Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AB1-124

Monocacy - Carroll 34.5 kV

(Retool)

January 2017

Preface

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

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

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

General

Legore Bridge Solar Center, LLC ("Interconnection Customer") has proposed a solar generating facility located at 12386 Clyde Young Road, Keymar, MD 21757 (lat/long: 39.572402,-77.307869) in Frederick County, MD. The installed facilities will have a total capability of 20 MW with 7.6 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 31, 2019. **This study does not imply a Potomac Edison ("Transmission Owner") commitment to this in-service date.**

Point of Interconnection

AB1-124 will interconnect with the Potomac Edison transmission system by tapping the Monocacy-Carroll 34.5 kV line. Please refer to the single line diagram in Appendix 2 for system configuration. This project POI is FERC jurisdictional.

Cost Summary and Transmission Owner Scope of Work

Transmission Owner facilities and network upgrades required to support AB1-124 project are:

(a) Attachment Facilities:

Estimated time to complete: Seven (7) Months

(a1) Carroll-Monocacy 34.5 kV Line Tap & Metering

1. Two (2) 34.5 kV, 1200A, load-break air switches on Carroll-Monocacy 34.5 kV line.
2. 34.5 kV metering equipment in AB1-124 facilities
3. Single span of 226 ACSR to the Point of Interconnection

Estimated cost: **$ 120,400 (w. Tax $ 158,500)**

(a2) Monocacy Substation

Revise relay and meter settings on the Carroll 34.5 kV Line for the AB1-124 Generation Interconnection at Monocacy Substation.

Estimated cost: **$ 5,900 (w. Tax $7,600)**

(a3) Carroll Substation

Revise relay and meter settings on the Monocacy 34.5 kV Line for the AB1-124 Generation Interconnection at Carroll Substation.

Estimated cost: **$ 5,900 (w. Tax $7,600)**

(b) Direct Connection Network Upgrades:	$ 0.0
(c) Non-Direct Connection Network Upgrades:	$ 0.0
(d) Direct Connection Local Upgrades:	$ 0.0
(e) Non-Direct Connection Local Upgrades:	$ 0.0
(f) Option to Build Upgrades:	$ 0.0

Estimated Total Costs (a) to (f): ***$ 132,200 (w. Tax $ 173,700)***

NOTE: The Federal Income Tax Gross Up charge may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129.

Interconnection Customer Requirements

In addition to the Potomac Edison facilities, Interconnection Customer will also be responsible for meeting all criteria as specified in the applicable sections of the FirstEnergy "Requirements for Transmission Connected Facilities" document including:

1. The purchase and installation of fully rated interrupting device on the high side of AB1-124 step-up transformer.
2. The purchase and installation of the minimum required FirstEnergy 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 FirstEnergy Transmission System Control Center.
4. The establishment of dedicated communication circuits for SCADA to the FirstEnergy Transmission System Control Center.
5. A compliance with the FirstEnergy and PJM generator power factor and voltage control requirements.
6. The execution of a back-up retail service agreement with the electric distribution company to serve the customer load supplied from AB1-124 generation project interconnection point when the units are out-of-service.
7. Provide a range of dynamic reactive capability that supports this project operation from 0.95 leading to 0.95 lagging power factor measured at Generator's Terminal (Power flow analysis). The addition of solar projects can cause voltage swings as their output oscillates with moving clouds without continuous regulation, and system voltages can exceed the established limits. Should the Interconnection Customer fail to provide dynamic reactive capability from this generation project for any reason once interconnected, PJM and/or FirstEnergy Dispatchers may curtail its output to prevent non-compliance with voltage criteria.
8. The specified inverter to be used for this project, Parker 890 GTB, shall meet UL 1741 standards otherwise anti-islanding direct transfer trip facilities to remote substations will be required.
9. The 34.5 kV side of the step up transformer shall be either ungrounded wye or delta in order to avoid possible miscoordination which triggers the need for a substation ring bus connection rather than a tap connection.

