Revised Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position Z2-107

East Carbondale-Lackawanna 69kV

September 2015

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

Waymart Wind Farm L.P., 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 10 MW with 0 MW of this output being recognized by PJM as capacity. The installed facilities will have a total capability of 74.5 MW with 10.1 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is December 2016. **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	$ 150,000
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 150.000**

Attachment Facilities

There are no Attachment Facilities required to be constructed by the Transmission Owner.

Direct Connection Cost Estimate

There are no Direct Connection Facilities required to be constructed by the Transmission Owner.

Non-Direct Connection Cost Estimate

To accommodate Z2-107, the following upgrades are required at PPL EU's Lackawanna 230-69kV Substation, assuming existing RTU at Waymart can accommodate the Z2-107:

- Modify SCADA for new alarms
- Modify AMS (Alarm Management System)
- Perform system checks and test equipment before placing in service
- Coordination, engineering, implementation, and testing

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
Lackawanna substation work *PJM Network Upgrade Number n4394*	$ 150,000
Total Non-Direct Connection Estimate	**$ 150,000**

Schedule

The estimated PPL EU elapsed time to complete the non-direct connection substation upgrades and network upgrades is approximately 12 months after the receipt of a fully executed ISA/CSA.

Assumptions and Notes

- 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.
- 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.
- 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

Queue Z2-107 Interconnection Customer will be responsible for the construction of all their generating station facilities on the Z2-107 side of the POI (Point of Interconnection).

Z2-107 Generator, GSU, and Line Modeling

The battery will be modeled as one unit and will inject and withdraw 10 MW into and from PPL EU's system.

Telephone Circuit Requirements

PPL EU will require communication paths between the Z2-107 customer substation and PPL EU's Lackawanna Substation for DTT, 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.
3. A protective relay-grade telephone circuit for the DTT communication requirements, type PRDA. This phone line needs to communicate between the Interconnection Customer's control house and PPL EU's Lackawanna Substation.

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.

All installation, maintenance, and monthly lease or billing charges for communications facilities for SCADA, Voice, Metering, etc., are the responsibility of the Interconnection Customer.

Note that PPL EU will evaluate the need for fiber based communication in lieu of telephone line communication as telephone lines are being phased out. PPL EU may specify fiber based communication at the Facilities Study stage or at a future point in time. If PPL EU needs to upgrade to fiber-based relaying in the future, PPL EU will be responsible for the replacement cost.

Intertie and POC Protective Relaying Equipment

The Interconnection Customer will need to ensure suitable protection and control equipment at its facilities based on PPL EU parallel generation requirements. 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

Isolation Breaker Requirement at the Interconnection Customer's Substation

It is assumed that the customer will utilize the existing isolation breaker at the Waymart POI as their isolation breaker. It is requested that the customer confirm this.

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 Z2-107 Project 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 Z2-107 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 Inverter Regulation or Reactive Supply Requirements

As specified in Interconnection Service Agreement, Appendix 2, and Section 4.7.1.1 of the PJM OATT (Open Access Transmission Tariff), the Z2-107 Project shall design its Facility to meet the following power factor requirement:

"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."

This indicates that the interconnection customer must maintain a composite power factor at the point of interconnection in between .95 leading or .95 lagging. If this capability cannot be met, the Z2-107 Project must provide a STATCOM or SVC device at its substation. A power factor (MW/MVAR) schedule will be provided in the Facilities Study stage.

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

PPL EU SCADA Equipment Requirements

PPL EU will require PPL EU approved SCADA equipment that will connect to its existing SCADA system to provide real time values of KW, KVAR, and kV metering data at the POC. SCADA equipment will also provide capability to trip and the status monitoring of the POC isolating circuit breaker. In addition to that, monitoring of other abnormal conditions at developer's plant will be provided where deemed necessary. This connection will be a 4-wire dedicated FDDA-type phone line. PPL EU will provide detailed specifications and design drawings for this equipment.

Revenue Metering Equipment Installation at the Point of Interconnection

Installation of revenue grade Bi-directional Metering Equipment will be required at the Queue Z2-107 Point of Interconnection (POI) to measure KWh and KVARh. PPL EU will design and supply the required metering equipment but all the installation cost would be borne by the developer including CT/PTs. All metering equipment must meet applicable PPL EU tariff requirements as well as being compliant with all applicable requirements of the PJM agreements. The equipment must provide bi-directional revenue metering (KWH and KVARH) and real-time data (KW, KVAR, circuit breaker status, and generator bus voltages) for the developer's generating resource. The equipment should be housed in a control cabinet or similar enclosure and must be accessible to PPL EU metering personnel.

