138 kV & Lallendorf 345kV	Engineering and Procurement
AB2-019	Erie West 345kV	Engineering and Procurement
AB2-170	East Lima-Marysville 345kV	Under Construction
AC1-051	Willard-S. Greenwich 69kV	Active
AC1-212	Minster 69kV	Engineering and Procurement
AC2-015	Chatfield-Howard 138kV	Active
AC2-103	Beaver-Davis Besse 345 kV I	Active
AD1-052	Freemont Energy Center	Under Construction
AD1-070	Fostoria Central 138 kV	Active
AD1-101	Continental 69 kV	Active
AD1-103	Beaver-Davis Besse 345 kV II	Active
AD1-118	Lemoyne	Active
AD2-075	Segreto 345kV	Active
AD2-091	Hardin Tap 345kV	Active
AD2-136	Melmore Tap 138kV	Active
AD2-191	Melmore 138kV	Withdrawn
AE1-119	Lemoyne 345 kV	Active
AE1-146	Ebersole #2-Fostoria Central 138 kV	Active
AE2-072	East Leipsic-Richland 138 kV	Active
AE2-174	Seneca 138 kV	Active
AE2-176	Groton 138 kV Solar	Active
AE2-181	Snyder 69kV	Active
AE2-216	Hardin Switch 345 kV	Active
AE2-282	East Fayette 138 kV	Active
AE2-324	Galion-Roberts South II 138 kV	Active
AF1-063	Lockwood Road 138 kV	Active
AF1-064	Weston 69 kV	Active
AF1-120	East Fayette 2 138 kV	Active
AF1-199	Avon Lake 10 138 kV	Partially in Service - Under Construction
AF1-205	Napoleon Muni 138 kV	Active
AF1-206	Fayette-Lyons 138 kV	Active
AF1-227	Marysville-East Lima 345 kV	Active
AF1-229	Galion-South Berwick 345 kV	Active
AF1-270	Blue Jacket-Kirby 138 kV	Active
AF1-279	Carlisle 138 kV	Active
AF1-285	Gunn Road 345 kV	Active
AF2-004	Beaver 345 kV	Active
AF2-005	Beaver 138 kV	Active

Queue Number	Project Name	Status
AF2-126	Weston 69 kV II	Active
AF2-127	Lockwood Road 138 kV	Active
AF2-209	South Hicksville 138 kV	Active
AF2-321	Stryker-Ridgeville 138 kV	Active
AF2-375	Fostoria Central 138 kV	Active
AF2-386	Bryan 69 kV	Active
U1-059	Ada-Dunkirk 69kV	In Service
U4-028	Fostoria Central-Greenlawn-Howard 138kV	Suspended
U4-029	Fostoria Central-Greenlawn-Howard 138kV	Suspended
V3-028	East Lima-Marysville 345kV	Under Construction
V4-010	Tiffin Center 138kV	Engineering and Procurement
W1-056	Ada-Dunkirk 69kV	In Service
Y1-069	Bay Shore-Fostoria Central 345kV & Bayshore-Monroe 345kV	In Service
Y3-092	Erie West 345kV	Engineering and Procurement
J1005	MISO	MISO
J1043	MISO	MISO
J1062	MISO	MISO
J1071	MISO	MISO
J1088	MISO	MISO
J1089	MISO	MISO
J1090	MISO	MISO
J1103	MISO	MISO
J1172	MISO	MISO
J1173	MISO	MISO
J1178	MISO	MISO
J201	MISO	MISO
J246	MISO	MISO
J325	MISO	MISO
J466	MISO	MISO
J533	MISO	MISO
J538	MISO	MISO
J589	MISO	MISO
J602	MISO	MISO
J646	MISO	MISO
J701	MISO	MISO
J717	MISO	MISO
J728	MISO	MISO
J752	MISO	MISO
J758	MISO	MISO
J793	MISO	MISO
J794	MISO	MISO
J796	MISO	MISO
J799	MISO	MISO
J806	MISO	MISO
J832	MISO	MISO
J833	MISO	MISO
J839	MISO	MISO
J857	MISO	MISO
J875	MISO	MISO
J984	MISO	MISO
J989	MISO	MISO
J996	MISO	MISO

