PIKE COUNTY
SOLAR PROJECT

Tab 9
Effect on the Electric Transmission System in Kentucky

TAB 9 EFFECT ON THE ELECTRIC TRANSMISSION SYSTEM IN KENTUCKY

KRS 278.706(2)(i) An analysis of the proposed facility's projected effect on the electricity transmission system in Kentucky.

To interconnect new generation facilities to the electric transmission grid, a facility owner must obtain approval from PJM, which is a regional transmission organization that coordinates the movement of wholesale electricity in most of the eastern half of Kentucky and all or parts of nearby states. The interconnection process includes completion of studies by PJM that determine the transmission upgrades required for a project to reliably interconnect to the PJM grid. These studies are completed in a series. The Feasibility Study, the System Impact Study, and the Facilities Study are designed to provide developers with increasingly refined information regarding the scope of required upgrades, completion deadlines, and implementation costs.

The Facility will be capable of generating up to 100 MW of renewable energy and will interconnect with the Kentucky Power transmission system. Kentucky Power is a wholly owned subsidiary of AEP, which provides electricity to 20 counties in eastern Kentucky, as well as 10 other states in the eastern and southern U.S.

The Project initiated a queue position with PJM on January 21, 2020, and was assigned the queue number AC1-101/AC1-102. To date, PJM has completed both the Facility Study and the System Impact Study for the Facility interconnection. The PJM Facility Study and System Impact Study are included with this Tab as Attachment F.

Attachments:

- Attachment F: PJM Facility Study and System Impact Study (22 pages)

PIKE COUNTY
SOLAR PROJECT

Attachment F
PJM Facility Study and System Impact Studies

Generation Interconnection

Facilities Study Report

for

Queue Project AC1-101/AC1-102

Johns Creek – Excel 138 kV

Pike County, Kentucky

March 2022

1 Facilities Study Summary

1.1 Project Description

Pike County Solar Project, LLC, proposes to install PJM Project AC1-101/AC1-102. Together, the two queue positions comprise a 100.0 MW (38.0 MW Capacity) solar generating facility in Pike County, Kentucky (see Figure 2). The Point of Interconnection (POI) for the generating facility will be via a new Rich Gap 138 kV station to be cut into AEP's Johns Creek – Excel 138 kV section of the Inez – Johns Creek 138 kV circuit, approximately 5.2 miles north of Johns Creek (see Figure 1).

1.2 Amendments/Changes to the Impact Study Report

The Interconnection Customer approached AEP and PJM to request consideration of moving the project from the original location between Excel and Johns Creek to a direct connection at Inez. The question was triggered by geo-tech conditions in the original location – a relatively recently reclaimed surface mine. AEP determined that while site preparation and foundation costs might be a bit higher than usual, the site conditions don't preclude construction of the new Rich Gap station on the proposed site. PJM subsequently determined that moving the POI would require submittal of a new interconnection request in the currently open queue. In addition, the distances between Rich Gap, Excel and Johns Creek have changed slightly, resulting from concerns about the constructability and maintainability of tap structures at the point of closest approach between the Rich Gap station site and the existing Excel-Johns Creek Right of Way. To address these concerns, the existing line is proposed to be cut several spans further north, near structure 55. See Figure 3.

1.3 Interconnection Customer Schedule

PJM and AEP understand that the Interconnection Customer originally had established the following schedule dates:

Receive back feed power from AEP: March 1, 2019.

Generation Commercial Operation Date: June 1, 2019.

Acknowledgment of the Interconnection Customer's requested back feed and commercial operation dates does not imply AEP's commitment to or guarantee of these dates.