Other Issues Impacting the Interconnection Customer

Alternate Outlet for Generation Operation during PPL EU Maintenance

No alternate outlet for the generation was requested by the Z2-107 developer. As such, Z2-107 will not be able to generate power during PPL EU line maintenance/outages.

Maintenance Considerations:

The Queue Z2-107 facility will not be able to generate into the PPL EU network during maintenance on the new 69 kV generator supply line or the Lackawanna-East Carbondale 69 kV line. PPL EU on-going annual and long-term planned maintenance of these circuits will require PPL EU to remove each circuit from operation one (1) time every four (4) years, for an outage period of approximately two (2) weeks. The actual duration may be shorter. During maintenance periods, the circuit may or may not be returned to service during the evening hours. That decision depends on the type of work being performed. Unexpected and unplanned maintenance outages are not included in the one-in-four number and duration time. Annual inspections that uncover damaged poles, conductors, or hardware, which require immediate repair, are scheduled as soon as practicable. These types of unplanned outages may last up to 16 hours.

Distribution Service Requirements

The Interconnection Customer must submit a request for electric service through PPL EU's Industrial and Commercial Services (ICS) group if the Z2-107 requires back-up electric service at a voltage less than 69 kV. The ICS Help Desk can be reached at 1-888-220-9991. Cost for distribution electric service is NOT included in the PPL scope of work transmission or substation estimates.

Future Conversion of line to 138 kV from 69 kV

PPL EU presently has no plans to convert the Lackawanna-East Carbondale line to 138 kV in the next 15-20 years. If the transmission system in this area is converted to 138 kV in the future, the Interconnection Customer would be responsible for conversion of its substation to 138kV at that time.

Network Impacts

The Queue Project Z2-107 was studied as a 10.0 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 100%. Potential network impacts were as follows:

Generator Deliverability

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

None.

Light Load Analysis

Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

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.

Short Circuit

(Summary of impacted circuit breakers)

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

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

None.

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

None.

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.

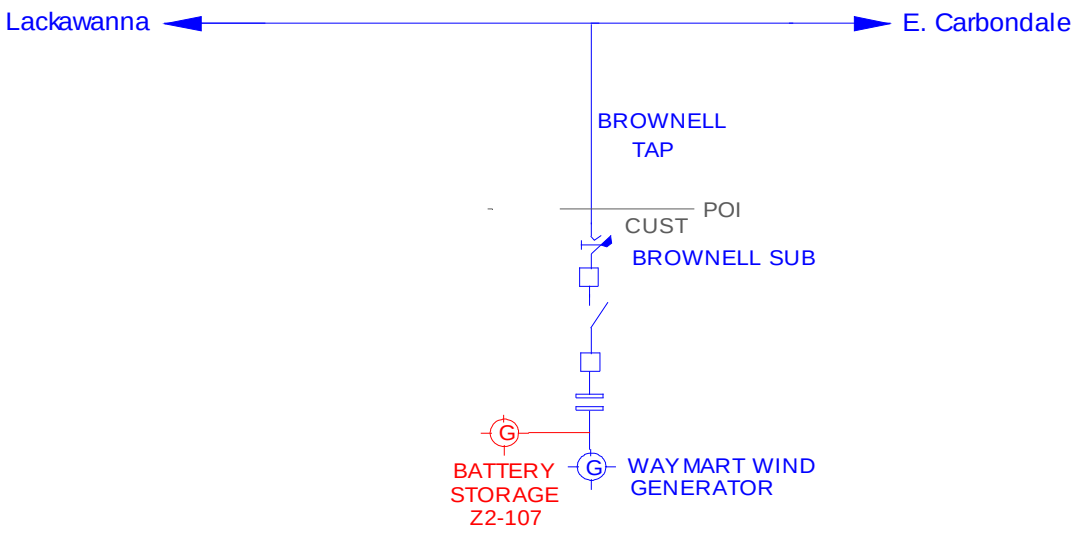
Potential Congestion due to Local Energy Deliverability

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.

Attachment 1. Description



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East Carbondale-Lackawanna 69kV

August 2015

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General

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Point of Interconnection

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Cost Summary

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

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Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 150.000**

Attachment Facilities

There are no Attachment Facilities required to be constructed by the Transmission Owner.