## 11.8 Contingency Descriptions

Contingency Name	Contingency Definition
<b>AEP_P4_#517_05FOSTOR 345_A1</b>	CONTINGENCY 'AEP_P4_#517_05FOSTOR 345_A1' OPEN BRANCH FROM BUS 241901 TO BUS 242936 CKT 1 / 241901 02LALLEND
<b>AEP_P2-2_#517_05FOSTOR 345_1</b>	CONTINGENCY 'AEP_P2-2_#517_05FOSTOR 345_1' OPEN BRANCH FROM BUS 241901 TO BUS 242936 CKT 1 / 241901 02LALLEND
<b>ATSI-P7-1-TE-345-027A</b>	CONTINGENCY 'ATSI-P7-1-TE-345-027A' /* DB - X1-027A & DB - HAYES 345 DISCONNECT BRANCH FROM BUS 238654 TO BUS 907060 CKT 1 /* 02DAV-BE 345 X1-027A_AT12 345 DISCONNECT BRANCH FROM BUS 238654 TO BUS 239289 CKT 1 /* 02DAV-BE 345 02HAYES 345 END
<b>ATSI-P1-2-TE-345-602T</b>	CONTINGENCY 'ATSI-P1-2-TE-345-602T' /*LINE OUTAGE: LALLEND
<b>ATSI-P2-3-OEC-345-026</b>	CONTINGENCY 'ATSI-P2-3-OEC-345-026' /* BEAVER 345KV BRK B-182 DISCONNECT BRANCH FROM BUS 238569 TO BUS 907060 CKT 1 /* 02BEAVER 345 X1-027A TAP 345 DISCONNECT BRANCH FROM BUS 238569 TO BUS 239171 CKT 1 /* 02BEAVER 345 02WLORG-2 14 DISCONNECT BRANCH FROM BUS 238569 TO BUS 239172 CKT 1 /* 02BEAVER 345 02WLORG-3 14 DISCONNECT BRANCH FROM BUS 238569 TO BUS 239173 CKT 1 /* 02BEAVER 345 02WLORG-4 14 DISCONNECT BRANCH FROM BUS 238569 TO BUS 239174 CKT 1 /* 02BEAVER 345 02WLORG-5 14 REMOVE MACHINE 2 FROM BUS 239171 /* 02WLORG-2 14 REMOVE MACHINE 3 FROM BUS 239172 /* 02WLORG-3 14 REMOVE MACHINE 4 FROM BUS 239173 /* 02WLORG-4 14 REMOVE MACHINE 5 FROM BUS 239174 /* 02WLORG-5 14 DISCONNECT BUS 239171 /* 02WLORG-2 14 DISCONNECT BUS 239172 /* 02WLORG-3 14 DISCONNECT BUS 239173 /* 02WLORG-4 14 DISCONNECT BUS 239174 /* 02WLORG-5 14 END
<b>ATSI-P2-3-TE-345-034T</b>	CONTINGENCY 'ATSI-P2-3-TE-345-034T' /* LALLEND



## **12 Short Circuit Analysis**

Short circuit analysis will be provided in the System Impact Study report.

## **13 Affected Systems**

### **13.1 NYISO**

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

### **13.2 MISO**

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

## 14 Attachment 1: One Line Diagram



**Generation Interconnection  
System Impact Study Report  
for  
Queue Project AF2-126  
WESTON 69 KV II  
34 MW Capacity / 51 MW Energy**

February 2021

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## 1 Introduction

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

## 2 Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances an Interconnection Customer may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement. The possibility of sharing the reinforcement costs with other projects may be identified in the Feasibility Study, but the actual allocation will be deferred until the System Impact Study is performed.

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

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

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

### 3 General

The Interconnection Customer (IC) has proposed an uprate to a planned solar generating facility located in Wood, Ohio. This project is an increase to the Interconnection Customer's AF1-064 project, which will share the same point of interconnection. The AF2-126 queue position is a 51 MW uprate (34 MW Capacity uprate) to the previous project. The total installed facilities will have a capability of 101 MW with 67.4 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this uprate project is December 31, 2021. This study does not imply a TO commitment to this in-service date.

<b>Queue Number</b>	<b>AF2-126</b>
<b>Project Name</b>	WESTON 69 KV II
<b>State</b>	Ohio
<b>County</b>	Wood
<b>Transmission Owner</b>	ATSI
<b>MFO</b>	101
<b>MWE</b>	51
<b>MWC</b>	34
<b>Fuel</b>	Solar
<b>Basecase Study Year</b>	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

AF2-126 will interconnect with the ATSI on transmission system as an uprate to AF1-064 at the Weston 69 kV Substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required.

Attachment 1 shows a one-line diagram of the proposed primary Direct Connection facilities for the AF2-126 generation project to connect to the FirstEnergy ("FE") transmission system. IC will be responsible for constructing all of the facilities on its side of the POI, including the Attachment Facilities which connect the generator to the FE transmission system.