1.4 AEP's Scope of Work to Facilitate Interconnection

- The Inez – Johns 138 kV circuit will be tapped by constructing a new three (3) circuit breaker 138 kV station, Rich Gap, physically configured and operated as a ring bus (Figure 1) approximately 5.2 miles north of Johns Creek (see Figure 1).
- Due to constraints of the local terrain, the Rich Gap station can't be located next to the existing Inez-Johns Creek 138 kV circuit. A double-circuit 138 kV line extension of approximately 0.9 miles will be constructed to reach the Rich Gap station site.
- Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required at Rich Gap 138 kV. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.
- AEP will extend one span of 138 kV transmission line for the generation-lead going to the adjacent AC1-101/AC1-102 collector station. AEP will build and own this span. AC1-101/102 will build and own the structure in the project collector station, to which AEP's conductor will attach.
- It is understood that the Interconnection Customer is responsible for all of the connection costs associated with interconnecting the PJM project AC1-101/AC1-102 to the AEP transmission system. The cost of the customer's generating facility and the costs for the line connecting the generating facility to AEP's transmission system are not included in this report; these are assumed to be the Customer's responsibility.
- (Dual independent) fiber connection(s) are required. AEP will extend the fiber-optic cable(s) from the POI into the Rich Gap control house. The Interconnection Customer will be responsible for the fiber-optic work from their telecom equipment to the POI.

1.5 Description of Transmission Owner Facilities Included in the Facilities Study

1.5.1 Direct Connection Work

- The Inez – Johns 138 kV circuit will be tapped by constructing a new three (3) circuit breaker 138 kV station, Rich Gap, physically configured and operated as a ring bus (Figure 1) approximately 5.2 miles north of Johns Creek (see Figure 1).
- AEP will install associated line protection and control equipment, 138 kV line risers, switches, jumpers, and SCADA, at the proposed Rich Gap 138 kV station. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.
- A double-circuit 138 kV line extension of approximately 0.9 miles will be constructed between the existing Inez-Johns Creek 138 kV circuit and the Rich Gap station site.

1.5.2 Non-Direct Connection Work

- AEP will perform final connection of the Excel - Johns Creek section of the Inez – Johns Creek 138 kV circuit to the new line extension and Rich Gap station.
- AEP will perform P&C checkout including end-to-end testing.

1.5.3 Attachment Facilities Work

- AEP will install 138 kV revenue metering at Rich Gap 138 kV substation.
- AEP will extend one span of 138 kV conductor for the generation-lead going from the Rich Gap station to the adjacent AC1-101/AC1-102 collector station. AEP will build and own this span, AC1-101/102 will build and own the structure in the project collector station, to which AEP's conductor will attach.
- (Dual independent) fiber connection(s) are required. AEP will extend the fiber-optic cable(s) from the POI into the Rich Gap control house. The customer will be responsible for the fiber work on the IPP side of the POI.

1.5.4 Network Upgrade Work

Due to system overloads found during the PJM studies, the following network reinforcements are driven by this project:

- None

1.6 Total Cost of Transmission Owner Facilities Included in the Facilities Study:

Attachment Facilities	$488,862
Direct Connection Facilities	$10,840,138
Non-Direct Connection Facilities	$1,031,000
Network Upgrade Facilities	$0
Total Cost	$12,360,000

The estimates do not include the impact that delays in obtaining ROW, permits, or other approvals may have.

1.7 Summary of Schedule Milestones for Completion of Transmission Owner Work Included in Facilities Study:

Standard Process: Typical Schedule for this type of Scope (Actual schedule to be determined at Kick Off)

Task	Dates(See Notes)
Engineering Start	Day 1*
Material Ordered	Day 172
Construction Start (Grading & Below Grade)	Day 430
Construction Start (Above Grade)	Day 530
Outage Requests Made By	Day 230
Outage (Structure Foundations)**	Starts Day 530
Outage (Cut-in & Testing)**	Starts Day 680
Ready For Back Feed (TO In-Service Date)	Day 730

***Day 1 occurs on the first working day after the ISA/ICSA have been fully executed or a mutually agreed upon start date that is later and meets the requested back feed date. Day 1 will generally not be before the PJM project kick off meeting.**

****Scheduled Outages are contingent upon outage availability. Longer duration outages are not available during peak load periods.**

Notes Regarding the Schedule

- **Slippage by the customer / developer in executing the ISA and ICSA agreement does not equate to a 'day for day' slippage in the scheduled back feed and in service dates. Depending on the time of year, planned outages, neighboring projects and maintenance of the grid, outage availability has the potential to shift by weeks or months depending on conditions at the time of the fully executed agreement.**
- **System conditions must allow scheduled outages to occur.**
- **All transmission outages are subject to PJM and AEP Operations outage scheduling requirements.**
- **Significant scope of work changes will impact the schedule.**

