

***PJM Generator Interconnection Request
Queue #Z2-115
Deer Creek East 12 kV
Feasibility Study Report***

August 2014

Preface

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

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

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

Transmission Portion of the Z2-115 Feasibility Study Report

General

The Interconnection Customer (IC) proposes to interconnect a 2.5 MW Solar Generation Plant to the Deer Creek 12.47 kV substation or the Deer Creek East 12.47 kV circuit fed from this station. For purposes of the Transmission portion of the Z2-115 Feasibility Study documented in this report, the estimated costs and impacts of the primary and alternate Points of Interconnection are assumed to be identical. Therefore for illustration purposes the simpler station configuration is shown (Figure 1).

PJM applies a default 38% capacity factor to Photovoltaic (PV) solar facilities. However, the Interconnection Customer has requested a 50% Capacity Factor for this project. Therefore, the PJM #Z1-115 project was studied as a 2.50 MW (1.25 MW Capacity) injection at the Deer Creek 12.47 kV substation.

The requested in service date is October 1, 2016.

The objective of this Feasibility study is to determine budgetary cost estimates and approximate construction timelines for identified transmission facilities required to connect the proposed generating facilities to the AEP Transmission System. These reinforcements include the Attachment Facilities, Local Upgrades, and Network Upgrades required to maintain the reliability of the AEP Transmission System. Stability analysis is not included as part of this study.

Attachment Facilities

Attachment facilities are described in the AEP Distribution portion of this report.

Local and Network Impacts

The impact of the proposed generating facility on the AEP Transmission System was assessed for adherence with applicable reliability criteria. AEP planning criteria require that the transmission system meet performance parameters prescribed in the AEP FERC Form 715¹ and Connection Requirements for AEP Transmission System². Therefore, these criterion were used to assess the impact of the proposed facility on the AEP System. PJM project # Z2-115 was studied as a 2.50 MW (1.25 MW capacity) increase at the Deer Creek 12.47 kV substation consistent with the interconnection application. Project #Z1-115 was evaluated for compliance with reliability criteria for summer peak conditions in 2018.

1

http://www.aep.com/about/codeofconduct/OASIS/TransmissionStudies/GuideLines/2014%20AEP%20PJM%20FERC%20715_Final_Part%204.pdf

2

http://www.aep.com/about/codeofconduct/OASIS/TransmissionStudies/Requirements/AEP_Interconnection_Requirements_Rev1.pdf

Potential network impacts were as follows:

Normal System (2018 Summer Conditions Capacity Output)

- No problems identified

Single Contingency (2018 Summer Conditions Capacity Output)

- No problems identified

Multiple Contingency (2018 Summer Conditions Capacity Output)

- No problems identified

Contribution to Previously Identified Overloads (2018 Summer Conditions Capacity Output)

- No problems identified

Normal System (2018 Summer Conditions Full Output)

- No problems identified

Single Contingency (2018 Summer Conditions Full Output)

- No problems identified

Multiple Contingency (2018 Summer Conditions Full Output)

- No problems identified

Contribution to Previously Identified Overloads (2018 Summer Conditions Full Output)

- No problems identified

Short Circuit Analysis

- No Problem identified.

Stability Analysis

- Stability study to be performed during the System Impact Study stage.

Voltage Variations

- No problems identified.

Additional Limitations of Concern

- Other concerns, if any, shall be addressed by AEP Distribution.

Local/Network Upgrades

- No problems identified.

