

***Generation Interconnection  
Feasibility Study Report***

***For***

***PJM Generation Interconnection Request  
Queue Position Y1-016***

***Baker 138 kV***

**August 2012**

## 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 a wind generating facility located in Hardy County, West Virginia. The installed facilities will have a total capability of 50 MW with 6.5 MW of this output being recognized by PJM as capacity. This means that the remaining 43.5 MW will be curtailable should a system reliability constraint occur. The proposed in-service date for this project is December 31, 2015. **This study does not imply a First Energy commitment to this in-service date.**

## Point of Interconnection

Y1-016 will interconnect with the Potomac Edison Company transmission system at one of two options:

Option 1 will interconnect directly into Baker Substation at 138 kV.

Option 2 will interconnect via a tap of the Baker-Hardy 138 kV line.

## Cost Summary

The Y1-016 project will be responsible for the following costs:

Description	Total Cost
Attachment Facilities	\$ 0
Direct Connection Network Upgrades	\$ 3,807,800
Non Direct Connection Network Upgrades	\$ 205,700
<b>Total Costs</b>	<b>\$ 4,013,500</b>

In addition, the Y1-016 project may be responsible for a contribution to the following costs:

<b>Description</b>	<b>Total Cost</b>
New System Upgrades	\$ 0
Previously Identified Upgrades	\$ 0
<b>Total Costs</b>	<b>\$ 0</b>

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

## Attachment Facilities

Attachment 1 shows a conceptual one-line diagram of the primary 138 kV interconnection to accommodate the attachment of the Baker 138 kV (Y1-016) Generation Project.

The Interconnection Customer will be responsible for constructing all of the facilities on its side of the point of interconnection including the attachment line. A summary of the FE facilities required for the Baker 138 kV (Y1-016) Generation Project primary connection and cost estimate are shown below.

## Direct Connection Cost Estimate

In compliance with the Regional Transmission Expansion Planning (RTEP) protocol, the Interconnection Customer has submitted a "Form of Generation Interconnection Feasibility Study Agreement " to PJM that identifies its plan to construct the Baker 138 kV (Y1-016) Generation Project comprised of wind turbine generators on a property that is approximately 1.5 miles from the existing Baker substation. The installed facilities will have a total capability of 50 MW with 6.5 MW of this output being recognized by PJM as capacity. This means that the remaining 43.5 MW will be subject to curtailment should a system reliability constraint occur.

As defined by the Interconnection Customer, the proposed Interconnection Customer site will be located at a point approximately 1.5 miles from Baker substation. The primary direct connection of this project will be accomplished by reconstructing the existing Baker substation into a 138 kV ring bus. An alternate point of interconnection would be accomplished by tapping the Baker – Hardy 138 kV line 1.5 miles from Baker substation. The Interconnection Customer will be responsible for constructing a radial 138 kV attachment line from the Y1-016 generation 138 kV export bus to the 138 kV point of interconnection. The Interconnection Customer may not install above ground equipment within any FirstEnergy right-of-way unless permission to do so is expressly granted by FirstEnergy.

The total preliminary cost estimate for Direct Connection work is given in the table below:

Description	Total Cost
<b>Baker SS:</b> Extend yard and fence on existing property, approximately 200' x 100'. Convert to 3-breaker 138 kV ring bus by installing 3-138 kV breakers, removing 138 kV transformer circuit switcher, and terminating the existing 138 kV line from Hardy substation, 138/34.5 kV transformer, and the Y1-016 Generator terminal onto the 138 kV Bus. Install new control building for new panels. Developer is to install OPGW from Y1-016 to Baker SS.	\$ 3,126,200
Engineering Oversight and Commissioning	\$ 132,300
<b>Tax</b>	\$ 549,300
<b>Total</b>	<b>\$ 3,807,800</b>

The primary direct connection for the Baker 138 kV (Y1-016) Generation Project to the Potomac Edison transmission system is detailed above. The associated one-line with the Baker 138 kV (Y1-016) Generation Project primary direct connection is shown in Attachment 1. Note that all cost estimates contained in this document were produced without a detailed engineering review and are therefore subject to error. More accurate estimates will be determined as a part of the

System Impact Study. The Interconnection Customer will be responsible for the actual cost of the direct connection that is implemented. In addition, the Interconnection Customer is responsible to provide the transmission line between the point of interconnection and the Baker 138 kV (Y1-016) Generation Project collector station, as the Interconnection Customer will own this transmission line. FE herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any reinforcements to the transmission or subtransmission systems.