Scope Assumptions

- **The customer will obtain, at its' cost, all necessary permits and provisions for the AEP direct connection facilities.**
- **The final design of the line extension from the existing 138 kV ROW to the new station site will result in line length less than 1 mile.**
- **AEP direct connection facilities included in Customer SUP if required.**
- **The customer will perform station site development, structure pads and road construction, in accordance with AEP specifications.**
- **The customer will provide a site acceptable to AEP (for transfer to AEP in Fee Simple) and any additional easements for the Rich Gap 138 kV station and line work to include access to all facilities and structures.**
- **The customer will have their construction and required checkout completed prior to the start of the cut-in and testing outage.**
- **Estimates provided are based on a table top process without the benefit of the results of site specific engineering studies (e.g., soil borings, environmental survey, ground grid, etc.)**
- **Soil is considered "normal" without rock formations or "poor" soil conditions or environmental concerns, beyond the test results already provided by the customer during the study. Differing soil conditions at the location of specific foundations may affect final costs.**
- **The POI station and Collector station are located in close enough proximity, and have a relative orientation, to allow the generator lead between them to consist of a single span of conductors between the respective station structures.**

2 Transmission Owner Facilities Study Results

2.1 Transmission Lines – New

- AEP will extend one span of 138 kV conductor for the generation lead going to the adjacent AC1-101/AC1-102 collector station from the Rich Gap 138 kV station. AEP will build and own this span. AC1-101/102 will build and own the structure in the project collector station, to which AEP's conductor will attach.
- A double-circuit 138 kV line extension consisting of approximately 0.9 miles will provide a loop feed to the Rich Gap station from the (Inez-John's Creek) 138 kV circuit.

- Johns Creek – Excel 138 kV – Perform final connection of the Inez-Johns Creek 138 kV circuit to the new line extension and Rich Gap 138 kV interconnection substation. PJM Network Upgrade Number n5595.

2.2 Transmission Lines – Upgrades

- No transmission line upgrades will be required for this project.

2.3 Station Facilities – New

- A new 138 kV station, Rich Gap Station, will be established consisting of a 3-breaker ring bus loop fed from AEP's Excel - Johns Creek section of the Inez – Johns Creek 138 kV circuit.
- Installation of a Drop In Control Module (DICM) and other associated line protection and control equipment, 138 kV line risers, switches, jumpers, and SCADA, will also be required.

2.4 Station Facilities – Upgrades

- None

2.5 Metering & Communications

Standard 138 kV metering will be installed at the Rich Gap 138 kV station. A standard station communication scheme will be used. All metering equipment shall meet the requirements as specified by AEP in the "AEP Metering and Telemetering Requirements for AEP Transmission Customers" document (SS-490011). Communication requirements are published in the "AEP SCADA RTU Requirements at Transmission Interconnection Facilities" (SS-500000).

Two (2) diverse fiber-optic paths to the AC1-101/102 collector station are required. AEP will extend two (2) fiber-optic cables from the proposed Rich Gap 138 kV Station control house to the POI. The Interconnection Customer will be responsible for the fiber work on the IPP side of the POI.

The Generation Interconnection Agreement does not in or by itself establish a requirement for American Electric Power 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 in installed. The metering work above and cost indicated below does not include any potential work or cost to address metering requirements of the local service provider. It is the responsibility of the developer to contact the local service provider to obtain a local service agreement. This is required prior to energization.

2.6 Environmental, Real Estate, and Permitting issues

The Interconnection customer is expected to obtain, at its' cost, all necessary permits and provisions for the IPP station connecting to the Rich Gap 138 kV station.

