Generation Interconnection Feasibility Study Report

For

PJM Generation Interconnection Request Queue Position Z2-107

East Carbondale-Lackawanna 69kV

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, the costs may be included in the study.

General

The Interconnection Customer (IC), has proposed to add batteries to an existing wind generating facility in Wayne County, Pennsylvania. This projects requests an increase to the install capability of 20 MW with 0 MW of this output being recognized by PJM as capacity. The installed facilities will have a total capability of 84.5 MW with 10.1 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 2015. **This study does not imply a PPL Electric Utilities (PPL EU) commitment to this in-service date.**

Point of Interconnection

Z2-107 will interconnect with the PPLEU transmission system along the East Carbondale-Lackawanna 69kV line. The Z2-107 project will utilize existing connection to PPL EU's 69 kV transmission system through the Brownell Tap line. Please see Attachment 1 for a one-line diagram of the POI.

Cost Summary

The Z2-107 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	$ 0
Direct Connection Network Upgrades	$ 0
Non Direct Connection Network Upgrades	$ 0
Total Costs	**$ 0**

The 69 kV connection estimate is based on the assumptions stated in the following Transmission Attachment Facilities and Substation Non- Direct Connection Work sections.

In addition, the Z2-107 project may be responsible for a contribution to the following costs:

Description	Total Cost
New System Upgrades	$ 0
Previously Identified Upgrades	$ 13,500,000
Total Costs	**$ 13,500,000**

Cost allocations for these upgrades will be provided in the System Impact Study Report.

The transmission and substation costs given above exclude any applicable state or federal taxes. If at a future date Federal CIAC (cost in aid of construction) taxes are deemed necessary by the IRS for this project, both PJM and PPL EU shall be reimbursed by the Interconnection Customer for such taxes.

Attachment Facilities

There are no new Attachment Facilities Required by PPL.

Direct Connection Cost Estimate

There are no new Direct Connection Facilities Required by PPL.

Non-Direct Connection Cost Estimate

There are no new Non-Direct Connection Facilities Required by PPL.

Alternate Outlet

The IC has not requested an alternate outlet for their generation. When the Lackawanna-East Carbondale 69 kV line needs to come off line for any line maintenance or repair activities, the generator will be asked to come off line.

Preliminary Schedule

The estimated PPL EU elapsed time to complete the 69 kV Direct connection transmission work is approximately 24 months after the receipt of a fully executed ISA/CSA.

The schedule for the 69 kV transmission work to accommodate Z2-107 would depend on the project's start date. The work to accommodate Z2-107 will require transmission facility outages. PPL EU's outage windows for construction are typically available in the spring and fall of the year. Missing an outage window could result in project delays.

PPL EU will commence siting, engineering design, material purchase and construction of the facilities identified in this study after receiving written authorization by PJM to begin work. This time frame is contingent upon the acquisition of all rights of way in the stated time frame before the start of construction and detailed design.

Transmission Owner Assumptions in Developing the Cost Estimates

- For the custom-designed steel transmission poles, the lead-time is approximately 32 to 42 weeks. It is estimated that custom designed steel poles will be needed for this project.
- During construction, if extreme weather conditions or other system safety concerns arise, field construction may need to be rescheduled, which could possibly delay the schedule.
- This magnitude estimate has been prepared without extensive research or field review.
- No environmental, real estate, or permitting issues were reviewed for the estimate of this project.
- Excepting any operational, governmental, and/or environmental regulatory delays, the use of additional resources, such as overtime, premiums for expedited material, and/or contractor labor, may enable PPL EU to decrease this construction period but no guarantees can be made. It is also assumed that all rights-of-way and easements are secured by the anticipated construction start dates.
- PPL EU recommends that an Interim ISA be completed during the Facilities Study stage to address critical path items, such as long lead-time purchases and any other compressed project schedule issues.

- The ISA/CSA or an Interim Interconnection Service Agreement (IISA) must be signed by the Z2-107 Interconnection Customer, PJM, and PPL EU before any PPL EU design and construction activities may commence.

Interconnection Customer Requirements

Z2-107 Generator, GSU, and Line Modeling

The battery will be modeled as one unit and will inject and withdraw 20 MW into and from PPL EU's system.

Telephone Circuit Requirements (At the IPP)

PPL EU will require communication paths between the Z2-107 customer substation and PPL EU's Lackawanna Substation for Voice and SCADA. For the telephone communication path, the Interconnection Customer will be responsible to procure the following to communicate with PPL EU Lackawanna substation:

1. A 4-wire dedicated FDDA-type phone line for SCADA.
2. A normal dialup telephone line for voice communication.

The SCADA phone line will go to one of our Service centers, to be determined during the Facility study. The Interconnection Customer should secure the necessary phone lines as soon as possible.

