



**Generation Interconnection
System Impact Study Report**

for

Queue Project AF2-263

SHELBY 138 KV

58.8 MW Capacity / 98 MW Energy

February 2021

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1 Introduction

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

2 Preface

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

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

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

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

3 General

The Interconnection Customer (IC), has proposed a Solar generating facility located in Shelby County, Ohio. The installed facilities will have a total capability of 98 MW with 58.8 MW of this output being recognized by PJM as Capacity.

The proposed in-service date for this project is July 01, 2022. This study does not imply a TO commitment to this in-service date.

Queue Number	AF2-263
Project Name	SHELBY 138 KV
State	Ohio
County	Shelby
Transmission Owner	Dayton
MFO	98
MWE	98
MWC	58.8
Fuel	Solar
Basecase Study Year	2023

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

4 Point of Interconnection

The AF2-263 project will interconnect with The Dayton Power and Light Company d/b/a AES Ohio ("AES Ohio") transmission system at the Shelby 138 kV substation. The current configuration for the AF2-212 project at the Shelby 138 kV substation is a breaker-and-a-half configuration with six breakers. This project will require an expansion of two additional 138kV breakers. The Point of Interconnection (POI) will be the 138 kV takeoff structure leaving the Shelby Substation. Dayton will own the takeoff structure and all attachment hardware. The Interconnection Customer will own the generator lead line conductor terminating onto the structure. This is the primary Point of Interconnection (POI) chosen by the IC. The IC will be responsible for acquiring all easements, properties, and permits that may be required to construct both the new interconnection substation and the associated attachment facilities.

Attachment 1 shows a one-line diagram of the proposed primary direct connection of the AF2-263 generation project to The Dayton Power and Light Company d/b/a AES Ohio ("AES Ohio"). Attachment 2 provides the proposed location for the point of interconnection. IC will be responsible for constructing all the facilities on its side of the POI including the attachment line.

5 Cost Summary

The AF2-263 project will be responsible for the following costs:

Description	Total Cost
Total Physical Interconnection Costs	\$3,390,000
System Upgrades (Local violations identified by TO, refer Section 8 table of this document)	\$18,186,000
Allocation towards System Network Upgrade Costs*	\$0
Total Costs	\$21,576,000

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

The estimates provided in this report are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements. In addition, Stability analysis will be completed during the Facilities Study stage. It is possible that a need for additional upgrades could be identified by these studies.

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.

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 AF2-263 project will use the existing interconnection facilities, so the only Transmission Owner work associated with this project is to provide engineering oversight and make remote relay setting changes at the AF2-263 interconnection substation and other related adjacent substations.

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

6.1 Attachment Facilities

This report assumes that the Interconnection Customer will construct and own the attachment line from its generating facility into the proposed Point of Interconnection as depicted on the one-line diagram in Attachment 1. The IC will also be responsible for the fiber/OPGW that Dayton requires on the generator line for the communication assisted trip scheme. The costs included below are for the necessary protection system review and any subsequent field changes needed to coordinate with IC attachment facilities.

The metering and necessary equipment to accept the generator lead line / bus will be classified as Attachment Facilities in the Facilities Study report.

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

Description	Total Cost
Engineering review and commissioning.	\$15,000
Total Attachment Facility Costs	\$15,000

6.2 Direct Connection Cost Estimate

The total preliminary cost estimate for the Direct Connection work is given in the table below. These costs do not include CIAC Tax Gross-up. The AF2-263 is connecting to the existing substation. Therefore, there is no Direct Connection scope of work required for this project.

Description	Total Cost
None	\$0
Total Direct Connection Facility Costs	\$0

6.3 Non-Direct Connection Cost Estimate

Two additional 138 kV breakers will be installed to the Shelby Substation to interconnect AF2-263 project. The 138 kV generator lead line will be constructed by the developer and will be terminated onto the 138 kV takeoff structure leaving the Shelby Substation. The new 138 kV breakers will be equipped with the necessary communication systems to facilitate remote supervisory control of the breakers and status monitoring. Dayton

will install the physical structures, line relaying, communications, and interconnection metering to accommodate the interconnection of the AF2-263 project.

Relay setting changes will also need to be made at the Shelby substation and other impacted facilities to facilitate the interconnection of the new generation.

