APPENDIX 10

PJM Studies

Generation Interconnection

Feasibility Study Report

for

Queue Project AG1-363

BLACK OAK-HATFIELD 500 KV

220 MW Capacity / 300 MW Energy

January 2021

Table of Contents

1 Introduction

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

2 Preface

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

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

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

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

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

3 General

The Interconnection Customer (IC), has proposed a Solar; Storage generating facility located in Garrett County, Maryland. The installed facilities will have a total capability of 300 MW with 220 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 31, 2024. This study does not imply a TO commitment to this in-service date.

Queue Number	**AG1-363**
Project Name	BLACK OAK-HATFIELD 500 KV
State	Maryland
County	Garrett
Transmission Owner	APS – Potomac Edison
MFO	300
MWE	300
MWC	220
Fuel	Solar; Storage
Basecase Study Year	2024

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

AG1-363 will interconnect with the APS system by tapping the Black Oak – Hatfield 500 kV line with a three-breaker ring bus interconnection substation and loop the Black Oak – Hatfield 500 kV line into the new substation. The transmission line tap will be located approximately 8.2 miles from Black Oak substation and 53.2 miles from Hatfield substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated Attachment facilities.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AG1-363 generation project to connect to the FirstEnergy ("FE") transmission system. IC will be responsible for constructing all of the facilities on its side of the POI, including the Attachment facilities which connect the generator to the FE transmission system.

5 Cost Summary

The AG1-363 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$17,689,000
Total System Network Upgrade Costs	$0
Total Costs	**$17,689,000**

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 2016-36, 2016-25 I.R.B. (6/20/2016). If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

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

6 Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by tapping the Black Oak – Hatfield 500 kV line with a three-breaker ring bus interconnection substation and loop the Black Oak – Hatfield 500 kV line into the new substation. The transmission line tap will be located approximately 8.2 miles from Black Oak substation and 53.2 miles from Hatfield substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated Attachment facilities.

The project will also require non-direct connection upgrades at Black Oak – Hatfield substations.

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

Description	Total Cost
Install disconnect switch, dead-end structure, and associated facilities for generator lead line exit at interconnection substation.	$650,000
Construct 500 kV three breaker ring bus interconnection substation	$8,967,000
Loop the Black Oak - Hatfield 500 kV line into the new substation.	$5,124,000
Upgrade relaying at Hatfield 500 kV.	$1,474,000
Upgrade relaying at Black Oak 500 kV.	$1,474,000
Total Physical Interconnection Costs	**$17,689,000**

7 Schedule

Based on the scope of work for the Attachment Facilities and the Direct and/or Non-Direct Connection facilities, it is expected to take a minimum of **36 months** after the signing of an Interconnection Construction Service Agreement to complete the installation. This includes the requirement for the IC to make a preliminary payment that compensates FE for the first three months of the engineering design work that is related to the construction of the interconnection substation. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and that all transmission system outages will be allowed when requested.

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

8 Transmission Owner Analysis

8.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AG1-363 project did not contribute to any overloads on the FE transmission <100 kV system.

9 Interconnection Customer Requirements

9.1 System Protection

The IC must design 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.

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

9.2 Compliance Issues and Interconnection Customer Requirements

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

1. The purchase and installation of a fully rated 500 kV circuit breaker to protect the AG1-363 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 AG1-363 generation project metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

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

9.3 Power Factor Requirements

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

10 Revenue Metering and SCADA Requirements

10.1 PJM Requirements

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

10.2 Meteorological Data Reporting Requirements

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

- Back Panel temperature (Fahrenheit) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Irradiance (Watts/meter2) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Ambient air temperature (Fahrenheit) - (Accepted, not required)
- Wind speed (meters/second) - (Accepted, not required)
- Wind direction (decimal degrees from true north) - (Accepted, not required)

10.3 Interconnected Transmission Owner Requirements

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

11 Summer Peak - Load Flow Analysis

The Queue Project AG1-363 was evaluated as a 300.0 MW (Capacity 220.0 MW) injection tapping the Black Oak to Hatfield 500 kV line in the APS area. Project AG1-363 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-363 was studied with a commercial probability of 53.0 %. Potential network impacts were as follows:

11.1 Generation Deliverability

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

None.

11.2 Multiple Facility Contingency

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

None.

11.3 Contribution to Previously Identified Overloads

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

None.

11.4 Potential Congestion due to Local Energy Deliverability

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

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
167956972	235492	01MTZION	138.0	AP	235518	01WESTVA	138.0	AP	1	AP-P1-2-PE-500-004-A	operation	206.0	112.18	113.63	DC	5.62
167956839	235518	01WESTVA	138.0	AP	237506	01CROSSCHOOL	138.0	AP	1	AP-P1-2-PE-500-004-A	operation	206.0	130.45	131.9	DC	5.62
167957022	237506	01CROSSCHOOL	138.0	AP	235446	01BLACKO	138.0	AP	1	AP-P1-2-PE-500-004-A	operation	268.0	104.02	105.13	DC	5.63

11.5 System Reinforcements - Summer Peak Load Flow - Primary POI

None.

11.6 Flow Gate Details

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

None.

11.7 Queue Dependencies

The Queue Projects below are listed in one or more indices for the overloads identified in your report. These projects contribute to the loading of the overloaded facilities identified in your report. The percent overload of a facility and cost allocation you may have towards a particular reinforcement could vary depending on the action of these earlier projects. The status of each project at the time of the analysis is presented in the table. This list may change as earlier projects withdraw or modify their requests.

None.

11.8 Contingency Descriptions

Contingency Name	Contingency Definition
AP-P1-2-PE-500-004-A	CONTINGENCY 'AP-P1-2-PE-500-004-A' /* HATFIELD - BLACK OAK 500KV DISCONNECT BRANCH FROM BUS 235108 TO BUS 964990 CKT 1 /* 01HATFLD 500 AG1-363 TAP 500 END

12 Short Circuit Analysis

The following Breakers are overdutied:

None.

12.1 System Reinforcements - Short Circuit

No short circuit impacts were identified for this project.

13 Affected Systems

13.1 NYISO

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

14 Attachment 1: One Line Diagram

Generation Interconnection

System Impact Study Report

for

Queue Project AG1-363

BLACK OAK-HATFIELD 500 KV

220 MW Capacity / 300 MW Energy

August 2021

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 the Interconnection Customer (IC), and PJM Interconnection, LLC (PJM), Transmission Provider (TP). The Interconnected Transmission Owner (ITO) is APS.

2 Preface

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

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

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

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

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

3 General

The Interconnection Customer (IC), has proposed a Solar; Storage generating facility located in Garrett County, Maryland. The installed facilities will have a total capability of 300 MW with 220 MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is December 31, 2024. This study does not imply a TO commitment to this in-service date.

Queue Number	**AG1-363**
Project Name	BLACK OAK-HATFIELD 500 KV
State	Maryland
County	Garrett
Transmission Owner	APS – Potomac Edison
MFO	300
MWE	300
MWC	220
Fuel	Solar; Storage
Basecase Study Year	2024

Any new service customers who can feasibly be commercially operable prior to June 1st of the basecase study year are required to request interim deliverability analysis.

4 Point of Interconnection

AG1-363 will interconnect with the APS system by connecting to the Black Oak – Hatfield 500 kV line with a three-breaker ring bus interconnection substation and looping the Black Oak – Hatfield 500 kV Line into the new substation. The transmission line tap will be located approximately 8.2 miles from Black Oak Substation and 53.2 miles from Hatfield Substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated Attachment facilities.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AG1-363 generation project to connect to the FirstEnergy ("FE") transmission system. IC will be responsible for constructing all of the facilities on its side of the POI, including the Attachment facilities which connect the generator to the FE transmission system.

