Generation Interconnection

System Impact Study Report

for

Queue Project AE1-123

EMLENTON 34.5 KV

18 MW Capacity / 18 MW Energy

August, 2019

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1 Introduction

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

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

Clarion Boards, LLC, the Interconnection Customer (IC), has proposed a Natural Gas generating facility (reciprocating engines) located in Shippenville, PA. The proposed generating unit site is approximately 2.9 miles southeast of Shippenville, PA., off Rt. 322 (Attachment 1). The installed facilities will have a total capability of 18MW with 18MW of this output being recognized by PJM as Capacity. The proposed in-service date for this project is September 30, 2018. **This study does not imply a Mid Atlantic Interstate Transmission (MAIT – Penelec) commitment to this in-service date.**

Queue Number	AE1-123
Project Name	EMLENTON 34.5 KV
Interconnection Customer	Clarion Boards LLC
State	Pennsylvania
County	Clarion
Transmission Owner	PENELEC
MFO	18
MWE	18
MWC	18
Fuel	Natural Gas
Basecase Study Year	2022

3.1 Point of Interconnection

AE1-123 will interconnect with the MAIT distribution system along the Emlenton 34.5kV circuit at pole # 6K5835134.5.

The interconnection of the project at the Primary POI will be accomplished by tapping the Clarion Industries 34.5 kV line and constructing a one span tap. The line tap will be located approximately 4.4 miles from Piney 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 Clarion Industries and Piney substations.

Attachment 1 shows a one-line diagram of the proposed primary direct connection facilities for the AE1-123 generation project to connect to the Penelec distribution 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 Penelec distribution system.

3.2 Cost Summary

The AE1-123 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$
Direct Connection Network Upgrade	$
Non Direct Connection Network Upgrades	$ 220,100
Total Costs	**$ 220,100**

In addition, the AE1-123 project may be responsible for a contribution to the following costs

Description	Total Cost
System Upgrades	**$ 0**

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.

4 Transmission Owner Scope of Work

4.1 Attachment Facilities

This project does not require any Attachment Facilities.

4.2 Direct Connection Cost Estimate

This project does not require any Direct Connection Facilities.

4.3 Non-Direct Connection Cost Estimate

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

Description	Total Cost
Install sync-check relaying and anti-islanding DTT transmitter on 34.5kV Emlenton circuit at the Piney substation	$ 147,400
Engineering oversite and commissioning	$ 65,200
RTU programming for the connection to the SCADA and relay support for the generation installation	$ 7,500
Total Direct Connection Facility Costs	**$ 220,100**

5 Schedule

Based on the scope of work for the Non-Direct Connection facilities, it is expected to take a minimum of 12 months after the signing of an Interconnection Construction Service Agreement to complete the installation. This includes the requirement for the IC to make a preliminary payment that compensates Penelec 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.

6 Transmission Owner Analysis

6.1 Power Flow Analysis

FE performed an analysis of its underlying transmission <100 kV system. The AE1-123 project did not contribute to any overloads on the FE transmission system.

6.2 Stability Analysis

A dynamic stability analysis was completed by FE. There were no stability concerns identified for the faults studied.

7 Interconnection Customer Requirements

7.1 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.

7.2 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 34.5 kV circuit breaker to protect the AE1-123 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 AE1-123 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.

The IC shall design its Customer Facility with the ability to maintain a power factor of at least 0.95 leading (absorbing VARs) to 0.90 lagging (supplying VARs) measured at the Primary Meter at Clarion Industries.

8 Revenue Metering and SCADA Requirements

8.1 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.

8.2 PENELEC 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

9 Network Impacts

The Queue Project AE1-123 was evaluated as a 18.0 MW (Capacity 18.0 MW) injection at Emlenton 34.5kV in the PENELEC area. Project AE1-123 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AE1-123 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Load Flow

10 Generation Deliverability

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

None.