The above requirements are in addition to any metering or other requirements imposed by PJM.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for Interconnection Customer's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

Transmission Owner Requirements

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

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

Schedule

Based on scope of the attachment facilities and network upgrades required to support this generation project, it is expected to take a minimum of seven (7) months from the date of a fully executed Interconnection Construction Service Agreement (ICSA) to complete the installation. It also assumes that Interconnection Customer will provide all rights-of-way, permits, easements, etc. required for project installations. A further assumption is that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined Direct and Non-Direct Network upgrades, and that all system outages will be allowed when requested.

Network Impacts

The Queue Project AB1-124 was evaluated as a 20.0 MW (Capacity 7.6 MW) injection into a tap of the Carroll – Monocacy 34.5 kV line in the APS area. Project AB1-124 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB1-124 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2019

Generator Deliverability

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

None

Multiple Facility Contingency

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

None

Contribution to Previously Identified Overloads

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

None

Steady-State Voltage Requirements

None

Short Circuit

No overdutied breakers found.

The X/R ratio and the fault currents on the Carroll - Monocacy 34.5 kV line are as follows

	Three-Phase	Single-Line
X/R Ratio	2.8849	3.9482
Fault Current (Amps)	4895	2700

These values are for the current system configuration. Any system changes in the area could have a significant impact on these values. It will be the responsibility of the Interconnection Customer to make any protection upgrades required should this occur and the proposed interconnection facilities shall be designed in accordance with the FirstEnergy "Requirements for Transmission Connected Facilities."

Delivery of Energy Portion of Interconnection Request

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.
Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

None

System Reinforcements

Short Circuit

None

Stability and Reactive Power Requirement

To be determined at later study stages.

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements

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

None

Contribution to Previously Identified System Reinforcements

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

None

Light Load Load Flow Analysis Reinforcements

New System Reinforcements

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

None

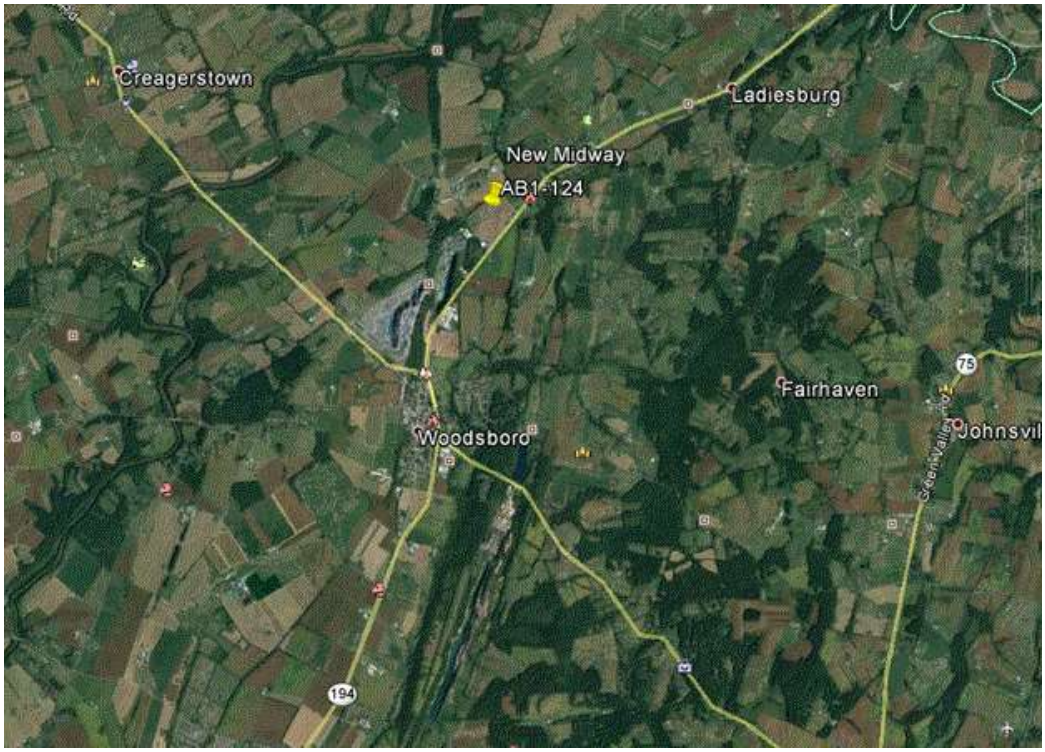
Contribution to Previously Identified System Reinforcements