## 5 Cost Summary

The AF2-126 project will be responsible for the following costs:

Description	Total Cost
<b>Total Physical Interconnection Costs</b>	\$300,200
<b>Total System Network Upgrade Costs (PJM Identified)</b>	\$0
<b>Total System Network Upgrade Costs (TO Identified)</b>	\$75,472
<b>Total Costs</b>	<b>\$375,672</b>

\*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.

Note 2: For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates \$0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a



System Reinforcement is presently \$0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

## 6 Transmission Owner Scope of Work

AF2-126 will interconnect with the ATSI on transmission system as an uprate to AF1-064 at the Weston 69 kV Substation. No additional interconnection facilities are required. The IC will be responsible for acquiring all easements, properties, and permits that may be required.

If the AF1-064 project withdraws from the New Services Queue, the AF2-126 project will be responsible for the interconnection facilities identified in the AF1-064 Facilities Study Agreement.

The total physical interconnection costs is given in the table below:

Description	Total Cost
Review drawings, nameplates, relay settings at AF2-126 Gen	\$14,000
Relay settings changes at Midway	\$95,400
Relay settings changes at Bowling Green No2	\$95,400
Relay settings changes at Weston	\$95,400
<b>Total Physical Interconnection Costs</b>	<b>\$300,200</b>

## 7 Schedule

Based on the scope of work for the interconnection facilities, it is expected to take a minimum of **6 months** after the signing of an Interconnection Construction Service Agreement and construction kickoff call to complete the installation of the physical connection work. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined interconnection work, and that all system outages will be allowed when requested.

The schedule for any required Network Impact Reinforcements will be more clearly identified in future study phases. The estimated time to complete each of the required reinforcements is identified in the "System Reinforcements" section of the report.

## 8 Transmission Owner Analysis

### 8.1 Transmission Owner Identified Network Impacts to Distribution Facilities

Potential TO identified network impacts to Transmission Owner distribution facilities were as follows:

None

### 8.2 Transmission Owner Identified Network Impacts to Sub-Regional Facilities

Potential TO identified network impacts to Transmission Owner Sub-Regional facilities were as follows:

Idx	Overloaded Element	Contingency	Rating [MVA]	Loading Before %	Loading After %	Contribution [MW]
37	240843 02BG2 69.0 240844 02BG3 69.0 1	ATSI-P1-2-TE-69-008[OP]	52	92.79%	104.23%	5.95
34	240902 02TNTGON 69.0 240843 02BG2 69.0 1	ATSI-P1-2-TE-69-009[OP]	52	86.40%	110.62%	15.51

### 8.3 System Reinforcements on Distribution Facilities

None

## 8.4 System Reinforcements on Sub-Regional Facilities

Idx	Facility	Upgrade ID	Upgrade Description	Cost	Cost Allocated to AF2-343	Queue Dependencies
37	240843 02BG2 69.0 240844 02BG3 69.0 1	TBD	Not FE Owned. This equipment is owned by Bowling Green. Will be evaluated during Facility Study.	TBD	TBD	N/A
34	240902 02TNTGON 69.0 240843 02BG2 69.0 1	TE-AG1-F-0008	<p><b>ATSI</b>  <b>TE-AG1-F-0008:</b> Replace existing sections of 250 CU 19 subconductor circular at Bowling Green -2 with a conductor able to meet or exceed 83 MVA STE.</p> <p>Reconductor existing sections of 3/0 ACSR 6/1 at Tontogany T - Bowling Green -2 with a conductor able to meet or exceed 83 MVA STE.</p> <p>Replace (1) 5.5 A relay thermal at Sharon.</p> <p>Time Estimate: 12 Cost: \$75,472</p>	\$75,472	\$75,472	N/A
			<b>TOTAL COST</b>	<b>\$75,472</b>	<b>\$75,472</b>	

## 9 Customer Requirements

### 9.1 System Protection

The IC must design its Customer Facilities in accordance with all applicable standards, including the standards in FE's "Requirements for Transmission Connected Facilities" document located at: <http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx>. Preliminary Protection requirements will be provided as part of the Facilities Study. Detailed Protection Requirements will be provided once the project enters the construction phase.

All new generator only and new generator plus load facilities must be isolated from the FE transmission System by a Power Transformer. Section 14.2.6 of FE's "Requirements for Transmission Connected Facilities" document specifies the winding configurations of the transformer connecting to a non-effectively grounded portion of the FE Transmission system shall be determined by FE on a case-by-case basis.