5 Cost Summary

The AG1-363 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	$25,223,256.98
Allocation towards System Network Upgrade Costs (PJM Identified - Summer Peak)*	$0
Allocation towards System Network Upgrade Costs (PJM Identified - Light Load)*	$0
Allocation towards System Network Upgrade Costs (TO Identified)*	$0
Total Costs	**$25,223,256.98**

*As your project progresses through the study process and other projects modify their request or withdraw, then your cost allocation could change.

This cost excludes a Federal Income Tax Gross Up charges. This tax may or may not be charged based on whether this project meets the eligibility requirements of IRS Notice 88-129. If at a future date it is determined that the Federal Income Tax Gross charge is required, the Transmission Owner shall be reimbursed by the Interconnection Customer for such taxes.

Note 1: PJM Open Access Transmission Tariff (OATT) section 217.3A outline cost allocation rules. The rules are further clarified in PJM Manual 14A Attachment B. The allocation of costs for a network upgrade will start with the first Queue project to cause the need for the upgrade. Later queue projects will receive cost allocation contingent on their contribution to the violation and are allocated to the queues that have not

closed less than 5 years following the execution of the first Interconnection Service Agreement which identifies the need for this upgrade.

Note 2: For customers with System Reinforcements listed: If your present cost allocation to a System Reinforcement indicates $0, then please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, the cost responsibilities can change and a cost allocation may be assigned to your project. In addition, although your present cost allocation to a System Reinforcement is presently $0, your project may need this system reinforcement completed to be deliverable to the PJM system. If your project comes into service prior to completion of the system reinforcement, an interim deliverability study for your project will be required.

6 Transmission Owner Scope of Work

The interconnection of the project at the Primary POI will be accomplished by connecting to the Black Oak – Hatfield 500 kV Line with a three-breaker ring bus interconnection substation and looping the Black Oak – Hatfield 500 kV Line into the new substation. The transmission line tap will be located approximately 8.2 miles from Black Oak Substation and 53.3 miles from Hatfield Substation. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection line tap and the associated Attachment facilities.

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

Description	Total Cost
Design, install, and test/commission MW radio to provide SCADA transport to AG1-363. Path from Dan's Rock MW to AG1-363. @ Dan's Rock MW	$211,810.36
Design, install, and test/commission MPLS and MW Equipment for SCADA transport. Path from AG1-363 to Dan's Rock MW. @ AG1-363 Interconnect	$761,251.98
Replace line relaying to Black Oak. @ Hatfield	$387,319.22
Cut the existing Hatfield-Black Oak 500 kV Line approximately 8.2 miles from the Black Oak Substation and 53.3 miles from the Hatfield substation (near structures 217 and 218) to create a loop into the new substation.	$5,910,443.94
Customer Substation Review. @ AG1-363 Customer Substation	$45,305.28
Install 3 bkr 500kV Ring Bus. @ AG1-363 Interconnection	$15,739,130.70
Replace Line Relaying. @ Black Oak	$419,203.20
Attachment Facilities - Install 3 bkr 500 kV Ring Bus. @ AG1-363 Interconnection	$1,748,792.30
Total Physical Interconnection Costs	**$25,223,256.98**

7 Schedule

Based on the scope of work for the interconnection facilities, it is expected to take a minimum of **29 months** after the signing of an Interconnection Construction Service Agreement (or "Interconnection Agreement" if non-FERC) and construction kickoff call to complete the installation of the physical connection work. This assumes that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined interconnection work, and that all system outages will be allowed when requested.

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

8 Transmission Owner Analysis

8.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AG1-363 project did not contribute to any overloads on the FE transmission <100 kV system.

9 Interconnection Customer Requirements

9.1 System Protection

The IC must design 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.

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. The Customer one line diagram shows a transformer with a grounded wye winding on the low side.

9.2 Compliance Issues and Interconnection Customer Requirements

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

1. The purchase and installation of a fully rated 500 kV circuit breaker to protect the AG1-363 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 [QUEUE] generation project metering point when the units are out-of-service. This assumes the intent of the IC is to net the generation with the load.

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

9.3 Power Factor Requirements

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

10 Revenue Metering and SCADA Requirements

10.1 PJM Requirements

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

10.2 Meteorological Data Reporting Requirements

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

- Back Panel temperature (Fahrenheit) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Irradiance (Watts/meter2) - (Required for plants with Maximum Facility Output of 3 MW or higher)
- Ambient air temperature (Fahrenheit) - (Accepted, not required)
- Wind speed (meters/second) - (Accepted, not required)
- Wind direction (decimal degrees from true north) - (Accepted, not required)

10.3 Interconnected Transmission Owner Requirements

The IC will be required to comply with all Interconnected Transmission Owner's revenue metering requirements for generation interconnection customers located at the following link:

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

11 Summer Peak Analysis

The Queue Project AG1-363 was evaluated as a 300.0 MW (Capacity 220.00 MW) injection tapping the Black Oak to Hatfield 500 kV line in the APS area. Project AG1-363 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-363 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

11.1 Generation Deliverability

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

None.

11.2 Multiple Facility Contingency

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

None.

11.3 Contribution to Previously Identified Overloads

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

None.

11.4 Steady-State Voltage Requirements

None.

11.5 Potential Congestion due to Local Energy Deliverability

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

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

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
167956972	235492	01MTZION	138.0	AP	235518	01WESTVA	138.0	AP	1	AP-P1-2-PE-500-004-A	operation	206.0	105.65	108.38	AC	5.62

ID	FROM BUS#	FROM BUS	kV	FROM BUS AREA	TO BUS#	TO BUS	kV	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
167956839	235518	01WESTVA	138.0	AP	237506	01CROSSCHOOL	138.0	AP	1	AP-P1-2-PE-500-004-A	operation	206.0	124.52	127.25	AC	5.62
167957022	237506	01CROSSCHOOL	138.0	AP	235446	01BLACKO	138.0	AP	1	AP-P1-2-PE-500-004-A	operation	268.0	99.5	101.6	AC	5.63

11.6 System Reinforcements

None.

11.7 Flow Gate Details

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

None.

11.8 Queue Dependencies

The Queue Projects below are listed in one or more indices for the overloads identified in your report. These projects contribute to the loading of the overloaded facilities identified in your report. The percent overload of a facility and cost allocation you may have towards a particular reinforcement could vary depending on the action of these earlier projects. The status of each project at the time of the analysis is presented in the table. This list may change as earlier projects withdraw or modify their requests.

None.

11.9 Contingency Descriptions

Contingency Name	Contingency Definition
AP-P1-2-PE-500-004-A	CONTINGENCY 'AP-P1-2-PE-500-004-A' /* HATFIELD - BLACK OAK 500KV DISCONNECT BRANCH FROM BUS 235108 TO BUS 964990 CKT 1 /* 01HATFLD 500 AG1-363 TAP 500 /* SET PRECONTRATING 2707 BRANCH FROM BUS 235101 TO BUS 235103 CKT 1/ 01BEDNGT 500.00 - 01BLACKO 500.00 RATEA /* SET POSTCONTRATING 2771 BRANCH FROM BUS 235101 TO BUS 235103 CKT 1/ 01BEDNGT 500.00 - 01BLACKO 500.00 RATEB END

12 Light Load Analysis

The Queue Project AG1-363 was evaluated as a 300.0 MW injection tapping the Black Oak to Hatfield 500 kV line in the APS area. Project AG1-363 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AG1-363 was studied with a commercial probability of 100.0 %. Potential network impacts were as follows:

12.1 Light Load Deliverability

(Single or N-1 contingencies)

None.

