Exhibit F
PJM Interconnection Studies

1. **AC2-195 Generation Interconnection Feasibility Study Report, July 2017**
2. **AC2-195 Generation Interconnection System Impact Study Report, June 2018**
3. **AC2-195 PJM Generator Interconnection Facility Study Report, June 2020**
4. **AE2-324 Generation Interconnection Feasibility Study Report, July 2019**
5. **AE2-324 Generation Interconnection System Impact Study Report, February 2020**

Exhibit F
Interconnection Studies

1. AC2-195 Generation Interconnection Feasibility Study Report, July 2017

Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position AC2-195

Galion-Roberts South 138kV

July 2017

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. 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 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.

General

Marion County Solar Project, LLC, the Interconnection Customer (IC), has proposed a solar generating facility located in Marion, OH. The installed facilities will have a total capability of 99.96 MW with 62.1MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 31, 2020. **This study does not imply a American Transmission Systems Inc. (or "ATSI") commitment to this in-service date.**

Point of Interconnection

AC2-195 will interconnect with the American Transmission Systems Inc. (or "ATSI") transmission system using one of the following options:

Primary: Along the Galion-Roberts South 138kV line

Secondary: Along the Galion-Roberts North 138kV line

Cost Summary

The AC2-195 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 6,289,600
Non Direct Connection Network Upgrades	$ 468,200
Total Costs	**$ 6,757,800**

Attachment Facilities

No Attachment Facilities are required to support this interconnection request.

Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Activity Cost	Tax (if applicable)	Total Cost
Construct a 138kV three breaker ring bus interconnect substation between Galion and Roberts. @ AC2-195 Interconnect	5,471,000	732,400	6,203,400
Loop the Galion-Roberts South 138kV circuit into the AC2-195 ring bus. The proposed location of the ring bus is near structure #3825 (Primary POI). @ Galion-Roberts South 138kV Loop to AC2-195 Ring Bus (Primary POI)	818,600	106,700	925,300
Total Direct Connection Facility Costs	**$6,289,600**	**$839,100**	**$7,128,700**

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	Activity Cost	Tax (if applicable)	Total Cost
Upgrade line relaying to AC2-195 Interconnect @ Galion SS	234,100	30,600	264,700
Upgrade line relaying to AC2-195 Interconnect @ Roberts SS	234,100	30,600	264,700
Total Non-Direct Connection Facility Costs	**$468,200**	**$61,200**	**$529,400**

Transmission Owner Scope of Work

The primary Point of Interconnection (POI) for the AC2-195 generation project is located one span outside of the proposed ATSI ring bus switch station which will be located on the Galion-Roberts South 138kV line. The direct connection of AC2-195 generation project will be accomplished by utilizing a three (3) breaker ring bus to connect to the Galion-Roberts South 138 kV line. The Marion County Solar Project, LLC will be responsible for constructing all of the facilities on its side of the POI, including the 138 kV line extension to its generation facilities. Marion County Solar Project, LLC may not install above ground equipment within any FirstEnergy right-of-way unless permission to do so is expressly granted by FirstEnergy. The ATSI facilities required for the Direct Connection of the generation project and the associated cost estimate are shown in Attachment 3.

Transmission Owner Schedule

Based on the extent of the ATSI primary direct connection required to support the AC2-195 generation project, it is expected to take a minimum of twenty-six (26) months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This assumes that Marion County Solar Project, LLC will provide all rights-of-way, permits, easements, etc. that will be needed. A further assumption is 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 facility upgrades, and that all system outages will be allowed when requested.

Interconnection Customer Requirements

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

3. The purchase and installation of fully rated 138 kV circuit breakers on the high side of the AC2-195 step-up transformer.

4. The purchase and installation of the minimum required ATSI generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.

5. 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.

6. The establishment of dedicated communication circuits for SCADA to the FE Transmission System Control Center.

7. A compliance with the FE and PJM generator power factor and voltage control requirements.

8. The execution of a back-up service agreement to serve the customer load supplied from the AC2-195 generation project metering point when the units are out-of-service. This assumes the intent of Marion County Solar Project, LLC is to net the generation with the load.

Revenue Metering and SCADA Requirements

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 Sections 24.1 and 24.2.

ATSI Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

http://www.firstenergycorp.com/feconnect
http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx

Network Impacts : Primary POI

The Queue Project AC2-195 was evaluated as a 99.96 MW (Capacity 62.1 MW) injection tapping the Hamilton – Dual Rail 138 kV line in the ATSI area. Project AC2-195 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-195 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
B2-OES-138-009_A	CONTINGENCY 'B2-OES-138-009_A' /* GALION - ROBERTS SOUTH 138KV LINE FAULT DISCONNECT BRANCH FROM BUS 238746 TO BUS 924790 CKT 1 /* 02GALION 138 AB2-131 TAP 138 END
B2-OES-138-009_C	CONTINGENCY 'B2-OES-138-009_C' /* GALION - ROBERTS SOUTH 138KV LINE FAULT DISCONNECT BRANCH FROM BUS 238667 TO BUS 239073 CKT 1 /* 02DUALR+ 138 02ROBERT 138 DISCONNECT BRANCH FROM BUS 238667 TO BUS 932720 CKT 1 /* 02DUALR+ 138 AC2-195 TAP 138 REMOVE LOAD O FROM BUS 238668 /* 02DUALRL 138 REMOVE LOAD C FROM BUS 238668 /* 02DUALRL 138 DISCONNECT BUS 238668 /* 02DUALRL 138 DISCONNECT BUS 238667 /* 02DUALR+ 138 END

Generator Deliverability

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

None.

Multiple Facility Contingency

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

None.

Contribution to Previously Identified Overloads

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

None.

Short Circuit

(Summary of impacted circuit breakers)

None.

Light Load Analysis - 2020

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

Stability and Reactive Power Requirement

Stability and Reactive study to be completed during later study phases

Steady-State Voltage Requirements

Steady-State Voltage study to be completed during later study phases

Affected System Analysis & Mitigation

MISO Impacts:

MISO Impacts to be determined during later study phases

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.

	Contingency		Affected		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
1	N-1	B2-OES-138-009_A	FE - FE	02DUALR+-02ROBERT 138 kV line	####	##	1	DC	61.6	110	ER	208	99.96	
2	N-1	B2-OES-138-009_C	FE - FE	AB2-131 TAP-02GALION 138 kV line	####	##	1	DC	63.6	107	ER	228	99.96	
3	N-1	B2-OES-138-009_A	FE - FE	AC2-195 TAP-02DUALR+ 138 kV line	####	##	1	DC	59.9	101	ER	242	99.96	

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

None.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

None.

Network Impacts : Secondary POI

The Queue Project AC2-195 was evaluated as a 100.0 MW (Capacity 62.1 MW) injection at the Marion Ethanol 138 kV substation in the ATSI area. Project AC2-195 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-195 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Generator Deliverability

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

None.

Multiple Facility Contingency

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

None.

Contribution to Previously Identified Overloads

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

None.

Short Circuit

(Summary of impacted circuit breakers)

None.

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.

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

None.

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

None.

Light Load Analysis - 2020

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

Stability and Reactive Power Requirement

Stability and Reactive study to be completed during later study phases

Steady-State Voltage Requirements

Steady-State Voltage study to be completed during later study phases

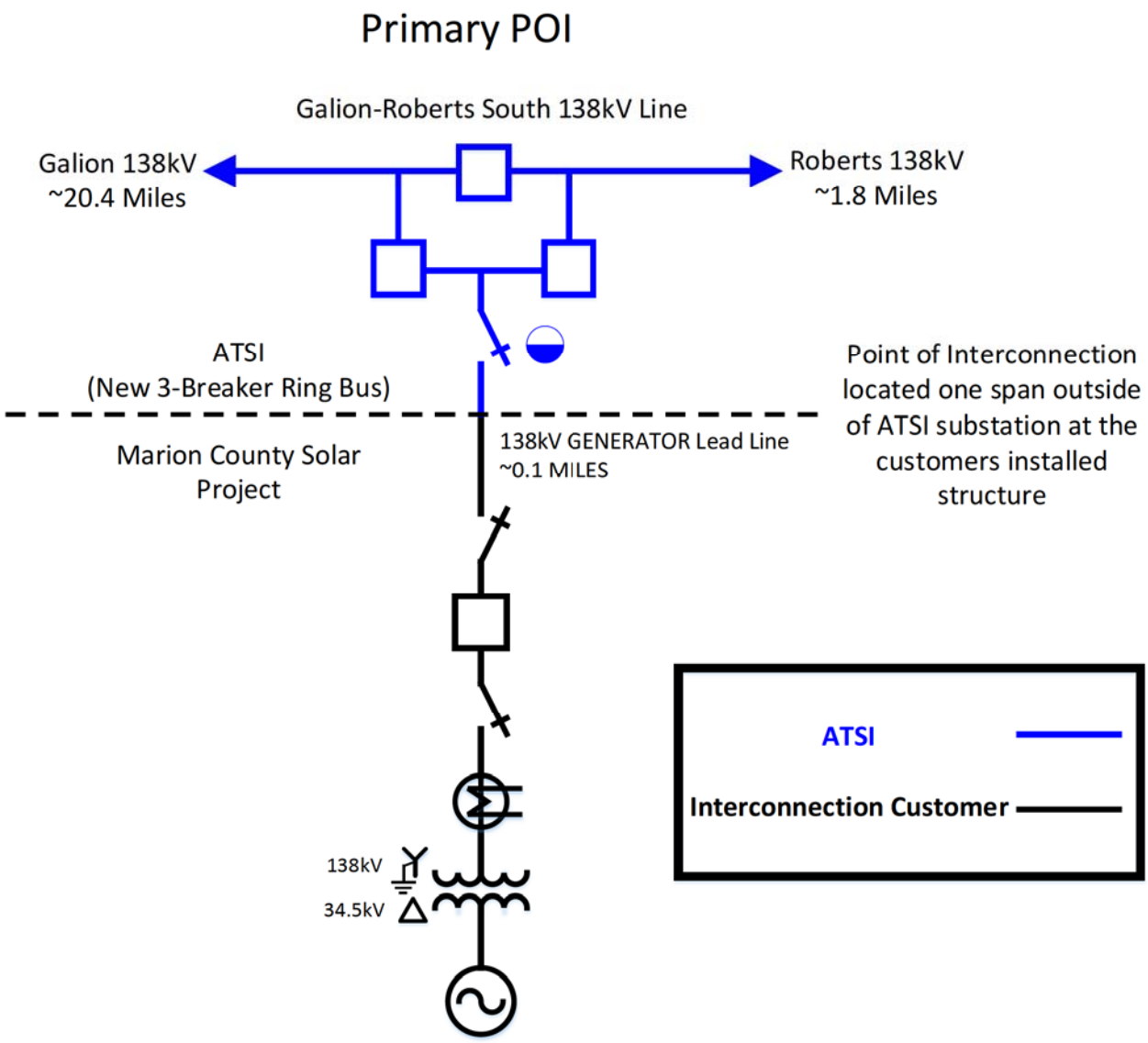
Affected System Analysis & Mitigation

MISO Impacts:

MISO Impacts to be determined during later study phases

Attachment 1. Project Location

Attachment 2. Single Line Diagram
PRIMARY OPTION



Attachment 3. Single Line Diagram
SECONDARY OPTION

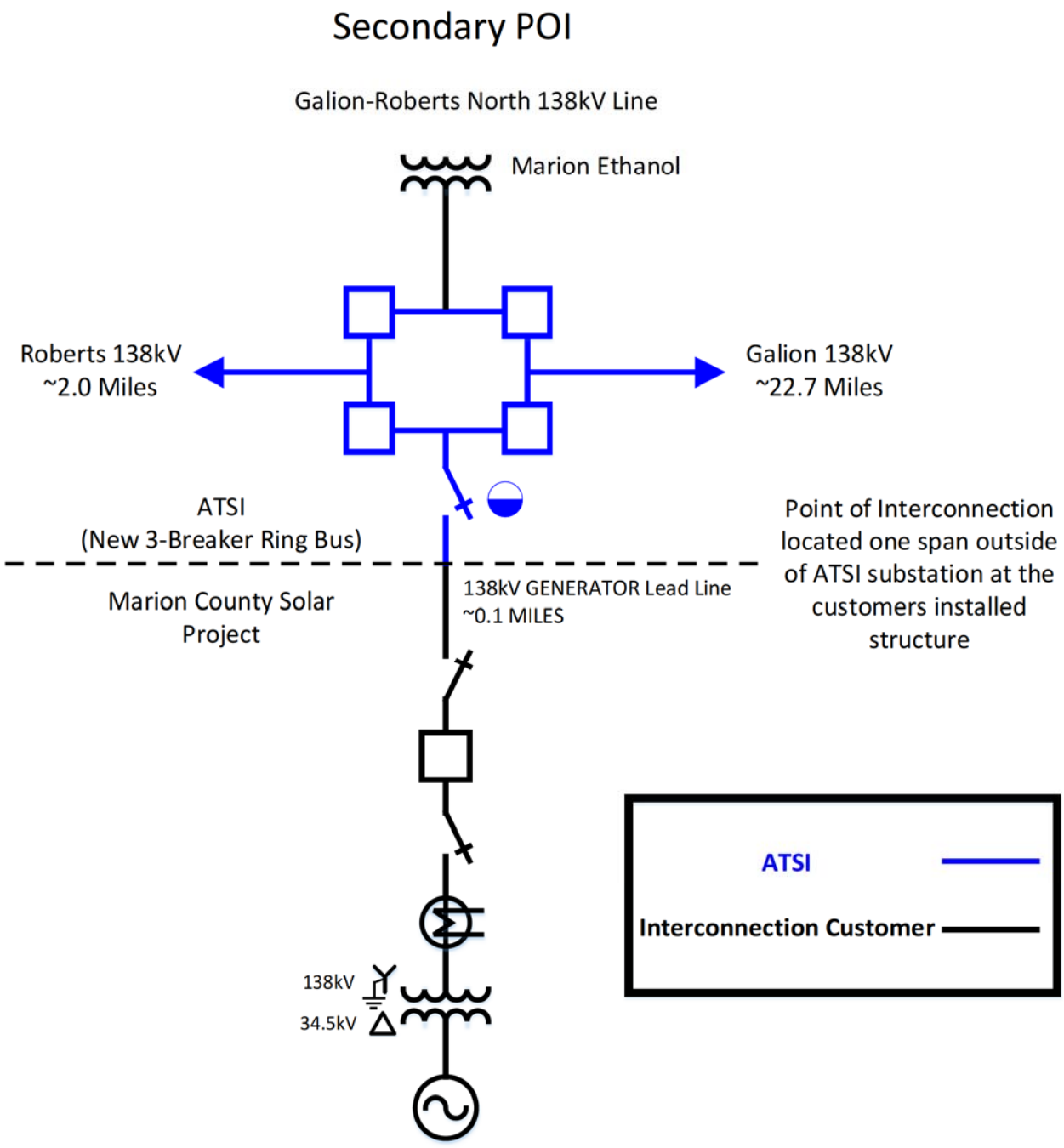


Exhibit F
Interconnection Studies

2. AC2-195 Generation Interconnection System Impact Study Report, June 2018

Generation Interconnection

System Impact Study Report

for

Queue Project AE2-324

GALION-ROBERTS SOUTH II 138 KV

20.3 MW Capacity / 20.3 MW Energy

February 2020

Table of Contents

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 Marion County Solar Project, LLC, 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 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.

3 General

The Interconnection Customer (IC), has proposed a storage uprate to the proposed Solar generating facility AC2-195 located in city of Marion, Marion County, Ohio. This project requests an increase to the install capability of the AC2-195 project by 20.3 MW with 20.3 MW of this output being recognized by PJM as additional Capacity. AE2-324 will share the same property and connection point as the AC2-195 project. The installed facilities will have a total capability of 120.3 MW with 82.4 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 1, 2022. This study does not imply a Transmission owner (TO) commitment to this in-service date.

Queue Number	AE2-324
Project Name	GALION-ROBERTS SOUTH II 138 KV
Interconnection Customer	Marion County Solar Project, LLC
State	Ohio
County	Marion
Transmission Owner	ATSI
MFO	120.3
MWE	20.3
MWC	20.3
Fuel	Storage
Basecase Study Year	2022

4 Point of Interconnection

AE2-324 will interconnect with the ATSI transmission system. The interconnection of the project at the Point of Interconnection (POI) will be accomplished through the prior queue project AC2-195. Gen Queue AC2-195 is to construct a new 138 kV three (3) breaker ring bus substation, looping the Galion – Roberts South 138 kV line into the new substation, and extending a new line exit to the POI. The new substation will be located approximately 20.4 miles from the FirstEnergy Galion substation. Due to the uprate of 20.3 MW, the project will require non-direct connection upgrades at the FirstEnergy Galion and Roberts substations.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-324 generation project to connect to the FirstEnergy ("FE") transmission system. Attachment 2 provides the proposed location for the point of interconnection. 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 AE2-324 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrade	$ 0
Non Direct Connection Network Upgrades	$41,400
System Upgrades	$0
Total Costs	**$41,400**

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 AE2-324 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.