### 9.2 Compliance Issues and Interconnection Customer Requirements

The proposed Customer Facilities must be designed in accordance with FE's "Requirements for Transmission Connected Facilities" document located at: <http://www.pjm.com/planning/design-engineering/to-tech-standards/private-firstenergy.aspx>. In particular, the IC is responsible for the following:

1. The purchase and installation of a fully rated 69 kV circuit breaker to protect the AF2-126 generator lead line. A single circuit breaker must be used to protect this line; if the project has several GSU transformers, the individual GSU transformer breakers cannot be used to protect this line.

2. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.
3. The purchase and installation of supervisory control and data acquisition (“SCADA”) equipment to provide information in a compatible format to the FE Transmission System Control Center.
4. Compliance with the FE and PJM generator power factor and voltage control requirements.
5. The execution of a back-up service agreement to serve the customer load supplied from the AF2-126 generation project metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

The IC will also be required to meet all PJM, ReliabilityFirst, and NERC reliability criteria and operating procedures for standards compliance. For example, the IC will need to properly locate and report the over and under voltage and over and under frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE system.

### 9.3 Power Factor Requirements

The IC shall design its non-synchronous Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs) measured at the high-side of the facility substation transformer(s) connected to the FE transmission system.

## 10 Revenue Metering and SCADA Requirements

### 10.1 PJM Requirements

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

### 10.2 Meteorological Data Reporting Requirements

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

- Back Panel temperature (Fahrenheit) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Irradiance (Watts/meter<sup>2</sup>) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- 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 AF2-126 was evaluated as a 51.0 MW (Capacity 34.0 MW) injection as an uprate to AF1-064 at the Weston 69 kV substation in the ATSI area. Project AF2-126 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-126 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

### 11.1 Generation Deliverability

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

None

### 11.2 Multiple Facility Contingency

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

None

### 11.3 Contribution to Previously Identified Overloads

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC/D C	MW IMPACT
100548068	238874	02LAKVEW	138.0	ATSI	238768	02GRNF LD	138.0	ATSI	1	ATSI-P7-1-TE-345-027A	tower	316.0	111.9	113.08	AC	3.6
95703055	243009	05FRMNT	138.0	AEP	243008	05FREMC T	138.0	AEP	1	AEP_P2-2_#517_05FOS TOR 345_1	bus	251.0	107.13	108.77	AC	2.82
95703255	243009	05FRMNT	138.0	AEP	243008	05FREMC T	138.0	AEP	1	AEP_P4_#517_05FOS TOR 345_A1	breaker	251.0	107.13	108.77	AC	2.82

### 11.4 Steady-State Voltage Requirements

To be determined in the Facilities Study phase.

### 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. None

## 11.6 System Reinforcements

ID	Idx	Facility	Upgrade Description	Cost	Cost Allocated to AF2-126	Upgrade Number
95703255,95703055	2	05FRMNT 138.0 kV - 05FREMCT 138.0 kV Ckt 1	<p><b>AEP</b>  <b>ProjectId : n6297.1 (AEPO0020e)</b>  <b>Description :</b> A sag study will be required on the 4.0 miles of ACSR ~ 795 ~ 45/7 ~ TERN - Conductor Section 1 to mitigate the overload. Depending on the sag study results, the cost for this upgrade is expected to be around \$20,000 (no remediation required, just sag study) and \$6 million (complete line reconductor/rebuild). New rating after sag study: S/N: 251 S/E: 335 MVA. 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.  <b>Type : FAC</b>  <b>Total Cost : \$20,000</b>  <b>Time Estimate : Sag Study : 6 - 12 Months</b>  <b>Ratings : 251.0/335.0</b></p> <p>This constraint is driven by a prior queue. Per PJM cost allocation rules, Queue Project AF2-126 presently does not receive cost allocation for this upgrade.</p> <p><b>Note 1:</b> as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, Queue Project AF2-126 could receive cost allocation.</p> <p><b>Note 2:</b> Although Queue Project AF2-126 may not have cost responsibility for this upgrade, Queue Project AF2-126 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AF2-126 comes into service prior to completion of the upgrade, Queue Project AF2-126 will need an interim study.</p>	\$20,000	\$0	n6297.1