11 Multiple Facility Contingency

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

None

12 Contribution to Previously Identified Overloads

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

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
4261681	235197	01KARNSC	AP	235152	01BUTLER	AP	1	PN-P1-2-PN-345-107T	single	179.0	111.89	113.34	DC	2.87
4261682	235197	01KARNSC	AP	235152	01BUTLER	AP	1	ATSI-P1-2-CEI-345-700T	single	179.0	111.89	113.34	DC	2.87
4261696	235240	01COLMBGPN	AP	235202	01KISKIV	AP	1	PN-P1-2-PN-345-107T	single	151.0	111.41	112.54	DC	1.74
4261697	235240	01COLMBGPN	AP	235202	01KISKIV	AP	1	ATSI-P1-2-CEI-345-700T	single	151.0	111.41	112.54	DC	1.74
4261640	235282	01GAR RN	AP	235240	01COLMBGPN	AP	1	ATSI-P1-2-CEI-345-700T	single	151.0	119.56	120.69	DC	1.74
4261641	235282	01GAR RN	AP	235240	01COLMBGPN	AP	1	PN-P1-2-PN-345-107T	single	151.0	119.56	120.69	DC	1.74

13 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
21853053	939385	AE1-169 TAP1	PENELEC	200571	26UNION CY	PENELEC	1	PN-P1-2-PN-345-001	operation	120.0	78.77	79.8	AC	1.46

14 System Reinforcements

ID	Index	Facility	Upgrade Description	Cost
4369546, 4369545	6	**01GAR RN 138.0 kV - 01COLMBGPN 138.0 kV Ckt 1**	Upgrade description: Reconductor the Columbia Big Pine – Garretts Run 138kV line. Cost : $20,150,000 Time Estimate : 22 months Rating after the upgrade: 261/311/311 n6183 Queue Project AE1-123 presently does not receive cost allocation for this upgrade. Note 1: as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, Queue Project AE1-123 could receive cost allocation. Note 2: Although Queue Project AE1-123 may not have cost responsibility for this upgrade, Queue Project AE1-123 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AE1-123 comes into service prior to completion of the upgrade, Queue Project AE1-123 will need an interim study.	$0
4369586, 4369587	4	**01KARNSC 138.0 kV - 01BUTLER 138.0 kV Ckt 1**	Upgrade description: Reconductor the Butler – Karns City 138kV line and replace terminal equipment at Butler Project Type : FAC Cost : $26,520,000 Time Estimate : 39 months Ratings after the upgrade: n6215 Queue Project AE1-123 presently does not receive cost allocation for this upgrade. Note 1: as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, Queue Project AE1-123 could receive cost allocation. Note 2: Although Queue Project AE1-123 may not have cost responsibility for this upgrade, Queue Project AE1-123 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AE1-123 comes into service prior to completion of the upgrade, Queue Project AE1-123 will need an interim study.	$0

ID	Index	Facility	Upgrade Description	Cost
4369601, 4369602	5	**01COLMBGPN 138.0 kV - 01KISKIV 138.0 kV Ckt 1**	Upgrade description: Reconductor the Columbia Big Pine – Kiski Valley 138kV line. Project Type : FAC Cost : $7,800,000 Time Estimate : 18 months Rating after the upgrade: 191/191/191 n6214 Queue Project AE1-123 presently does not receive cost allocation for this upgrade. Note 1: as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, Queue Project AE1-123 could receive cost allocation. Note 2: Although Queue Project AE1-123 may not have cost responsibility for this upgrade, Queue Project AE1-123 may need this upgrade in-service to be deliverable to the PJM system. If Queue Project AE1-123 comes into service prior to completion of the upgrade, Queue Project AE1-123 will need an interim study.	$0
			TOTAL COST	**$0**

15 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.