Note: 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.

6 Transmission Owner Scope of Work

AE2-324 will interconnect with the ATSI transmission system. The interconnection of the project at the Primary POI will be accomplished through the prior queue project AC2-195. Gen Queue AC2-195 is to construct a new 138 kV three (3) breaker ring bus substation, looping the Galion – Roberts South 138 kV line into the new substation, and extending a new line exit to the Primary POI. The new substation will be located approximately 20.4 miles from the FirstEnergy Galion substation. Due to the uprate of 20.3 MW, the project will require non-direct connection upgrades at the FirstEnergy Galion and Roberts substations.

7 Attachment Facilities

There is no Attachment Facility scope of work required.

8 Direct Connection Cost Estimate

There is no Direct Connection scope of work required.

9 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
Relay settings changes for Roberts South line due to AE2-324 uprate. @ Galion SS	$20,700
Relay settings changes for Galion South line due to AE2-324 uprate @ Roberts SS	$20,700
Total Non-Direct Connection Facility Costs	**$41,400**

10 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 **four months** after the signing of an Interconnection Construction Service Agreement to complete the facility changes. This includes the requirement for the IC to make a preliminary payment that compensates FE for the Non-Direct Connection work identified. This assumes that there will be no environmental issues with any of the new properties associated with this project and that all transmission system outages will be allowed when requested.

11 Transmission Owner Analysis

11.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AE2-324 project did not contribute to any overloads on the FE transmission system

12 Interconnection Customer Requirements

1.1 System Protection

The IC must design it's 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.

1.2 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 138 kV circuit breaker to protect the AE2-324/AC2-195 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 AE2-324/AC2-195 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.

12.1 Power Factor Requirements

The existing non-synchronous 99.96 MW portion of the Customer Facility shall retain 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.

The increase of 20.3 MW to the non-synchronous Customer Facility associated with AE2-324 project shall be designed with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs).

13 Revenue Metering and SCADA Requirements

13.1 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.

13.2 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

14 Network Impacts

The Queue Project AE2-324 was evaluated as a 20.3 MW (Capacity 20.3 MW) injection at the AC2-195 tap (Hamilton to Dual Rail 138kV line) POI in the ATSI area. Project AE2-324 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-324 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Load Flow

15 Generation Deliverability

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

None.

16 Multiple Facility Contingency

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

None.

17 Contribution to Previously Identified Overloads

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

None.

18 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.

19 System Reinforcements

None.

Affected Systems

20 Affected Systems

None.

Short Circuit

21 Short Circuit

The following Breakers are overduty:

None.

Stability

22 Stability Analysis and Reactive Power Requirement

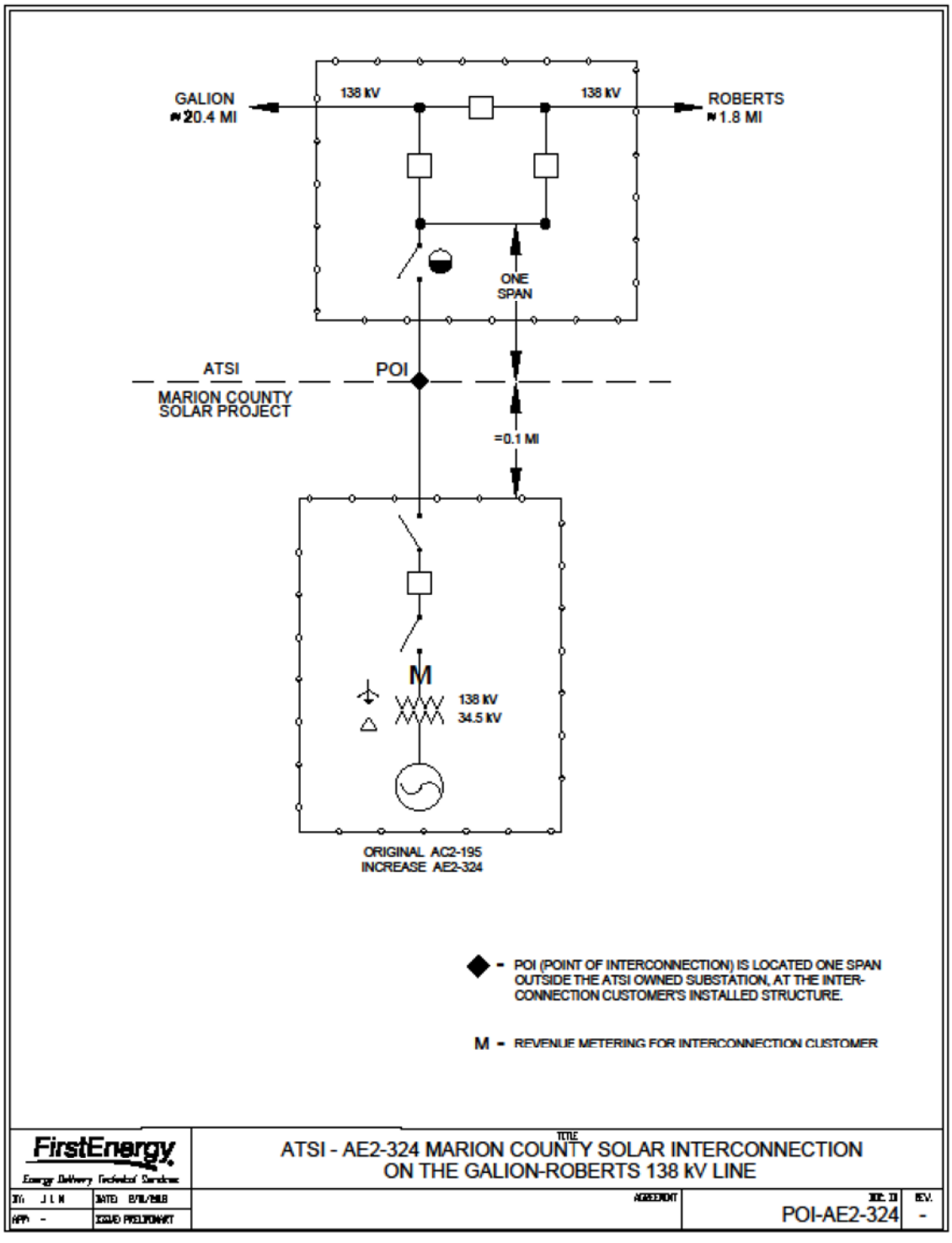
To be finalized in Facilities Study phase.

Light Load

23 Light Load Analysis

No impacts.

24 Attachment 1 – One Line



25 Attachment 2 – Project Location

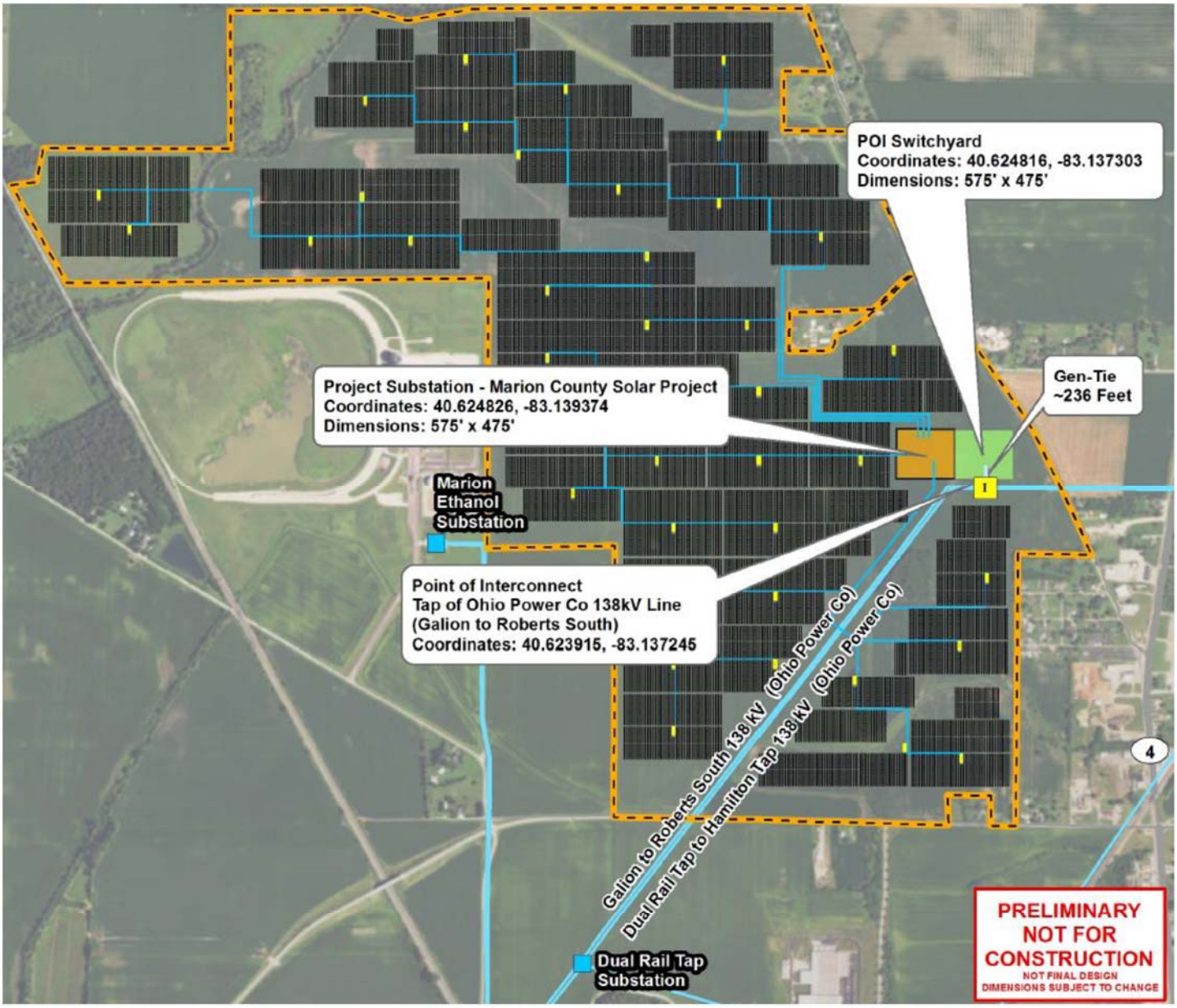


Exhibit F
Interconnection Studies

3. AC2-195 PJM Generator Interconnection Facility Study Report, June 2020

PJM Generator Interconnection Facility Study Report

For

PJM Generation Interconnection Request Queue Position AC2-195

"Galion-Roberts South 138kV"

June 2020

Queue #AC2-195 Galion-Roberts 138 kV
Facilities Study Report

General

This Facilities Study has been prepared in accordance with the PJM Open Access Transmission Tariff, Section 205, as well as the Facilities Study Agreement between Marion County Solar Project, LLC, the Interconnection Customer ("IC" or "Developer") and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner ("ITO" or "TO") is American Transmission Systems, Incorporated (ATSI).

Preface

The intent of the Facility 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 Facility Study estimates attempt to identify the estimated 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.

1. Description of the Project

The IC has proposed a solar generating facility located in Marion, OH. The installed facilities will have a total capability of 99.96 MW with 62.1 MW of this output being recognized by PJM as capacity. AC2-195 consists of 60 x 1.835 MW TMEIC L1833 GRQ 1.66 MW solar inverters with a point of interconnection on the Galion-Roberts South 138 kV line. AC2-195 will be connected to the POI via a 138/34.5 kV main collector transformer with a rating of 65/87/108 MVA connected to a 34.5/0.418 kV generator step-up transformer with a rating of 60 x 1.835 MVA. The facilities are proposed to connect to the Galion-Roberts South 138 kV line through a three breaker ring interconnection switchyard. The IC's expected Commercial Operation Date is September 30, 2023.

The generation facility will interconnect with **American Transmission Systems, Incorporated (ATSI),** a FirstEnergy Company (FE) hereinafter referred to as "Transmission Owner" (TO), at a point of interconnection along the Galion-Roberts South 138 kV line, with the interconnection substation located

to the north and west of the transmission line corridor. The generating facilities are to be located on both the north and south side of the transmission line corridor.

2. Cost Summary

The AC2-195 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 371,500
Direct Connection Network Upgrades	$ 7,313,400
Non Direct Connection Network Upgrades	$ 1,412,300
System Upgrades	$ 0
Total Costs	**$ 9,097,200**

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.

3. Interconnection Customer's Submitted Milestone Schedule

IC's requested Commercial Operation Date (COD) for the generation facility is September 30, 2023. Transmission Owner's proposed schedule does not match the Developer's requested Milestone Schedule.

Developer's Requested Milestone Schedule:

06/01/2023 Initial Back-feed through Project Substation Date
09/30/2023 Project Commercial Operation Date

Attachment Facilities Schedule:
In order to meet the Back-feed Date, a twenty-four (24) month schedule is estimated, from the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting, to complete the engineering, construction and associated activities, as detailed in the "Attachment Facilities" section below.

Direct Connection Schedule:
In order to meet the Back-feed Date, a twenty four (24) month schedule is estimated, from the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting, to complete the engineering, construction and associated activities, as detailed in the "Direct Connection" section below.

This assumes that sufficient engineering details are available to evaluate the scope of work. It also assumes that there is limited or no transmission line work for the months of June, July and August due to potential lack of obtaining system outages during that timeframe.

24 month Schedule

Activity	Start Month	End Month
Preliminary Engineering	1	3
Siting, Permits & Real Estate	2	12
Detailed Engineering	2	12
Equipment Delivery	14	15
Below Grade Construction – Substation	15	18
Below Grade Construction – T-Lines	21	22
Above Grade Construction – Substation	18	23
Above Grade Construction – T-Lines	22	23
Testing & Commissioning	24	24

Non-Direct Connection Schedule: A proposed twenty four (24) month schedule is estimated to complete the engineering, construction and associated activities, as detailed in the "Non-Direct Connection" section below, assuming an Interconnection Construction Service Agreement has been fully-executed, and a Construction Kick-Off Meeting has occurred. It is assumed these system reinforcements are able to be constructed within the same time frame as the interconnection substation. The estimated time to complete these tasks is approximately twelve (12) months, but this work would be coordinated with the engineering and construction associated with the Direct Connection work and therefore would take as long (24 months) as the Direct Connection schedule.

System Reinforcements Schedule: None.

4. Scope of IC's Work

Direct Connection Facilities

Developer will construct facilities, including the generation step-up (GSU) transformer, 138 kV (AC2-195) generator lead line, and connect to the new 3 breaker ring bus interconnection substation.

Point of Interconnection (POI): The POI will be located within the new 138 kV ring bus interconnection where Developer-owned 138 kV attachment line conductor will terminate on the insulators on the dead-end structure and will be defined as the POI. (see Figure 1)

Developer is required to own, install, and maintain a fully rated, fault-interrupting circuit breaker on the high-side of the GSU transformer with revenue metering equipment between the collector bus and the incoming generator lead line. These facilities are considered radial equipment from the terminal to the point of interconnection.

Project Scope

The AC2-195 project will be interconnected via generator lead line to a new 3 breaker ring bus substation which will be built in close proximity to the Galion-Roberts South 138 kV line.

Developer is responsible for constructing all the facilities on its side of the POI, as shown in the attached single-line diagram (see Figure 1).

The Transmission Owner is responsible for the design, procurement, and construction of the new 3 breaker ring bus substation and loop feed from the Galion-Roberts South 138 kV line.

5. Description of Facilities Work:

a. Attachment Facilities Work to be constructed by IC:

- Construct generator lead line approximately 0.01-mile interconnection to AC2-195 from the new terminal (POI) at the ring bus interconnection substation.