ID	Idx	Facility	Upgrade Description	Cost	Cost Allocated to AF2-126	Upgrade Number
100548068	1	02LAKVEW 138.0 kV - 02GRNFLD 138.0 kV Ckt 1	<p><b>ATSI</b>  <b>ProjectId : n6481 (OEC-011B-R1)</b>  <b>Description : Reconductor roughly 13.58 miles of the Greenfield-Lakeview 138 kV Line. Replace two line switches. Upgrade substation conductor at Greenfield and upgrade relaying for B-242.</b>  <b>Type : FAC</b>  <b>Total Cost : \$52,740,000</b>  <b>Time Estimate : Sag Study : 54 Months</b>  <b>Ratings : 435.0/500.0/547.0</b></p> <p>Per PJM cost allocation rules, Queue Project AF2-126 presently does not receive cost allocation for these upgrades.</p> <p><b>Note 1: as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, Queue Project AF2-126 could receive cost allocation.</b></p> <p><b>Note 2: Although Queue Project AF2-126 may not have cost responsibility for this upgrade, Queue Project AF2-126 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AF2-126 comes into service prior to completion of the upgrade, Queue Project AF2-126 will need an interim study.</b></p>	\$52,740,000	\$0	n6481
			<b>TOTAL COST</b>	<b>\$52,760,000</b>	<b>\$0</b>	

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".

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### 11.7.1 Index 1

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC DC	MW IMPACT
100548068	238874	02LAKVEW	ATSI	238768	02GRNFLD	ATSI	1	ATSI-P7-1-TE-345-027A	tower	316.0	111.9	113.08	AC	3.6

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
238601	02FRMENG 1	2.9833	50/50	2.9833
238602	02FRMENG 2	2.9833	50/50	2.9833
238603	02FRMENG 3	5.3858	50/50	5.3858
238979	02NAPMUN	2.0238	Adder	2.38
247548	V4-010 C	1.4246	Adder	1.68
247551	U4-028 C (Suspended)	0.6094	Adder	0.72
247552	U4-029 C (Suspended)	0.6094	Adder	0.72
247940	U4-028 E (Suspended)	4.0783	Adder	4.8
247941	U4-029 E (Suspended)	4.0783	Adder	4.8
247947	V4-010 E	9.5336	Adder	11.22
931951	AB1-107 1 (Suspended)	20.5547	Adder	24.18
931961	AB1-107 2 (Suspended)	33.5515	Adder	39.47
932791	AC2-103 C	-2.1800	Adder	-2.56
934251	AD1-052 C1	0.2214	50/50	0.2214
934252	AD1-052 E1	0.5861	50/50	0.5861
934261	AD1-052 C2	0.2214	50/50	0.2214
934262	AD1-052 E2	0.5861	50/50	0.5861
934461	AD1-070 C O1	1.5618	Adder	1.84
934462	AD1-070 E O1	7.3319	Adder	8.63
934891	AD1-118	3.6694	Adder	4.32
937021	AD2-136 C O1	2.1939	Adder	2.58
937022	AD2-136 E O1	14.6820	Adder	17.27
938911	AE1-119	28.8307	Adder	33.92
941741	AE2-174 C	1.9095	Adder	2.25
941742	AE2-174 E	8.9392	Adder	10.52
941781	AE2-181 C	1.5341	Adder	1.8
941782	AE2-181 E	1.0228	Adder	1.2
942661	AE2-282 C O1	2.3572	Adder	2.77
942662	AE2-282 E O1	1.2403	Adder	1.46
943961	AF1-064 C O1	2.0060	Adder	2.36
943962	AF1-064 E O1	0.9970	Adder	1.17
944551	AF1-120 C	1.4283	Adder	1.68
944552	AF1-120 E	0.7195	Adder	0.85
945401	AF1-205 C O1	1.3127	Adder	1.54
945402	AF1-205 E O1	0.8752	Adder	1.03
945411	AF1-206 C O1	6.4111	Adder	7.54
945412	AF1-206 E O1	4.2741	Adder	5.03
958321	AF2-126 C	2.0421	Adder	2.4
958322	AF2-126 E	1.0210	Adder	1.2
960301	AF2-321 C	4.4126	Adder	5.19
960302	AF2-321 E	2.9417	Adder	3.46

<b>Bus #</b>	<b>Bus</b>	<b>Gendeliv MW Impact</b>	<b>Type</b>	<b>Full MW Impact</b>
<b>WEC</b>	WEC	0.5774	Confirmed LTF	0.5774
<b>LGEE</b>	LGEE	0.7217	Confirmed LTF	0.7217
<b>CPL</b>	CPL	0.1607	Confirmed LTF	0.1607
<b>CBM-W2</b>	CBM-W2	10.4095	Confirmed LTF	10.4095
<b>NY</b>	NY	0.6326	Confirmed LTF	0.6326
<b>TVA</b>	TVA	1.3608	Confirmed LTF	1.3608
<b>O-066</b>	O-066	6.5654	Confirmed LTF	6.5654
<b>CBM-S2</b>	CBM-S2	2.3525	Confirmed LTF	2.3525
<b>CBM-S1</b>	CBM-S1	8.7415	Confirmed LTF	8.7415
<b>G-007</b>	G-007	1.0067	Confirmed LTF	1.0067
<b>MADISON</b>	MADISON	0.6733	Confirmed LTF	0.6733
<b>MEC</b>	MEC	2.5694	Confirmed LTF	2.5694
<b>CBM-W1</b>	CBM-W1	33.7019	Confirmed LTF	33.7019