12.2 Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies).

None.

12.3 Contribution to Previously Identified Overloads

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

None.

12.4 Potential Congestion due to Local Energy Deliverability

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

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

None.

12.5 System Reinforcements

None.

12.6 Flow Gate Details

The following indices contain additional information about each facility presented in the body of the report. For each index, a description of the flowgate and its contingency was included for convenience. The intent of the indices is to provide more details on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the indices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the indices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators. It should be noted the project/generator MW contributions presented in the body of the report are Full MW Impact contributions which are also noted in the indices column named "Full MW Impact", whereas the loading percentages reported in the body of the report, take into consideration the PJM Generator Deliverability Test rules such as commercial probability of each project as well as the ramping impact of "Adder" contributions. The MW Impact found and used in the analysis is shown in the indices column named "Gendeliv MW Impact".

None.

12.7 Contingency Descriptions

None.

13 Short Circuit Analysis

The following Breakers are overdutied:

None.

13.1 System Reinforcements - Short Circuit

None.

14 Stability and Reactive Power

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

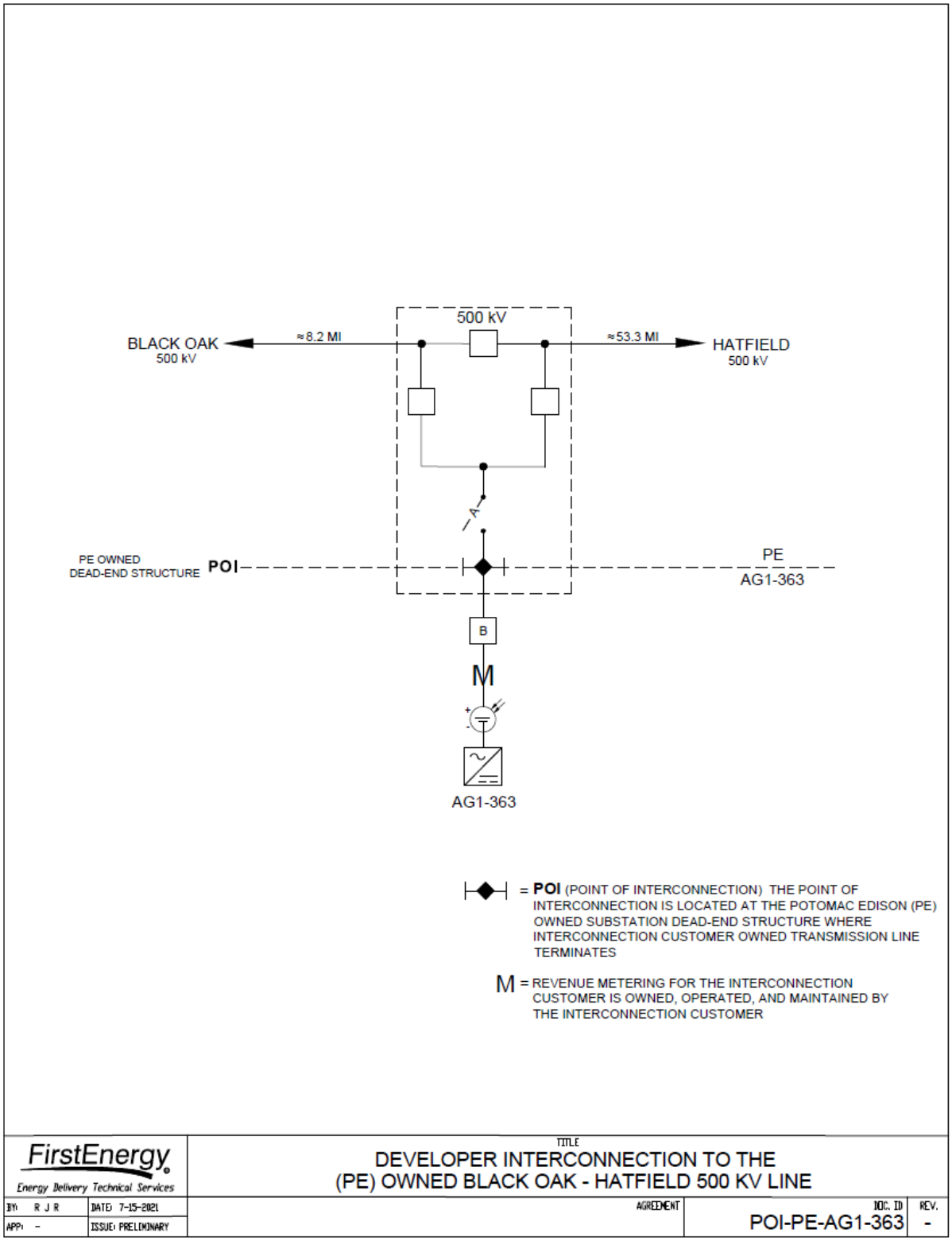
Stability analysis will be performed in the Facilities Study Phase.

15 Affected Systems

15.1 NYISO

No impacts.

16 Attachment 1: One Line Diagram



Generation Interconnection Facilities Study Report

For

PJM Transmission Interconnection Request Project Identifier AG1-363

“Black Oak-Hatfield 500 kV”

October 2024

Table of Contents

Preface

The intent of the Facilities 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 Project Developer. As a requirement for interconnection, the Project Developer 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.

The Facilities 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.

A. Transmission Owner Facilities Study Summary

1. Description of Project

The Project Developer has proposed a solar/storage generating facility located in Garrett County, Maryland. The total installed facilities for AG1-363 will have a total capability of 300 MW (300 MW PV and 100 MW BESS limited to combined 300MW output) with 220 MW of this output being recognized by PJM as capacity. The generation facility will interconnect with Potomac Edison Company (PE), a FirstEnergy Company (FE), hereinafter referred to as "Transmission Owner" (TO), by constructing a new 500kV three-breaker ring bus substation and looping the Black Oak-Hatfield 500kV Line into the new station. The transmission line tap will be located approximately 5.3 miles from Black Oak Substation (PE owned) and 56 miles from Hatfield substation (KATCo owned).

2. Amendments to the System Impact Study or System Impact Study Results

None

3. Project Developer's Milestone Schedule

Project Developer's Commercial Operation Date (COD) for the generation facility is **3/31/2028**.

Project Developer's Milestone Schedule:

January 31, 2028	Initial back-feed through Project Substation Date
March 31, 2028	Project Commercial Operation Date

4. Project Developer's Scope of Work

Project Developer is responsible for all design and construction related to activities on their side of the Point of Change in Ownership (PCO).

Point of Change in Ownership: The PCO will be located within the new 500 kV substation where Project Developer-owned 500 kV interconnection line conductor will terminate on the insulators on the dead-end takeoff structure.

Project Developer is required to own, install, and maintain a fully rated, fault-interrupting circuit breaker on the high-side of the GSU transformer, as well as the necessary revenue metering equipment. The revenue metering current and voltage transformers shall be installed on the high voltage side of the GSU, on the generation side of the fault-interrupting device, and within the local zone of fault protection for the facility. The protective relaying and metering design must comply with Transmission Owner's applicable standards as well as with PJM requirements.