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

None

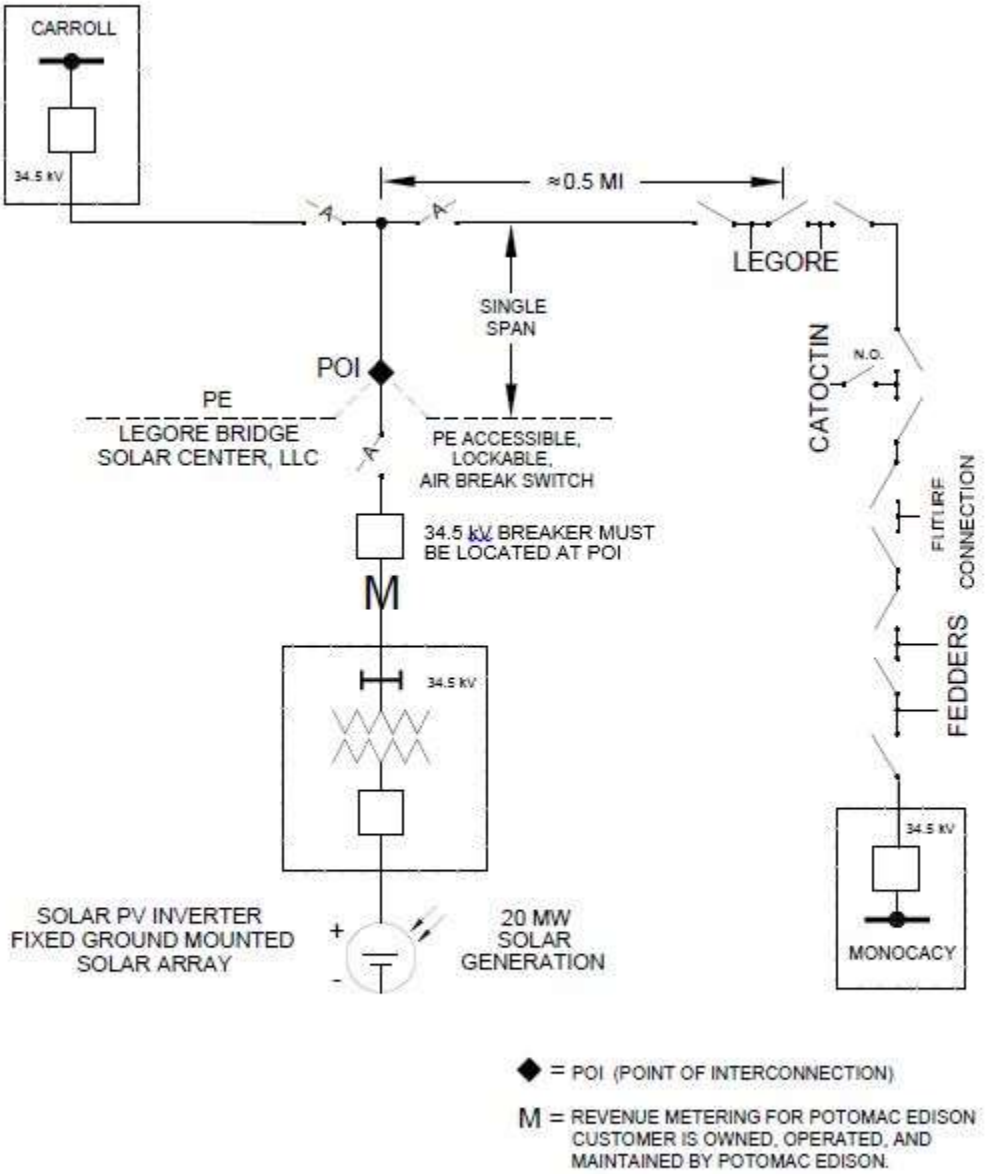
Appendix 1

Facility Location
PJM Queue Position: AB1-124



Appendix 2

Interconnection Single Line Diagram
PJM Queue Position: AB1-124



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For

PJM Generation Interconnection Request
Queue Position AB1-124

Monocacy - Carroll 34.5 kV

(Revised)