## 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 %	ACID C	MW IMPACT
95703255	243009	05FRMNT	AEP	243008	05FREMC T	AEP	1	AEP_P4_#517_05FOSTOR 345_A1	breaker	251.0	107.13	108.77	AC	2.82

Bus #	Bus	Gendeliv MW Impact	Type	Full MW Impact
238601	02FRMENG 1	5.0626	50/50	5.0626
238602	02FRMENG 2	5.0626	50/50	5.0626
238603	02FRMENG 3	9.1395	50/50	9.1395
244357	05GRANGER EL	-0.1967	Adder	-0.23
931951	AB1-107 1 (Suspended)	14.5793	Adder	17.15
931961	AB1-107 2 (Suspended)	26.0676	Adder	30.67
934251	AD1-052 C1	0.3757	50/50	0.3757
934252	AD1-052 E1	0.9946	50/50	0.9946
934261	AD1-052 C2	0.3757	50/50	0.3757
934262	AD1-052 E2	0.9946	50/50	0.9946
934891	AD1-118	3.0595	Adder	3.6
938911	AE1-119	24.0388	Adder	28.28
941761	AE2-176 C	8.1457	50/50	8.1457
941762	AE2-176 E	5.4305	50/50	5.4305
943961	AF1-064 C O1	1.5683	Adder	1.85
943962	AF1-064 E O1	0.7794	Adder	0.92
958321	AF2-126 C	1.5964	Adder	1.88
958322	AF2-126 E	0.7982	Adder	0.94
NEWTON	NEWTON	0.4180	Confirmed LTF	0.4180
BLUEG	BLUEG	1.0468	Confirmed LTF	1.0468
G-007A	G-007A	0.0623	Confirmed LTF	0.0623
VFT	VFT	0.1870	Confirmed LTF	0.1870
PRAIRIE	PRAIRIE	0.9712	Confirmed LTF	0.9712
COFFEEN	COFFEEN	0.0690	Confirmed LTF	0.0690
CHEOAH	CHEOAH	0.2432	Confirmed LTF	0.2432
EDWARDS	EDWARDS	0.0774	Confirmed LTF	0.0774
TILTON	TILTON	0.2173	Confirmed LTF	0.2173
MADISON	MADISON	1.1592	Confirmed LTF	1.1592
GIBSON	GIBSON	0.2703	Confirmed LTF	0.2703
CALDERWOOD	CALDERWOOD	0.2425	Confirmed LTF	0.2425
FARMERCITY	FARMERCITY	0.0171	Confirmed LTF	0.0171
TRIMBLE	TRIMBLE	0.3384	Confirmed LTF	0.3384
CATAWBA	CATAWBA	0.1544	Confirmed LTF	0.1544
CBM-W1	CBM-W1	10.1081	Confirmed LTF	10.1081

## 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
AB1-107	Bayshore-GM Powertrain 138 kV & Lallendorf 345kV	Suspended
AC1-181	Richland 138kV	In Service
AC2-103	Beaver-Davis Besse 345 kV I	Engineering and Procurement
AD1-052	Freemont Energy Center	Under Construction
AD1-070	Fostoria Central 138 kV	Active
AD1-118	Lemoyne	Active
AD2-136	Melmore Tap 138kV	Active
AE1-119	Lemoyne 345 kV	Active
AE2-072	East Leipsic-Richland 138 kV	Active
AE2-174	Seneca 138 kV	Active
AE2-176	Groton 138 kV Solar	Active
AE2-181	Snyder 69kV	Active
AE2-282	East Fayette 138 kV	Active
AF1-047	Mark Center 69 kV	Active
AF1-064	Weston 69 kV	Active
AF1-120	East Fayette 2 138 kV	Active
AF1-205	Napoleon Muni 138 kV	Active
AF1-206	East Fayette 138 kV	Active
AF2-126	Weston 69 kV II	Active
AF2-321	Stryker-Ridgeville 138 kV	Active
U4-028	Fostoria Central-Greenlawn-Howard 138kV	Suspended
U4-029	Fostoria Central-Greenlawn-Howard 138kV	Suspended
V4-010	Tiffin Center 138kV	Engineering and Procurement