Site Grading and Preparation Requirements:

It is the responsibility of the developer to properly vet a proposed substation location. The proposed location should be reviewed by a Civil Engineer to determine the site's suitability for construction and operation as a substation (refer to Attachment 5 to FE's Geotechnical summary report). This should include a review of available information regarding the specific site location that should be considered when estimating constructability, risk, cost, and schedule. The substation is considered the substation and all associated FirstEnergy Facilities needed to operate and maintain the site such as, access roads, stormwater management facilities, walls/structures, and utilities. This review should include, but is not limited to:

- Geologic Hazards
    - Karst
    - Geologic formation/group
        - Hard bedrock (shallow bedrock difficult to excavate)
        - Weak bedrock
    - Landslide susceptibility and topography
    - Surficial soils survey
    - Coal resource mapping
- Environmental Hazards
    - Flood mapping
    - Wetland Mapping
    - Any pollution information that could affect construction.
    - Corrosivity
- Past development
    - Previous mine activity
    - Previously reclaimed site

Assumptions / Notes:

- Project Developer will coordinate design and alignment of proposed 500 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.

- Project Developer will coordinate design and construction of proposed 500 kV generator lead line. For these areas, the Project Developer shall provide TO with proposed plan and profile or PLS-CADD 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 500 kV terminal positions. As a minimum, Project Developer facilities should not encroach within 100 feet of TO centerline at blowout conditions. If Project Developer's line design does not comply with this requirement TO would need to review this area as a special exception.
- Additional costs will be incurred by the Project Developer, if final alignment of the 500 kV generator lead line causes encroachments, changes, or modifications to any existing or relocated TO facilities. See Section B7 if this report for additional information.

5. Description of Facilities Included in the Facilities Study

Transmission Owner Interconnection Facilities

AG1-363 Collector Substation
Integrate Interconnection Facilities protection and controls to the transmission system.

Stand-Alone Network Upgrades

AG1-363 Interconnection Substation 500 kV (Option to Build) (PJM Network Upgrade n8840.0)
A new three breaker ring bus substation will be constructed by the Project Developer (who has elected the Option to Build) along the Black Oak- Hatfield 500 kV transmission line to interconnect the AG1-363 solar project. Transmission Owner will install security and camera system, indoor security cabinet, program Supervisory Control and Data Acquisition Remote Terminal Unit at AG1-363 interconnection substation.

Black Oak-AG1-363 Interconnection Substation (PJM Network Upgrade n8841.0)
Install/Test approximately 3,115 feet underground and 96,888 feet aerial 48F/SM ADSS from the Jade Meadow AG1-363 substation control house to the Black Oak #1 substation control house.

Network Upgrades

AG1-363 Interconnection Substation (PJM Network Upgrade n8842.0)
Design, installation, and testing/commissioning for MPLS equipment for SCADA transport at Hatfield Substation.

Hatfield-Black Oak 500kV Line (PJM Network Upgrade n8843.0)
Cut the existing Hatfield-Black Oak 500kV Line approximately 5.3 miles from the Black Oak Substation and 56 miles from the Hatfield substation (near structures 227 and 228) to create a loop into the new substation.

Black Oak Substation (PJM Network Upgrade n8844.0)
One (1) line relaying panel with (1) SEL-421, (1) SEL-411L, and (1) SEL-2505 will be installed.

Hatfield Substation (KATCo) (PJM Network Upgrade n8845.0)
One (1) line relaying panel with (1) SEL-421, (1) SEL-411L, (1) carrier panel with (3) UPLC and (3) PCM-5350 will be installed.

Other

AG1-363 Interconnection Substation 500 kV (Option to Build)
A new three breaker ring bus substation will be constructed by the Project Developer. Transmission Owner will provide oversight to assure TO standards and requirements are met.

Revenue Metering
Revenue metering installation support.

6. Total Cost of Transmission Owner Facilities Included in the Facilities Study

Description	Total (w/o Tax)
Transmission Owner Interconnection Facilities:	**$60,521**
Total Stand-Alone Network Upgrades Costs:	**$4,565,471**
Total Network Upgrades Costs:	**$8,354,515**
Other Costs:	**$1,281,525**

TOTAL Costs (ALL Categories):	**$14,262,032**

7. Summary of the Schedule for Completion of Work for the Facilities Study

Activity	*Timeframe*
Engineering, Procurement, and Construction	57 months

B. Transmission Owner Facilities Study Results

This section describes facilities identified to be installed, replaced, and/or upgraded by Transmission Owner to accommodate the project. During detailed design and analysis other components may be identified for installation or replacement due to this interconnection.

1. Transmission Lines –New

None

2. Transmission Lines – Upgrade

Hatfield-Black Oak 500kV Line

- Description of Work
  - Cut the existing Hatfield-Black Oak 500kV Line approximately 5.3 miles from the Black Oak Substation and 56 miles from the Hatfield substation (near structures 227 and 228) to create a loop into the new substation.
- Existing Conditions
  - The line is built on single circuit steel lattice towers. Per TAMI, the conductor is bundled 2032 kcmil 72/7 ACSR shielded by (2) 7#6 alumoweld shieldwires.
  - The existing line is strung horizontally.
- Structures Installed
  - (2) 500kV single circuit steel 3-pole deadend structures on drilled shaft foundations.
  - (2) spans of bundled 2032 kcmil 72/7 ACSR conductor (approximately (0.1) circuit miles total) shielded by (2) 7#8 alumoweld shieldwires (approximately (0.2) miles total).
    - Per the scooping checklist each phase is to be comprised of (2) conductors
  - (6) 500kV substation deadend insulator assemblies
  - Transfer the existing bundled conductor and shieldwire onto the new deadend structures.
  - It is assumed that the existing conductor and shield wire are in good condition and can be transferred to the new structures.
- Structures Removed
  - Approximately (0.1) circuit miles of bundled 2032 kcmil 72/7 ACSR shielded by approximately (0.1) miles of 7#6 alumoweld shieldwire.
- Construction Considerations
  - None
- Siting/Licensing
  - Due to line voltage and project location, it is assumed that a full application will be required.
- Assumptions
  - Assume the outage requirements for construction on the line can be met.
  - A ground survey will be required.
  - Assume adjacent existing structures have adequate capacity to handle the new loading. A PLS-Tower model and an engineering analysis during project development will be required to confirm.

- Transmission line design is based on the approximate location of the new substation bays and new fence line as shown in the preliminary substation layout. Once the exact location of the new substation bays has been finalized, a detailed engineering analysis will need to be conducted to confirm feasibility. Any changes to the preliminary substation design will likely result in a change to the transmission line scope.

- **Support Estimates**
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY
    - Some clearing will be required. Priority tree rights may be expanded.
  - RE/ROW
    - Assume all work will be performed within the existing ROW or on substation property.
    - A rights and restrictions review by Real Estate will be required.
    - Georeferenced ROW extents will be required to be provided to engineering.
    - Real estate $s have been included for:
      ~Internal support including document review, project planning meetings, subcontractor oversight and assistance with transfer of assets if required.
      ~External support for an acquisition of 1 access road (Assumed) rights & restrictions reviews, general project support, and minimal construction support and damage settlements/releases.
      ~We have not included acquisition labor or cost of potential priority tree rights unless specified as needed in the scope and assumptions.
      ~Direct damage payments not included in estimate.
  - ENVIRONMENTAL
    - An environmental review will be required to identify any construction constraints and additional permitting requirements.
  - REVENUE METERING
    - None
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - None
    - SCADA
      - None
  - ACCESS ROAD CONSTRUCTION
    - An existing dirt road is present in the area. Assuming that road is not adequate for access, approximately 0.5 miles of access roads will be required. The terrain is hilly.
  - DISTRIBUTION
    - None

3. New Substation/Switchyard Facilities

AG1-363 Collector Sub

- Below Grade
  - None
- Above Grade
  - None
- Relay & Control
  - Integrate Interconnection Facilities protection and controls to the transmission system.
- Additional Equipment to be Removed
  - None
- Assumptions
  - None

- **Support Estimates**
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY
    - None
  - RE/ROW
    - None
  - ENVIRONMENTAL
    - None
  - REVENUE METERING
    - Located at AG1-363 collector substation.
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - None.
    - SCADA
      - None.
  - TESTING & COMMISSIONING (TSCS)
    - Testing and commissioning services as required.