October 2016

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General

Legore Bridge Solar Center, LLC ("Interconnection Customer") has proposed a solar generating facility located at 12386 Clyde Young Road, Keymar, MD 21757 (lat/long: 39.572402,-77.307869) in Frederick County, MD. The installed facilities will have a total capability of 20 MW with 7.6 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is July 1, 2017. **This study does not imply a Potomac Edison ("Transmission Owner" or "PE") commitment to this in-service date.**

Point of Interconnection

AB1-124 will interconnect with the Potomac Edison transmission system by tapping onto the Monocacy-Carroll 34.5 kV line. This POI is FERC jurisdictional. Refer to the one line diagram in Appendix 2 for system configuration.

Cost Summary

Interconnected Transmission Owner facilities and network upgrades as well as related costs estimates required for this interconnection project are listed below.

(a.) Attachment Facilities:

Region Line estimate. Include Metering package 7900 ft of new 34.5 kV line.

- Estimated total time to complete: 12 Months
- Estimated total costs w/o. tax: **$ 544,100** (Tax included: **$ 688,900)**
- Network Upgrade Number: not required

(b.) Direct Connection Network Upgrades:

(b.1) AB1-124 Interconnection -Install a tapped substation on the Carroll-Monocacy 34.5 kV with a breaker to the Legore Bridge Solar Center.

- Estimated total time to complete: 12 Months
- Estimated total costs w/o. tax: **$ 1,381,100** (Tax included: **$ 1,750,800)**
- Network Upgrade Number: To be determined at a later study stage.

(b.2) Adjust Remote Relay and Metering Settings.

- Estimated total time to complete: 12 Months
- Estimated total costs w/o. tax: **$ 12,500** (Tax included: **$ 15,900)**
- Network Upgrade Number: To be determined at a later study stage.

(c.) Non-Direct Connection Network Upgrades: **$ 0.0**

(d.) Direct Connection Local Upgrades: **$ 0.0**

(e.) Non-Direct Connection Local Upgrades: **$ 0.0**

(f.) Contributions for Previously Identified Upgrades: **$ 0.0**

(g.) Baseline Upgrades: **$ 0.0**

(h.) Option to Build Upgrades: **$ 0.0**

Total costs (a.) to (h.) without Tax: $ 1,937,900 (Tax included: $ 2,455,600)

Interconnection Customer Requirements

In addition to the Potomac Edison facilities, Interconnection Customer will also be responsible for meeting all criteria as specified in the applicable sections of the FirstEnergy "Requirements for Transmission Connected Facilities" document including:

1. The purchase and installation of fully rated interrupting device on the high side of the AB1-124 step-up transformer.

2. The purchase and installation of the minimum required FirstEnergy 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. The establishment of dedicated communication circuits for SCADA to the FirstEnergy Transmission System Control Center.

5. A compliance with the FirstEnergy and PJM generator power factor and voltage control requirements.

6. The execution of a back-up retail service agreement with the electric distribution company to serve the customer load supplied from the AB1-124 generation project interconnection point when the units are out-of-service.

The above requirements are in addition to any metering or other requirements imposed by PJM.

Revenue Metering and SCADA Requirements

PJM Requirements

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Schedule

Based on the extent of the FirstEnergy Attachment Facilities and Network Upgrades required to support the AB1-124 generation project, it is expected to take a minimum of thirteen (13) months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This includes the requirement for Interconnection Customer to make a preliminary payment to FirstEnergy which funds the first three months of engineering design that is related to the construction of the Attachment Facilities and Direct Network Upgrades. It further assumes that Interconnection Customer will provide all rights-of-way, permits, easements, etc. that will be needed. A further assumption is that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined Direct and Non-Direct Network upgrades, and that all system outages will be allowed when requested.