2.7 System Modeling & Operating Requirements

In addition to the IPP modeling requirements imposed by PJM as part of the Generation Interconnection process, the following system modeling parameters will need to be supplied by the Interconnection Customer to AEP:

- Modeling parameters are required as outlined in the 'Connection Requirements for the AEP Transmission System.' These requirements can be accessed at: https://aep.com/requiredpostings/AEPTransmissionStudies

2.8 Summary of Results of Study

Cost Estimates for AEP

Task	Network Upgrade Number	Engineering	Material	Construction	Other	TOTAL
New 138kV Switching Station & Line Extension	n5599	$235,936	$2,806,698	$6,401,294	$1,412,577	**$10,856,505**
Inez - Johns Creek 138kV T-Line Cut-In & checkout	n5595	$95,000	$106,000	$595,000	$235,000	$1,031,000
138kV Revenue Metering Cost	n5596	$22,000	$122,000	$143,000	$60,000	**$347,000**
Gen Lead	n5596	$23,064	$16,302	$58,706	$27,423	$125,495
TOTAL		**$376,000**	**$3,051,000**	**$7,198,000**	**$1,735,000**	**$12,360,000**

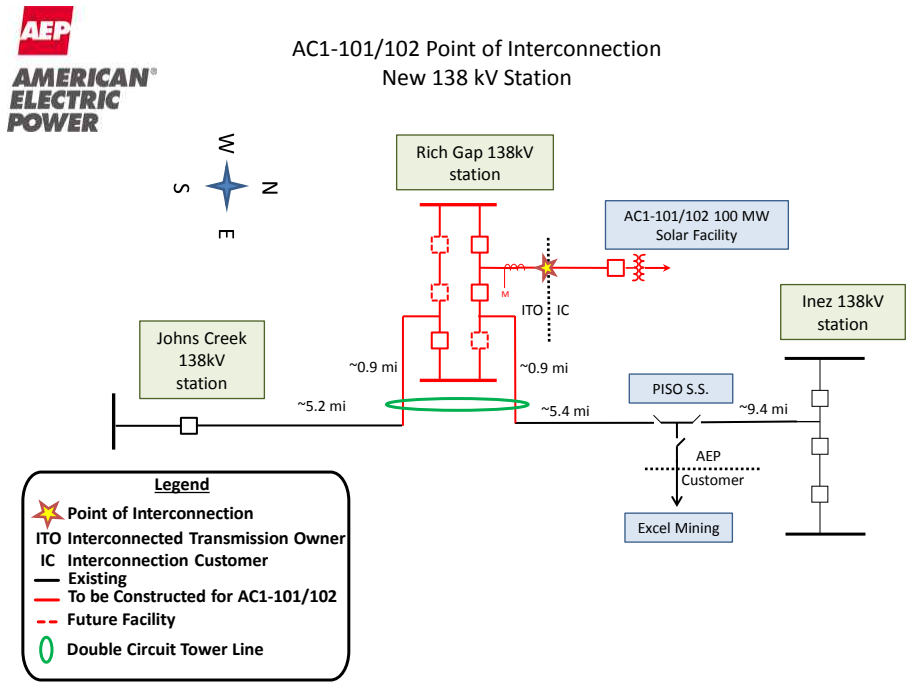
2.9 Information Required for Interconnection Service Agreement

Description	Direct-Connect Facilities	Non-Direct Connect Facilities	Attachment Facilities	TOTAL
Direct Material	$2,806,698.00	$106,000.00	$138,302.00	$3,051,000.00
Direct Labor	$6,637,230.00	$750,000.00	$246,770.00	$7,634,000.00
Indirect Material	$561,441.66	$44,000.00	$21,558.34	$627,000.00
Indirect Labor	$834,768.34	$131,000.00	$82,231.66	$1,048,000.00
TOTAL	$10,840,138.00	$1,031,000.00	$488,862.00	$12,360,000.00

Figure 1: AC1-101/102 Johns Creek – Excel 138 kV

(proposed Rich Gap 138 kV station)

Point of Interconnection One-Line Diagram



The Point of Interconnection is the first structure outside of the new 138 kV station (such structure being located in Interconnection Customer's Collector Substation) with the Interconnected Transmission Owner owning the first span of conductors, and the Interconnection Customer owning the first structure.