AG1-363: Interconnection Substation

- Below Grade
  - None
- Above Grade
  - Install (1) Security System and Camera System.
  - Install (1) Indoor Security AC Cabinet.
- Relay & Control
  - Install (1) Network fiber termination rack
  - Programming of SCADA RTU
- Additional Equipment to be Removed
  - None
- Assumptions
  - Assumed Project Developer will install camera foundations and conduits to Transmission Owner Standards.

- Assumed 2 Weeks of Testing and Commissioning for testing to Transmission Control Centers.
- Assumed Project Developer will install fiber from AG1-363 Collector Substation to AG1-363 Interconnection Substation and bring fiber into control house.
- Transmission Owner will be responsible for network fiber

- **Support Estimates**
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY
    - None
  - RE/ROW
    - None
  - ENVIRONMENTAL
    - None
  - REVENUE METERING
    - None
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - Install/Test approximately 3,115 feet underground and 96,888 feet aerial 48F/SM ADSS from the Jade Meadow AG1-363 substation control house to the Black Oak #1 substation control house.
    - SCADA
      - SCADA work at AG1-363 Substation to camera installation, as well as the installation of a SAS-K12 Switch with drawing updates.
      - Estimated design, installation, and testing/commissioning for MPLS equipment for SCADA transport at Hatfield Substation.
  - TESTING & COMMISSIONING (TSCS)
    - Testing and commissioning services as required for new equipment and relays.

AG1-363: Interconnection Substation (Option to Build Oversight)

- Below Grade
  - Must Meet Transmission Owner Standards-Option to Build.
- Above Grade
  - Must Meet Transmission Owner Standards-Option to Build.
- Relay & Control
  - Must Meet Transmission Owner Standards-Option to Build.
- Assumptions
  - Engineering Oversight for review/comment of OTB site design for meeting Transmission Owner Standards.
  - Geotechnical/Site/Civil oversight for review/comment of OTB site grading design for meeting Transmission Owner Standards.
  - Construction Oversight assumed for 6 months.
  - Developer responsible for apparatus testing of devices and supplying results to Transmission Owner.
  - Transmission Owner commissioning oversight is assumed for duration of Construction.

- **Support Estimates**
  - PROJECT MANAGEMENT (PM)
    - Coordinate with developer and provide project management, coordination, administration, scheduling, material management and project development for Transmission Owner scope of work.
    - Provide construction oversight for duration of project construction.
  - FORESTRY (FOR)
    - None
  - RE/ROW (RE-ROW)
    - Support as required for Transfer of Property to Transmission Owner upon construction completion.
    - Internal support including document review, project planning meetings, and assistance with transfer of assets as required.
  - ENVIRONMENTAL (ENV)
    - Environmental Review of Proposed Site
  - REVENUE METERING (METER)
    - None
  - DISTRIBUTION (DX)
    - Responsibility of the Project Developer – Transferred to Transmission Owner at station completion
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - Captured under Transmission Owner work for new Interconnection Substation
    - SCADA
      - Captured Under Transmission Owner work for new Interconnection Substation
  - TESTING & COMMISSIONING (TSCS)
    - Commissioning review of developer supplied information and witness of critical testing.

4. Substation/Switchyard Facility Upgrades

Black Oak Substation

- Below Grade
  - Conduit for fiber run to control building
- Above Grade
  - None
- Relay & Control
  - Replace 500kV Hatfield line relaying with:
    - (1) line relaying panel with (1) SEL-421, (1) SEL-411L, and (1) SEL-2505.
  - Install (1) lot of control cables, SEL cables, and fiber.
  - Install (1) fiber distribution panel.
- Additional Equipment to be Removed

- Remove wave trap, line tuner, coax, including foundations and steel structures, and carrier set.

- Assumptions
  - Breaker failure does not require replacement
  - Control building has adequate space for new panels
  - DC system and SCADA RTU are adequate
  - Existing fiber patch panel is adequate
  - There may be a need for lead abatement and asbestos removal, but neither are included in this estimate. Please review at substation site visit and make determination.

- **Support Estimates**
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY (FOR)
    - None
  - RE/ROW (RE-ROW)
    - None
  - ENVIRONMENTAL (ENV)
    - None
  - REVENUE METERING (METER)
    - None
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - Support as required for fiber communication.
    - SCADA
      - Points list changes for new equipment
  - TESTING & COMMISSIONING (TSCS)
    - Testing and commissioning services as required for new relays.

Hatfield Substation

- Below Grade
  - None
- Above Grade
  - None
  - Replace 500kV Black Oak line relaying and carrier with:
    - (1) line relaying panel with (1) SEL-421, (1) SEL-411L.
    - (1) carrier panel with (3) UPLC and (3) PCM-5350.
  - Install (1) lot of control cables and SEL cables.
- Additional Equipment to be Removed
  - None
- Assumptions
  - Breaker failure does not require replacement.
  - Wave trap and line tuner do not require replacement.
  - Control building has adequate space for new panels.
  - DC system and SCADA RTU are adequate.
  - There may be a need for lead abatement and asbestos removal, but neither are included in this estimate. Please review at substation site visit and make determination.

- **Support Estimates**
  - PROJECT MANAGEMENT (PM)
    - Project management will be required for this asset.
  - FORESTRY
    - None
  - RE/ROW
    - None
  - ENVIRONMENTAL
    - None
  - REVENUE METERING
    - None
  - IT/NETWORK
    - FIBER (RELAYING AND COMMUNICATION)
      - None
    - SCADA
      - Points list changes for new equipment
  - TESTING & COMMISSIONING (TSCS)
    - Testing and commissioning services as required for new relays.

5. Telecommunications Facilities – Upgrades

Project Developer will design, provide, install, own and maintain a fiber-optic communications cable between the new interconnection substation, and Project 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. Should subsequent/additional PJM studies indicate that stability issues exist, the primary and backup relay fiber-optic communication channels must be in separately routed cable paths and additional fiber-optic connection costs would apply (not included herein).

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

Transmission Owner will make the fiber termination connections for its cable(s) at the interconnection substation control house.

6. Metering & Communications

Project Developer shall install, own, operate, test and maintain the necessary revenue metering equipment to provide revenue metering (KWH, KVARH) and real time data (KW, KVAR) for the Project Developer's Facility that comply with the requirements set forth in PJM Manuals M-01 and M-14D.
The revenue metering system (particularly the revenue metering current transformers) shall be designed to accurately meter the light loads that will occur when the facility is not generating power and only back-feeding station service from the Transmission Owner. This may require the use of high accuracy extended range current transformers.

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

7. Environmental, Real Estate and Permitting

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

- Environmental permitting, Real Estate acquisition, and Maryland Public Service Commission notifications vary, some up to twenty-four (24) months after preliminary engineering is completed to secure the required approvals.
- Project Developer is responsible for all property acquisition (including easements/rights-of-way (ROW)) for transmission, distribution and communication facilities needed for the generator interconnection.
- All work occurs within an existing transmission line right-of-way or on Project 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.
- Project 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.
- Project Developer will obtain all necessary permits.
- Project Developer will conduct all necessary wetlands and waterways studies and permits.
- Project Developer will conduct all necessary historical and archaeological studies.
- If the Project 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

8. Summary of Results of Study

The cost estimates provided in this report were developed as of **6/19/24**. Hence, they are subject to significant changes in the event that project implementation is delayed for over one year. Notwithstanding the cost estimates from this report being used in the Generator Interconnection Agreement for the related project, Transmission Owner reserves the right to re-evaluate and provide a more accurate cost estimate during the implementation phase of the project.