## Non-Direct Connection Cost Estimate

In addition to the direct connection upgrades, the Interconnection Customer will also be responsible for the following work to support the installation of Y1-016.

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

Description	Total Cost
<b>Hardy SS:</b> Install 138 kV transfer trip facilities including wave trap, CVT, structures, foundations, tuner, transmitter/receiver and associated facilities.	\$ 177,000
<b>Tax</b>	\$ 28,700
<b>Total</b>	\$ <b>205,700</b>

## Interconnection Customer Requirements

### System Protection Analysis

An analysis was conducted to assess the impact of the Baker 138 kV (Y1-016) Generation Project on the system protection requirements in the area. The results of this review have identified the following:

- Anti-Islanding Scheme between Baker, Hardy, and the Interconnection Customer’s substations to remove the customer generation from service should the breaker at Baker open, or if the breaker at Hardy opens.
- Standard 138 kV Line protection for new line terminals at Baker Substation.

Attachment 2 shows the specific power and protection equipment requirements.

### Compliance Issues

The proposed interconnection facilities must be designed in accordance with the FirstEnergy “Requirements for Transmission Connected Facilities” located at:

<http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx>

The Interconnection Customer will also be responsible for following the requirements of the “FirstEnergy Wholesale Generation Interconnection (WGI) Manual” and the “FE Approved Vendors and Contractors” documents which are also located at the above link.

The Interconnection Customer will also be required to meet all PJM, ReliabilityFirst and NERC reliability criteria and operating procedures for standards compliance. For example, the Interconnection Customer will need to properly locate and report the over and under-voltage and over and under-frequency system protection elements for its units as well as the submission of the generator model and protection data required to satisfy the PJM and ReliabilityFirst audits. Failure to comply with these requirements may result in a disconnection of service if the violation is found to compromise the reliability of the FE system.

### **Other Requirements**

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

1. The purchase and installation of a fully rated 138 kV circuit breaker to permit tripping of the entire plant.
2. The purchase and installation of the minimum required FE generation interconnection relaying and control facilities. This includes over/under voltage protection, over/under frequency protection, and zero sequence voltage protection relays.
3. The purchase and installation of supervisory control and data acquisition (SCADA) equipment to provide information in a compatible format to the FE Transmission System Control Center.
4. The establishment of dedicated communication circuits for SCADA to the FE Transmission System Control Center.
5. A compliance with the FE and PJM generator power factor and voltage control requirements.
6. The execution of a back-up service agreement to serve the customer load supplied from the Baker 138 kV (Y1-016) Generation Project metering point when the units are out-of-service. This assumes the intent of the Interconnection Customer is to net the generation with the load.

Note that a further conclusion of this study is that it will be mandatory for the Baker 138 kV (Y1-016) Generation Project to have a range of dynamic reactive capability that supports its operation from a .95 lead to .95 lag power factor. Should the Interconnection Customer fail to provide a dynamic reactive capability from the Baker 138 kV (Y1-016) Generation Project for any reason once interconnected, the FE and/or PJM Dispatchers may need to take action to curtail both the energy and capacity portion of its output to prevent a non-compliance with voltage criteria.

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

# Revenue Metering and SCADA Requirements

## PJM Requirements

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

## First Energy Requirements

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

<http://www.firstenergycorp.com/feconnect>

<http://www.pjm.com/planning/design-engineering/to-tech-standards.aspx>

## Summary

The Baker 138 kV (Y1-016) Generation Project primary direct connection will require the facility upgrades defined above. As shown, the estimated cost of the primary direct and non-direct connection facilities is \$4,013,500. This cost includes a CIAC (Contribution in Aid of Construction) Federal Income Tax Gross Up charge of \$578,000. This tax may or may not be charged based on whether or not this project meets the eligibility requirements of IRS Notice 88-129.