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 two 138 kV breakers at the Shelby Substation to interconnect the AF2-263 project. This will include the installation of all physical structures, P&C equipment, communications equipment, metering equipment, and associated facilities.	\$3,300,000
Shelby 138 kV Substation - protection system settings changes	\$75,000
Total Non-Direct Connection Facility Costs	\$3,375,000

7 Schedule

Based on the extent of the Dayton primary Attachment Facilities and Non-Direct Connection work required to support the AF2-263 generation project, it is expected to take a minimum of **twenty-four (24) months** from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This includes the requirement for the IC to make a preliminary payment to Dayton which funds the Non-Direct Connection work and the first three months of engineering design that is related to the construction of the Attachment Facilities. It further assumes that the IC will provide all rights-of-way, permits, easements, etc. that will be needed. A further assumption is that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined Attachment Facilities and Non-Direct Connection work, and that all system outages will be allowed when requested.

8 Transmission Owner Analysis

The analysis from the Feasibility Study was updated during the System Impact Study phase and can be found below:

BRANCH	CONTINGENCY	MVAFLOW	AMPFLOW	RATE RATE1/ RATE2	% FLOW AFTER	% FLOW BEFORE	COMMENTS
253099 09ATLNTA 69.000 253100 09ATLNTA 345.00 1	BASE CASE	314.93	314.93	250.00	125.97	125.86	Reinforcement Project, r190012 will add a second 250MVA, 345/69kV transformer at Atlanta.
253151 09HNDA E 69.000 253153 09HNDAMT 69.000 1	BASE CASE	-80.50	81.74	80.00	102.18	102.96	PJM Network Upgrade #DAYr20003 proposes to reconductor Honda East Liberty to Honda Marysville Tap with 1351 AAC to raise the rating to 98/112.
253041 09LOGAN 69.000 253119 09BELFON 69.000 1	DAY P1 6619 _PEORIA_HON DA E. LIBERTY_69K V_SRT-A	102.72	102.77	98.00	104.87	101.16	PJM Network Upgrade #DAYr190032 proposes to reconductor Logan-Bellefontaine 69kV line with 795 ACSR to raise the rating to 136/158.
253089 09WMILT 138.00 957850 AF2-079 TAP 138.00 1	DAY_P1_6644 _COVINGTON_ GREENVILLE_ 69KV_SRT-A	-191.73	185.78	165.00	112.60	112.68	Supplemental Project # S1846 (Greenville Trf) will raise the line rating to 200/220MVA.
253089 09WMILT 138.00 957850 AF2-079 TAP 138.00 1	DAY P1 6661 _TREATY_ROS SBURG 69KV SRT-A	-198.26	192.08	165.00	116.41	116.27	Supplemental Project # S1846 (Greenville Trf) will raise the line rating to 200/220MVA.