Work Description	Direct		Indirect		Total Cost
	Labor	Material	Labor	Material	
Integrate Interconnection Facilities protection and controls to the Transmission System	$57,236	$0	$3,285	$0	$60,521
Total Transmission Owner Interconnection Facilities Cost	**$57,236**	**$0**	**$3,285**	**$0**	**$60,521**
OTB Estimate: Installation of security and camera system, indoor security cabinet, program Supervisory Control and Data Acquisition Remote Terminal Unit at AG1-363 interconnection substation. (PJM Network Upgrade n8840.0)	$594,590	$268,310	$31,632	$6,493	$901,025
Install/Test approximately 3,115 feet underground and 96,888 feet aerial 48F/SM ADSS from the Jade Meadow AG1-363 substation control house to the Black Oak #1 substation control house. (PJM Network Upgrade n8841.0)	$2,627,422	$645,141	$139,779	$15,612	$3,427,954
Total Stand-Alone Network Upgrades Cost	**$3,222,012**	**$913,451**	**$171,411**	**$22,105**	**$4,328,979**
Design, install, and test/commission MPLS Equipment for SCADA transport. (PJM Network n8842.0)	$136,391	$90,651	$7,256	$2,194	$236,492
Hatfield-Black Oak 500kV Line: Cut the existing Hatfield-Black Oak 500kV Line approximately 5.3 miles from the Black Oak Substation and 56 miles from the Hatfield substation (near structures 227 and 228) to create a loop into the new substation. (PJM Network n8843.0)	$5,854,227	$819,493	$311,445	$23,711	$7,008,876
Black Oak Substation: Replace line relaying equipment (PJM Network n8844.0)	$592,830	$37,732	$31,539	$913	$663,014
Hatfield Substation (KATCo): Replace Relay Panel (PJM Network n8845.0)	$517,866	$112,896	$45,676	$6,187	$682,625
Total Network Upgrades Cost	**$7,101,314**	**$1,060,772**	**$395,916**	**$33,005**	**$8,591,007**

OTB Oversight Estimate	$1,212,500	$0	$64,505	$0	$1,277,005
Revenue Metering	$3,390	$0	$1,130	$0	$4,520
Other Cost	**$1,215,890**	**$0**	**$65,635**	**$0**	**$1,281,525**
Total Project Costs	**$11,596,452**	**$1,974,223**	**$636,247**	**$55,110**	**$14,262,032**

Generation projects meeting IRS "Safe Harbor" provisions generally do not incur tax on "CIAC" (Contribution in Aid to Construction), a tax collected by the utility for the state or federal government. Transmission Owner does not expect to collect tax on CIAC for this project. If for any reason, tax on "CIAC" would be required for this project, it would be the responsibility of the party owning the generator to pay this cost.

Transmission Owner reserves the right to charge the Project Developer operation and maintenance expenses to maintain the Interconnection Facilities, including metering facilities, owned by Transmission Owner.

9. Schedules and Assumptions

A proposed **fifty-seven (57)** month **Direct Connection** schedule is estimated to complete the engineering, construction and the associated activities, from the date of a fully executed Generator Interconnection 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. Construction cannot begin until after all applicable permits and/or easements have been obtained.

FirstEnergy's ability to support this schedule also depends on the feasibility of taking the required outages to support construction. Outages that are determined to negatively impact system reliability or cause congestion may be delayed or denied, at any time, even if they are submitted on time based on the Outage Submittal Rules in section 4.2.1 of PJM Manual 03. This includes, but is not limited to, outages requested between the months of June and September, as well as January and March, which typically get denied due to summer and winter peak conditions. Therefore, the construction schedule will be adjusted as needed to accommodate any outage restrictions that have been identified by FirstEnergy or the Transmission Provider.

57-month Schedule

Activity	Start Month	End Month
Preliminary Engineering	1	2
Detailed Engineering	3	54
Siting, Permits & Real Estate	4	49
Equipment Delivery	47	52
Construction	49	57
Testing & Commissioning	56	57

Attachment #1: Protection Study

This protection scope matches the requirements from system impact except due to the location of the three-breaker ring bus moving fiber between the ring bus station and Black Oak is now required. Also Project Developer protection requirements have been added.

AG1-363 Interconnection Substation

- Install (3) 500kV breakers.
- Install (3) SEL-451 for breaker failure protection.
- Install (3) sets of three, CCVTs. One set for each line exit.
- Install dual SEL-411L Standard BES line protection for primary and backup line differential schemes communicating over fiber channels for interconnection tie line to generator collector substation.
- Install SEL-421/SEL-411L Standard BES line protection for primary DCB over fiber and backup current differential line protection for the Black Oak 500kV line.
- Install SEL-421/SEL-411L Standard BES line protection for primary DCB and backup step distance line protection for the Hatfield 500kV line, and carrier equipment, including carrier transmitter receiver (UPLCII) and PCM-5350 power line carrier monitor, wide band line tuner, and wide band line trap.
- Install SEL-2505 or equivalent device to send/receive breaker failure transfer trip.
- Install (2) UPLC-II FSK Tx/Rx to transmit and receive dual channel transfer trip to and from Hatfield.
- SEL-3530 RTAC data concentrator for relay distance to fault information to SCADA, and remote access to relays if a network connection is available.

Black Oak Substation

- Replace existing primary ALPS and backup electromechanical Black Oak line relays with SEL-421/SEL-411L Standard BES line protection for primary DCB over fiber and backup step distance line protection for the AG1-363 500kV line protection.
- All existing carrier equipment can be removed.
- Install SEL-2505 or equivalent device to send/receive breaker failure transfer trip
- AG1-363 Generator Substation: AG1-363 Interconnection Switching Station 500kV line exit – Install SEL-411L primary and SEL-411L backup line protection relays, each utilizing a current differential protection scheme over dedicated fiber, with backup overcurrent and step distance protection.
- The SEL-411L relays will also be used for sending and receiving breaker failure transfer trip, with the transfer trip I/O configured in the same manner as at the interconnection station.
- A dedicate breaker failure to trip relay is required for the 500kV breaker.
- Two independent relay schemes are required for clearing faults between the developer's 500kV breaker and the high-side windings of their generator step-up transformer high-speed. These schemes must include the 500kV breaker in their zones of protection. A protection scheme containing generator Intertie functions is required. Voltages and currents for the Intertie relaying must come from the 500kV system. Also, all requirements from "Requirements for Transmission Connected Facilities document" must also be adhered to.

Hatfield Substation

- Replace existing primary ALPS and backup electromechanical Hatfield line relays with SEL-421/SEL-411L Standard BES line protection for primary DCB and backup step distance line protection for the AG1-363 500kV line protection. Also replace existing CS61C ON/OFF carrier set with UPLCII. Install (2) PCM-5350 power line carrier monitors for DCB and DTT monitoring.
- Install (2) UPLC-II FSK Tx/Rx to transmit and receive dual channel transfer trip to and from AG1-363.