Other Supporting Facilities Charge

Subject to any required regulatory approvals or acceptance, the IC shall pay to PE a monthly charge of $29,682 for the connection of the customer facility to the PJM transmission system via the distribution system. The monthly charge will be part of Attachment H of the PJM OATT for this specific interconnection. Such charge may be billed to, and collected from the IC on behalf of PE by PJM and may be adjusted from time to time in accordance with Applicable Laws and Regulations.

Network Impacts

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Generator Deliverability

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None

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Contribution to Previously Identified Overloads

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None

Steady-State Voltage Requirements

None

Short Circuit

No overdutied breakers found.

Delivery of Energy Portion of Interconnection Request

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None

System Reinforcements

Short Circuit

None

Stability and Reactive Power Requirement

To be determined at later study stages.

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements

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

None

Contribution to Previously Identified System Reinforcements

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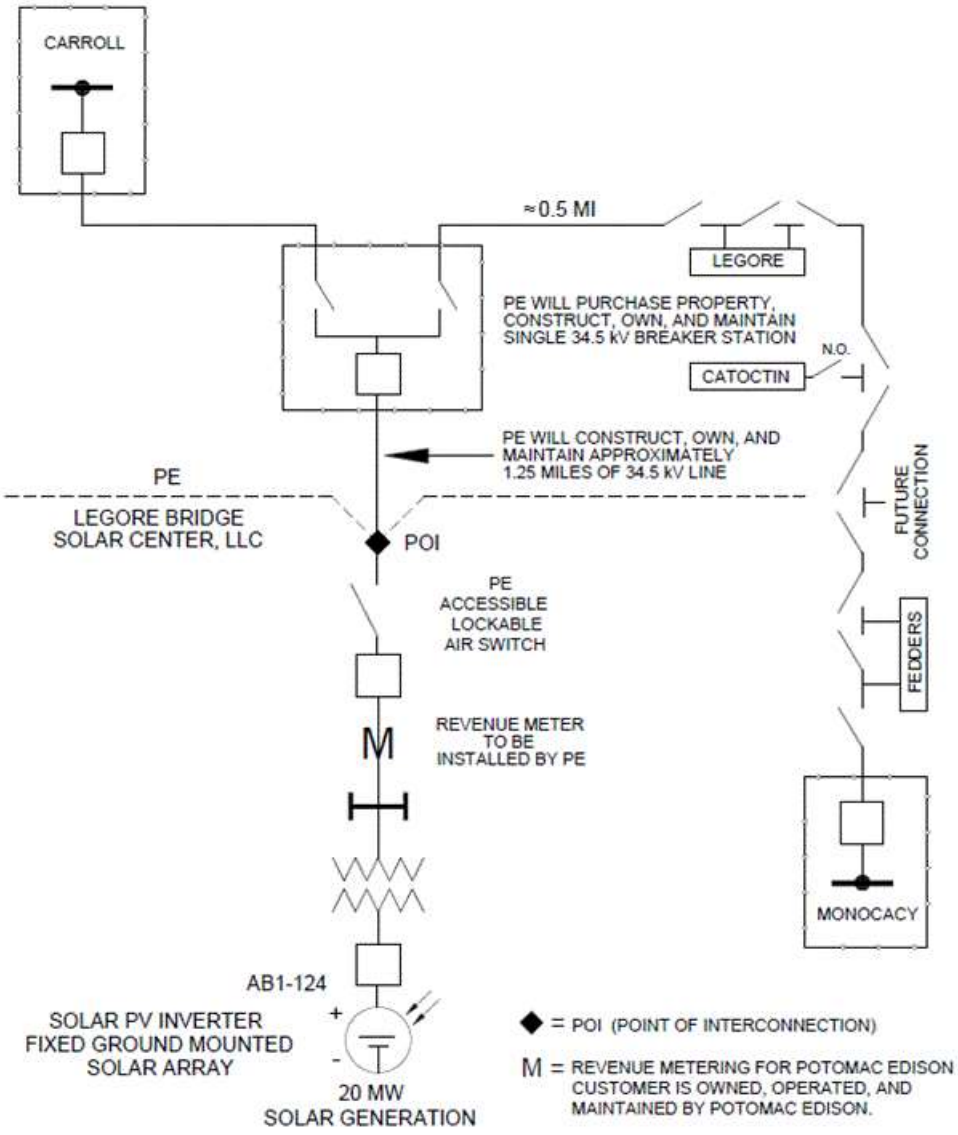
PJM Queue Position: AB1-124