Figure 2: Point of Interconnection Map

[Proposed Rich Gap station at approximately 37.597041, -82.397532]

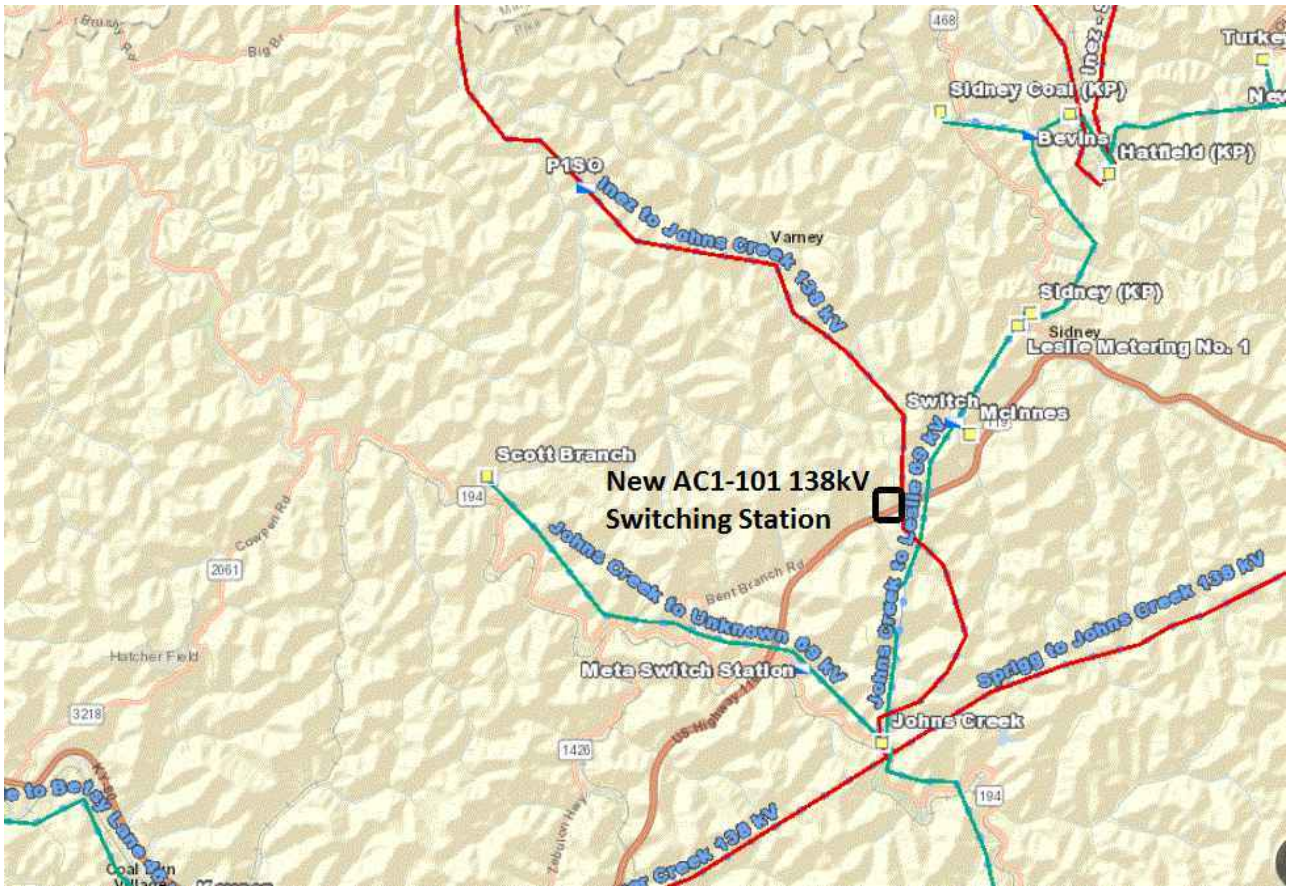
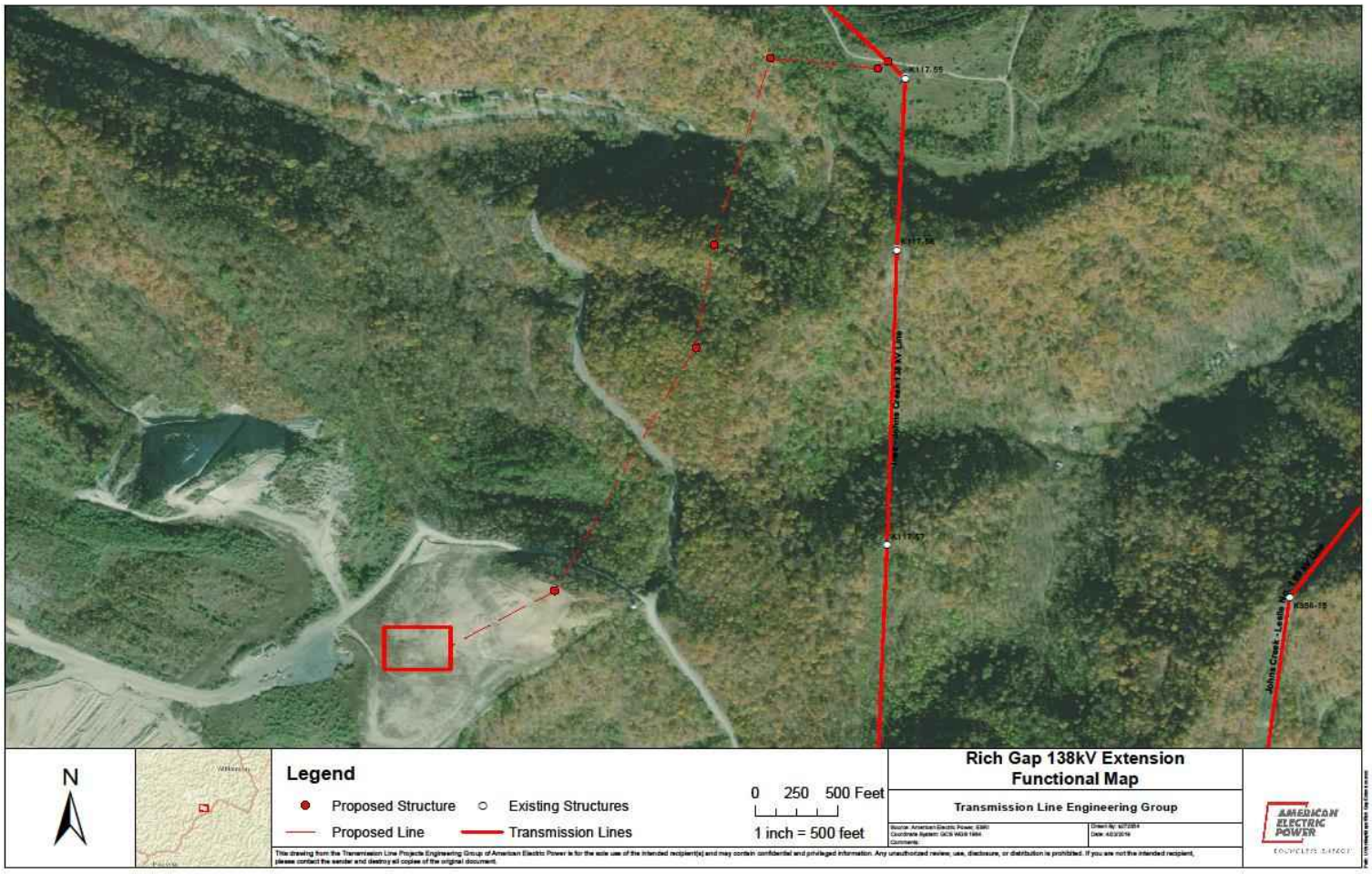