Short Circuit Analysis

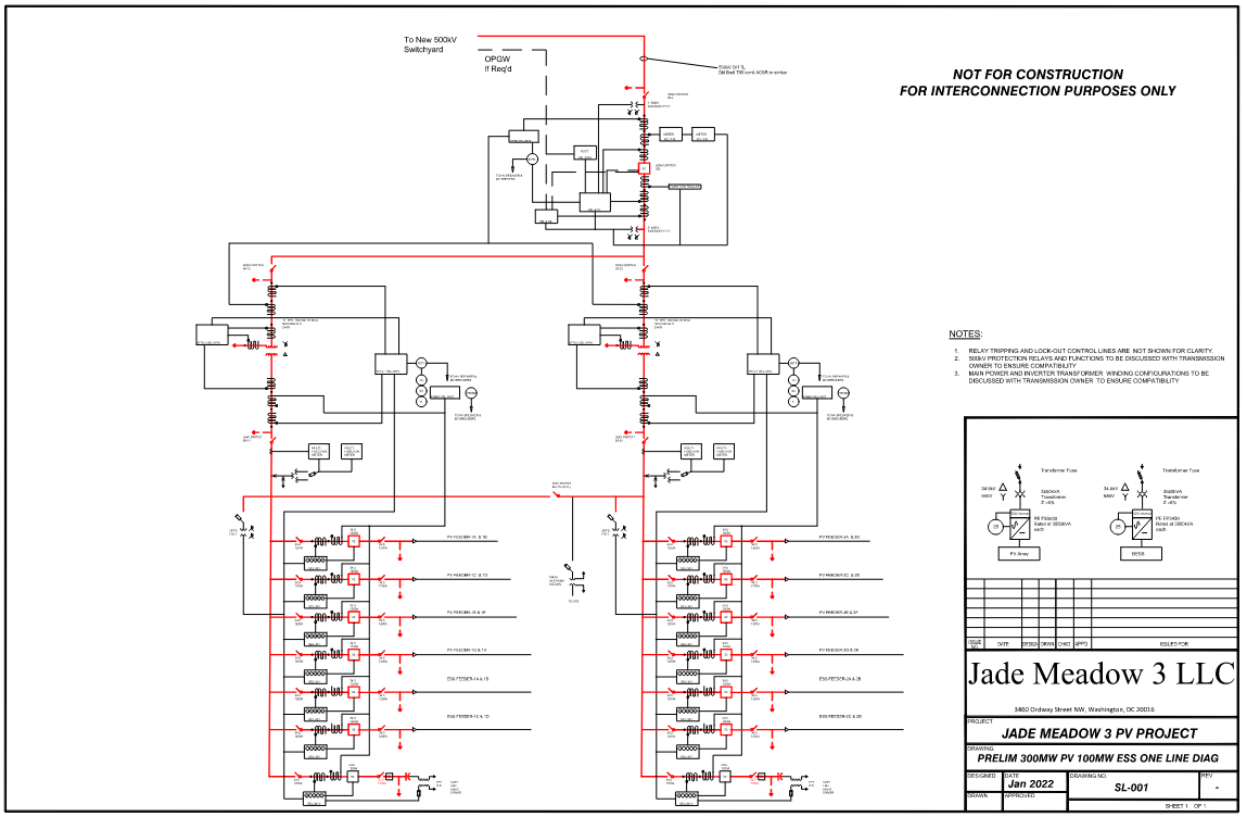
Fault values for the AG1-363 Interconnection Substation location with no AG1-363 generation equipment in service are:

Three phase = 11,800 A
Single line to ground = 10,400 A
Z1= 0.049 + j 0.976 %
Z0= 0.241 + j 1.368 %

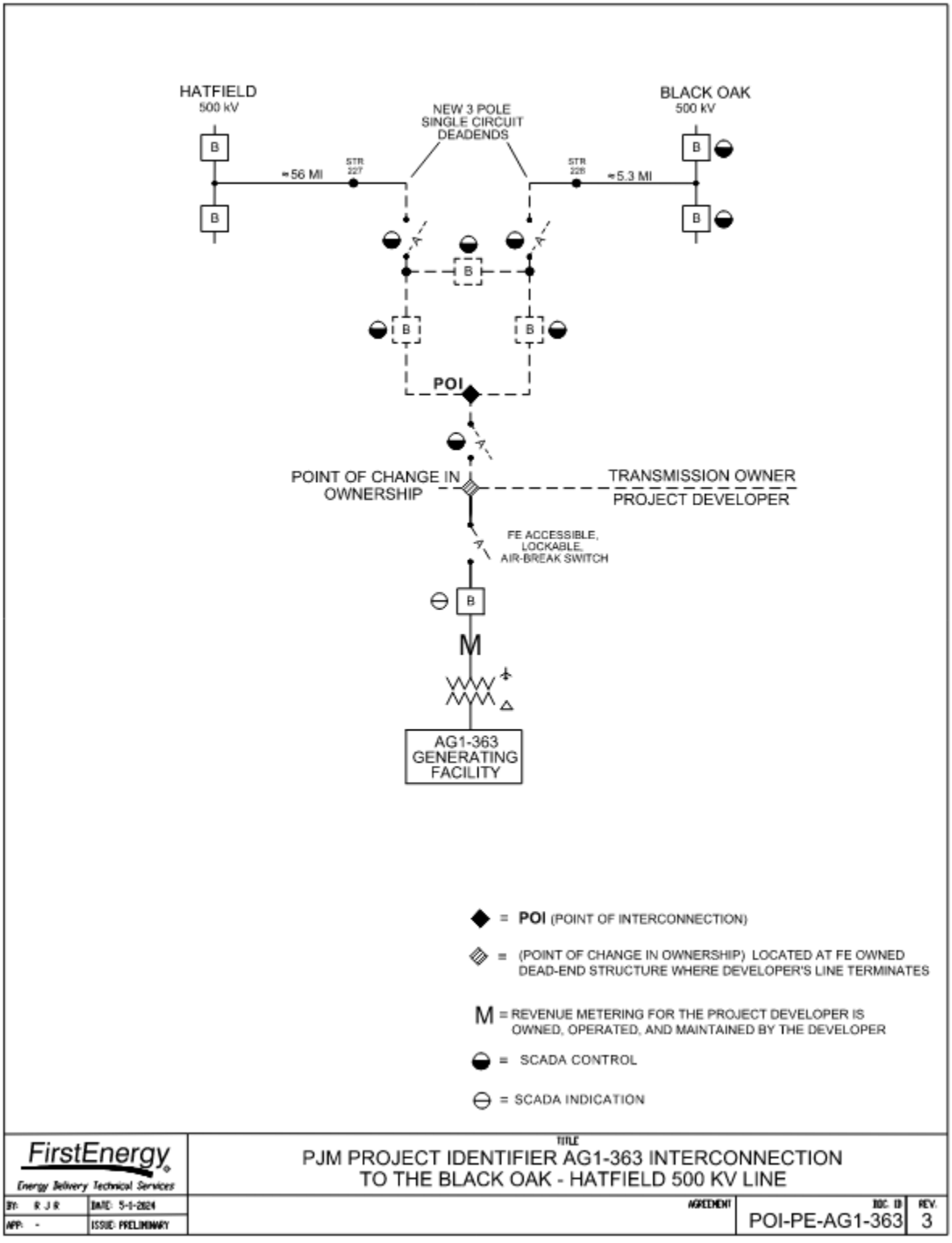
Impedances are given on a 100 MVA and 500kV base. The fault currents provided are bolted, symmetrical values for normal system conditions, using the PJM Short Circuit case. Future increases in fault currents are possible and it is the Developer's responsibility to upgrade its equipment and/or protective equipment coordination when necessary.