## 11.9 Contingency Descriptions

Contingency Name	Contingency Definition
<b>AEP_P1-2_#10755-A</b>	CONTINGENCY 'AEP_P1-2_#10755-A' OPEN BRANCH FROM BUS 243029 TO BUS 243086 CKT 1 / 243029 05LCKWRD 138 243086 05S HICK 138 1 OPEN BRANCH FROM BUS 243086 TO BUS 959180 CKT 1 / 243086 05S HICK 138 959180 AF2-209 TAP 138 1 OPEN BRANCH FROM BUS 243086 TO BUS 243179 CKT 1 / 243086 05S HICK 138 243179 05S HICKSV 69.0 1 END
<b>AEP_P4_#517_05FOSTOR 345_A1</b>	CONTINGENCY 'AEP_P4_#517_05FOSTOR 345_A1' OPEN BRANCH FROM BUS 241901 TO BUS 242936 CKT 1 / 241901 02LALLEND
<b>AEP_P2-2_#517_05FOSTOR 345_1</b>	CONTINGENCY 'AEP_P2-2_#517_05FOSTOR 345_1' OPEN BRANCH FROM BUS 241901 TO BUS 242936 CKT 1 / 241901 02LALLEND
<b>AEP_P2-2_#6817_05E.LPSC 138_2-B</b>	CONTINGENCY 'AEP_P2-2_#6817_05E.LPSC 138_2-B' OPEN BRANCH FROM BUS 940840 TO BUS 242993 CKT 1 / 940840 AE2-072 TAP 138 242993 05E.LPSC 138 1 OPEN BRANCH FROM BUS 242993 TO BUS 245792 CKT 1 / 242993 05E.LPSC 138 245792 05E.LEIPSC 69.0 1 END
<b>AEP_P1-2_#7097-B</b>	CONTINGENCY 'AEP_P1-2_#7097-B' OPEN BRANCH FROM BUS 940840 TO BUS 242993 CKT 1 / 940840 AE2-072 TAP 138 242993 05E.LPSC 138 1 END
<b>ATSI-P7-1-TE-345-027A</b>	CONTINGENCY 'ATSI-P7-1-TE-345-027A' /* DB - X1-027A & DB - HAYES 345 DISCONNECT BRANCH FROM BUS 238654 TO BUS 907060 CKT 1 /* 02DAV-BE 345 X1- 027A_AT12 345 DISCONNECT BRANCH FROM BUS 238654 TO BUS 239289 CKT 1 /* 02DAV-BE 345 02HAYES 345 END
<b>Base Case</b>	

Contingency Name	Contingency Definition
<b>AEP_P4_#8101_05E.LPSC 138_G</b>	CONTINGENCY 'AEP_P4_#8101_05E.LPSC 138_G' OPEN BRANCH FROM BUS 940840 TO BUS 242993 CKT 1 / 940840 AE2-072 TAP 138 242993 05E.LPSC 138 1 OPEN BRANCH FROM BUS 242993 TO BUS 245456 CKT 1 / 242993 05E.LPSC 138 245456 05NEWBERY 138 1 OPEN BRANCH FROM BUS 242993 TO BUS 245792 CKT 1 / 242993 05E.LPSC 138 245792 05E.LEIPSC 69.0 1 REMOVE SWSHUNT FROM BUS 242993 / 242993 05W WOOSTE 69.0 END
<b>AEP_P4_#6817_05E.LPSC 138_B</b>	CONTINGENCY 'AEP_P4_#6817_05E.LPSC 138_B' OPEN BRANCH FROM BUS 940840 TO BUS 242993 CKT 1 / 940840 AE2-072 TAP 138 242993 05E.LPSC 138 1 OPEN BRANCH FROM BUS 242993 TO BUS 245792 CKT 1 / 242993 05E.LPSC 138 245792 05E.LEIPSC 69.0 1 END
<b>AEP_P7-1_#10984-B</b>	CONTINGENCY 'AEP_P7-1_#10984-B' OPEN BRANCH FROM BUS 940840 TO BUS 242993 CKT 1 / 940840 AE2-072 TAP 138 242993 05E.LPSC 138 1 OPEN BRANCH FROM BUS 242957 TO BUS 243080 CKT 1 / 242957 05BASEL8 138 243080 05RILEYC 138 1 OPEN BRANCH FROM BUS 243083 TO BUS 242989 CKT 1 / 243083 05CAMPSS 138 242989 05E LIMA 138 1 OPEN BRANCH FROM BUS 243083 TO BUS 243121 CKT 1 / 243083 05CAMPSS 138 243121 05ROCKPO 138 1 OPEN BRANCH FROM BUS 243080 TO BUS 247000 CKT 1 / 243080 05RILEYC 138 247000 05YELLWC 138 1 END



## 12 Light Load Analysis

Light load analysis is not required for solar projects.