Figure 3: Proposed Line Extension



Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position AC1-101/AC1-102

Johns Creek-Excel 138 kV

April 2018

Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (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. 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 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 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

EDF Renewable Development, Inc. (EDF Renewable) proposes to install PJM Project #AC1-101/AC1-102, a 100.0 MW (38.0 MW Capacity) solar generating facility in Pike County, Kentucky (see Figure 2). The point of interconnection is to AEP's Johns Creek – Excel 138 kV section of the Inez – Johns Creek 138 kV circuit approximately 4.5 miles north of Johns Creek (see Figure 1).

The requested Backfeed date is March 1, 2019.

The requested in service date is June 1, 2019.

Attachment Facilities

Point of Interconnection (Johns Creek – Excel 138 kV)

To accommodate the interconnection on the Johns Creek – Excel 138 kV section of the Inez – Johns Creek 138 kV circuit 4.5 miles north of Johns Creek substation, a new three (3) circuit breaker 138 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus will be constructed (see Figure 1). Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.

<u>New Switching Station Work:</u>

- Construct a new three (3) circuit breaker 138 kV switching station physically configured in a breaker and half bus arrangement but operated as a ring-bus. Installation of associated protection and control equipment, 138 kV line risers, SCADA, and 138 kV revenue metering will also be required (see Figure 1).
    - **Estimated Station Cost: $5,000,000**

Direct Connection Cost Estimate

The total preliminary cost estimate for Direct Connection work is given in the following tables below.

For AEP building Direct Connection cost estimates: None

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for Non-Direct Connection work is given in the following tables below:

For AEP building Direct Connection cost estimates:

Description	Estimated Cost
Johns Creek-Excel 138 kV T-Line Cut In	**$1,000,000**
138 kV Revenue Metering	**$300,000**
Upgrade line protection and controls at the Johns Creek 138 kV substation to coordinate with the new 138 kV switching station.	**$250,000**
Upgrade line protection and controls at the Inez 138 kV substation to coordinate with the new 138 kV switching station.	**$250,000**
Total	**$1,800,000**

Table 1

Interconnection Customer Requirements

It is understood that EDF Renewable is responsible for all costs associated with this interconnection. The costs above are reimbursable to AEP. The cost of EDF Renewable's generating plant and the costs for the line connecting the generating plant to EDF Renewable's switching station are not included in this report; these are assumed to be EDF Renewable's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for American Electric Power 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.

Requirement from the PJM Open Access Transmission Tariff:

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.

Revenue Metering and SCADA Requirements

PJM Requirements

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

AEP Requirements

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx

Network Impacts

The Queue Projects AC1-101/AC1-102 was evaluated as a 100.0 MW (Capacity 38.0 MW) injection into a tap of the Johns Creek – Excel 138 kV line in the AEP area. Project AC1-101/AC1-102 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AC1-101/AC1-102 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Base Case Used

Summer Peak Analysis – 2020 Case

Contingency Descriptions

The following contingencies resulted in overloads:

None

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

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Stability Analysis

No problems identified

Affected System Analysis & Mitigation

LGEE Impacts:

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

MISO Impacts:

None

Duke, Progress & TVA Impacts:

None

OVEC Impacts:

None

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.

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

Additional Limitations of Concern

None

New System Reinforcements

None

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would be between 24 to 36 months after signing an interconnection agreement.

Note: The time provided between anticipated normal completion of System Impact, Facilities Studies, subsequent execution of ISA and ICSA documents, and the proposed Backfeed Date is shorter than usual and may be difficult to achieve.

Conclusion

Based upon the results of this System Impact Study, the construction of the 50.0 MW (19.0 MW Capacity) solar generating facility of EDF Renewable (PJM Project #AC1-101/AC1-102) will require the following additional interconnection charges. This plan of service will interconnect the proposed solar generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the EDF Renewable generating facility.

Cost Breakdown for Point of Interconnection (Ravenswood-Hemlock 69 kV)			
Network Upgrade Type	**Network Upgrade Number**	**Description**	**Estimated Cost**
Attachment Facilities	**n5594**	New 138 kV Switching Station	**$5,000,000**
Non-Direct Connection	**n5595**	Johns Creek-Excel 138 kV T-Line Cut In	**$1,000,000**
	n5596	138 kV Revenue Metering	**$300,000**
	n5597	Upgrade line protection and controls at the Johns Creek 138 kV substation to coordinate with the new 138 kV switching station.	**$250,000**
	n5598	Upgrade line protection and controls at the Inez 138 kV substation to coordinate with the new 138 kV switching station.	**$250,000**
		Total Estimated Cost for Project AC1-101 and AC1-102	**$6,800,000**

Table 2

The estimates 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.