Direct Connection Cost Estimate

There are no Direct Connection Facilities required to be constructed by the Transmission Owner.

Non-Direct Connection Cost Estimate

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Assumptions and Notes

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- 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

Queue Z2-107 Interconnection Customer will be responsible for the construction of all their generating station facilities on the Z2-107 side of the POI (Point of Interconnection).

Z2-107 Generator, GSU, and Line Modeling

The battery will be modeled as one unit and will inject and withdraw 10 MW into and from PPL EU's system.

Telephone Circuit Requirements

PPL EU will require communication paths between the Z2-107 customer substation and PPL EU's Lackawanna Substation for DTT, 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:

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2. A normal dialup telephone line for voice communication.
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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.

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Intertie and POC Protective Relaying Equipment

The Interconnection Customer will need to ensure suitable protection and control equipment at its facilities based on PPL EU parallel generation requirements. 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:

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Isolation Breaker Requirement at the Interconnection Customer's Substation

It is assumed that the customer will utilize the existing isolation breaker at the Waymart POI as their isolation breaker. It is requested that the customer confirm this.

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.

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Concerning voltage flicker, the Z2-107 Project 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 Z2-107 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 Inverter Regulation or Reactive Supply Requirements

As specified in Interconnection Service Agreement, Appendix 2, and Section 4.7.1.1 of the PJM OATT (Open Access Transmission Tariff), the Z2-107 Project shall design its Facility to meet the following power factor requirement:

"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."

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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.

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PPL EU SCADA Equipment Requirements

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Revenue Metering Equipment Installation at the Point of Interconnection

Installation of revenue grade Bi-directional Metering Equipment will be required at the Queue Z2-107 Point of Interconnection (POI) to measure KWh and KVARh. PPL EU will design and supply the required metering equipment but all the installation cost would be borne by the developer including CT/PTs. All metering equipment must meet applicable PPL EU tariff requirements as well as being compliant with all applicable requirements of the PJM agreements. The equipment must provide bi-directional revenue metering (KWH and KVARH) and real-time data (KW, KVAR, circuit breaker status, and generator bus voltages) for the developer's generating resource. The equipment should be housed in a control cabinet or similar enclosure and must be accessible to PPL EU metering personnel.

Other Issues Impacting the Interconnection Customer

Alternate Outlet for Generation Operation during PPL EU Maintenance

No alternate outlet for the generation was requested by the Z2-107 developer. As such, Z2-107 will not be able to generate power during PPL EU line maintenance/outages.

Maintenance Considerations:

The Queue Z2-107 facility will not be able to generate into the PPL EU network during maintenance on the new 69 kV generator supply line or the Lackawanna-East Carbondale 69 kV line. PPL EU on-going annual and long-term planned maintenance of these circuits will require PPL EU to remove each circuit from operation one (1) time every four (4) years, for an outage period of approximately two (2) weeks. The actual duration may be shorter. During maintenance periods, the circuit may or may not be returned to service during the evening hours. That decision depends on the type of work being performed. Unexpected and unplanned maintenance outages are not included in the one-in-four number and duration time. Annual inspections that uncover damaged poles, conductors, or hardware, which require immediate repair, are scheduled as soon as practicable. These types of unplanned outages may last up to 16 hours.

Distribution Service Requirements

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Future Conversion of line to 138 kV from 69 kV

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Light Load Analysis

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Multiple Facility Contingency

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None.

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(Summary of impacted circuit breakers)

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

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(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

None.

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

None.