Attachment #2: One-Line Diagrams

Project Developer One-Lines
Not Approved for Construction

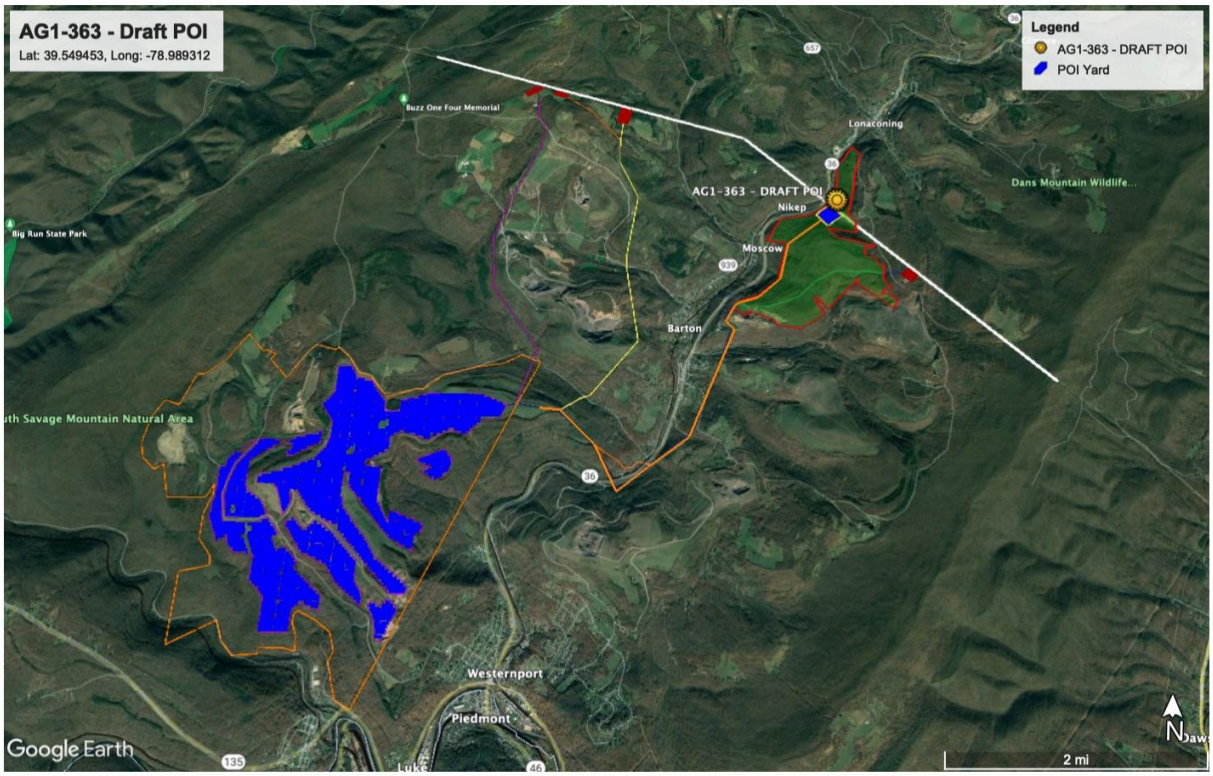


Transmission Owner One-Line



Attachment #3: Project Developer Site Plan and Interconnection Facilities

Project Developer Site Plan




500kV LINE
TO MATTFELD
500kV LINE
TO BLACK OAK
500kV LINE
TO DEVELOPER
OWNED SUBSTATION

Attachment #4: Generation Connection Requirements

Generation Connection Requirements

The proposed interconnection facilities must be designed in accordance with the *First Energy Transmission Planning and Protection 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 the *First Energy Transmission Planning and Protection Requirements for Transmission Connected Facilities* document:

> *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 PCO 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.*

For projects that entered PJM's New Service Request after November 1, 2016, the power factor requirement will be as follows:

Generation Type	New / Increase	Size	Power Factor Requirement	Measurement Location
Wind or Non-Synchronous	New	All	0.95 leading to 0.95 lagging	High Side of the Facility Substation Transformers

> *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).*

> *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

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

Transmission Design Requirements

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. Project 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:	500 kV
• Maximum phase-to-phase:	550 kV
• Basic impulse level (BIL):	1800 kV
• Maximum continuous current carrying capacity:	4000 A
• Design fault current:	40kA, Confirm for site specific exception
• Single Contingency (breaker failure) clearing time:	30 cycles

Clearances and Spacing

• Recommended rigid bus center-to-center phase spacing:	300"
• Minimum phase-to-phase, metal-to-metal distance:	222"
• Recommended phase-to-ground:	152"
• Minimum phase-to-ground:	144"

- Low bus height above top of foundations (match existing): 30’-0”
- High bus height above top of foundations (match existing): 55’-0”
- Minimum vertical clearance from live parts to grade: 20’-6”
- Minimum horizontal clearance from live parts: 15’-0”
- Minimum conductor clearance above roads in switchyard: 42’-0”
- Minimum bottom of insulator to top of foundation: 8’-6”

Attachment #5: Preliminary Geotechnical Summary

List of Observations/Concerns

- Potential for weak clayey soils (CL).
- Colluvium Material likely on-site.
- Deep organic soils identified on-site.
- Site geology consists of the Monongahela and Conemaugh formations. It is unlikely to have karst in these formations. These formations do have the potential for landslides and are known for large deposits of the Pittsburgh Coal seam.
- The proposed substation is located within hilly terrain. There is also a large ravine within the proposed substation location.
- This site is directly downslope of an active surface coal mine. The mine is called the "Watertank Pittsburgh Mine", owned by Cobra Mining, Inc. It is difficult to determine if the area directly upslope of proposed substation has already been mined and reclaimed or is clear cut and is planned to be mined in the future. Mines can significantly affect both surface storm water runoff and subsurface water. It is possible to have water management issues when developing adjacent to an active or reclaimed mine.

Recommendations

These recommendations assume this is an option to build project:

- Developer should provide a preliminary site investigation report. This should include:
    - Investigation of geotechnical risk which are:
        - deep organic soils.
        - hard shallow bedrock.
        - landslides cause by construction.
        - rutting of clayey soils.
    - Hydrological study of the site to investigate the large ravine and water from the upslope mine.
    - An understanding of previous and proposed mining activities upslope.
- Based on Tami 2 this is on the mine's property. Assuming the mine has sold the property already, we should review our easements and confirm the mine will not have domain over us.
- Developer should budget for higher-than-average civil construction costs due to steep terrain, organic soils, potential for hard shallow bedrock in some area and risk of the mine directly upslope

Preliminary Geotechnical Opinion

Based on a very high-level desktop study not backed with any field or testing verification there, appears to be a low risk of karst. Constructing 2 new substations and the associated access roads will be expensive because of the amount of earthwork to construct this on a side slope. As mentioned, the risk of karst is low but the risk of other geohazards should be considered moderate to high on this site. Our opinion of risk is:

- Karst – low.
- Deep organic soils (peat) – moderate.
- Hard shallow bedrock in some areas – moderate.
- Construction induced landslides – moderate to high.
- Rutting – high.
- Stormwater and drainage problems – high.

Building on significant side slopes will make it difficult to design a balanced earthwork site. FirstEnergy should have concerns about proposed fill pads, stockpiles, and over-steepened cutslopes. The Project Developer will need to provide FE with detailed slope stability analysis for all proposed significant slopes.

In our preliminary opinion, the proposed site location should be reconsidered based on the geotechnical risks. It is possible that some risks could be reduced by relocating the substation downslope at the base of the hill. This would need to be confirmed with a detailed subsurface investigation.

Estimating

Estimating construction costs for the proposed location is difficult at this stage in the development. Based on the opinion that site is a difficult site to develop, we recommend assuming 200%-300% increased cost compared to constructing a similar sized substation on flat terrain with no to low risks of geohazards.