Assumptions / Notes:

- Developer will coordinate design and alignment of proposed AC2-195, 138 kV generator lead line with the Transmission Owner for review of any clearance, right-of-way or right-of-way encroachment issues with TO owned facilities.
- Developer will coordinate design and construction of proposed AC2-195 138 kV Lead Line. For these areas, the Developer shall provide TO with proposed transmission plan & profile drawings prior to construction and as-built drawings, confirmed by as-built survey data post-construction.
- Transmission Owner's preference would be to limit interference and avoid transmission line crossings with new 138 kV terminal positions. As a minimum, Developer facilities should not encroach within 100 feet of TO centerline at blowout conditions. If Developer's line design does not comply with this requirement TO would need to review this area as a special exception.
- Given the proposed location of the developer's substation the Developer should be aware of any facilities that may cross the transmission corridor. It will require permission of FirstEnergy for design, clearances and route of the generator tie line that will need to cross the Transmission line right-of-way.
- If the Developer plans to cross the transmission line right of way with facilities or access roads, please refer to the Transmission Rights-of-Way Restrictions information located at:
    - https://www.firstenergycorp.com/help/safety/real-estate-power-lines/transmission-right-of-way.html#ROWform
- Additional costs will be incurred by the Developer, if final alignment of AC2-195 138 kV generator lead line causes encroachments, changes, or modifications to any existing or relocated TO facilities.

b. Facilities Work to be constructed by Transmission Owner:

Attachment Facilities

Transmission Owner will design, furnish and construct the new 138 kV line terminal and take off structure. This work will include, but not be limited to, installation of a 138 kV line exit take-off structure,

foundations, disconnect switch and associated equipment to accommodate the termination of the 138 kV generator lead line.

Direct Connection

Interconnection Substation (138 kV 3 breaker ring bus)

[PJM Network Upgrade N6707]

Transmission Owner will design, furnish and construct the new 138 kV line terminal for the Developer as part of the new 3-breaker ring bus interconnection substation, including the following:

- Three (3) 138 kV, 3000 ampere, 40 kA interrupting power circuit breakers
- Six (6) 138 kV, 3000 ampere, three-pole, manually-operated, group disconnect switches
- Three (3) 138 kV, motor-operated, disconnect switches
- Six (6) surge arresters for application on a 138 kV system
- Nine (9) 138 kV capacitor voltage transformers for relaying
- Station Service – Transmission Owner requires a primary and a backup station power supply with automatic transfer. This consists of the following sources:
    - Primary: One (1) 138 kV power voltage transformer
    - Backup: Feed from a local distribution feeder
- Three (3) 138 kV transmission line termination structures
- 138 kV bus (with damper wire) and conductor with associated structures
- Prefabricated building with battery and charger
- Transmission Owner relaying and controls per the Protection Requirements (provided as Attachment "A").
- SCADA RTU/Communications circuit – Contact Transmission Owner for specifics
- Foundations for the equipment listed above.
- Substation fencing, cable trench & conduit system, ground grid and stoning.
- Compliance with Transmission Owner security standards. Developer to contact Transmission Owner for design / equipment details

Assumptions / Notes:

- A rough-graded, level site and access road is to be provided by Developer.
- In order to meet the requested Backfeed Date of **10/01/2022**, the exact substation site, pull-off structure location, and structure details (for connection to the transmission line loop) are required from Developer no later than 4/01/2021 (i.e. minimum **eighteen** (18) months lead-time from Backfeed Date). Delays in provision of substation site details will affect the schedule.
- Developer will acquire adequate land size to accommodate the Transmission Owner interconnection substation. Transmission Owner did not perform an evaluation to determine if Developer has secured an adequate amount of land for the interconnection substation. The proposed land for the interconnection substation has not yet been finalized. Schedule may be affected based upon size of the property and the terrain. The property should be large enough to contain the fenced area, graded slopes, and any storm water management for the Transmission

Owner interconnection substation. Transmission Owner would need to review Developer's substation layout to determine if the land size is adequate.

SCADA and fiber installation within interconnection substation

A MPLS router at the new interconnect substation to provide SCADA transport for new RTU and the in-sub fiber run for connection from new interconnect substation to fiber backbone are included within the estimates for the interconnection. SCADA work at new interconnect substation to support new RTU and work at Galion and Roberts substations to support line relay replacements were included in the SCADA estimate.

Non-Direct Connection

Galion-Roberts 138 kV Line Loop

[PJM Network Upgrades N6708 and N6709]

Transmission Owner will sectionalize the existing 138 kV transmission line at the new Transmission Owner interconnection substation, at a site to be selected by Developer with agreement from Transmission Owner.

The station is to be located at the following GPS coordinates:

Latitude: 40.6214980
Longitude: -83.1494530

This study assumes that the interconnection new substation will be located adjacent to the Transmission Owner 138 kV line right-of-way (See "Figure 2") and the dead-end structures will each be within one (1) span of the line (approximately 300 feet). The estimated costs shown in this study are typical for this type of design. The actual costs will be determined by the final substation and line loop locations.

Transmission Owner will install a loop, approximately 300 feet in length, from the Galion-Roberts South 138kV line to the proposed 3-breaker ring bus substation.

The line loop from the Galion-Roberts South 138 kV line to the interconnection substation crosses under the Galion-Roberts North 138kV line. The existing line at the assumed loop location does not have adequate ground clearance for the line loop to pass under it. The estimated cost assumes a single circuit wood light angle structure will be installed mid-span on the Galion-Roberts North 138kV line between the new 3-pole deadend structures to raise conductors to a sufficient height to allow the line loop to be constructed with no clearance issues.

The 24 month schedule assumes that engineering for both the Direct and Non-Direct work will occur simultaneously. It also assumes the Ohio PUC will grant a waiver to a full application. The 'exact' substation location and details are required from Developer prior to the start of engineering. Delays in provision of substation site details will affect the schedule.

Note: An outage on the source line is unlikely to be granted from May 1 to October 1. Therefore, the engineering and construction for the project must be completed by 5/01/2023 in order to meet the

requested Backfeed Date. The schedule is based on no issues with siting/permitting, right-of-way acquisition, or outage requirements.

Assumptions:

Engineering Assumptions:

1. Install two guyed wood deadend structures for the loop. Install an additional guyed wood monopole deadend on each leg of the loop to route the loop into the substation bays.
2. Install a mid-span, single circuit light angle wood structure on the Galion-Roberts North 138 kV circuit to raise the height.
3. Substation is adjacent to the existing line with the substation being approx. 300' in length (1 span length) off the transmission corridor.
4. Assume that the loop will tie into existing circuit between towers #3825 and #3826.
5. Access will be provided through the substation area and substation access roads.
6. No forestry work is anticipated.
7. It is assumed that no existing structures will need to be removed.

Siting Assumptions:

1. An application to the Ohio Power Siting Board will be required. One of the issues required for approval is in determining what will be needed as far as property acquisition. It is expected that Developer will acquire all of the necessary property and transfer it to Transmission Owner.
2. The estimate assumes a Letter of Notification (LON) is required for OPSB approval. If a full siting application is required, significant external legal involvement and environmental studies will be required which would greatly increase costs and schedule (not included herein).
3. It is expected that the Erosion & Sedimentation Control Plan will be combined with the substation work and be the responsibility of the Transmission Owner.

Right-of-Way Assumptions:

1. Right-of-way is required from Developer only. The project is entirely on Developer's property and the property will be transferred to Transmission Owner at no cost.
2. Developer will provide Company with Real Property rights in a form that is acceptable to the Company, meeting all requirements for construction, operation and maintenance of the proposed facilities.
3. Right-of-way acquisition must occur prior to Ohio Power Siting Board review of the submittal.
4. Title completed by Developer and provided to Transmission Owner upon request.

Environmental Assumptions:

1. If FirstEnergy builds the transmission interconnect, then permitting will be required for access and build of the structures needed. Should the developer choose the option to build, permits will need to be obtained by the developer for FE to perform the interconnection activities.

Roberts Substation

[PJM Network Upgrade N6711]

Upgrade line relaying for Galion 138kV line exit and rename for new AC2-195 PJM station.

Galion Substation
[PJM Network Upgrade N6710]

Upgrade line relaying for Roberts 138kV line exit and rename for new AC2-195 PJM station.

* Note: The relay upgrades at both Roberts and Galion Substation (see above) may be completed as part of AB1-131. If they are completed prior to construction of AC2-195, the work required may be reduced to modification of relay settings.

Dual Rail Substation
[PJM Network Upgrade N6713]

Upgrade relay settings, drawings and nameplates.

Hamilton Substation
[PJM Network Upgrade N6714]

Upgrade relay settings, drawings and nameplates.

Fiber Installation from Galion and Roberts Substations
[PJM Network Upgrade N5262 and N6712]

Due to fiber constraints in this area and no available fibers on the existing OPGW from Roberts to Galion, a new ADSS fiber build will be required from the proposed ring bus to both Galion and Roberts substations. It is assumed that the fiber installation (approximately 25.4 miles) for AB2-131 to both Galion substation to support relaying protection over a fiber optic channel and to Roberts substation to support relaying protection over a fiber optic channel has been installed prior to this project. The fiber for this project is from the new AC2-195 interconnection substation to the anticipated ADSS cable near the intersection of Marion Williamsport Road and N Main Street. The assumed route is a combination of aerial ADSS (0.87 miles) and underground bore (0.14 miles). It is assumed the new ADSS fiber will also be used for SCADA communications backhaul from the proposed ring bus to both MPLS routers at Roberts and Galion.

NOTE: It is assumed that fiber has been approved in a previous AB2 Generation Queue study (AB2-131). The costs mentioned in this study will need to be adjusted if the previous AB2 project withdraws from the queue and entire fiber route required for the system protection and SCADA transport for AC2-195 (similar route and cost to what was described in AB2-131 in addition to what is described in this report for AC2-195) will then be the responsibility of AC2-195.

Engineering Assumptions:

1. Assumed that structures are suitable and capable for installation of ADSS. If structures are unable to accommodate additional loading, then estimate will need to be re-evaluated for another alternative route or additional costs to replace structures.
2. No forestry work is anticipated.

3. Existing structures are assumed to need no modifications to support the new ADSS conductor
4. The preliminary route used for this estimate includes one highway crossing and slightly over 700 feet of underground bore.

6. Schedule:

A proposed **twenty-four (24)-month Direct Connection** and **Non-Direct Connection** schedule is estimated to complete the engineering, construction and the associated activities, from the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting. This schedule assumes that all issues covered by the "Environmental, Real Estate and Permitting Issues" section of this document are resolved, and outages will occur as planned.

Assumptions / Notes:

Construction cannot begin until after all applicable permits and/or easements have been obtained.

Engineering Assumptions

- Existing structures are assumed to need no modifications to support the new ADSS conductor.

Siting and Right-of-Way Assumptions

- In OH, assume that project will receive local municipal approval with no public or municipal opposition.
- In OH, assume that project line work will require a Letter of Notification (LON).
- Assume all work occurs within an existing transmission line right-of-way with little or no modifications to existing structures; however, additional clearing rights from property owners may be required where additional vegetation clearing is needed.
- All work will occur within existing FE right-of-way. Some off-ROW access will likely be required from adjacent property owners. These additional costs are NOT included as part of the estimate.
- Temporary land rental may be required for contractor material with material/equipment staging areas, depending upon size of property provided for interconnection substation.
- Schedule assumes no property owner, governmental, or municipal opposition to the overall AC2-195 project.

Environmental Assumptions

- Environmental permits from OH will be required.
- Environmental studies will be required to develop E&S Control Plans and required measures. Costs include development and submittal of E&S Plan, periodic monitoring of E&S measures including post construction removal and rehabilitation.

Forestry/Vegetation Management Assumptions

- Additional vegetation clearing may be required for access road installation and within existing right-of-way where additional conductor clearance is required.
- No special conditions for vegetation clearing. Vegetation removal may be constrained due to seasonal restrictions due to T&E's (10/1 - 3/31) for native bat habitat. This should be included and verified as part of project environmental studies

7. Total Estimated Costs of TO Facilities for Direct and Non-Direct Connection:

The following table summarizes the total estimated costs according to FERC criteria. The estimated costs are in 2020 dollars. The taxes are a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 88-129.

Description	Total Cost	Tax (if applicable)	Total Cost (w/tax)
Installation of a 138 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 138 kV generator lead line.	$ 342,400	$ 44,500	$ 386,900
Review Developer's drawings, one-lines, metering & protection settings.	$29,100	$ 3,800	$ 32,900
Total Attachment Facilities (AF) Costs	**$ 371,500**	**$ 48,300**	**$ 419,800**
Install 138kV three breaker ring bus interconnection station for new customer generation addition. PJM Upgrade #N6707	$ 6,113,500	$ 793,600	$ 6,907,100
Project Management, Construction Management, Commissioning, Meter, and ROW. PJM Upgrade #N6707	$ 813,400	$ 105,600	$ 919,000
SCADA – MPLS router at AC2-195 to provide SCADA transport, in-sub fiber runs to last line structures, in-sub fiber runs to connect fiber coming from Developer's substation site and SCADA programming/configuration. PJM Upgrade #N6707	$ 386,500	$ 50,200	$ 436,700
Total Direct Connect (DC) Costs	**$ 7,313,400**	**$ 949,400**	**$ 8,262,800**
Loop the Galion-Roberts South 138kV circuit into the proposed 3-breaker ring	$ 677,100	$ 87,900	$ 765,000

bus near towers 3825 & 3826. @ Galion-Roberts South 138kV Loop. PJM Upgrade #N6708			
Install mid-span structure to raise height of Galion-Roberts North 138 kV to permit loop of Galion-Roberts 138 kV South to the new interconnection substation for AC2-195. PJM Upgrade #N6709	$ 109,600	$ 14,300	$ 123,900
Galion Substation - Upgrade line relaying for Roberts 138kV line exit and rename for new AC2-195 PJM station. PJM Upgrade #N6710	$ 214,200	$ 27,900	$ 242,100
Roberts Substation - Upgrade line relaying for Galion 138kV line exit and rename for new AC2-195 PJM station. PJM Upgrade #N6711	$ 214,200	$ 27,900	$ 242,100
A new ADSS fiber build will be required. The fiber for this project is from the new AC2-195 interconnection substation to the anticipated ADSS cable near the intersection of Marion Williamsport Road and N Main Street proposed for PJM queue position AB2-131. The assumed route is a combination of aerial ADSS (0.87 miles) and underground bore (0.14 miles). PJM Upgrade #N6712	$ 165,000	$ 21,500	$ 186,500
Dual Rail Substation – Change nameplates, revise engineering drawings and settings. PJM Upgrade #N6713	$ 16,100	$ 2,100	$ 18,200
Hamilton Substation – Change nameplates, revise engineering drawings and settings. PJM Upgrade #N6714	$ 16,100	$ 2,100	$ 18,200
Total Non Direct Connect (NDC) Costs	**$ 1,412,300**	**$ 183,700**	**$ 1,596,000**
Total AF + DC + NDC Costs	**$ 9,097,200**	**$ 1,181,400**	**$ 10,278,600**

Schedule:

A proposed **twenty-four (24) month Direct Connection and Non-Direct Connection** schedule is estimated to complete the engineering, construction and the associated activities, from the date of a fully executed Interconnection Construction Service Agreement and Construction Kick-Off Meeting. This schedule assumes that all issues covered by the "Environmental, Real Estate and Permitting Issues" section of this document are resolved, and outages will occur as planned. Construction cannot begin until after all applicable permits and/or easements have been obtained.