New System Reinforcements

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

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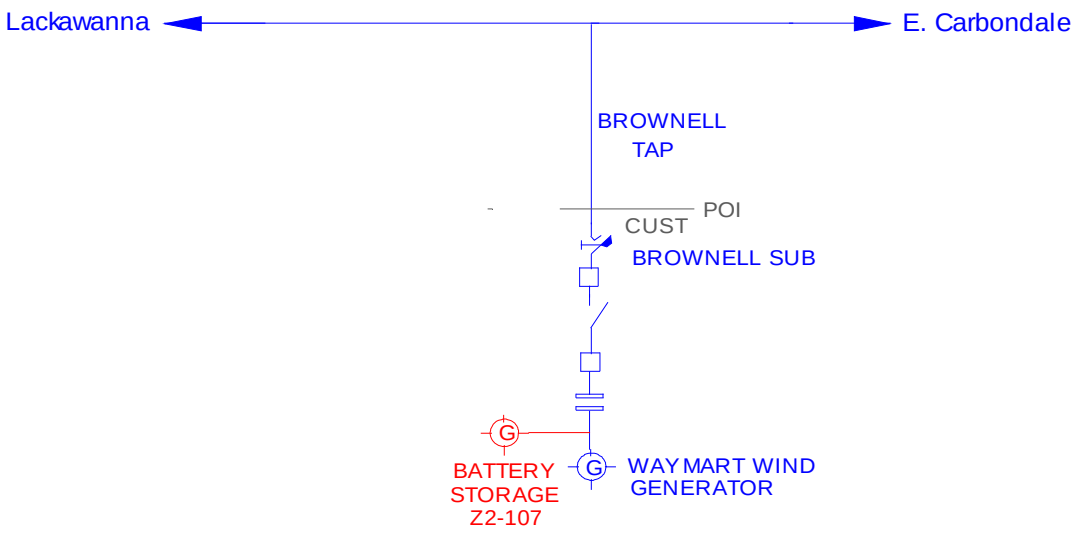

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Waymart Wind Farm L.P., the Interconnection Customer (IC), has proposed to add batteries to an existing wind generating facility in Wayne County, Pennsylvania. This projects requests an increase to the install capability of 10 MW with 0 MW of this 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	$ 150,000
Allocation for New System Upgrades	$ 0
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 150.000**

Attachment Facilities

There are no Attachment Facilities required to be constructed by the Transmission Owner.

Direct Connection Cost Estimate

There are no Direct Connection Facilities required to be constructed by the Transmission Owner.

Non-Direct Connection Cost Estimate

To accommodate Z2-107, the following upgrades are required at PPL EU's Lackawanna 230-69kV Substation, assuming existing RTU at Waymart can accommodate the Z2-107:

- Modify SCADA for new alarms
- Modify AMS (Alarm Management System)
- Perform system checks and test equipment before placing in service
- Coordination, engineering, implementation, and testing

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
Lackawanna substation work *PJM Network Upgrade Number n4394*	$ 150,000
Total Non-Direct Connection Estimate	**$ 150,000**

Schedule

The estimated PPL EU elapsed time to complete the non-direct connection substation upgrades and network upgrades is approximately 12 months after the receipt of a fully executed ISA/CSA.

Assumptions and Notes

- 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.
- 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.
- 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

Queue Z2-107 Interconnection Customer will be responsible for the construction of all their generating station facilities on the Z2-107 side of the POI (Point of Interconnection).

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

PPL EU will require communication paths between the Z2-107 customer substation and PPL EU's Lackawanna Substation for DTT, 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.
3. A protective relay-grade telephone circuit for the DTT communication requirements, type PRDA. This phone line needs to communicate between the Interconnection Customer's control house and PPL EU's Lackawanna Substation.

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.

All installation, maintenance, and monthly lease or billing charges for communications facilities for SCADA, Voice, Metering, etc., are the responsibility of the Interconnection Customer.

Note that PPL EU will evaluate the need for fiber based communication in lieu of telephone line communication as telephone lines are being phased out. PPL EU may specify fiber based communication at the Facilities Study stage or at a future point in time. If PPL EU needs to upgrade to fiber-based relaying in the future, PPL EU will be responsible for the replacement cost.

Intertie and POC Protective Relaying Equipment

The Interconnection Customer will need to ensure suitable protection and control equipment at its facilities based on PPL EU parallel generation requirements. 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

Isolation Breaker Requirement at the Interconnection Customer's Substation

It is assumed that the customer will utilize the existing isolation breaker at the Waymart POI as their isolation breaker. It is requested that the customer confirm this.

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 Z2-107 Project 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 Z2-107 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 Inverter Regulation or Reactive Supply Requirements

As specified in Interconnection Service Agreement, Appendix 2, and Section 4.7.1.1 of the PJM OATT (Open Access Transmission Tariff), the Z2-107 Project shall design its Facility to meet the following power factor requirement:

"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."

This indicates that the interconnection customer must maintain a composite power factor at the point of interconnection in between .95 leading or .95 lagging. If this capability cannot be met, the Z2-107 Project must provide a STATCOM or SVC device at its substation. A power factor (MW/MVAR) schedule will be provided in the Facilities Study stage.