253089 09WMILTN 138.00 957850 AF2-079 TAP 138.00 1	DAY_P1_6932 _TREATY_GRE ENVILLE_69K V_SRT-A	-205.06	198.66	165.00	120.40	120.26	Supplemental Project # S1846 (Greenville Trf) will raise the line rating to 200/220MVA.
253041 09LOGAN 69.000 253119 09BELFON 69.000 1	DAY_P1_OUTA GE_28A-A	100.20	100.34	98.00	102.39	102.95	PJM Network Upgrade #DAYr190032 proposes to reconductor Logan-Bellefontaine 69kV line with 795 ACSR to raise the rating to 136/157.
253016 09CVNGTN 69.000 253145 09GTYSBU 69.000 1	DAY_P1_OUTA GE_32A_B-B- WMILTON _AF2- 079_TAP	-109.24	110.83	98.00	113.09	113.78	PJM Network Upgrade #DAYr20010 proposes to reconductor Gettysburg to Covington 69kV line to raise the rating to 98/110.
253028 09GRNVIL 69.000 253029 09GRNVIL 138.00 1	DAY_P1_OUTA GE_32A_B-B- WMILTON _AF2- 079_TAP	-165.22	165.22	165.00	100.13	100.16	Supplemental Project # S1846 (Greenville Trf) will raise the line rating to 200/220MVA.
BRANCH	CONTINGENCY	MVAFLOW	AMPFLOW	RATE RATE1/ RATE2	% FLOW AFTER	% FLOW BEFORE	COMMENTS
253028 09GRNVIL 69.000 253145 09GTYSBU 69.000 1	DAY_P1_OUTA GE_32A_B-B- WMILTON _AF2- 079_TAP	124.15	121.40	98.00	123.88	124.59	Existing overload caused by AF2-079. Reinforcement project #r190019 proposes to reconductor Greenville to Gettysburg 69kV line with 1351 AAC taking the line rating to 98/110. The estimated cost of this upgrade is USD 10,556,000. The cost responsibility lies with AF2-079. Reinforcement project #r190020 proposes to reconductor substation conductor at Greenville with 1351 AAC taking the line rating to 100/110. The estimated cost of this upgrade is USD 25,000. The cost responsibility lies with AF2-079. Reinforcement project #r190021 proposes to replace the current 800A wavetrap at Greenville with a new 1200 A wavetrap taking the line rating to 126/144. The estimated cost of this upgrade is USD 125,000. The cost responsibility lies with AF2-079. If AF2-079 withdraws from the queue, this project may require the upgrades prescribed as part of the AF2-079 reinforcements.
253028 09GRNVIL 69.000 253230 09TREATY 69.000 1	DAY_P1_OUTA GE_32A_B-B- WMILTON _AF2- 079_TAP	-136.16	135.36	134.00	101.01	101.12	Existing overload caused by AF2-079. Reinforcement project #r190022 proposes to reconductor Greenville to Treaty 69kV line with 1351 AAC taking the line rating to 134/155. The estimated cost of this upgrade is USD 6,188,000. The cost responsibility lies with AF2-079. If AF2-079 withdraws from the queue, this project may require the upgrades prescribed as part of the AF2-079 reinforcements.

253067 09ROSSBG 69.000 253230 09TREATY 69.000 1	DAY P1 OUTA GE_32A B-B- WMILTON _AF2- 079_TAP	-110.79	110.14	98.00	112.39	112.49	Existing overload caused by AF2-079. Reinforcement project #r190023 proposes to reconductor Rossburg to Treaty 69kV line with 1351 AAC taking the line rating to 98/112. The estimated cost of this upgrade is USD 17,528,000. The cost responsibility lies with AF2-079. If AF2-079 withdraws from the queue, this project may require the upgrades prescribed as part of the AF2-079 reinforcements.
253041 09LOGAN 69.000 253119 09BELFON 69.000 1	253024 09ESIDNY 138 941940 AE2-206 TAP 138 1	100.21	100.36	98.00	102.41	102.75	PJM Network Upgrade #DAYr190032 proposes to reconductor Logan-Bellefontaine 69kV line with 795 ACSR to raise the rating to 136/158.
253003 09AMSTRD 69.000 253180 09N BREM 69.000 1	DAY_P1- 2_#765-A_ 242945 05SW LIM 345 944480 AF1- 113 TAP 345	86.55	85.33	81.00	105.35	97.36	New overload created by AF2-263. Reinforcement project #r190024 proposes to reconductor Amsterdam to New Bremen 69kV line with 1351 AAC to raise the final rating to 81/92. The estimated cost of this upgrade is \$658,000. The cost responsibility lies with AF2-263.
253073 09ST.MRY 69.000 253180 09N BREM 69.000 1	DAY_P1- 2_#765-A_ 242945 05SW LIM 345 944480 AF1- 113 TAP 345	-74.12	73.26	72.00	101.75	92.69	New overload created by AF2-263. Reinforcement project #r190025 proposes to reconductor New Bremen to St. Marys 69kV line with 1351 AAC to raise the final rating to 81/92. The estimated cost of this upgrade is \$17,528,000. The cost responsibility lies with AF2-263.
BRANCH	CONTINGENCY	MVAFLOW	AMPFLOW	RATE RATE1/ RATE2	% FLOW AFTER	% FLOW BEFORE	COMMENTS
253181 09NHOLLN 69.000 253201 09ROBINS 69.000 1	DAY_P1- 2_#762_ 243453 05BEATTY 345 253110 09ADKINS 345 1	204.72	213.61	165.00	129.46	129.7	PJM Network Upgrade #N5456, replaces existing 1200A wave trap with a 2000A wave trap.