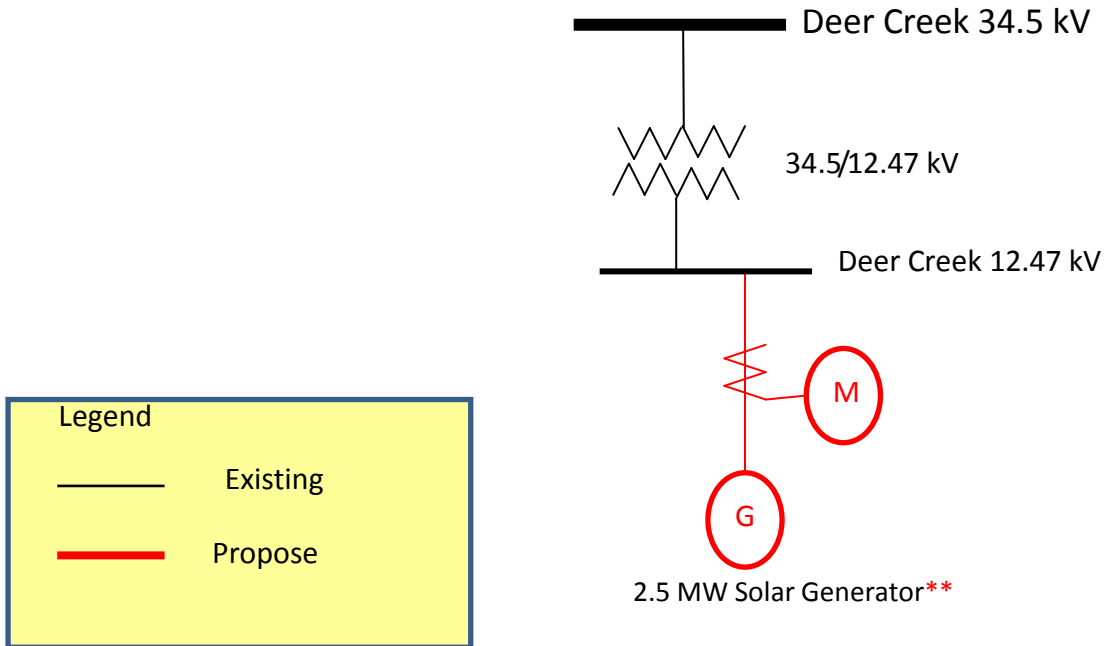
Conclusion

Based upon the results of this Feasibility Study, the injection of 2.50 MW (1.25 MW Capacity) at Deer Creek 12.47 kV substation (PJM Project #Z2-115) will not require additional Transmission System Network upgrades.

Requirements and estimates for the project's attachment facilities will be provided by AEP Distribution in the AEP Distribution portion of this report.

Figure 1

Z2-115 Point of Interconnection
Deer Creek 34.5/12.47 kV Substation*



* Deer Creek 34.5/12.47 kV Substation is partially shown

** 1.25 MW Capacity

Disclaimer

The contents of this feasibility study apply only to the facility described in the feasibility study agreement. All modeling is based on the DG location at Latitude: 40.15491 Longitude: -85.641887.

Modeling and Assumptions

The Deer Creek Solar project will interconnect with AEP distribution system via the 12.47 kV LL, 7.2 kV LG East circuit (0519-22) originating from Deer Creek station. Circuit 0519-22 is a radial configuration, three-phase multi-grounded four wire system. The customer service Point of Common Coupling (PCC) is assumed to be near location GR0050D40035. (Note: In the original documentation, the point of interconnection was not specifically identified.)

The specs for the Solar Panels (SunEdson F330 Solar Module) and DC/AC Inverters (Sunny Central 500CP-US) were obtained from the applicant's one line diagram, e-mail, and manufacturer's documentation and web sites. The information submitted on the one line is preliminary. Detailed specifications will need to be provided if this project moves forward to an impact study.

The step up transformer configuration needs to be discussed. During site visits, we discussed whether DELTA – WYE, or WYE – WYE would be the best alternative, and indicated WYE – WYE. After further investigation, we are continuing to evaluate this decision, as the configuration needs to supply a Zero Sequence path for fault current, and the proposed configuration, WYE – Grounded WYE, does not provide that required path.

It is expected the applicant understand and comply with IEEE 1547 concerning the DG installation and its requirements for interconnection with the utility grid.

CymDist Version 5.02 revision 10 was utilized to model the Generator's effect on the Distribution System. A high level analysis was performed to determine if there are any apparent steady state loading issues or excess fault current issues.

AEP Fault Values and Thevenin Impedances

The following are AEP symmetrical fault values and AEP Thevenin impedances calculated at the Generator's assumed PCC (without the generator connected). The nominal voltage can vary +/- 5%.

Deer Creek - East Circuit

- LLL = 6209 A LG = 6055A
- Z1 = Z2 = 0.1121 + j 1.2122 ohms @ 12.47 kV
- Z0 = 0.1579+ j 1.3013 ohms @ 12.47/7.2 kV

Distribution Study Conclusion

The high level study did not reveal any steady state loading issues and did not reveal any issues due to the additional fault current contribution of the generators. During light load conditions, defined at 30% of peak load, there is a condition where the DG will be back feeding through the station bus regulators and Transformer #4, on to the 138kV. (The condition in question is the Deer Creek - West 12 kV circuit breaker being open for any reason.) The regulator controls must be able to be set-up for bi-directional operation, and if necessary, replaced. This does not mean that additional issues will not be discovered during a more complete impact study. AEP Protection and Control (P&C) Engineers will provide a more detailed evaluation of the P&C requirements during the System Impact Study phase of this project.

During the site visit, there were two additional points discussed:

1. Possible relocation of the Deer Creek Service Center pole/lay down yard and
2. Possible relocation of the Distribution feeder.

Neither of these points has been explored further. If still desired, local I&M Management agreement must be received and cost estimates can be provided.

Conceptual Costs for Interconnection

The presumption based upon the documents submitted is that the developer will be extending a line to AEP's circuit and we will only need to provide a metering structure and the related facilities to permit interconnection.

12 kV metering at interconnection point	\$50,000
SCADA communication and real time monitoring	\$25,000
Regulator controls replacement (if necessary)	\$15,000

Total estimated cost, **\$75,000 or \$90,000**, is based on our high level analysis. When detailed engineering is performed the costs could be determined to be higher or lower. Also, an impact study may reveal additional work that might need to be done to AEP facilities in order to permit interconnection.

As noted previously, this high level estimate does not include the cost for relocation of the 12 kV circuit or the cost to move the pole/laydown yard at the Deer Creek Service Center.

Timetable for Construction

Total time to complete this project is six (6) months from the time that all required, signed agreements are received. This time estimate is based upon the known work that is required as a result of this study, metering and monitoring equipment and regulator controls. Additional work that might be indicated by an impact study would likely alter the required time.