## 13 Short Circuit Analysis

The following Breakers are overdutied:

None

## 14 Stability and Reactive Power

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

To be determined in the Facilities Study Phase.

## 15 Affected Systems

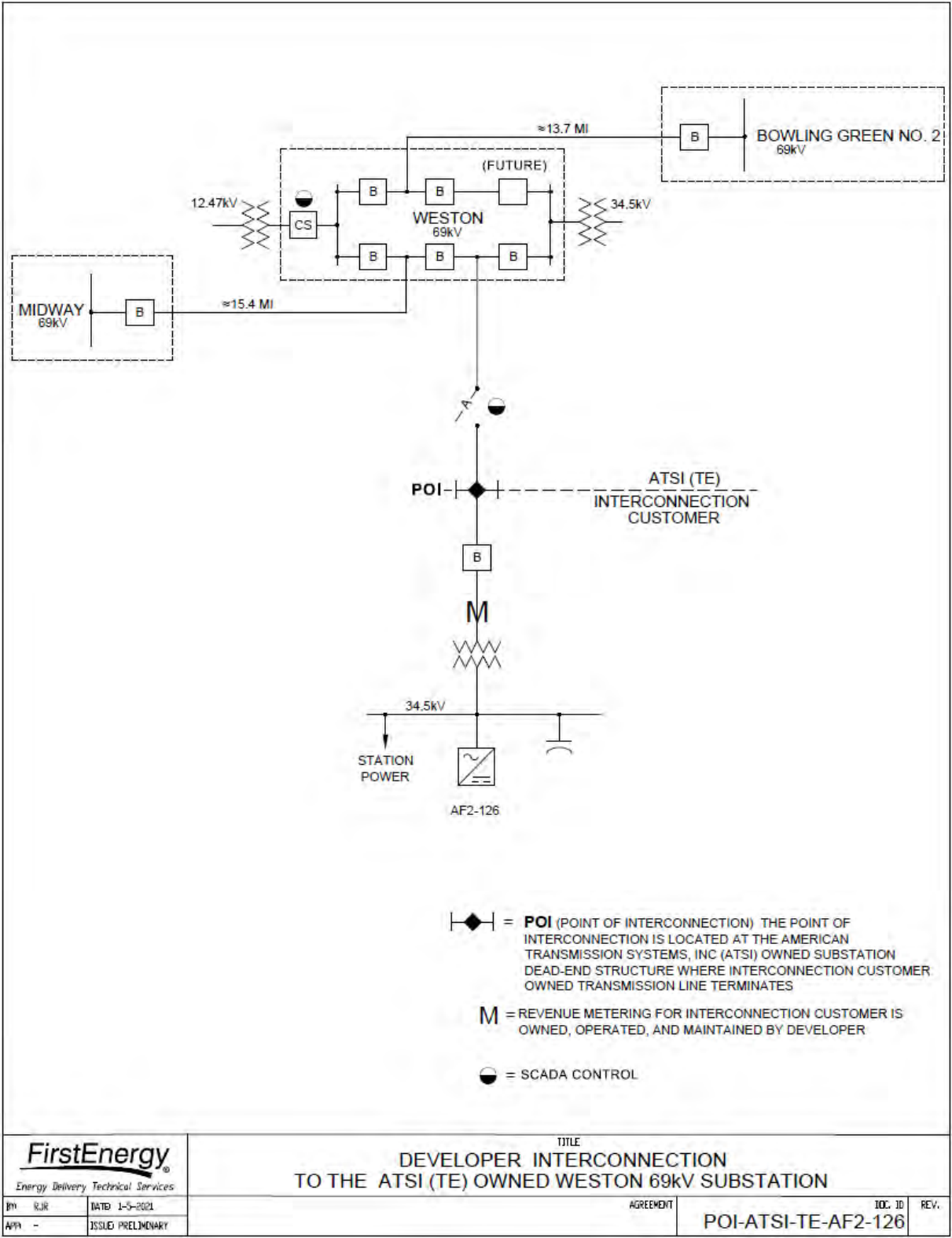
### 15.1 NYISO

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

### 15.2 MISO

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

16 Attachment 1: One Line Diagram



**This foregoing document was electronically filed with the Public Utilities**

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**Case No(s). 20-1760-EL-BGN**

Summary: Application Exhibit I - PJM Interconnection Studies electronically filed by Teresa Orahod on behalf of Dylan F. Borchers