Upgrade Description	Cost Allocated to AF2-263
System Upgrades identified by Dayton for the violations on the sub transmission system are shown in the table above.	\$18,186,000

8.1 Transmission Owner Analysis: Non-Converted Contingencies

CONTINGENCY	EVENTS	CONVERGED	CONVERGENCE STATE	MVAWORST	MVATOTAL
DAY_P1_34551_ATLANTA_ADKINS_345KV_SRT-A	OPEN LINE FROM BUS 253100 [09ATLNTA 345.00] TO BUS 253110 [09ADKINS 345.00] CKT 1	FALSE	Blown up	766.6536	10659.4766

DAY_P1_ATLANTA_345_ATLANTA_69_BK_N_SRT-A	OPEN LINE FROM BUS 253100 [09ATLNTA 345.00] TO BUS 253110 [09ADKINS 345.00] CKT 1	FALSE	Blown up	766.6536	10659.4766
DAY_LINE_FB_ATLANTA_FB_BB KV_SRT-A	OPEN LINE FROM BUS 253100 [09ATLNTA 345.00] TO BUS 253110 [09ADKINS 345.00] CKT 1	FALSE	Blown up	766.6536	10659.4766
DAY_P1_1339_B3	OPEN BRANCH FROM BUS 253100 [09ATLNTA 345.00] TO BUS 253099 [09ATLNTA 69.000] CKT 1	FALSE	Blown up	766.0912	10640.5898
DAY_P1_160_B3	OPEN BRANCH FROM BUS 253110 [09ADKINS 345.00] TO BUS 253100 [09ATLNTA 345.00] CKT 1	FALSE	Blown up	766.6727	10651.0586

8.1.1 Transmission Owner Analysis: Non-Converged Contingencies Comments

To solve non-convergence issues identified in this report, PJM & Dayton d/b/a AES Ohio are working with previous queue generators that are currently under study to resolve the non-convergence issues. Please be aware that as changes to the interconnection process occur, such as prior queued projects withdrawing from the queue, reducing in size, etc, and if the non-convergence issues are still present, then the upgrade responsibilities can change and it may be reassigned to your project. In addition, as PJM & Dayton further evaluate the System Reinforcements to resolve the non-convergence issues, a restudy of the analysis may be necessary during the Facilities Study Phase.

9 Interconnection Customer Requirements

9.1 Requirements from the PJM Open Access Transmission Tariff:

It is understood that the Interconnection Customer (IC) is responsible for all costs associated with this interconnection. The costs above are reimbursable to the Transmission Owner. The cost of the IC's generating plant and the costs for the line connecting the generating plant to the Point of Interconnection are not included in this report; these are assumed to be the IC's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for the Transmission Owner to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider to determine if a local service agreement is required.

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.
2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

9.2 System Protection

The IC must design its Customer Facilities in accordance with all applicable standards, including the standards in Dayton's "Requirements for the connection of Facilities to the Dayton Power & Light company Transmission System" document located at: <https://www.pjm.com/planning/design-engineering/to-tech-standards/private-dayton.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.

9.3 Compliance Issues and Interconnection Customer Requirements

The Dayton Power and Light Company (DP&L) has prepared this Facilities Connection Requirements document to ensure compliance with North American Electric Reliability Council (NERC) Reliability Standards and applicable Regional Reliability Organization, sub regional, Power Pool, and individual Transmission Owner planning criteria and facility connection requirements in compliance to NERC Standard FAC-001-2. These connection requirements apply to all generation facilities, transmission facilities, and end-users connecting to the DP&L transmission system. Detailed information outlining DP&L interconnection requirements can be reviewed utilizing the following link:

<https://www.pjm.com/~media/planning/plan-standards/private-dayton/dayton-facilities-connection-requirements.ashx>

9.4 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 Dayton 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 AF2-263 was evaluated as a 98.0 MW (Capacity 58.8 MW) injection at the Shelby 138 kV substation in the Dayton area. Project AF2-263 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AF2-263 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

To be determined

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.

None

11.6 System Reinforcements

ID	Idx	Facility	Upgrade Description	Cost	Cost Allocated to AF2-263	Upgrade Number
			TOTAL COST	\$0	\$0	

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

12 Light Load Analysis

Not applicable

13 Short Circuit Analysis

The following Breakers are overdutied:

None.