Based on the extent of the FE primary direct connection and system upgrades required to support this project, it is expected to take a minimum of eighteen (18) months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation required for the Baker 138 kV (Y1-016) Generation Project. This includes the requirement for the Interconnection Customer to make a preliminary payment to FE which funds the first three months of engineering design that is related to the construction of the Direct Connection facilities. It further assumes that the Interconnection Customer will provide all rights-of-way, permits, easements, etc. that will be needed. A further assumption is that there will be no environmental issues with any of the new properties associated with this project, that there will be no delays in acquiring the necessary permits for implementing the defined direct connection and network upgrades, and that all system outages will be allowed when requested.

Note that the FE findings were made from a conceptual review of this project. A more detailed review of the connection facilities and their cost will be identified in the System Impact Study. Further note that the cost estimate data contained in this document should be considered as only ballpark since it was produced without a detailed engineering review. The applicant will be responsible for the actual cost of construction. FE herein reserves the right to return to any issues in this document and, upon appropriate justification, request additional monies to complete any reinforcements to the transmission or subtransmission systems.

## **Network Impacts**

### **Option 1**

The Queue Project #Y1-016 was studied as a 50.0MW (Capacity 6.5MW) injection at the Baker 138 kV substation in the APS area. Project #Y1-016 was evaluated for compliance with reliability criteria for summer peak conditions in 2015. Potential network impacts were as follows:

### **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 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)*

New circuit breakers found to be over-duty:

None.

Contributions to previously identified circuit breakers found to be over-duty:

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)*

To be determined.

## **Stability and Reactive Power Requirement for Low Voltage Ride Through**

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

To be determined.

## **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.

## **Option 2**

The Queue Project #Y1-016 was studied as a 50.0MW (Capacity 6.5MW) injection as a tap of the Baker – Hardy 138 kV line in the APS area. Project #Y1-016 was evaluated for compliance with reliability criteria for summer peak conditions in 2015. Potential network impacts were as follows:

### **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 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)*

New circuit breakers found to be over-duty:

None.

Contributions to previously identified circuit breakers found to be over-duty:

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)*

To be determined.

## **Stability and Reactive Power Requirement for Low Voltage Ride Through**

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

To be determined.

## **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**

## ***System Configuration***

## **Attachment 2**

### *Protection and Measurement Equipment Specifications*

#### **RELAY AND COMMUNICATION EQUIPMENT SPECIFICATIONS**

##### **Baker SS**

Three phase, dual-winding capacitor voltage transformers, dual ratio = 1200/700/1, required at the generator line exit and at the Hardy line exit.

Fiber optic cable required between Baker substation and the customer substation for primary line differential protection and transfer-trip.

- (1) 2000A wide band line trap for the Hardy line exit.
  - (1) Wide band line tuner for the Hardy line exit.
  - (3) SATEC digital multimeter – one for each breaker.
  - (3) SEL-451 relays – one for each breaker for breaker failure and reclosing.
- Install new SCADA RTU and associated communications.

Generator line protection to include:

- SEL-311L with fiber optic interface for primary line diff protection and over-,under-, voltage and frequency protection.
- SEL-311A for backup line protection.
- SATEC digital multimeters for generator line indication.
- SD relay for generator line potential monitoring.

Hardy line protection to include:

- SEL-321 relay for primary line protection, configured for directional comparison blocking using power line carrier.
- SEL-311A relay for backup line protection.
- SATEC digital multimeter.
- Pulsar UPLC universal power line carrier transmitter/receiver configured for blocking carrier operation.
- Pulsar UPLC universal power line carrier transmitter/receiver configured for direct transfer trip from and to Hardy.
- Skewed hybrid transformer for blocking carrier and direct transfer trip equipment coupling.

##### **Hardy SS**

Single phase, dual-winding capacitor voltage transformers, dual ratio = 1200/700/1, required at the Baker line exit.

- (1) 2000A wide band line trap for the Baker line exit.
- (1) Wide band line tuner for the Baker line exit.

Baker line protection to be modified to include:

- Pulsar UPLC universal power line carrier transmitter/receiver configured for blocking carrier operation.
- Pulsar UPLC universal power line carrier transmitter/receiver configured for direct transfer trip from and to Baker.
- Skewed hybrid transformer for blocking carrier and direct transfer trip equipment coupling.