Appendix 2

Interconnection One-Line Diagram
PJM Queue Position: AB1-124



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Schedule

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Other Supporting Facilities Charge

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Summer Peak Analysis - 2019

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None

Short Circuit

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None

System Reinforcements

Short Circuit

None

Stability and Reactive Power Requirement

To be determined at later study stages.

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements

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Contribution to Previously Identified System Reinforcements

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Appendix 2

Interconnection One-Line Diagram
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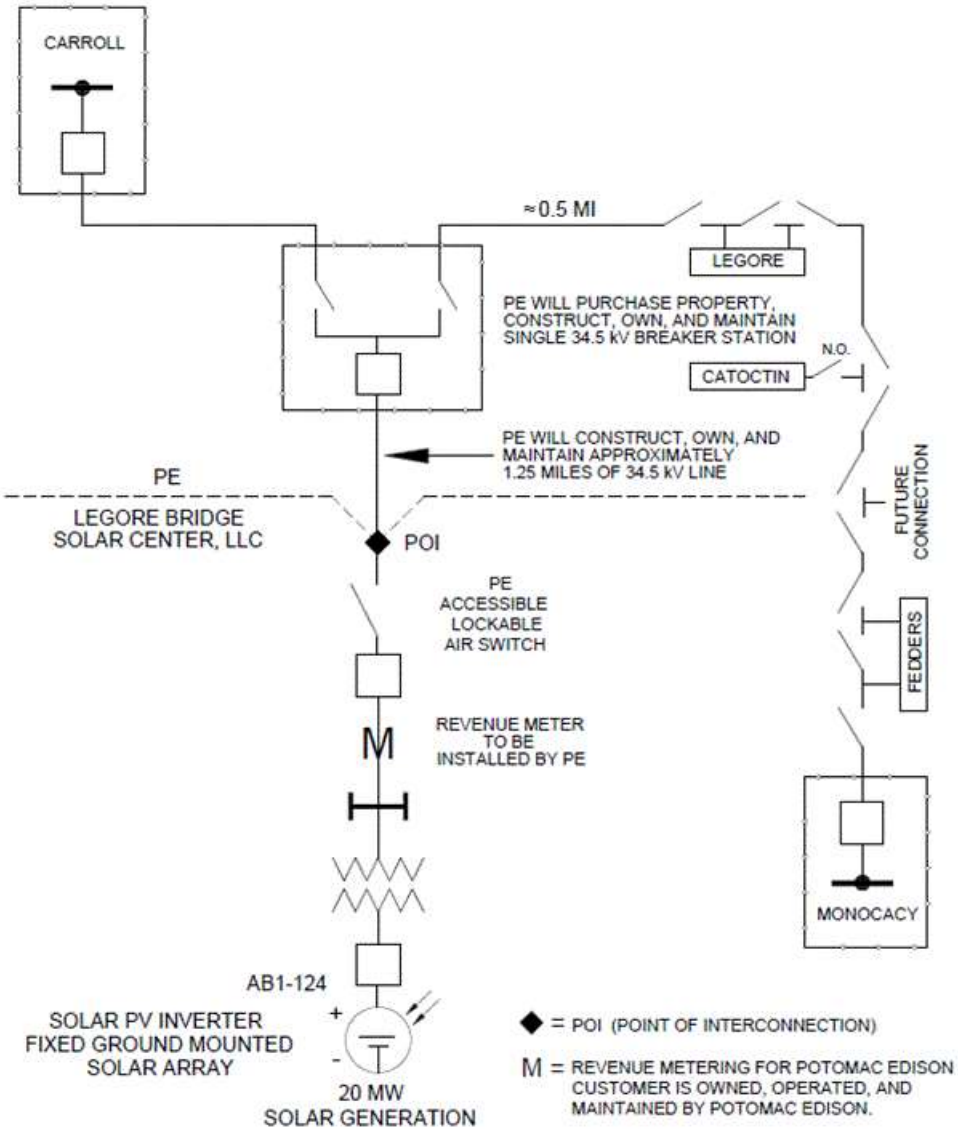