15.1 Contingency Descriptions

Contingency Name	Contingency Definition
PN-P1-2-PN-345-001	CONTINGENCY 'PN-P1-2-PN-345-001' /* ERIE WEST - WAYNE 345KV DISCONNECT BRANCH FROM BUS 200599 TO BUS 200595 CKT 1 /* 26ERIE W 345 26WAYNE 345 END
PN-P1-2-PN-345-107T	CONTINGENCY 'PN-P1-2-PN-345-107T' /* ERIE WEST - ASHTABULA - PERRY 345KV DISCONNECT BRANCH FROM BUS 200599 TO BUS 238547 CKT 1 /* 26ERIE W 345 02AT 345 DISCONNECT BRANCH FROM BUS 238547 TO BUS 239082 CKT 1 /* 02AT 345 02S8-ATT 345 DISCONNECT BRANCH FROM BUS 238547 TO BUS 239036 CKT 1 /* 02AT 345 02PERRY 345 DISCONNECT BUS 238547 /* 02AT 345 END
ATSI-P1-2-CEI-345-700T	CONTINGENCY 'ATSI-P1-2-CEI-345-700T' /* PN/ATSI ERIE WEST - ASHTABULA - PERRY 345KV DISCONNECT BRANCH FROM BUS 239036 TO BUS 238547 CKT 1 /* 02PERRY 345 02AT 345 DISCONNECT BRANCH FROM BUS 238547 TO BUS 239082 CKT 1 /* 02AT 345 02S8-ATT 345 DISCONNECT BRANCH FROM BUS 239082 TO BUS 238544 CKT 8 /* 02S8-ATT 345 02ASH_3 138 DISCONNECT BRANCH FROM BUS 238547 TO BUS 200599 CKT 1 /* 02AT 345 26ERIE W 345 END

15.2 Index 2

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
4261682	235197	01KARNSC	AP	235152	01BUTLER	AP	1	ATSI-P1-2-CEI-345-700T	single	179.0	111.89	113.34	DC	2.87

Bus #	Bus	MW Impact
200608	26PINEY #1	0.73
200642	26SENECA#1	2.4
200643	26SENECA#2	2.55
200644	26SENECA#3	0.21
200649	26PENNTECH	0.43
200662	26SCRUB GR	1.54
200805	26COLVER13	7.32
200828	26HNSMLK 1	0.72
200829	26HNSMLK 2	0.72
200830	26HNSMLK 3	0.72
200831	26HNSMLK 4	0.72
200832	26HNSMLK 5	0.72
200849	26LAKVU GN	0.06
201201	26WRREN CT	0.61
235030	01MHNG-T155	0.16
235134	01AL&D6	0.14
903643	W3-099 C OP1	1.04
915951	Y3-092 FTIR	85.87
919491	AA2-000	26.55
930411	AB1-082	1.22
930511	AB1-092	0.97
932571	AC2-077	1.12
935191	AD1-154	2.38
936421	AD2-055	2.01
936991	AD2-133 C	0.92
938951	AE1-123	2.87
939171	AE1-147 C	0.62
939291	AE1-160 C	1.54
939381	AE1-169 C O1	6.53
BLUEG	BLUEG	3.41
CALDERWOOD	CALDERWOOD	0.32
CANNELTON	CANNELTON	0.2
CATAWBA	CATAWBA	0.18
CBM-N	CBM-N	1.71
CHEOAH	CHEOAH	0.29
CHILHOWEE	CHILHOWEE	0.1
COFFEEN	COFFEEN	0.36
COTTONWOOD	COTTONWOOD	1.3
DUCKCREEK	DUCKCREEK	0.79
EDWARDS	EDWARDS	0.36

Bus #	Bus	MW Impact
FARMERCITY	FARMERCITY	0.23
G-007A	G-007A	1.69
GIBSON	GIBSON	0.14
HAMLET	HAMLET	0.27
NEWTON	NEWTON	0.93
NYISO	NYISO	7.44
PRAIRIE	PRAIRIE	1.71
SANTEETLA	SANTEETLA	0.09
SMITHLAND	SMITHLAND	0.13
TATANKA	TATANKA	0.43
TILTON	TILTON	0.43
TRIMBLE	TRIMBLE	0.38
TVA	TVA	1.07
UNIONPOWER	UNIONPOWER	0.47
VFT	VFT	4.68

15.3 Index 3

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
4261697	235240	01COLMBGPN	AP	235202	01KISKIV	AP	1	ATSI-P1-2-CEI-345-700T	single	151.0	111.41	112.54	DC	1.74