Figure 1: Point of Interconnection (Johns Creek - Excel 138 kV)

Single-Line Diagram

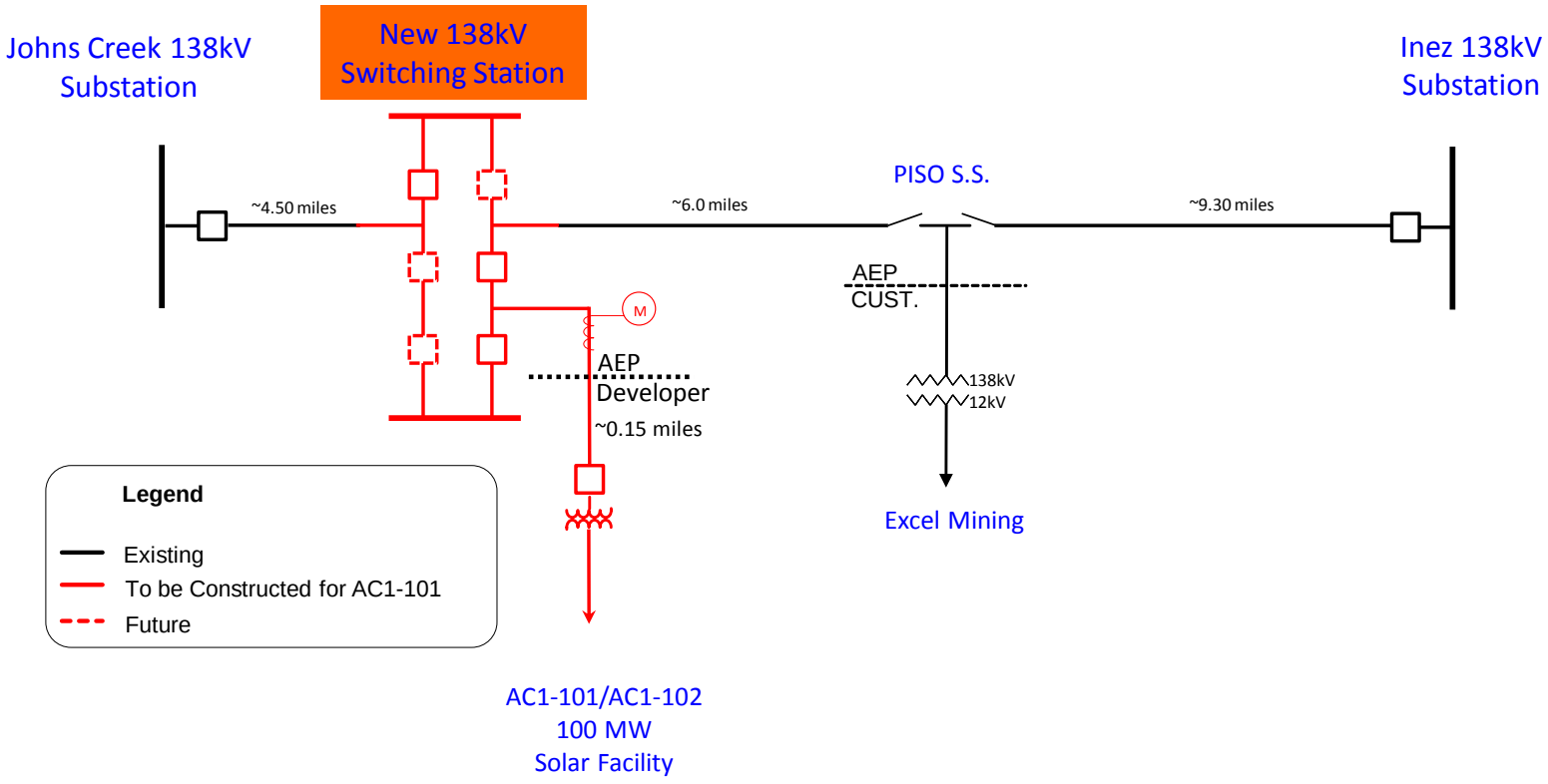


Figure 2: Point of Interconnection (Johns Creek – Excel 138 kV)