Generation Interconnection
System Impact Study Report

For

PJM Generation Interconnection Request
Queue Position AB1-124

Monocacy - Carroll 34.5 kV

September 2016

Preface

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

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

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

General

Legore Bridge Solar Center, LLC ("Interconnection Customer") has proposed a solar generating facility located at 12386 Clyde Young Road, Keymar, MD 21757 (lat/long: 39.572402,-77.307869) in Frederick County, MD. The installed facilities will have a total capability of 20 MW with 7.6 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is July 1, 2017. **This study does not imply a Potomac Edison ("Transmission Owner" or "PE") commitment to this in-service date.**

Point of Interconnection

AB1-124 will interconnect with the Potomac Edison transmission system by tapping onto the Monocacy-Carroll 34.5 kV line. This POI is FERC jurisdictional. Refer to the one line diagram in Appendix 2 for system configuration.

Cost Summary

Interconnected Transmission Owner facilities and network upgrades as well as related costs estimates required for this interconnection project are listed below.

(a.) Attachment Facilities:

Region Line estimate. Include Metering package 7900 ft of new 34.5 kV line.

- Estimated total time to complete: 12 Months
- Estimated total costs w/o. tax: **$ 544,300** (Tax included: **$ 689,153)**
- Network Upgrade Number: not required

(b.) Direct Connection Network Upgrades:

- Estimated total time to complete: 13 Months
- Estimated total costs w/o. tax: **1,393,600** (w. Tax included: **$1,766,475**), detailed as follows:

(b.1) AB1-124 Interconnection -Install a tapped substation on the Carroll-Monocacy 34.5 kV with a breaker to the Legore Bridge Solar Center.

- Estimated total costs w/o. tax: **$ 1,381,100** (Tax included: **$1,750,800**)
- Network Upgrade Number: To be determined at a later study stage.

(b.2) Adjust Remote Relay and Metering Settings.

- Estimated total costs w/o. tax: **$ 12,500** (Tax included: **$ 15,900)**
- Network Upgrade Number: To be determined at a later study stage.

(c.) Non-Direct Connection Network Upgrades: **$ 0.0**

(d.) Direct Connection Local Upgrades: **$ 0.0**

(e.) Non-Direct Connection Local Upgrades: **$ 0.0**

(f.) Contributions for Previously Identified Upgrades: **$ 0.0**

(g.) Baseline Upgrades: **$ 0.0**

(h.) Option to Build Upgrades: **$ 0.0**

Total costs (a.) to (h.) without Tax: $ 1,937,900 (Tax included: $ 2,455,600)

Interconnection Customer Requirements

In addition to the Potomac Edison facilities, Interconnection Customer will also be responsible for meeting all criteria as specified in the applicable sections of the FirstEnergy "Requirements for Transmission Connected Facilities" document including:

1. The purchase and installation of fully rated interrupting device on the high side of the AB1-124 step-up transformer.

2. The purchase and installation of the minimum required FirstEnergy 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. The establishment of dedicated communication circuits for SCADA to the FirstEnergy Transmission System Control Center.

5. A compliance with the FirstEnergy and PJM generator power factor and voltage control requirements.

6. The execution of a back-up retail service agreement with the electric distribution company to serve the customer load supplied from the AB1-124 generation project interconnection point when the units are out-of-service.

The above requirements are in addition to any metering or other requirements imposed by PJM.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for Interconnection Customer's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

Interconnected Transmission Owner Requirements

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

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

Schedule

Based on the extent of the FirstEnergy Attachment Facilities and Network Upgrades required to support the AB1-124 generation project, it is expected to take a minimum of thirteen (13) months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation. This includes the requirement for Interconnection Customer to make a preliminary payment to FirstEnergy which funds the first three months of engineering design that is related to the construction of the Attachment Facilities and Direct Network Upgrades. It further assumes that Interconnection Customer will provide all rights-of-way, permits, easements, etc. that will be needed. A further assumption is that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined Direct and Non-Direct Network upgrades, and that all system outages will be allowed when requested.