Bus #	Bus	MW Impact
200608	26PINEY #1	0.44
200642	26SENECA#1	2.0
200643	26SENECA#2	2.13
200644	26SENECA#3	0.18
200649	26PENNTECH	0.35
200662	26SCRUB GR	1.07
200828	26HNSMLK 1	0.67
200829	26HNSMLK 2	0.67
200830	26HNSMLK 3	0.67
200831	26HNSMLK 4	0.67
200832	26HNSMLK 5	0.67
200849	26LAKVU GN	0.05
201201	26WRREN CT	0.52
235030	01MHNG-T155	0.18
235134	01AL&D6	0.31
903643	W3-099 C OP1	0.89
915951	Y3-092 FTIR	74.85
930411	AB1-082	1.04
935191	AD1-154	1.43
938951	AE1-123	1.74
939291	AE1-160 C	1.09
939381	AE1-169 C O1	4.66
BLUEG	BLUEG	2.68
CALDERWOOD	CALDERWOOD	0.26
CANNELTON	CANNELTON	0.16
CATAWBA	CATAWBA	0.15
CBM-N	CBM-N	1.46
CHEOAH	CHEOAH	0.23
CHILHOWEE	CHILHOWEE	0.08
COFFEEN	COFFEEN	0.28
COTTONWOOD	COTTONWOOD	1.03
DUCKCREEK	DUCKCREEK	0.62
EDWARDS	EDWARDS	0.28
FARMERCITY	FARMERCITY	0.18
G-007A	G-007A	1.45
GIBSON	GIBSON	0.11
HAMLET	HAMLET	0.23
NEWTON	NEWTON	0.73
NYISO	NYISO	6.39
PRAIRIE	PRAIRIE	1.34

Bus #	Bus	MW Impact
SANTEETLA	SANTEETLA	0.07
SMITHLAND	SMITHLAND	0.11
TATANKA	TATANKA	0.33
TILTON	TILTON	0.34
TRIMBLE	TRIMBLE	0.3
TVA	TVA	0.85
UNIONPOWER	UNIONPOWER	0.38
VFT	VFT	4.02

15.4 Index 4

ID	FROM BUS#	FROM BUS	FROM BUS AREA	TO BUS#	TO BUS	TO BUS AREA	CKT ID	CONT NAME	Type	Rating MVA	PRE PROJECT LOADING %	POST PROJECT LOADING %	AC|DC	MW IMPACT
4261641	235282	01GARRN	AP	235240	01COLMBGPN	AP	1	PN-P1-2-PN-345-107T	single	151.0	119.56	120.69	DC	1.74

Bus #	Bus	MW Impact
200608	26PINEY #1	0.44
200642	26SENECA#1	2.0
200643	26SENECA#2	2.13
200644	26SENECA#3	0.18
200649	26PENNTECH	0.35
200662	26SCRUB GR	1.07
200828	26HNSMLK 1	0.67
200829	26HNSMLK 2	0.67
200830	26HNSMLK 3	0.67
200831	26HNSMLK 4	0.67
200832	26HNSMLK 5	0.67
200849	26LAKVU GN	0.05
201201	26WRREN CT	0.52
235030	01MHNG-T155	0.18
235134	01AL&D6	0.31
903643	W3-099 C OP1	0.89
915951	Y3-092 FTIR	74.85
930411	AB1-082	1.04
935191	AD1-154	1.43
938951	AE1-123	1.74
939291	AE1-160 C	1.09
939381	AE1-169 C O1	4.66
BLUEG	BLUEG	2.68
CALDERWOOD	CALDERWOOD	0.26
CANNELTON	CANNELTON	0.16
CATAWBA	CATAWBA	0.15
CBM-N	CBM-N	1.46
CHEOAH	CHEOAH	0.23
CHILHOWEE	CHILHOWEE	0.08
COFFEEN	COFFEEN	0.28
COTTONWOOD	COTTONWOOD	1.03
DUCKCREEK	DUCKCREEK	0.62
EDWARDS	EDWARDS	0.28
FARMERCITY	FARMERCITY	0.18
G-007A	G-007A	1.45
GIBSON	GIBSON	0.11
HAMLET	HAMLET	0.23
NEWTON	NEWTON	0.73
NYISO	NYISO	6.39
PRAIRIE	PRAIRIE	1.34

Bus #	Bus	MW Impact
SANTEETLA	SANTEETLA	0.07
SMITHLAND	SMITHLAND	0.11
TATANKA	TATANKA	0.33
TILTON	TILTON	0.34
TRIMBLE	TRIMBLE	0.3
TVA	TVA	0.85
UNIONPOWER	UNIONPOWER	0.38
VFT	VFT	4.02

Affected Systems

16 Affected Systems

None.