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

PPL EU SCADA Equipment Requirements

PPL EU will require PPL EU approved SCADA equipment that will connect to its existing SCADA system to provide real time values of KW, KVAR, and kV metering data at the POC. SCADA equipment will also provide capability to trip and the status monitoring of the POC isolating circuit breaker. In addition to that, monitoring of other abnormal conditions at developer's plant will be provided where deemed necessary. This connection will be a 4-wire dedicated FDDA-type phone line. PPL EU will provide detailed specifications and design drawings for this equipment.

Revenue Metering Equipment Installation at the Point of Interconnection

Installation of revenue grade Bi-directional Metering Equipment will be required at the Queue Z2-107 Point of Interconnection (POI) to measure KWh and KVARh. PPL EU will design and supply the required metering equipment but all the installation cost would be borne by the developer including CT/PTs. All metering equipment must meet applicable PPL EU tariff requirements as well as being compliant with all applicable requirements of the PJM agreements. The equipment must provide bi-directional revenue metering (KWH and KVARH) and real-time data (KW, KVAR, circuit breaker status, and generator bus voltages) for the developer's generating resource. The equipment should be housed in a control cabinet or similar enclosure and must be accessible to PPL EU metering personnel.

Other Issues Impacting the Interconnection Customer

Alternate Outlet for Generation Operation during PPL EU Maintenance

No alternate outlet for the generation was requested by the Z2-107 developer. As such, Z2-107 will not be able to generate power during PPL EU line maintenance/outages.

Maintenance Considerations:

The Queue Z2-107 facility will not be able to generate into the PPL EU network during maintenance on the new 69 kV generator supply line or the Lackawanna-East Carbondale 69 kV line. PPL EU on-going annual and long-term planned maintenance of these circuits will require PPL EU to remove each circuit from operation one (1) time every four (4) years, for an outage period of approximately two (2) weeks. The actual duration may be shorter. During maintenance periods, the circuit may or may not be returned to service during the evening hours. That decision depends on the type of work being performed. Unexpected and unplanned maintenance outages are not included in the one-in-four number and duration time. Annual inspections that uncover damaged poles, conductors, or hardware, which require immediate repair, are scheduled as soon as practicable. These types of unplanned outages may last up to 16 hours.

Distribution Service Requirements

The Interconnection Customer must submit a request for electric service through PPL EU's Industrial and Commercial Services (ICS) group if the Z2-107 requires back-up electric service at a voltage less than 69 kV. The ICS Help Desk can be reached at 1-888-220-9991. Cost for distribution electric service is NOT included in the PPL scope of work transmission or substation estimates.

Future Conversion of line to 138 kV from 69 kV

PPL EU presently has no plans to convert the Lackawanna-East Carbondale line to 138 kV in the next 15-20 years. If the transmission system in this area is converted to 138 kV in the future, the Interconnection Customer would be responsible for conversion of its substation to 138kV at that time.

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 100%. Potential network impacts were as follows:

Generator Deliverability

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

None.

Light Load Analysis

Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

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.

Short Circuit

(Summary of impacted circuit breakers)

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

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

None.

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

None.

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.

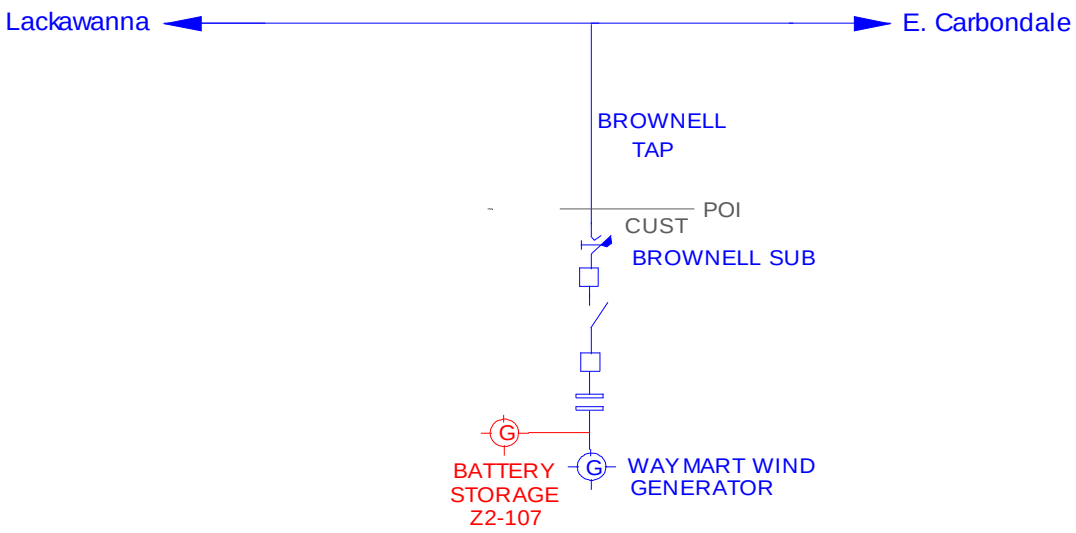
Potential Congestion due to Local Energy Deliverability

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.