Network Impacts

The Queue Project AB1-124 was evaluated as a 20.0 MW (Capacity 7.6 MW) injection into a tap of the Carroll – Monocacy 34.5 kV line in the APS area. Project AB1-124 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB1-124 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2019

Generator Deliverability

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

None

Multiple Facility Contingency

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

None

Contribution to Previously Identified Overloads

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

None

Steady-State Voltage Requirements

None

Short Circuit

No overdutied breakers found.

Delivery of Energy Portion of Interconnection Request

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.
Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

None

System Reinforcements

Short Circuit

None

Stability and Reactive Power Requirement

To be determined at later study stages.

Summer Peak Load Flow Analysis Reinforcements

New System Reinforcements

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

None

Contribution to Previously Identified System Reinforcements

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

None

Light Load Load Flow Analysis Reinforcements

New System Reinforcements

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

None

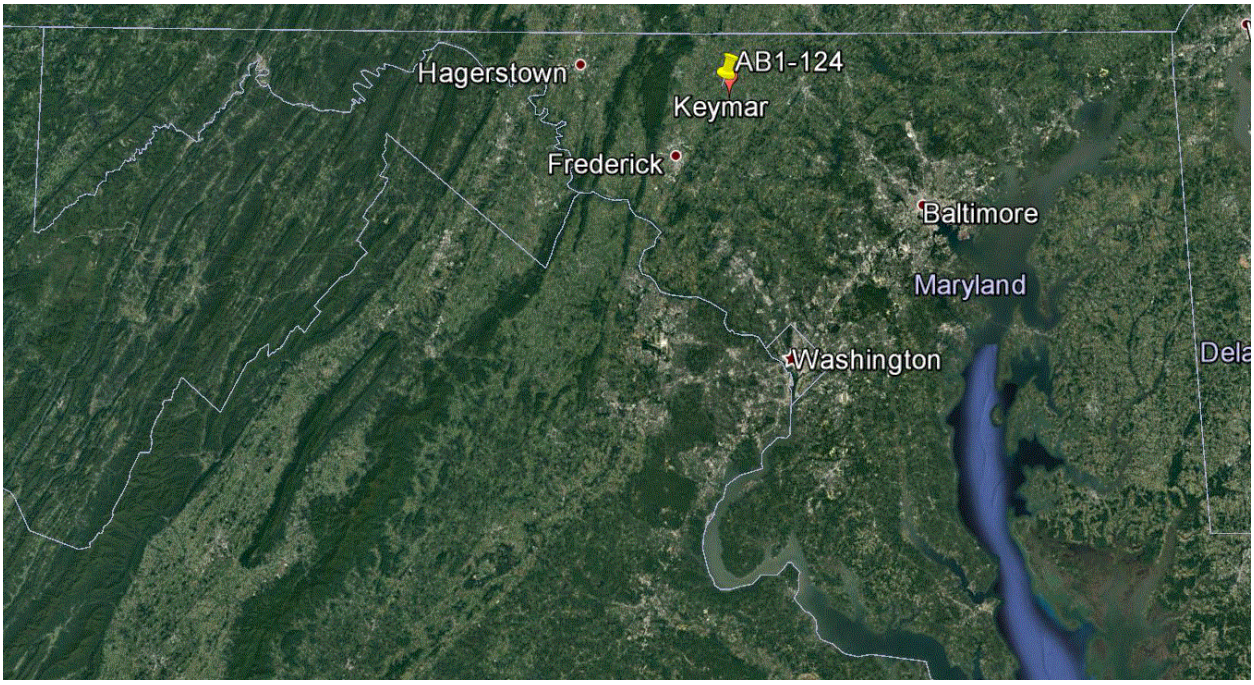
Contribution to Previously Identified System Reinforcements

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

None

Appendix 1

Facility Location
PJM Queue Position: AB1-124



Appendix 2

Interconnection One-Line Diagram
PJM Queue Position: AB1-124