24 month Schedule

Activity	Start Month	End Month
Preliminary Engineering	1	3
Siting, Permits & Real Estate	2	12
Detailed Engineering	2	12
Equipment Delivery	14	15
Below Grade Construction – Substation	15	18
Below Grade Construction – T-Lines	21	22
Above Grade Construction – Substation	18	23
Above Grade Construction – T-Lines	22	23
Testing & Commissioning	24	24

8. New System Reinforcements and Network Upgrades

Description of the Upgrade

- Not applicable. None

Cost Estimate:

- Not applicable. None

Schedule:

- Not applicable. None

9. Total Estimated Costs of Transmission Owner Facilities:

Description	Total (w/ Tax)	Tax (if applicable)	Total Cost
Attachment Facilities:	**$ 371,500**	**$ 48,300**	**$ 419,800**
Total Direct Connection (DC) Costs:	**$ 7,313,400**	**$ 949,400**	**$ 8,262,800**
Total Non-Direct (NDC) Upgrade Costs:	**$ 1,412,300**	**$ 183,700**	**$ 1,596,000**

TOTAL Costs (ALL Categories)	**$9,097,200**	**$1,181,400**	**$10,278,600**

10. Information Required for Interconnection Service Agreement

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Installation of a 138 kV line exit take-off structure, foundations, disconnect switch and associated equipment to accommodate the termination of the 138 kV generator lead line.	$ 150,656	$ 109,568	$ 37,664	$ 44,512	$ 342,400
Review Developer's drawings, one-lines, metering & protection settings.	$12,804	$9,312	$3,201	$3,783	$29,100
Total Attachment Facilities Cost	**$ 163,460**	**$ 118,880**	**$ 40,865**	**$ 48,295**	**$ 371,500**
AC2-195 Interconnection Switchyard including SCADA, metering and Project Management. PJM Upgrade #N6707	$ 3,217,896	$ 2,340,288	$ 804,474	$ 950,742	$ 7,313,400
Total Direct Connection Cost	**$ 3,217,896**	**$ 2,340,288**	**$ 804,474**	**$ 950,742**	**$ 7,313,400**
Loop the Galion-Roberts South 138kV circuit into the proposed 3-breaker ring bus near towers 3825 & 3826. @ Galion-Roberts South 138kV Loop. PJM Upgrade #N6708	$ 297,294	$ 216,672	$ 74,481	$ 88,023	$ 677,100
Install mid-span structure to raise height of Galion-Roberts North 138 kV to permit loop of Galion-Roberts 138 kV South to the new interconnection substation for AC2-195. PJM Upgrade #N6709	$ 48,224	$ 35,072	$ 12,056	$ 14,248	$ 109,600
Galion Substation - Upgrade line relaying for Roberts 138kV line exit and rename for new AC2-195 PJM station. PJM Upgrade #N6710	$ 94,248	$ 68,544	$ 23,562	$ 27,846	$ 214,200
Roberts Substation - Upgrade line relaying for Galion 138kV line exit and rename for new AC2-195 PJM station. PJM Upgrade #N6711	$ 94,248	$ 68,544	$ 23,562	$ 27,846	$ 214,200
Fiber Communication - A new ADSS fiber build will be required. The fiber for this project is from the new AC2-195 interconnection substation to the anticipated ADSS cable near the intersection of Marion Williamsport Road and N Main Street proposed for PJM queue position AB2-131. The	$72,600	$52,800	$18,150	$21,450	$165,000

assumed route is a combination of aerial ADSS (0.87 miles) and underground bore (0.14 miles). PJM Upgrade #N6712					
Dual Rail Substation – Change nameplates, revise engineering drawings and settings. PJM Upgrade #N6713	$7,084	$5,152	$1,771	$2,093	$16,100
Hamilton Substation – Change nameplates, revise engineering drawings and settings. PJM Upgrade #N6714	$7,084	$5,152	$1,771	$2,093	$16,100
Total Non-Direct Connection Network Upgrades	**$ 621,412**	**$ 451,936**	**$ 155,353**	**$ 183,599**	**$ 1,412,300**
Total Project Costs	**$ 4,002,768**	**$ 2,911,104**	**$ 1,000,692**	**$ 1,182,636**	**$ 9,097,200**

11. Generation Connection Requirements

The proposed interconnection facilities must be designed in accordance with the Transmission Owner's *Requirements for Transmission Connected Facilities* documents located at either of the following links:

www.firstenergycorp.com/feconnect

www.pjm.com/planning/design-engineering/to-tech-standards.aspx

The following is an excerpt taken from Transmission Owner's *Requirements for Transmission Connected Facilities* document:

For all generation facilities, other than wind-powered and other non-synchronous generating facilities, the minimum requirement shall be the provision of a reactive power capability sufficient to maintain a composite power delivery at continuous rated power output at a power factor as defined in the table below. This requirement will be measured at either the POI or generator terminals as specified in the table below. These reactive requirements apply to both the initial installation as well as to any incremental change in unit MW capability. FE will coordinate with the Connecting Party to identify the optimal generator step-up transformer tap to make such a capability available when demanded.

For all wind-powered or other non-synchronous generating facilities the minimum requirement shall be the provision of a reactive power capability sufficient to maintain a composite power delivery at a power factor as defined in the table. This requirement will be measured at either the POI or generator's terminals as specified in the table below. These reactive requirements apply to both the initial installation as well as to any incremental change in unit MW capability. FE will coordinate with the Connecting Party to identify the optimal generator step-up transformer tap to make such a capability available when needed.

Generation Type	New / Increase	Size	Power Factor Requirement	Measurement Location
Synchronous	New	> 20 MW	0.95 leading to 0.90 lagging	Generator's Terminals
Synchronous	New	<= 20 MW	0.95 leading to 0.90 lagging	Point of Interconnection
Wind or Non-Synchronous	New	All	0.95 leading to 0.95 lagging	Generator's Terminals[1]
Synchronous	Increase	> 20 MW	1.0 (unity) to 0.90 lagging	Generator's Terminals
Synchronous	Increase	<= 20 MW	1.0 (unity) to 0.90 lagging	Point of Interconnection
Wind or Non-Synchronous	Increase	All	0.95 leading to 0.95 lagging[2]	Generator's Terminals

Any different reactive power requirements that FE and/or PJM determines to be appropriate for wind-powered or other non-synchronous generation facilities will be stated in the applicable interconnection agreement(s).

[1] For projects that entered PJM's New Service Queue prior to May 1, 2015, the power factor requirement will be measured at the Point of Interconnection.
[2] For projects that entered PJM's New Service Queue prior to May 1, 2015, the power factor requirement is 1.0 (unity) to 0.95 lagging.

Induction generators and other generators with no inherent VAR (reactive power) control capability, or those that have a restricted VAR capability less than the defined requirements, must provide dynamic supplementary reactive support located at the generation facility with electrical characteristics equivalent to that provided by a similar-sized synchronous generator.

Design Requirements

Developer is responsible for specifying appropriate equipment and facilities such that the parallel generation is compatible with Transmission Owner's Transmission System. Developer is also responsible for meeting any applicable federal, state, and local codes.

Design Criteria

Facilities owned and operated by Transmission Owner shall comply with the applicable Transmission Owner technical requirements and standards posted on the PJM website per the PJM Tariff, and the following criteria. Where there are different requirements for the same criterion, the more restrictive shall apply. Developer must abide by any PJM, RFC or NERC criteria imposed that is more restrictive than those of Transmission Owner.

General Design Requirements

• System phasing (counter clockwise)	X-Y-Z
• System frequency:	60 hertz
• Elevation, AMSL:	Less than 1000 meters
• Isokeraunic level:	40
• Maximum ambient temperature:	40 degrees C
• Minimum ambient temperature:	-40 degrees C
• Maximum conductor operating temperature:	Contact Transmission Owner
• Wind Loading (round shapes):	Per ASCE 7-98, per Fig. 6-1 depending on location
• Ice loading – Substations (no wind):	25 mm
• Seismic zone:	Per ASCE 7-98, per Fig. 9.4.1.1(a) and (b). Equipment qualification per IEEE 693-97

Voltage and Current Ratings

• Nominal phase-to-phase:	138 kV
• Maximum phase-to-phase:	145 kV
• Basic impulse level (BIL):	650 kV
• Maximum continuous current carrying capacity:	2000 A
• Design fault current:	40 kA
• Single Contingency (breaker failure) clearing time:	60 cycles

Clearances and Spacing

- Recommended rigid bus center-to-center phase spacing: 96”
- Minimum phase-to-phase, metal-to-metal distance: 63”
- Recommended phase-to-ground: 52.5”
- Minimum phase-to-ground: 50”
- Low bus height above top of foundations (match existing): 16’-0”
- High bus height above top of foundations (match existing): 24’-0”
- Minimum vertical clearance from live parts to grade: 12’-2”
- Minimum horizontal clearance from live parts: 6’-8”
- Minimum conductor clearance above roads in switchyard: 25’-0”
- Minimum bottom of insulator to top of foundation: 8’-6”

Metering, SCADA and Communications

Developer shall install, own, operate, test and maintain the necessary revenue metering equipment. Developer shall provide Transmission Owner with dial-up communication to the revenue meter.

Transmission Owner’s Revenue Metering Requirements may be found in the *Requirements for Transmission Connected Facilities* document located at the following links:

www.firstenergycorp.com/feconnect

www.pjm.com/planning/design-engineering/to-tech-standards.aspx

These requirements are in addition to any metering required by PJM.

Transmission Owner will provide the telecommunication circuits for the SCADA RTU and the telephone in the Transmission Owner interconnection substation.

Transmission Owner will obtain real-time, site-specific, generation data from PJM, via the required communication link from Developer to PJM. Transmission Owner will work with PJM and Developer to ensure the generation data provided to PJM meets Transmission Owner's requirements.

Communications for transmission line protection between the new **interconnection** substation, and Developer’s **generation** (collector) substation, will be via fiber optics (see “Fiber Optic Communication Channels” section below).

Fiber Optic Communication Channels

Developer will design, provide, install, own and maintain a fiber-optic communications cable between the new **interconnection** substation, and Developer’s **generation** (collector) substation. Two (2) fiber-optic channels are required for each generator protection scheme to obtain high-speed tripping capability for any fault within the zone of protection. The primary and backup relay fiber-optic communication channels must be in separately routed cable paths and additional fiber-optic connection costs will apply. The Developer will make the fiber-optic cable termination connections for its cable(s) at the interconnection substation control house.

Transmission Owner will make the fiber termination connections for its cable(s) at the interconnection substation control house. Developer is responsible for obtaining and maintaining all associated Rights-of-Way (ROW), Easements, and Permits for its fiber cable.

Environmental, Real Estate and Permitting Issues

The following are possible environmental, real estate and permitting issues:

- Environmental permitting, Real Estate acquisition, and Public Utilities Commission of Ohio (PUCO) notifications vary, some up to twelve (12) months after preliminary engineering is completed to secure the required approvals.
- Prior to agreement by Developer to purchase the property, a Phase 1 Environmental Assessment should be conducted for the entire site to avoid assumption of environmental liabilities by Developer or Transmission Owner.
- The Transmission Owner interconnection substation may involve environmental surveys, permits, approvals and plans with federal, state, and/or local agencies.
- Assumed Developer is to provide all access rights, easements, ROW and permits necessary to complete the Project to the satisfaction of Transmission Owner. Environmental permitting shall encompass all federal, state and local requirements, consultations and agency coordination. Confirmation of meeting all permitting requirements shall be provided to Transmission Owner, prior to start of construction. Following construction and energization, confirmation of permit closeout shall be provided to the satisfaction of Transmission Owner, prior to transfer of ownership. If any of these elements are not included in the final agreement between Transmission Owner and Developer, twelve (12) to eighteen (18) months should be added to the Project Schedule to secure necessary permits, and additional costs would apply.
- Developer will provide copies of all of the relative environmental permits and other necessary approvals to Transmission Owner before Transmission Owner accepts the interconnection facilities.
- Developer is required to install an access road from the new interconnection substation to the nearest public road (must be approved by Transmission Owner), and obtain access rights for Transmission Owner. Developer is responsible to maintain access road and ensure unimpeded access for Transmission Owner at all times.
- Developer is responsible for all property acquisition (including easements/rights-of-way (ROW)) for transmission, distribution and communication facilities needed for the generator interconnection.
- If Developer owns the project property, in fee title, Transmission Owner will require a fee property transfer for the interconnection substation site which may require subdivision approval, together with permanent access rights to and from the substation, as well as a perpetual easement for any transmission lines to the substation. Developer is responsible for all costs, including but not limited to subdivision, associated with the property transfer.
- If Developer leases the project property, the Developer will be required to obtain fee property from the underlying fee property owner, on behalf of Transmission Owner, for the interconnection substation site, together with permanent access rights to and from the substation, as well as a perpetual easement for any transmission lines to the substation.
- All property rights must be surveyed and metes and bounds descriptions prepared for incorporation into Transmission Owner's document forms, for transfer of title.

- The Transmission Owner interconnection substation and transmission line loop will involve Public Utilities Commission of Ohio (PUCO) and Ohio Power Siting Board (OPSB) notification/approval.

General Assumptions/Qualifiers

The accomplishment of the work on the Transmission Owner system to support the estimated costs and proposed schedule is dependent on the following:

The accomplishment of the work on the Transmission Owner system to support the estimated costs and proposed schedule is dependent on the following:

- Obtaining the necessary line outages. Transmission line outages are typically not granted from June to September and are discouraged during extreme winter conditions.
- No equipment delivery, environmental, permitting, regulatory or real estate delays.
- No extreme weather.
- No force majeure.
- Estimates assume no significant rock encountered during construction, and suitable soil conditions exist to accommodate a standard ground-grid and foundation installation.
- It is assumed that the new interconnection substation will be located on the northwest side of the transmission corridor (see "Figure 2") and the loop will avoid crossing other Transmission Owner transmission lines.
- All work occurs within an existing transmission line right-of-way or on Developer's property with access to all existing structures possible via that property and the right-of- way following established access routes that do not cross wetlands or streams.
- Right-of-way is required from Developer only. The project is entirely on Developer's property.
- Developer will develop, and secure regulatory approval for, all necessary Erosion and Sediment Control (E&SC) plans and National Pollutant Discharge Elimination System (NPDES) permits.
- Developer will obtain all necessary permits.
- Developer will develop all necessary access roads for project sites.
- Developer will conduct all necessary wetlands and waterways studies and permits.
- Developer will conduct all necessary historical and archaeological studies.
- Assumed the interconnection substation and generation (collector) substation are not adjacent (i.e. share a common fence). The 138 kV connection between the substations will be via a 138 kV transmission line.
- In order to meet the requested Backfeed Date, the exact substation site, pull-off structure location, and structure details (for connection to the transmission line loop) are required from the interconnection customer within six (6) months from the construction kickoff meeting. Delays in provision of substation site details will affect the schedule.
- Developer is responsible to make all arrangements for electric distribution service (if required) for its generation station. No costs or schedule included herein.
- The execution of a back-up service agreement to serve the customer load supplied from the AC2-195 generation project metering point when the units are out-of-service. This assumes the intent of Marion County Solar Project, LLC is to net the generation with the load.

- Developer's generation step-up (GSU) transformer winding configuration shall have a wye-grounded winding on the high-side (transmission system) and have a delta connected winding on the low side.
- If the Developer were to choose the "Option to Build" for the interconnection substation, it must utilize an approved Transmission Owner A/E & Construction Contractor. A listing of Transmission Owner Approved Vendors and Contractors is located at the following PJM site:
  www.pjm.com/planning/design-engineering/to-tech-standards.aspx
- Developer shall maintain adequate clearances for its 138 kV generation attachment line from Transmission Owner's electric lines and structures. Developer shall submit final engineering design of its generation attachment line to Transmission Owner for approval prior to proceeding with the construction of the attachment line.
- The Developer should also take into consideration how they plan to cross the transmission corridor with any facilities. If there are plans to cross the transmission line right of way with facilities or access roads, please refer to the Transmission Rights-of-Way Restrictions information located at:
  - https://www.firstenergycorp.com/help/safety/real-estate-power-lines/transmission-right-of-way.html#ROWform

ATTACHMENTS
&
FIGURES

ATTACHMENT A
Queue # AC2-195

Detailed Protection Requirements

Short Circuit Values

The 138kV fault values for the AC2-195 interconnection location with all new generation out of service are:

Three phase = 10.5kA
Single line to ground = 8.7kA
Z1= (0.888 + j 3.867)%
Z0= (1.512 + j 6.340)%

Impedances are given on 100 MVA and 138kV bases. The faults provided are bolted, symmetrical values for normal system conditions. Future increases in fault currents are possible and it is the customer's responsibility to upgrade their equipment and/or protective equipment coordination when necessary.

General Connection Requirements

The AC2-195 delivery point substation (DPS) is a 138kV three-breaker ring bus on the Galion-Roberts South 138kV line.

The existing line relays at Galion and Roberts require replacement.

Line protection between Galion and AC2-195 and between Roberts and AC2-195 shall consist of two independent SEL-411L line current differential schemes with pilot communication over fiber optic cable for each 138kV line, at each terminal.

At the AC2-195 DPS, each 138kV breaker shall have breaker failure-to-trip protection. SEL-501 relays are acceptable for this application.

Protection of the 138kV Generator Lead Line of approximately 0.1 miles shall consist of two SEL-411L line current differential schemes with pilot communication over fiber optic cable, at each terminal.

The AC2-195 generator protection system, shall include a Transfer Trip Receiver for Anti-Islanding via AC2-195 138kV breaker.

Protection Requirements

AC2-195 138kV Interconnecting Substation

138kV Transmission Line Protection

- Galion line exits
  - Primary relay: SEL-411L relay with line current differential protection over fiber
  - Backup relay: SEL-411L relay with line current differential protection over fiber

- Roberts line exit
  - Primary relay: SEL-411L relay with line current differential protection over fiber
  - Backup relay: SEL-411L relay with line current differential protection over fiber

- AC2-195 generating facility
  - Primary relay: SEL-411L relay with line current differential protection over fiber
  - Backup relay: SEL-411L relay with line current differential protection over fiber

138kV AC2-195 Interconnecting Station Communications

- AC2-195 Interconnecting Station to Galion and Roberts
  - Fiber-optic cable(s) with dedicated fibers for use with the SEL-411L primary and backup relaying
    - It is assumed that the fiber has been installed in a previous AB2-131 generation queue project.