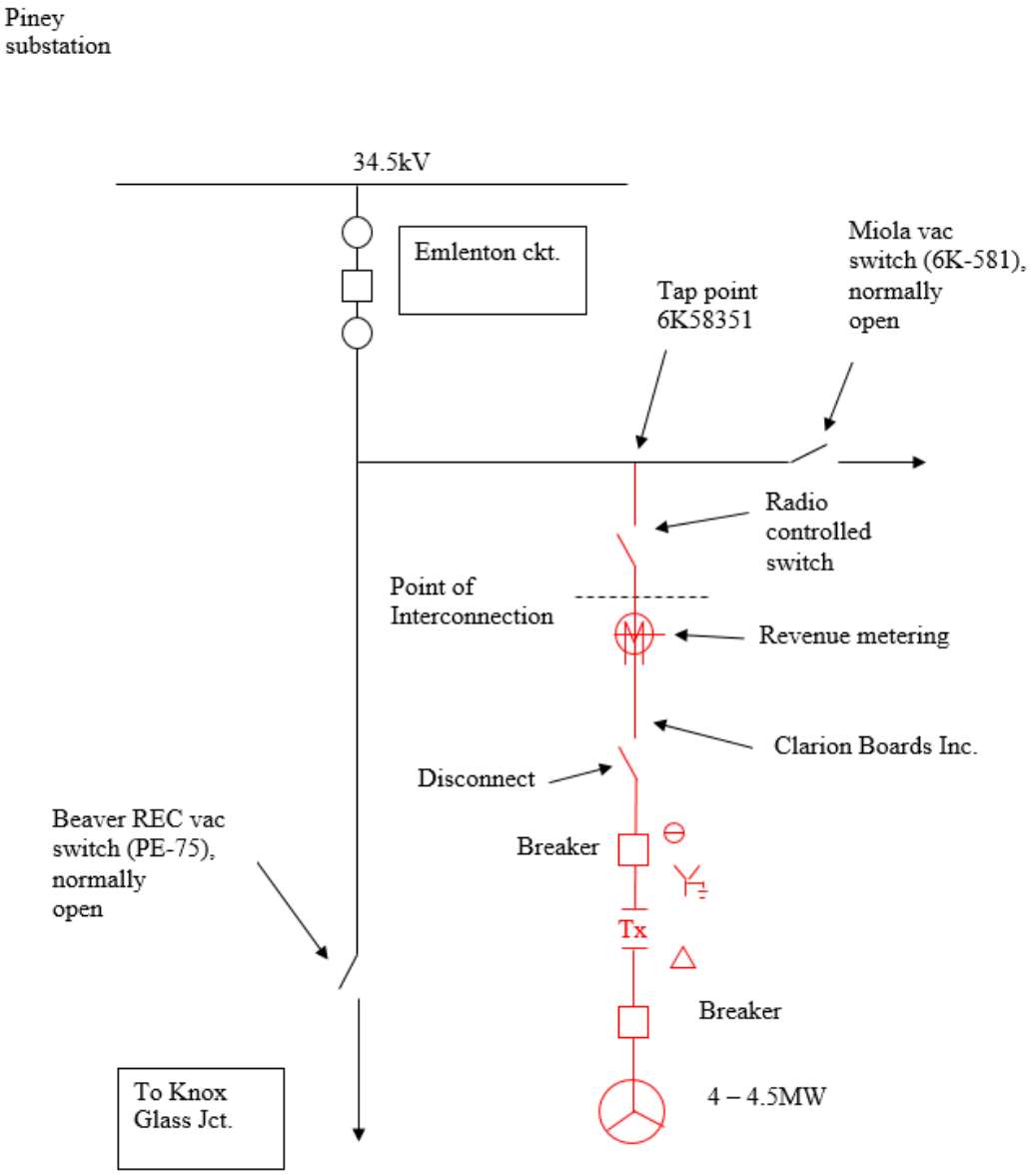
Short Circuit

17 Short Circuit

The following Breakers are overduty

None

Attachment 1 – One-Line Diagram



Attachment 2 – Project Location