Intertie and POC Protective Relaying Equipment

The Interconnection Customer will need to meet PPL EU's requirements for parallel generation interconnection. This includes both Intertie Protective Relaying (IPR) and Point of Contact (POC) relaying. Please refer to the PPL EU web site for the IPR and POC requirements. The website addresses are shown below:

IPR Requirements:

https://www.pplelectric.com/at-your-service/electric-rates-and-rules/customer-owned-generation.aspx

POC Requirements:

https://www.pplelectric.com/at-your-service/electric-rates-and-rules/point-of-contact-requirements-for-high-voltage-facilities.aspx

DTT Equipment Requirements

The existing DTT at the Interconnection Customer's site can be utilized for this interconnection.

Isolation Breaker Requirement at the Interconnection Customer's Substation

The existing isolation breaker at the Interconnection Customer's site can be utilized for this interconnection.

Z2-107 Generator Harmonic and Flicker Requirements

On the PPL EU 69 kV system, the total harmonic distortion to the fundamental voltage wave from a single customer is limited to 1.5% of nominal. In addition, no individual harmonic component can exceed 1.0% of the fundamental system voltage.

If PPL EU discovers that objectionable harmonics in excess of the stated limits are being injected into the system from Z2-107's equipment, the Queue Z2-107 Interconnection Customer will be responsible for taking corrective measures to mitigate harmonic currents.

Concerning voltage flicker, the Interconnection Customer must limit the severity of their voltage variation to within a level which will not cause objectionable flickers to other customers. A voltage drop greater than 5% at the point of interconnection is generally not acceptable. The frequency and severity of the voltage variation will be considered when determining whether a customer's equipment is violating PPL EU flicker guidelines. PPL EU uses the General Electric flicker-irritation curves as a guideline to determine if the system is operating within acceptable limits. PPL EU will require corrective actions by the Interconnection Customer if their operation causes flickers that exceed PPL EU guidelines. One such correction could be the installation of static var compensators (SVC) to hold a constant voltage.

Z2-107 Generator Regulation or Reactive Support Requirements

As specified in Part IV, Subpart E at 54.7 of the PJM OATT, the Project Z2-107 generator shall design its "Facility" to maintain a composite power factor delivery at continuous rated power output at the generators terminals at a power factor of at least 0.95 leading (absorbing vars) to 0.95 lagging (supplying vars).

"For all new wind-powered and other non-synchronous generation facilities, if determined in the system Feasibility study to be required for the safety or reliability of the Transmission System, the Generation Interconnection Customer shall design its Customer Facility with the ability to maintain a composite power delivery at continuous rated power output at a power factor of at least 0.95 leading to 0.95 lagging."

The PPL EU preliminary load flow studies have indicated that the Z2-107 generator will maintain the required voltage regulation within the required ranges. A voltage schedule will be developed at the time of the Facilities Study.

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.

PPL EU Requirements

SCADA Equipment Requirements

The developer can use the existing SCADA equipment and just incorporate the data for the new generation.

Revenue Metering Equipment Installation at the Point of Interconnection

Metering Requirements for this additional generation at the Interconnection Customer site will be assessed at a later study phase.

Network Impacts

The Queue Project Z2-107 was studied as a 20.0 MW (Capacity 0.0 MW) injection at WAYM IPP 34.5 kV substation in the PPL area. Project Z2-107 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project Z2-107 was studied with a commercial probability of 53%. A Summer 2018 case was used for this analysis.

Potential network impacts were as follows:

Generator Deliverability

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

None.

Multiple Facility Contingency

(Double Circuit Tower Line contingencies were studied for the full energy output. The contingencies of Line with Failed Breaker and Bus Fault will be performed for the Impact Study.)

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.

Short Circuit

(Summary of impacted circuit breakers)

None.

Potential Congestion due to Local Energy Deliverability

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Note: Only the most severely overloaded conditions are listed below. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed which shall study all overload conditions associated with the overloaded element(s) identified.

None.

Transmission Owner Network Impacts

The rating of the line:

- Tinker Tap (211905) to Brownell Tap (211416) has a 336,400 ACSR/AW 26/7 conductor with a normal rating of 66 MW.
- Greenfield (211551) to Tinker Tap (211905) has a 336,400 ACSR/AW 26/7 conductor with a normal rating of 69 MW.

With the Wayward Wind Generator (64.5 MW) online and new 20 MW battery off line the flow on the lines is as follows:

- Tinker Tap (211905) to Brownell Tap (211416) – about 50 MW
- Greenfield (211551) to Tinker Tap (211905) - about 45 MW

With the Wayward Wind Generator (64.5 MW) online and new 20 MW battery on line and acting as a generator the flow on the lines is as follows:

- Tinker Tap (211905) to Brownell Tap (211416) – about 69 MW
- Greenfield (211551) to Tinker Tap (211905) - about 63 MW

New System Reinforcements

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

Rebuild approximately 4.5 mi of the Lackawanna – East Carbondale 69kV line using 556 ACSR. The rebuild requires the removal of 110 existing structures and the installation of 55 new structures. 24,000 feet of (3) 336 MCM 30/7 ACSR will be removed for this rebuild.

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
Rebuild Lackawanna-East Carbondale 69kV	$ 13,500,000
Total Non-Direct Connection Facility Costs	**$ 13,500,000**

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.

Attachment 1. Single Line Diagram