Attachment 1. Description



Generation Interconnection System Impact Study Report

For

PJM Generation Interconnection Request Queue Position Z2-107

East Carbondale-Lackawanna 69kV

March 2015

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

Waymart Wind Farm L.P., 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	$ 150,000
Allocation for New System Upgrades	$ 13,500,000
Contribution for Previously Identified Upgrades	$ 0
Total Costs	**$ 13,650,000**

Attachment Facilities

There are no Attachment Facilities required to be constructed by the Transmission Owner.

Direct Connection Cost Estimate

There are no Direct Connection Facilities required to be constructed by the Transmission Owner.

Non-Direct Connection Cost Estimate

To accommodate Z2-107, the following upgrades are required at PPL EU's Lackawanna 230-69kV Substation, assuming existing RTU at Waymart can accommodate the Z2-107:

- Modify SCADA for new alarms
- Modify AMS (Alarm Management System)
- Perform system checks and test equipment before placing in service
- Coordination, engineering, implementation, and testing

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
Lackawanna substation work *PJM Network Upgrade Number n4394*	$ 150,000
Total Non-Direct Connection Estimate	**$ 150,000**

Schedule

The estimated PPL EU elapsed time to complete the non-direct connection substation upgrades and network upgrades is approximately 24 months after the receipt of a fully executed ISA/CSA.

The schedule for the 69 kV transmission and substation work to accommodate Z2-107 would depend on the project start date. The work to accommodate Z2-107 will require an outage of the Lackawanna-E. Carbondale 69 kV line. 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.

The transmission and substation work can be completed concurrently. 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.

Assumptions and Notes

- For the custom-designed steel transmission poles, the lead-time is approximately 32 to 42 weeks. It is estimated that approximately 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.
- This estimate assumes that suitable facility outages can be schedule as required to install the new circuit breaker. Failure to meet a scheduled facility outage may result in project delays.
- 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

Queue Z2-107 Interconnection Customer will be responsible for the construction of all their generating station facilities on the Z2-107 side of the POI (Point of Interconnection).

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

PPL EU will require communication paths between the Z2-107 customer substation and PPL EU's Lackawanna Substation for DTT, 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.
3. A protective relay-grade telephone circuit for the DTT communication requirements, type PRDA. This phone line needs to communicate between the Interconnection Customer's control house and PPL EU's Lackawanna Substation.

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.

All installation, maintenance, and monthly lease or billing charges for communications facilities for SCADA, Voice, Metering, etc., are the responsibility of the Interconnection Customer.

Note that PPL EU will evaluate the need for fiber based communication in lieu of telephone line communication as telephone lines are being phased out. PPL EU may specify fiber based communication at the Facilities Study stage or at a future point in time. If PPL EU needs to upgrade to fiber-based relaying in the future, PPL EU will be responsible for the replacement cost.

Intertie and POC Protective Relaying Equipment

The Interconnection Customer will need to ensure suitable protection and control equipment at its facilities based on PPL EU parallel generation requirements. 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

Isolation Breaker Requirement at the Interconnection Customer's Substation

It is assumed that the customer will utilize the existing isolation breaker at the Waymart POI as their isolation breaker. It is requested that the customer confirm this.

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 Z2-107 Project 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 Z2-107 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 Inverter Regulation or Reactive Supply Requirements

As specified in Interconnection Service Agreement, Appendix 2, and Section 4.7.1.1 of the PJM OATT (Open Access Transmission Tariff), the Z2-107 Project shall design its Facility to meet the following power factor requirement:

"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."

This indicates that the interconnection customer must maintain a composite power factor at the point of interconnection in between .95 leading or .95 lagging. If this capability cannot be met, the Z2-107 Project must provide a STATCOM or SVC device at its substation. A power factor (MW/MVAR) schedule will be provided in the Facilities Study stage.