- AC2-195 Interconnecting Station to AC2-195 generating facility
  - Dual, independent fiber-optic cable paths with dedicated fibers for use with the SEL-411L primary and backup relaying
    - Minimum of 12 fibers, separate primary and backup fiber cables

138kV Breaker Failure to Trip Protection

- 138kV Breaker Failure to Trip Relaying – SEL501 relay per breaker

AC2-195 Generating Station 138kV

138kV Transmission Line Protection @ AC2-195 generating station

- AC2-195 Interconnecting Station line exit
  - Primary relay: SEL-411L relay with line current differential protection over fiber
  - Backup relay: SEL-411L relay with line current differential protection over fiber
  - Synch check for manual/SCADA close on the interconnecting line to be done at AB2-131 Generating Station

138kV Breaker Failure to Trip Protection

- 138kV Breaker Failure to Trip Relaying
  - SEL-352-2 breaker failure to trip relaying on AC2-195 138kV Generating Station breaker. The breaker failure to trip relaying on the AC2-195 Interconnecting Station line exit breaker shall initiate direct transfer trip via the SEL-411L primary and backup line relays (fiber).

138kV Bus & GSU Transformer Protection @ AC2-195 generating station (minimum protection to meet FE requirements)

- Dual, independent transformer differential protection schemes (Transformer and Overall)
- Transformer neutral time overcurrent relay

The Connecting Party shall provide utility-grade relays for protection of the FE Transmission System. FE shall approve all relays specified for the protection of the FE Transmission System, including time delay and auxiliary relays. Relay operation for any of the listed functions that are required shall initiate immediate separation of the parallel generation from the FE Transmission System:

Relay	**Function**
Frequency	To detect underfrequency and overfrequency operation.
Overvoltage	To detect overvoltage operation.
Undervoltage	To detect undervoltage operation.
Ground Fault Detector	To detect a circuit ground on the FE Transmission System.
Phase Fault Detector	To detect phase to phase faults on the FE Transmission System.
Transfer Trip Receiver	To provide tripping logic to the generation owner for isolation of the generation upon opening of the FE supply circuits.
Directional Power	To detect, under all system conditions, a loss of FE primary source. The relay shall be sensitive enough to detect transformer magnetizing current supplied by the generation.

The Interconnection Customer will be required to comply with all FE Generation Protection Requirements for Generation Interconnection Customers. The Generation Protection Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

www.firstenergycorp.com/feconnect

www.pjm.com/planning/design-engineering/to-tech-standards.aspx

FE System Modifications

Galion Substation

138kV Transmission Line Protection

- AC2-195 Interconnecting Station line exit Primary Relaying
  - Primary relay: SEL-411L relay with line current differential protection over fiber
  - Backup relay: SEL-411L relay with line current differential protection over fiber

Roberts Substation

138kV Transmission Line Protection

- AC2-195 Interconnecting Station line exit Primary Relaying
  - Primary relay: SEL-411L relay with line current differential protection over fiber
  - Backup relay: SEL-411L relay with line current differential protection over fiber

Settings Changes

- Settings changes are possible at remote substations.

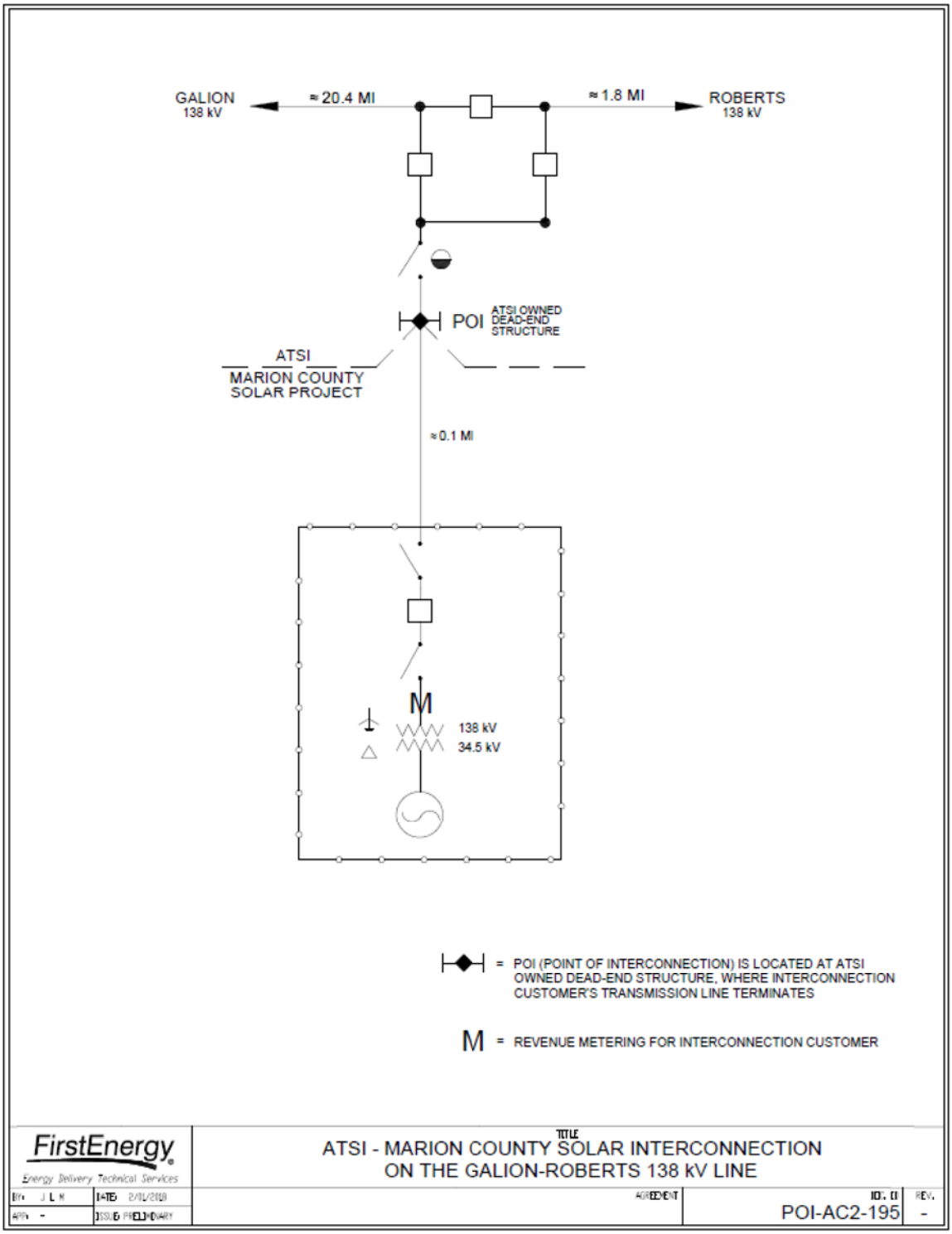
Revenue Metering and SCADA Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

www.firstenergycorp.com/feconnect

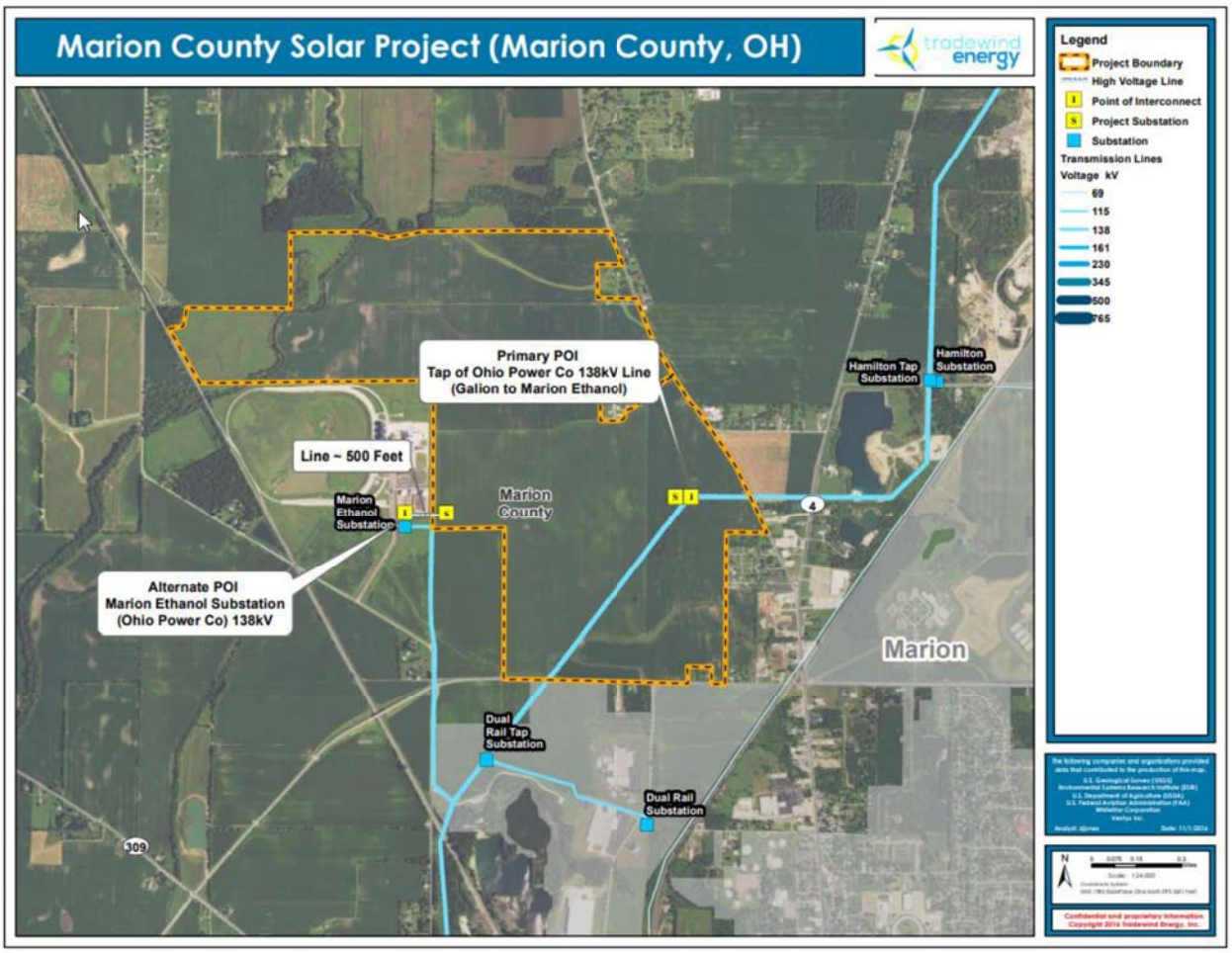
www.pjm.com/planning/design-engineering/to-tech-standards.aspx

FIGURE 1
Queue #AC2-195
Planning Single-Line Diagram*

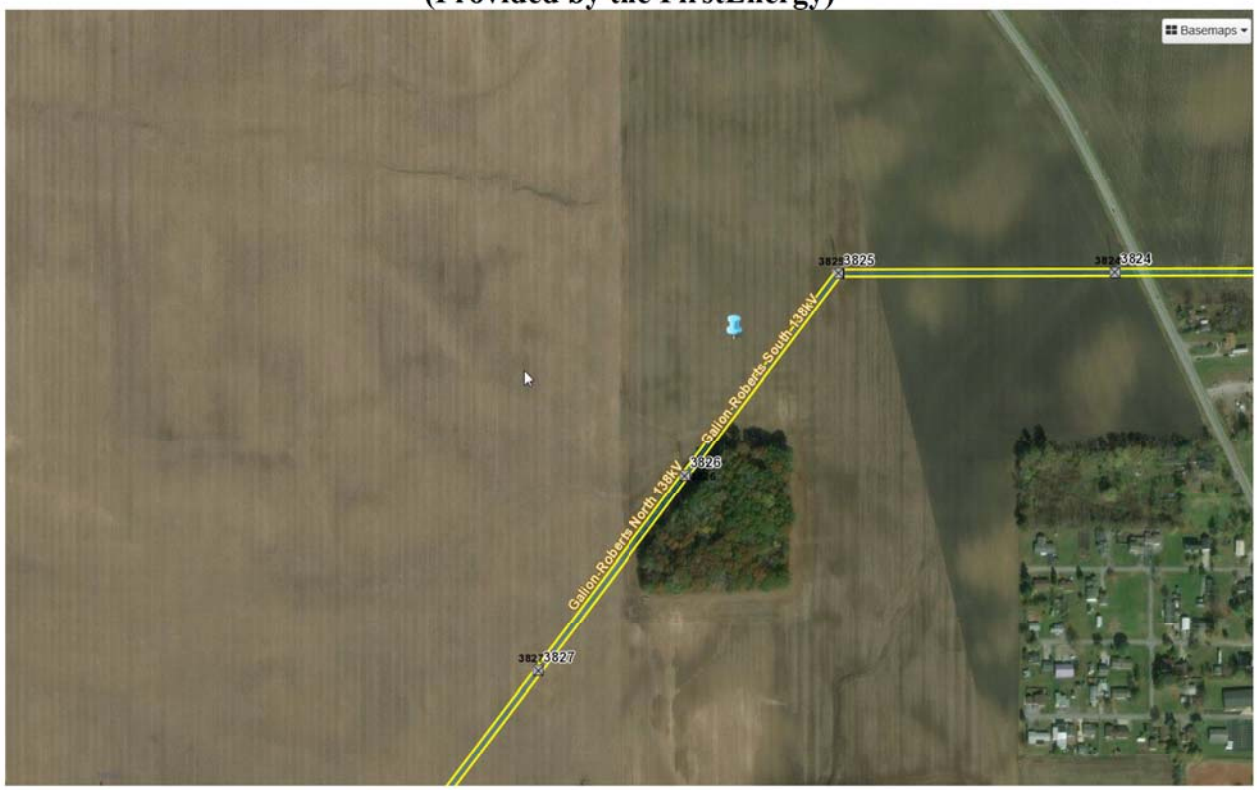


* Note: Diagram does not represent a physical layout. Not to be used for construction.

FIGURE 2
Queue #AC2-195
Proposed Project Location
(Provided by the Developer)


Marion County Solar Project (Marion County, OH)
tradewind energy
Legend
Project Boundary
High Voltage Line
Point of Interconnect
Project Substation
Substation
Transmission Lines
Voltage kV
69
115
138
161
230
345
500
765
Primary POI
Tap of Ohio Power Co 138kV Line
(Galion to Marion Ethanol)
Line ~ 500 Feet
Marion Ethanol Substation
Marion County
Alternate POI
Marion Ethanol Substation
(Ohio Power Co) 138kV
Hamilton Tap Substation
Hamilton Substation
Marion
Dual Rail Tap Substation
Dual Rail Substation
309
4

Proposed Substation Location
(Provided by the FirstEnergy)



Single Line Diagram
(Provided by the Developer)