14 Stability and Reactive Power

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

To be determined in the Facilities Study Phase.

15 Affected Systems

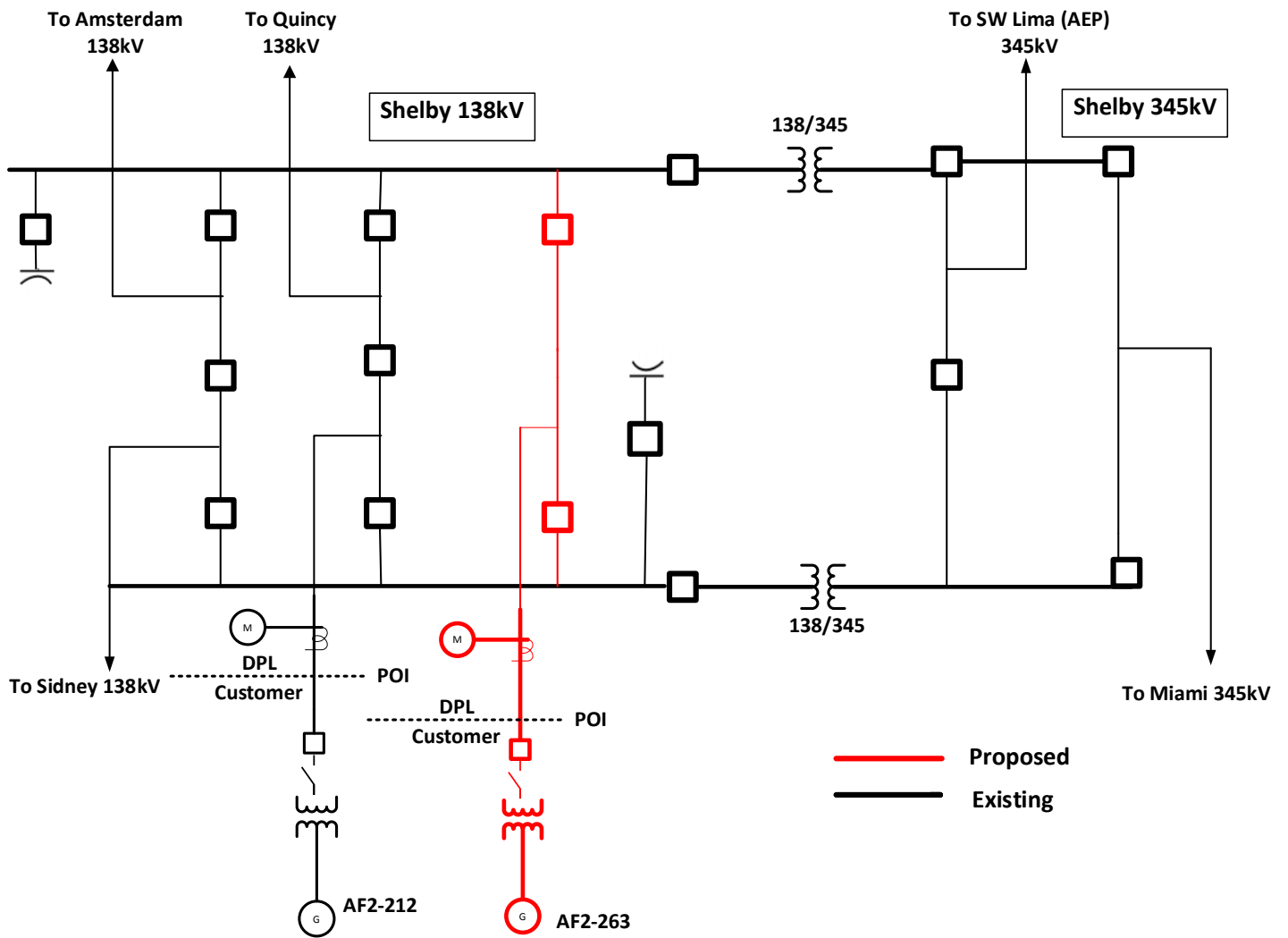
15.1 MISO

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

15.2 LG&E

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

16 Attachment 1: One Line Diagram



17 Attachment 2: Project Location