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

PPL EU SCADA Equipment Requirements

PPL EU will require PPL EU approved SCADA equipment that will connect to its existing SCADA system to provide real time values of KW, KVAR, and kV metering data at the POC. SCADA equipment will also provide capability to trip and the status monitoring of the POC isolating circuit breaker. In addition to that, monitoring of other abnormal conditions at developer's plant will be provided where deemed necessary. This connection will be a 4-wire dedicated FDDA-type phone line. PPL EU will provide detailed specifications and design drawings for this equipment.

Revenue Metering Equipment Installation at the Point of Interconnection

Installation of revenue grade Bi-directional Metering Equipment will be required at the Queue Z2-107 Point of Interconnection (POI) to measure KWh and KVARh. PPL EU will design and supply the required metering equipment but all the installation cost would be borne by the developer including CT/PTs. All metering equipment must meet applicable PPL EU tariff requirements as well as being compliant with all applicable requirements of the PJM agreements. The equipment must provide bi-directional revenue metering (KWH and KVARH) and real-time data (KW, KVAR, circuit breaker status, and generator bus voltages) for the developer's generating resource. The equipment should be housed in a control cabinet or similar enclosure and must be accessible to PPL EU metering personnel.

Other Issues Impacting the Interconnection Customer

Alternate Outlet for Generation Operation during PPL EU Maintenance

No alternate outlet for the generation was requested by the Z2-107 developer. As such, Z2-107 will not be able to generate power during PPL EU line maintenance/outages.

Maintenance Considerations:

The Queue Z2-107 facility will not be able to generate into the PPL EU network during maintenance on the new 69 kV generator supply line or the Lackawanna-East Carbondale 69 kV line. PPL EU on-going annual and long-term planned maintenance of these circuits will require PPL EU to remove each circuit from operation one (1) time every four (4) years, for an outage period of approximately two (2) weeks. The actual duration may be shorter. During maintenance periods, the circuit may or may not be returned to service during the evening hours. That decision depends on the type of work being performed. Unexpected and unplanned maintenance outages are not included in the one-in-four number and duration time. Annual inspections that uncover damaged poles, conductors, or hardware, which require immediate repair, are scheduled as soon as practicable. These types of unplanned outages may last up to 16 hours.

Distribution Service Requirements

The Interconnection Customer must submit a request for electric service through PPL EU's Industrial and Commercial Services (ICS) group if the Z2-107 requires back-up electric service

at a voltage less than 69 kV. The ICS Help Desk can be reached at 1-888-220-9991. Cost for distribution electric service is NOT included in the PPL scope of work transmission or substation estimates.

Future Conversion of line to 138 kV from 69 kV

PPL EU presently has no plans to convert the Lackawanna-East Carbondale line to 138 kV in the next 15-20 years. If the transmission system in this area is converted to 138 kV in the future, the Interconnection Customer would be responsible for conversion of its substation to 138kV at that time.

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 100%. Potential network impacts were as follows:

Contingency Descriptions

The following contingencies resulted in overloads:

Contingency Name	Description
PL100468	CONTINGENCY 'PL100468' /*SUSQUEHANNA UNIT 2 500KV OUT DISCONNECT BUS 200038 END

Generator Deliverability

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

None.

Light Load Analysis

Light Load Studies to be conducted during later study phases (applicable to wind, coal, nuclear, and pumped storage projects).

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.

Short Circuit

(Summary of impacted circuit breakers)

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

(Summary of the VAR requirements based upon the results of the steady-state voltage studies)

None.

Stability and Reactive Power Requirement for Low Voltage Ride Through

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

Will be confirmed during the Facility Study stage.

Transmission Owner Identified Overloads

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)

Violation #	Overloaded Facility	Upgrade Description	Network Upgrade Number	Upgrade Cost	Z2-107 Allocation
TO	East Carbondale-Lackawanna 69kV	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.	N4393	$ 13,500,000	**$ 13,500,000**
				Total New Network Upgrades	**$ 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.

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.

	Contingency		Affected		Bus			Power	Loading %		Rating		MW	
#	Type	Name	Area	Facility Description	From	To	Circuit	Flow	Initial	Final	Type	MVA	Contribution	Ref
1	N-1	PL100468	Penelec-PPL	26OXBOW-LACK 230kV line	200708	208009	1	AC	99.92	100.06	ER	624	2.37	

Attachment 1. Description