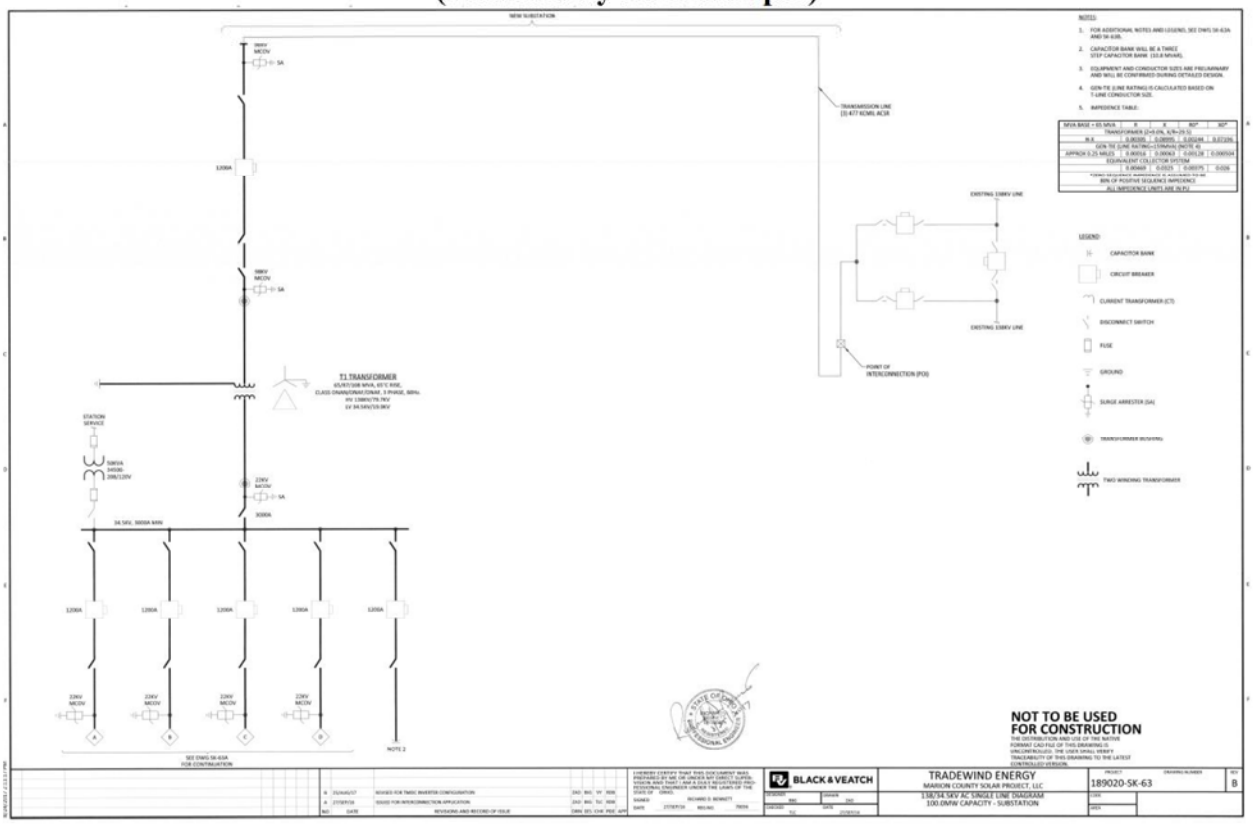


Exhibit F
Interconnection Studies

4. AE2-324 Generation Interconnection Feasibility Study Report, July 2019

Generation Interconnection

Feasibility Study Report

for

Queue Project AE2-324

GALION-ROBERTS SOUTH II 138 KV

20.3 MW Capacity / 20.3 MW Energy

July 2019

Table Of Contents

1 Preface

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

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

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

PJM utilizes manufacturer models to ensure the performance of turbines is properly captured during the simulations performed for stability verification and, where applicable, for compliance with low voltage ride through requirements. Turbine manufacturers provide such models to their customers. The list of manufacturer models PJM has already validated is contained in Attachment B of Manual 14G. Manufacturer models may be updated from time to time, for various reasons such as to reflect changes to the control systems or to more accurately represent the capabilities turbines and controls which are currently available in the field. Additionally, as new turbine models are developed, turbine manufacturers provide such new models which must be used in the conduct of these studies. PJM needs adequate time to evaluate the new models in order to reduce delays to the System Impact Study process timeline for the Interconnection Customer as well as other Interconnection Customers in the study group. Therefore, PJM will require that any Interconnection Customer with a new manufacturer model must supply that model to PJM, along with a $10,000 fully refundable deposit, no later than three (3) months prior to the starting date of the System Impact Study (See Section 4.3 for starting dates) for the Interconnection Request which shall specify the use of the new model. The Interconnection Customer will be required to submit a completed dynamic model study request form (Attachment B-1 of Manual 14G) in order to document the request for the study.

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

2 General

The Interconnection Customer (IC) has proposed an uprate to the proposed AC2-195 Storage generating facility to be located in the city of Marion, Marion County, Ohio. This project requests an increase to the install capability of the AC2-195 project by 20.3 MW with 20.3 MW of this output being recognized by PJM as additional Capacity. AE2-324 will share the same property and connection point as the AC2-195 project. The installed facilities will have a total capability of 120.3 MW with 82.4 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 1, 2022. This study does not imply a Transmission owner (TO) commitment to this in-service date.

Queue Number	AE2-324
Project Name	GALION-ROBERTS SOUTH II 138 KV
Interconnection Customer	
State	Ohio
County	Marion
Transmission Owner	ATSI
MFO	20.3
MWE	20.3
MWC	20.3
Fuel	Storage
Basecase Study Year	2022

3 Point of Interconnection

AE2-324 will interconnect with the ATSI transmission system. The interconnection of the project at the Primary POI will be accomplished through the prior queue project AC2-195. Gen Queue AC2-195 is to construct a new 138 kV three (3) breaker ring bus substation, looping the Galion – Roberts South 138 kV line into the new substation, and extending a new line exit to the Primary POI. The new substation will be located approximately 20.4 miles from the FirstEnergy Galion substation. Due to the uprate of 20.3 MW, the project will require non-direct connection upgrades at the FirstEnergy Galion and Roberts substations.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE2-324 generation project to connect to the FirstEnergy ("FE") transmission system. Attachment 2 provides the proposed location for the point of interconnection. 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.

4 Cost Summary

The AE2-324 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$0
Direct Connection Network Upgrade	$0
Non Direct Connection Network Upgrades	$41,400
Total Costs	$41,400

In addition, the AE2-324 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	$0

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

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 Non-Direct Connection work for the interconnection of the AE2-324 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.

5 Transmission Owner Scope of Work

AE2-324 will interconnect with the ATSI transmission system. The interconnection of the project at the Primary POI will be accomplished through the prior queue project AC2-195. Gen Queue AC2-195 is to construct a new 138 kV three (3) breaker ring bus substation, looping the Galion – Roberts South 138 kV line into the new substation, and extending a new line exit to the Primary POI. The new substation will be located approximately 20.4 miles from the FirstEnergy Galion substation. Due to the uprate of 20.3 MW, the project will require non-direct connection upgrades at the FirstEnergy Galion and Roberts substations.

6 Attachment Facilities

There is no Attachment Facility scope of work required.

7 Direct Connection Cost Estimate

There is no Direct Connection scope of work required.

8 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
Relay settings changes for Roberts South line due to AE2-324 uprate. @ Galion SS	$20,700
Relay settings changes for Galion South line due to AE2-324 uprate @ Roberts SS	$20,700
Total Non-Direct Connection Facility Costs	$41,400

9 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 four months after the signing of an Interconnection Construction Service Agreement to complete the facility changes. This includes the requirement for the IC to make a preliminary payment that compensates FE for the Non-Direct Connection work identified. This assumes that there will be no environmental issues with any of the new properties associated with this project and that all transmission system outages will be allowed when requested.

10 Transmission Owner Analysis

10.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AE2-324 project did not contribute to any overloads on the FE transmission system

10.2 Stability Analysis

None.

11 Interconnection Customer Requirements

11.1 System Protection

The IC must design it's 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.

Regarding the Primary POI, 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.

11.2 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 138 kV circuit breaker to protect the AE2-324 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 AE2-324 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.

11.3 Power Factor Requirements

The existing non-synchronous 99.96 MW portion of the Customer Facility shall retain 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.

The increase of 20.3 MW to the non-synchronous Customer Facility associated with AE2-324 project shall be designed with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.95 lagging (supplying VARs).

12 Revenue Metering and SCADA Requirements

12.1 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.

12.2 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

13 Network Impacts

The Queue Project AE2-324 was evaluated as a 21.4 MW (Capacity 20.4 MW) as an uprate to AC2-195 tapping the Hamilton to Dual Rail section of the Galion-Roberts South 138kV line in the ATSI area. Project AE2-324 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE2-324 was studied with a commercial probability of 53%. Potential network impacts were as follows:

Summer Peak Load Flow

14 Generation Deliverability

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

None

15 Multiple Facility Contingency

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

None

16 Contribution to Previously Identified Overloads

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

None

17 Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
8991206	238667	02DUALR+	ATSI	239073	02ROBERT	ATSI	1	ATSI-P1-2-OES-138-009-A	operation	225.0	102.29	111.36	DC	20.4
8991129	924790	AB2-131 TAP	ATSI	238746	02GALION	ATSI	1	ATSI-P1-2-OES-138-009-C	operation	228.0	107.7	116.65	DC	20.4
8991222	933720	AC2-195 TAP	ATSI	238667	02DUALR+	ATSI	1	ATSI-P1-2-OES-138-009-A	operation	242.0	101.47	109.9	DC	20.4

18 System Reinforcements:

None

19 Flow Gate Details

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

None

Affected Systems

20 Affected Systems

20.1 LG&E

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

20.2 MISO

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

20.3 TVA

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

20.4 Duke Energy Progress

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

20.5 NYISO

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

21 Contingency Descriptions

Contingency Name	Contingency Definition
ATSI-P1-2-OES-138-009-A	CONTINGENCY 'ATSI-P1-2-OES-138-009-A' /* GALION - ROBERTS SOUTH 138KV LINE FAULT DISCONNECT BRANCH FROM BUS 238746 TO BUS 924790 CKT 1 /* 02GALION 138 AB2-131 TAP 138 END
ATSI-P1-2-OES-138-009-C	CONTINGENCY 'ATSI-P1-2-OES-138-009-C' /* GALION - ROBERTS SOUTH 138KV LINE FAULT DISCONNECT BRANCH FROM BUS 238667 TO BUS 239073 CKT 1 /* 02DUALR+ 138 02ROBERT 138 DISCONNECT BRANCH FROM BUS 238667 TO BUS 933720 CKT 1 /* 02DUALR+ 138 AC2-195 TAP 138 REMOVE LOAD O FROM BUS 238668 /* 02DUALRL 138 REMOVE LOAD C FROM BUS 238668 /* 02DUALRL 138 DISCONNECT BUS 238668 /* 02DUALRL 138 DISCONNECT BUS 238667 /* 02DUALR+ 138 END

Short Circuit

22 Short Circuit

The following Breakers are overduty:

None

23 Attachment 1 – One Line

24 Attachment 2 – Project Location

Exhibit F
Interconnection Studies

5. AE2-324 Generation Interconnection System Impact Study Report, February 2020

Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC2-195

Galion-Roberts South 138kV

June 2018

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.

General

Marion County Solar Project, LLC, the Interconnection Customer (IC), has proposed a solar generating facility located in Marion, OH. The installed facilities will have a total capability of 99.96 MW with 62.1MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 31, 2020. **This study does not imply a American Transmission Systems Inc. (or "ATSI") commitment to this in-service date.**

Point of Interconnection

AC2-195 will interconnect with the American Transmission Systems Inc. (or "ATSI") transmission system along the Galion-Roberts South 138kV line

Cost Summary

The AC2-195 project will be responsible for the following costs:

Description	Cost	Tax (if applicable)	Total Cost
Attachment Facilities	$ 0	$ 0	$ 0
Direct Connection Network Upgrades	$ 6,289,600	$ 839,100	$ 7,128,700
Non Direct Connection Network Upgrades	$ 468,200	$ 61,200	$ 529,400
Allocation for New System Upgrades	$ 8,806,300	$ 1,173,000	$ 9,979,300
Contribution for Previously Identified Upgrades	$ 0	$ 0	$ 0
Total Costs	**$ 15,564,100**	**$ 2,073,300**	**$ 17,637,400**

Attachment Facilities

There are no Attachment Facilities are required to support this interconnection.

Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up.

Description	Activity Cost	Tax (if applicable)	Total Cost
Construct a 138kV three breaker ring bus interconnect substation between Galion and Roberts. @ AC2-195 Interconnect	$ 5,471,000	$ 732,400	$ 6,203,400
Loop the Galion-Roberts South 138kV circuit into the AC2-195 ring bus. The proposed location of the ring bus is near structure #3825 (Primary POI). @ Galion-Roberts South 138kV Loop to AC2-195 Ring Bus (Primary POI)	$ 818,600	$ 106,700	$ 925,300
Total Direct Connection Facility Costs	**$ 6,289,600**	**$ 839,100**	**$ 7,128,700**

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	Activity Cost	Tax (if applicable)	Total Cost
Upgrade line relaying to AC2-195 Interconnect @ Galion SS	$ 234,100	$ 30,600	$ 264,700
Upgrade line relaying to AC2-195 Interconnect @ Roberts SS	$ 234,100	$ 30,600	$ 264,700
Total Non-Direct Connection Facility Costs	**$ 468,200**	**$ 61,200**	**$ 529,400**

NOTE: It is assumed that fiber has been approved in a previous AB2 Generation Queue study. The costs mentioned above will be adjusted if the previous AB2 project withdraws from the queue and fiber is required for the system protection.

Transmission Owner Scope of Work

Galion – Roberts South 138 kV

The primary Point of Interconnection (POI) for the AC2-195 generation project is located one span outside of the proposed ATSI ring bus switch station which will be located on the Galion – Roberts South 138kV line. The direct connection of AC2-195 generation project will be accomplished by utilizing a three (3) breaker ring bus to connect to the Galion – Roberts South 138 kV line. The Marion County Solar Project, LLC will be responsible for constructing all of the facilities on its side of the POI, including the 138-kV line extension to its generation facilities. Marion County Solar Project, LLC may not install above ground equipment within any FirstEnergy right-of-way unless permission to do so is expressly granted by FirstEnergy.

Based on the extent of the ATSI primary direct connection required to support the AC2-195 generation project, it is expected to take a minimum of twenty-six (26) months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This includes the requirement for Marion County Solar Project, LLC to make a preliminary payment to ATSI which funds the first three months of engineering design that is related to the construction of the Direct Connection facilities. It further assumes that Marion County Solar Project, LLC will provide all rights-of-way, permits, easements, etc. that will be needed. A further assumption is 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 facility upgrades, and that all system outages will be allowed when requested.

Note that the FE findings were made from a conceptual review of this project. A more detailed review of the connection facilities and their cost will be identified in the Facilities Study. Further note that the cost estimate data contained in this document are subject to further refinement after the Facilities Study is complete. The applicant will be responsible for the actual cost of construction. FE herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any reinforcements to the transmission or sub-transmission systems.

Interconnection Customer Requirements

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

3. The Interconnection Customer seeking to interconnect a wind generation facility shall maintain meteorological data facilities as well as provide that meteorological data which is required per item 5.iv. of Schedule H to the Interconnection Service Agreement.

4. The purchase and installation of fully rated 138 kV circuit breakers on the high side of the AC2-195 step-up transformers.

5. The purchase and installation of the minimum required ATSI generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.

6. 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.

7. The establishment of dedicated communication circuits for SCADA to the FE Transmission System Control Center.

8. A compliance with the FE and PJM generator power factor and voltage control requirements.

9. The execution of a back-up service agreement to serve the customer load supplied from the AC2-195 generation project metering point when the units are out-of-service. This assumes the intent of Marion County Solar Project, LLC is to net the generation with the load.

Revenue Metering and SCADA Requirements

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 Sections 24.1 and 24.2.

ATSI Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

http://www.firstenergycorp.com/feconnect
http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx

Network Impacts

The Queue Project AC2-195 was evaluated as a 100.0 MW (Capacity 62.1 MW) injection into a tap of the Dual Rail – Hamilton 138 kV segment (part of the Galion – Roberts South 138 kV line) in the ATSI area. Project AC2-195 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC2-195 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
C2-BRK-SR044_A	CONTINGENCY 'C2-BRK-SR044_A' /* ROBERTS B-60 FAILURE TO TRIP DISCONNECT BRANCH FROM BUS 239073 TO BUS 238861 CKT 1 /* 02ROBERT 138 02KIRBY 138 DISCONNECT BRANCH FROM BUS 239073 TO BUS 239308 CKT 1 /* 02ROBERT 138 02MR-ETH 138 DISCONNECT BRANCH FROM BUS 239073 TO BUS 238667 CKT 1 /* 02ROBERT 138 02DUALR+ 138 DISCONNECT BRANCH FROM BUS 238928 TO BUS 239073 CKT ZL /* 02LTV+ 138 02ROBERT 138 DISCONNECT BRANCH FROM BUS 239073 TO BUS 239074 CKT 1 /* 02ROBERT 138 02ROBERT 35 DISCONNECT BRANCH FROM BUS 239073 TO BUS 239074 CKT 2 /* 02ROBERT 138 02ROBERT 35 DISCONNECT BRANCH FROM BUS 239073 TO BUS 239074 CKT 3 /* 02ROBERT 138 02ROBERT 35 REDUCE BUS 239073 SHUNT BY 100 PERCENT /* 02ROBERT 138 DISCONNECT BRANCH FROM BUS 238667 TO BUS 238668 CKT 1 /* 02DUALR+ 138 02DUALRL 138 DISCONNECT BRANCH FROM BUS 238667 TO BUS 933720 CKT 1 /* 02DUALR+ 138 AC2-195 138 REMOVE LOAD O FROM BUS 238668 /* 02DUALRL 138 DISCONNECT BUS 239073 /* 02ROBERT 138 DISCONNECT BUS 238667 /* 02DUALR+ 138 DISCONNECT BUS 238668 /* 02DUALRL 138 END

Generator Deliverability

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

None

Light Load Analysis

Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

None

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

	Contingency		Affected		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
1	LFFB	C2-BRK-SR044_A	FE - FE	AB2-131 TAP-02GALION 138 kV line	924790	238746	1	AC	62.37	106.81	ER	228	99.96	1

Note: Please see Attachment 3 for projects providing impacts to flowgate violations. The values in the Reference column correspond to the proper table in the Attachment.

Short Circuit

(Summary of impacted circuit breakers)

None

Contribution to Previously Identified Overloads

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

None

Steady-State Voltage Requirements

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

See Attachment 4

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

See Attachment 4

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	AC2-195 Allocation
#1	AB2-131 Tap - Galion 138 kV line	In order to mitigate the overloads of facilities above, the following reinforcements are required: ATSI upgrade to reconductor approximately 17 miles of transmission line with 477 ACSS from FE Galion substation to a proposed AB2-131 substation tap location and replace substation conductor at Galion. Cost estimate is $8.8063 M. PJM Network Upgrade N5552. AC2-195 is responsible for this cost.	n5552	**$ 8,806,300**	**$ 8,806,300**
				Total New Network Upgrades	**$ 8,806,300**

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)

None

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.

None

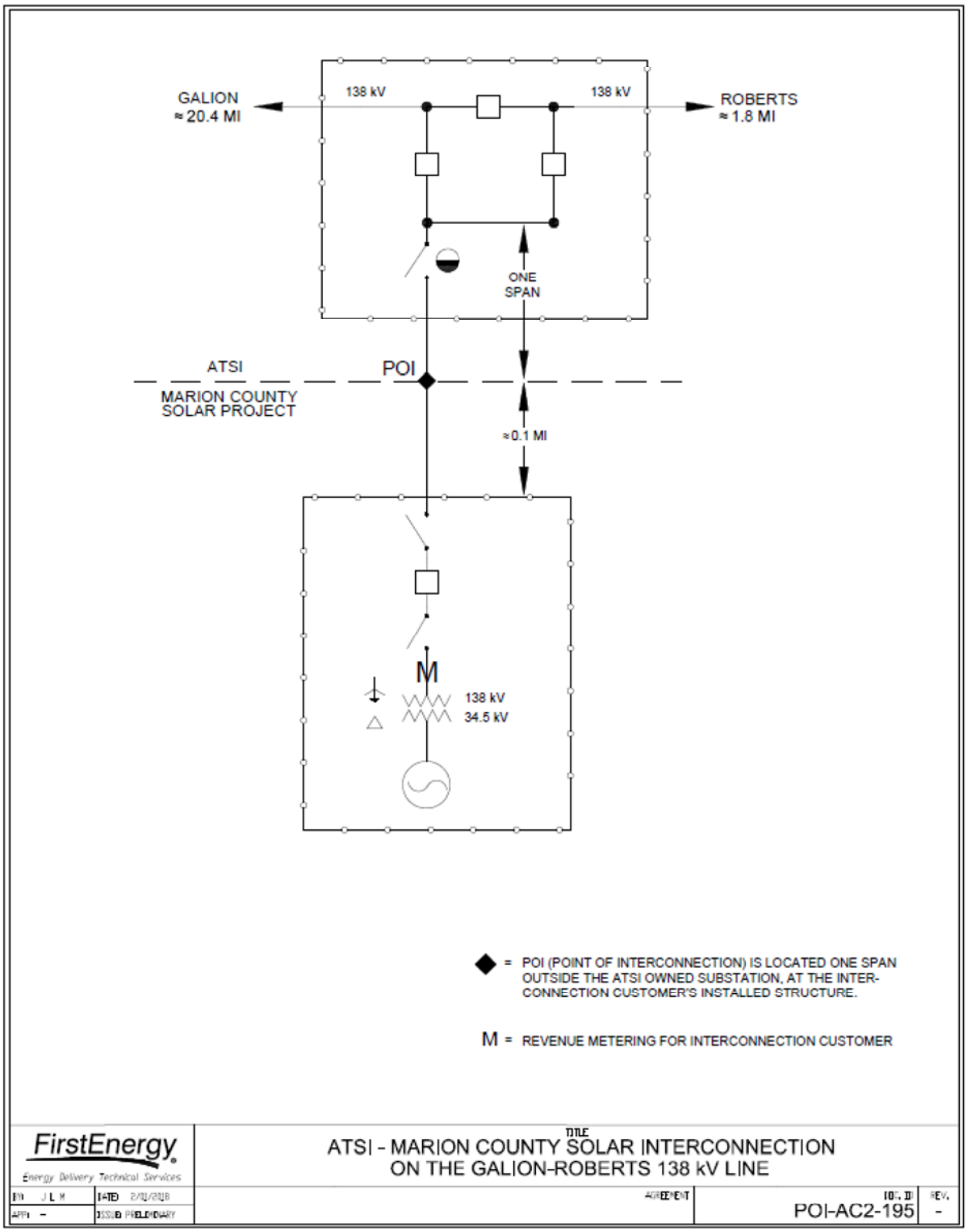
Affected System Analysis & Mitigation

MISO Impacts:

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

Attachment 1. Project Location

Attachment 2. Single Line Diagram



Attachment 3. Flowgate Details

Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

Appendix 2

(FE - FE) The AB2-131 TAP-02GALION 138 kV line (from bus 924790 to bus 238746 ckt 1) loads from 62.37% to 106.81% (AC power flow) of its emergency rating (228 MVA) for the line fault with failed breaker contingency outage of 'C2-BRK-SR044_A'. This project contributes approximately 99.96 MW to the thermal violation.

Bus Number	Bus Name	Full Contribution
933721	AC2-195 C O1	62.1
933722	AC2-195 E O1	37.86

Bus Number	Bus Name	Full Contribution
924791	AB2-131 C OP	57
924792	AB2-131 E OP	93

Attachment 4. Dynamic Simulation Analysis

TABLE OF CONTENTS

Executive Summary

Generator Interconnection Request AC2-195 is for a 99.96 MW Maximum Facility Output (MFO) solar powered generating facility with a Point of Interconnection (POI) tapped into Galion – Roberts 138kV line in the ATSI system, Marion County, Ohio. 60 TMEIC L1833 GRQ 1.66MW solar inverters would be used for this project.

This report describes a dynamic simulation analysis of AC2-195 as part of the overall system impact study.

The load flow scenario for the analysis was based on the RTEP 2020 Summer Peak case, modified to include applicable queue projects. AC2-195 has been dispatched online at maximum power output, with POI voltage of (1.011 p.u.), consistent with the default generator reference voltage specified in PJM Manual 03 Transmission Operations Section 3.3.3 for generator connections to the PJM 138 kV system.

The AC2-195 queue project was tested for compliance with NERC, PJM and other applicable criteria. The range of contingencies evaluated was limited to that necessary to assess compliance and each was limited to a 20-second simulation time period.

Simulated NERC Standard TPL-001 faults include:

1. Three-phase (3ph) fault with normal clearing (Category P1)
2. Operating of a line section w/o a fault, Single-line-to-ground (slg) on Bus Section and Breaker. (Category P2)
3. Single-line-to-ground (slg) with delayed clearing as a result of breaker failure (Category P4)
4. Single-line-to-ground (slg) with delayed clearing as a result of protection failure (Category P5)
5. Single-line-to-ground (slg) with normal clearing for common structure (Category P7)

Note: For generator interconnection studies, Category P3 and P6 faults will be studied on an as needed basis. In this study, P2 contingencies are covered by P1 and P4 contingencies.

The system was tested for a system intact condition and the fault types listed above. Specific fault descriptions and breaker clearing times used for this study are provided in the result table.

No relevant High Speed Reclosing (HSR) contingencies were identified.

For all simulations, the queue project under study along with the rest of the PJM system were required to maintain synchronism and with all states returning to an acceptable new condition following the disturbance.

For the remaining fault contingencies tested on the 2020 Summer Peak case:

a) Post-contingency oscillations were positively damped with a damping margin of at least 3%.

b) The AC2-195 generator was able to ride through all faults (except for faults where protective action trips a generator(s)).

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of that fault.

No mitigations were found to be required.

1. Introduction

Generator Interconnection Request AC2-195 is for a 99.96 MW Maximum Facility Output (MFO) solar powered generating facility with a Point of Interconnection (POI) tapped into Galion – Roberts 138kV line in the ATSI system, Marion County, Ohio. 60 TMEIC L1833 GRQ 1.66MW solar inverters would be used for this project.

This analysis is effectively a screening study to determine whether the addition of AC2-195 will meet the dynamic requirements of the NERC, PJM and Transmission Owner reliability standards.

In this report the AC2-195 project and how it is proposed to be connected to the grid are first described, followed by a description of how the project is modeled in this study. The fault cases are then described and analyzed, and lastly a discussion of the results is provided.

2. Description of Project

Generator Interconnection Request AC2-195 is for a 99.96 MW Maximum Facility Output (MFO) solar powered generating facility with a Point of Interconnection (POI) tapped into Galion – Roberts 138kV line in the ATSI system, Marion County, Ohio. 60 TMEIC L1833 GRQ 1.66MW solar inverters would be used for this project.

Figure 1 shows the simplified one-line diagram of the AC2-195 loadflow model. Table 1 lists the parameters given in the impact study data and the corresponding parameters of the AC2-195 loadflow model.

The dynamic model for the AC2-195 plant is based on the PSSE standard REGCAU1 and REECAU1 model with parameters provided by customer.

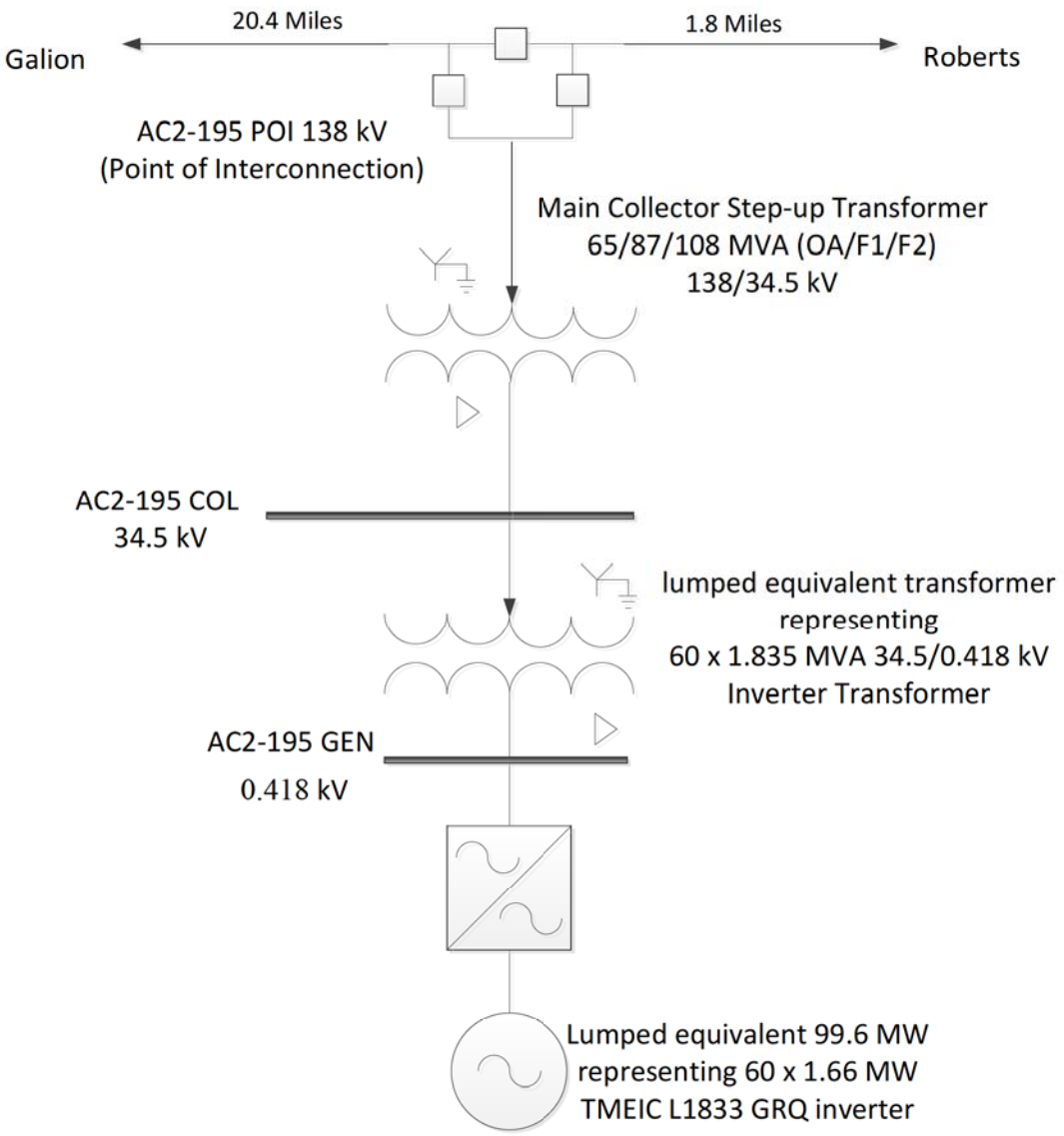


Figure 1: AC2-195 Plant Model

Table 1: AC2-195 Plant Model

	Impact Study Data	Model
Inverters	60 × 1.66 MW TMEIC L1833 GRQ Solar Inverters MVA base = 1.835 MVA Vt = 0.418 kV	Lumped equivalent representing 60 × 1.66 MW TMEIC L1833 GRQ Solar Inverters Pgen 99.96 MW Pmax 99.96 MW Pmin 0 MW Qmax 45.576 MVAr Qmin - 45.576 MVAr Mbase 109.85 MVA Zsorce 0.0 + j9999.0 pu @Mbase
GSU transformer	60 x 34.5/0.418 kV two winding transformers Transformer base = 1.835 MVA Rating = 1.835 MVA Impedance = 0.00575 + j0.0575 pu @ MVA base Number of taps = NA Tap step size = N/A	Lumped equivalent representing 60 x 34.5/0.418 kV two winding transformers Transformer base = 110.1MVA Rating = 110.1MVA Impedance = 0.00575 + j0.0575 pu @ MVA base Number of taps = 5 Tap step size = 2.5%
Collector step-up transformer	1 x 138/34.5 kV two winding transformers Transformer base = 65MVA Rating = 65 / 87 / 108 MVA Impedances: High – Low = 0.003050+ j0.089950 pu @ MVA base Number of taps = N/A Tap step size = N/A	1 x 138/34.5 kV two winding transformers Transformer base = 65MVA Rating = 65 / 87 / 108 MVA Impedances: High – Low = 0.003050+ j0.089950 pu @ MVA base Number of taps = 5 Tap step size = 2.5%
Collector System Equivalent	R= 0.00469 X= 0.032500 B=0 @ 65MVA	R= 0.0072 X= 0.05 B=0 @ 100MVA
Auxiliary load	0	0
Transmission Line	Positive Sequence Impedance = 0.000160+ j0.000630pu Charging Susceptance = j 0 pu All impedances @ 65 MVA base	Positive Sequence Impedance = 0.000246+ j0.000969pu Charging Susceptance = j 0 pu All impedances @ 100 MVA base

3. Loadflow and Dynamics Case Setup

The dynamics simulation analysis was carried out using PSS/E Version 33.7.

The load flow scenario and fault cases for this study are based on PJM's Regional Transmission Planning Process[1].

The selected load flow scenario is the RTEP 2020 Summer Peak case with the following modifications:

a) Addition of all applicable queue projects prior to AC2-195.

b) Addition of AC2-195 queue project.

c) Removal of withdrawn and subsequent queue projects in the vicinity of AC2-195.

d) Dispatch of units in the PJM system to maintain slack generators within limits.

The AC2-195 initial conditions are listed in Table 2, indicating maximum power output, with AC2-195 regulating POI voltage of (1.011 p.u.), consistent with the default generator reference voltage specified in PJM Manual 03 Transmission Operations Section 3.3.3 for generator connections to the PJM 138 kV system.

Table 2: AC2-195 machine initial conditions

Bus	Name	Unit	PGEN (MW)	QGEN (MVAR)	ETERM (p.u.)	POI Voltage (p.u.)
932723	AC2-195 GEN 0.4180	1	99.96	34.8	1.0348	1.0110

Generation within the vicinity of AC2-195 has been dispatched online at maximum output (PMAX). The dispatch of generation in the vicinity of AC2-195 is given in Attachment 3.

[1] Manual 14B: PJM Region Transmission Planning Process, Rev 33, May 5 2016, Attachment G : PJM Stability, Short Circuit, and Special RTEP Practices and Procedures.

4. Fault Cases

Tables 3 listed the contingencies and results that were studied, with representative worst case total clearing times provided by PJM. Each contingency was studied over a 20 second simulation time interval.

Simulated NERC Standard TPL-001 faults include:

1. Three-phase (3ph) fault with normal clearing (Category P1)
2. Operating of a line section w/o a fault, Single-line-to-ground (slg) on Bus Section and Breaker. (Category P2)
3. Single-line-to-ground (slg) with delayed clearing as a result of breaker failure (Category P4)
4. Single-line-to-ground (slg) with delayed clearing as a result of protection failure (Category P5)
5. Single-line-to-ground (slg) with normal clearing for common structure (Category P7)

Note: For generator interconnection studies, Category P3 and P6 faults will be studied on an as needed basis. In this study, P2 contingencies are covered by P1 and P4 contingencies.

The system was tested for a system intact condition and the fault types listed above. No relevant High Speed Reclosing (HSR) contingencies were studied.

5. Evaluation Criteria

This study is focused on AC2-195, along with the rest of the PJM system, maintaining synchronism and having all states return to an acceptable new condition following the disturbance. The recovery criteria applicable to this study are as per PJM's Regional Transmission Planning Process and Transmission Owner criteria:

a) The system with AC2-195 included is transiently stable and post-contingency oscillations should be positively damped with a damping margin of at least 3%.

b) The AC2-195 is able to ride through faults (except for faults where protective action trips AC2-195).

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of that fault.

6. Summary of Results

Plots from the dynamic simulations are provided in Attachment 4, with results summarized in Table 3.

The frequency protection was disabled due to the PSSE deficiency in calculating frequencies for 3ph fault at POIs.

For the fault contingencies tested in this study:

a) Post-contingency oscillations were positively damped with a damping margin of at least 3%.

b) The AC2-195 generator was able to withstand all contingencies.

c) Following fault clearing, all bus voltages recover to a minimum of 0.7 per unit after 2.5 seconds (except where protective action isolates that bus).

d) No transmission element trips, other than those either directly connected or designed to trip as a consequence of that fault.

7. Mitigations

No Mitigations were found to be required.

Table 3: Fault list

P0: Steady State

Fault ID	Duration
P0.00	Steady State 20 sec run

P1: Three Phase Faults with normal clearing

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P1.00	3PG @ AB2-131 Main – AB2-131 POI 138kV line with normal clearing, trip the generator	6	Stable
P1.01	3PG @ AB2-131 POI – Hamilton – AC2-195 138kV line with normal clearing	6	Stable
P1.02	3PG @ AB2-131 POI – Galion 138kV line with normal clearing	6	Stable
P1.03	3PG @ Galion – Roberts 138kV North line with normal clearing	6	Stable
P1.04	3PG @ Galion – Leaside 138kV line with normal clearing	6	Stable
P1.05	3PG @ Galion – Ontario – Cairns – Empire – Longview 138kV line with normal clearing	6	Stable
P1.06	3PG @ Galion – Cardington 138kV line with normal clearing	6	Stable
P1.07	3PG @ Galion 345/138kV T3 with normal clearing	6	Stable
P1.08	3PG @ Galion 345/138kV T4 with normal clearing	6	Stable
P1.09	3PG @ Galion 138/69kV T1 with normal clearing	6	Stable
P1.10	3PG @ Galion 138/69kV T2 with normal clearing	6	Stable
P1.11	3PG @ Galion – South Berwick 345kV line with normal clearing	5	Stable
P1.12	3PG @ Galion – Ohio Central 345kV line with normal clearing	5	Stable
P1.13	3PG @ Roberts – Galion 138kV North line with normal clearing	6	Stable
P1.14	3PG @ Roberts – Kirby 138kV line with normal clearing	6	Stable
P1.15	3PG @ Roberts – Crissinger 138kV line with normal clearing	6	Stable
P1.16	3PG @ Roberts 138/69kV T1 with normal clearing	6	Stable
P1.17	3PG @ Roberts 138/69kV T2 with normal clearing	6	Stable

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P1.18	3PG @ Roberts 138/69kV T3 with normal clearing	6	Stable
P1.19	3PG @ AC2-195 Main – AC2-195 POI 138kV line with normal clearing, trip generator	6	Stable
P1.20	3PG @ AC2-195 POI – Hamilton – AB2-131 POI 138kV line with normal clearing	6	Stable
P1.21	3PG @ AC2-195 POI – Dual Rail – Roberts 138kV line with normal clearing	6	Stable

P4: SLG Stuck Breaker (SB) Faults at Backup Clearing

Fault ID	Fault description	Clearing Time Normal/Delayed (Cycles)	Results
P4.01	SLG at Galion – Leaside 138kV line, SB 52 @ Galion 138kV, loss of Galion 138/69kV T2	6/20	Stable
P4.02	SLG at Galion – Leaside 138kV line, SB 53 @ Galion 138kV, loss of Galion – Ontario – Cairns – Empire – Longview 138kV line	6/65	Stable
P4.03	SGL at Galion – Ontario – Cairns – Empire – Longview 138kV line, SB 54 @ Galion 138kV, loss of Galion 138/69kV T1	6/20	Stable
P4.04	SLG at Galion – AB2-131 POI 138kV line, SB 55 @ Galion 138kV, loss of Galion 138/69kV T2	6/20	Stable
P4.05	SLG at Galion – AB2-131 POI 138kV line, SB 56 @ Galion 138kV, loss of Galion – Cardington 138kV line	6/65	Stable
P4.06	SLG at Galion – Cardington 138kV line, SB 57 @ Galion 138kV, loss of Galion 138/69kV T1	6/20	Stable
P4.07	SLG at Galion 138/345kV T3, SB 58 @ Galion 138kV, loss of Galion 138/69kV T2	6/20	Stable
P4.08	SLG at Galion 138/345kV T3, SB 59 @ Galion 138kV, loss of Galion – Roberts 138kV North line	6/65	Stable
P4.09	SLG at Galion – Roberts 138kV North line, SB 60 @ Galion 138kV, loss of Galion 138/69kV T1	6/20	Stable
P4.10	SLG at Galion 138/345kV T4, SB 165 @ Galion 138kV, loss of Galion 138/69kV T2	6/20	Stable
P4.11	SLG at Galion 138/345kV T4, SB 168 @ Galion 138kV, loss of Galion 138/69kV T1	6/20	Stable

Fault ID	Fault description	Clearing Time Normal/Delayed (Cycles)	Results
P4.12	SLG at Roberts – Dual Rail – AC2-195 POI 138kV line, SB 60 @ Roberts 138kV, loss of Roberts 138kV bus	6/20	Stable
P4.13	SLG at Roberts – Galion 138kV North line, SB 10 @ Roberts 138kV, loss of Roberts 138kV bus	6/20	Stable
P4.14	SLG at Roberts – Kirby 138kV line, SB 12 @ Roberts 138kV, loss of Roberts 138kV bus	6/20	Stable
P4.15	SLG at Roberts – Crissinger 138kV line, SB 132 @ Roberts 138kV, loss of Roberts 138kV bus	6/20	Stable
P4.16	SLG at Galion 345/138kV T4, SB 63 @ Galion 345kV, loss of Galion – South Berwick 345kV	6/14	Stable
P4.17	SLG at Galion 345/138kV T4, SB 62 @ Galion 345kV, loss of Galion – Ohio Central 345kV	6/14	Stable
P4.18	SLG at Galion 345/138kV T3, SB 162 @ Galion 345kV, loss of Galion – Ohio Central 345kV	6/14	Stable
P4.19	SLG at Galion 345/138kV T3, SB 159 @ Galion 345kV, loss of Galion – South Berwick 345kV	6/20	Stable
P4.20	SLG at AB2-131 POI 138kV, Normal clear loss of AB2-131 – Galion 138kV line, SB @ AB2-131 POI 138kV, loss of AB2-131, AB2-131 – Hamilton – AC2-195 138kV line	6/20	Stable
P4.21	SLG at AC2-195 POI 138kV, Normal clear loss of AC2-195 – Dual Rail – Roberts 138kV line, SB @ AC2-195 POI 138kV, loss of AC2-195, AB2-131 – Hamilton – AC2-195 138kV line	6/20	Stable

P5: SLG Fault (80% on the line) with Delayed (Zone 2) Clearing

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P5.01	SLG fault at 80% on Galion – AB1-131 POI 138 kV line, Galion 138kV relay failed and delayed clearing	6/65	Stable

Fault ID	Fault description	Clearing Time Normal (Cycles)	Results
P5.02	SLG fault at 80% on AB1-131 POI – Galion 138 kV line, AB1-131 POI 138kV relay failed and delayed clearing	6/65	Stable
P5.03	SLG fault at 80% on AC2-195 POI – Hamilton – AB2-131 POI 138kV, AC2-195 138kV relay failed and delayed clearing	6/65	Stable
P5.04	SLG fault at 80% on AB2-131 POI – Hamilton – AC2-195 POI 138kV, AB2-131 POI 138kV relay failed and delayed clearing	6/65	Stable
P5.05	SLG fault at 80% on Galion – Roberts 138kV North line, Galion 138kV relay failed and delayed clearing	6/65	Stable
P5.06	SLG fault at 80% on Galion – Leaside 138kV line, Galion 138kV relay failed and delayed clearing	6/65	Stable
P5.07	SLG fault at 80% on Galion – Longview 138kV line, Galion 138kV relay failed and delayed clearing	6/65	Stable
P5.08	SLG fault at 80% on Galion – Cardington 138kV line, Galion 138kV relay failed and delayed clearing	6/65	Stable
P5.09	SLG fault at 80% on Roberts – Galion 138kV North line, Roberts 138kV relay failed and delayed clearing	6/65	Stable
P5.10	SLG fault at 80% on Roberts – Kirby 138kV North line, Roberts 138kV relay failed and delayed clearing	6/65	Stable
P5.11	SLG fault at 80% on Roberts – Crissinger 138kV North line, Roberts 138kV relay failed and delayed clearing	6/65	Stable
P5.12	SLG fault at 80% on AC2-195 – Dual Rail – Roberts 138kV, AC2-195 POI 138kV relay failed and delayed clearing	6/65	Stable
P5.13	SLG fault at 80% on Roberts – Dual Rail – AC2-195 138kV, Roberts POI 138kV relay failed and delayed clearing	6/65	Stable

P7: Common Structure

Fault ID	Fault description	Clearing Time (Cycles)	Results

Fault ID	Fault description	Clearing Time (Cycles)	Results
P7.01	SLG fault at AB2-131 – Galion 138 kV line resulting in tower failure. Fault cleared with loss of Galion – Roberts 138kV north. CONTINGENCY 'C5-TWL-SR064_B'	6	Stable
P7.02	SLG fault at AB2-131 – AC2-195 138 kV line resulting in tower failure. Fault cleared with loss of Galion – Roberts 138kV north. CONTINGENCY 'C5-TWL-SR064_B'	6	Stable
P7.03	SLG fault at Galion – Leaside 138 kV line resulting in tower failure. Fault cleared with loss of Galion – Ontario – Cairns – Empire – Longview 138kV line. CONTINGENCY 'C5-TWL-SR063'	6	Stable
P7.04	SLG fault at AC2-195 – Roberts 138 kV line resulting in tower failure. Fault cleared with loss of Galion – Roberts 138kV north. CONTINGENCY 'C5-TWL-SR064_B'	6	Stable

Attachment 5. Detailed Protection Requirements

PJM AC2-195 Preliminary Short Circuit Duties & Protection Requirements

(2-7-2018)

Short Circuit Analysis

Short Circuit Values

The 138kV fault values for the AC2-195 interconnection location with all new generation out of service are:

Three phase = 10.5kA
Single line to ground = 8.7kA
Z1= (0.888 + j 3.867)%
Z0= (1.512 + j 6.340)%

Impedances are given on 100 MVA and 138kV bases. The faults provided are bolted, symmetrical values for normal system conditions. Future increases in fault currents are possible and it is the customer's responsibility to upgrade their equipment and/or protective equipment coordination when necessary.

General Connection Requirements

The AC2-195 delivery point substation (DPS) is a 138kV three-breaker ring bus on the Galion- Roberts South 138kV line.

The existing line relays at Galion and Roberts require replacement.

Line protection between Galion and AC2-195 and between Roberts and AC2-195 shall consist of two independent SEL-411L line current differential schemes with pilot communication over fiber optic cable for each 138kV line, at each terminal.

At the AC2-195 DPS, each 138kV breaker shall have breaker failure-to-trip protection. SEL-501 relays are acceptable for this application.

Protection of the 138kV Generator Lead Line of approximately 0.1 miles shall consist of two SEL-411L line current differential schemes with pilot communication over fiber optic cable, at each terminal.

The AC2-195 generator protection system, shall include a Transfer Trip Receiver for Anti- Islanding via AC2-195 138kV breaker.

Protection Requirements

AC2-195 138kV Interconnecting Substation

138kV Transmission Line Protection

- Galion line exits
  - Primary relay: SEL-411L relay with line current differential protection over fiber
  - Backup relay: SEL-411L relay with line current differential protection over fiber

- Roberts line exit
  - Primary relay: SEL-411L relay with line current differential protection over fiber
  - Backup relay: SEL-411L relay with line current differential protection over fiber

- AC2-195 generating facility
  - Primary relay: SEL-411L relay with line current differential protection over fiber
  - Backup relay: SEL-411L relay with line current differential protection over fiber

138kV AC2-195 Interconnecting Station Communications

- AC2-195 Interconnecting Station to Galion and Roberts
  - Fiber-optic cable(s) with dedicated fibers for use with the SEL-411L primary and backup relaying
    - It is assumed that the fiber has been installed in a previous AB2-131 generation queue project.

- AC2-195 Interconnecting Station to AC2-195 generating facility
  - Dual, independent fiber-optic cable paths with dedicated fibers for use with the SEL- 411L primary and backup relaying
    - Minimum of 12 fibers, separate primary and backup fiber cables

138kV Breaker Failure to Trip Protection

- 138kV Breaker Failure to Trip Relaying – SEL501 relay per breaker

AC2-195 Generating Station 138kV

138kV Transmission Line Protection @ AC2-195 generating station

- AC2-195 Interconnecting Station line exit
  - Primary relay: SEL-411L relay with line current differential protection over fiber
  - Backup relay: SEL-411L relay with line current differential protection over fiber
  - Synch check for manual/SCADA close on the interconnecting line to be done at AB2- 131 Generating Station

138kV Breaker Failure to Trip Protection

- 138kV Breaker Failure to Trip Relaying

- SEL-352-2 breaker failure to trip relaying on AC2-195 138kV Generating Station breaker. The breaker failure to trip relaying on the AC2-195 Interconnecting Station line exit breaker shall initiate direct transfer trip via the SEL-411L primary and backup line relays (fiber).

138kV Bus & GSU Transformer Protection @ AC2-195 generating station (minimum protection to meet FE requirements)

- Dual, independent transformer differential protection schemes (Transformer and Overall)
- Transformer neutral time overcurrent relay

The Connecting Party shall provide utility-grade relays for protection of the FE Transmission System. FE shall approve all relays specified for the protection of the FE Transmission System, including time delay and auxiliary relays. Relay operation for any of the listed functions that are required shall initiate immediate separation of the parallel generation from the FE Transmission System:

Relay	Function
Frequency	To detect underfrequency and overfrequency operation.
Overvoltage	To detect overvoltage operation.
Undervoltage	To detect undervoltage operation.
Ground Fault Detector	To detect a circuit ground on the FE Transmission System.
Phase Fault Detector	To detect phase to phase faults on the FE Transmission System.
Transfer Trip Receiver	To provide tripping logic to the generation owner for isolation of the generation upon opening of the FE supply circuits.
Directional Power	To detect, under all system conditions, a loss of FE primary source. The relay shall be sensitive enough to detect transformer magnetizing current supplied by the generation.

The Interconnection Customer will be required to comply with all FE Generation Protection Requirements for Generation Interconnection Customers. The Generation Protection Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

www.firstenergycorp.com/feconnect

www.pjm.com/planning/design-engineering/to-tech-standards.aspx

FE System Modifications

Galion Substation

138kV Transmission Line Protection

- AC2-195 Interconnecting Station line exit Primary Relaying

- Primary relay: SEL-411L relay with line current differential protection over fiber
- Backup relay: SEL-411L relay with line current differential protection over fiber

Roberts Substation

138kV Transmission Line Protection

- AC2-195 Interconnecting Station line exit Primary Relaying
  - Primary relay: SEL-411L relay with line current differential protection over fiber
  - Backup relay: SEL-411L relay with line current differential protection over fiber

Settings Changes

- Settings changes are possible at remote substations.

Revenue Metering and SCADA Requirements

The Interconnection Customer will be required to comply with all FE Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "FirstEnergy Requirements for Transmission Connected Facilities" document located at the following links:

www.firstenergycorp.com/feconnect

www.pjm.com/planning/design-engineering/to-tech-standards.aspx

Summary: Application - 8 of 30 (Exhibit F - PJM Interconnection Studies) electronically filed by Christine M.T. Pirik on behalf of Marion County Solar Project, LLC