

***Generation Interconnection
Combined Feasibility and System
Impact Study Report***

For

***PJM Generation Interconnection Request
Queue Position AB2-178***

Beckjord 138 kV

(Revised)

October 2016

Preface

The intent of the Combined Feasibility and 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, if any, is included in the System Impact Study.

The Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. Interconnection Customer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs associated with them will be addressed when seeking an Interconnection Agreement as outlined below. Interconnection Customer will also be responsible for providing and installing metering equipment in compliance with applicable PJM and Transmission Owner standards.

General

Duke Energy Beckjord Storage, LLC (“Interconnection Customer” or “Beckjord Storage”) has proposed a battery storage generating facility located inside Beckjord Substation in New Richmond, Ohio. The installed facilities will have a total capability of 19.8 MW with 0 MW of this output being recognized by PJM as capacity. The proposed in-service date for this project is November 30, 2017. **This study does not imply a Duke Energy Ohio (“Transmission Owner” or “DEO”) commitment to this in-service date.**

Point of Interconnection

AB2-178 generating facility will interconnect with the DEO transmission system at the take-off structure between busses 5 and 6 inside Beckjord Substation. Refer to the one-line diagram in Appendix 2 for system configuration.

Costs Summary

Interconnected Transmission Owner facilities and network upgrades as well as related costs estimates required for this interconnection project are listed below. Contributions in Aid of Construction (CIAC) tax gross-up is not included.

(a.) Attachment Facilities:

(a.1) Replace the existing 138kV breaker and its associated disconnect switches and jumpers, and install revenue metering and relaying.

- *Estimated time to complete: 12 Months*
- *Network upgrade number: Not Required*
- *Cost estimate: \$ 1,254,644*

(b.) Direct Connection Network Upgrades, \$ 0.0

(c.) Non-Direct Connection Network Upgrades, \$ 0.0

(d.) Direct Connection Local Upgrades: \$ 0.0

(e.) Non-Direct Connection Local Upgrades: \$ 0.0

(g.) Baseline Upgrades: \$ 0.0

(g.) Option to Build: \$ 0.0

Total costs (a.) to (g.): \$ 1,254,644

Interconnection Customer Requirements

Interconnection Customer shall engineer, procure and construct an overhead line connecting the storage plant to the take-off structure in the Beckjord substation. Work to be performed by Duke Energy Ohio.

Revenue Metering and SCADA Requirements

PJM Requirements

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

Interconnected Transmission Owner Requirements

A revenue metering package shall be located at the storage plant, have a visible and lockable means of isolation, and be accessible by DEO personnel. The Interconnection Customer will be required to comply with all DEO Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of Facilities to the Duke Energy Midwest Transmission System" document located at the following link:

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

Schedule

Based on the extent of attachment facilities connection upgrades required to support this project, it is expected to take a minimum of twelve (12) months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation required for the Beckjord 138 kV (AB2-178) Project. This includes the requirement for Duke Energy Beckjord Storage, LLC to make a preliminary payment to DEO which funds the first three months of engineering design that is related to the construction of the attachment facilities.

The following is an estimated project schedule that may be subject to change:

	Responsibility	Date
Project Development Start	DEO	12/1/2016
Hand off to Project Management	DEO	12/15/2016
Engineering Start	DEO	3/1/2017
System Protection Issue	DEO	9/1/2017
Electrical Engineering Issue	DEO	9/1/2017
Electrical Construction Start	Duke Energy Beckjord Storage	10/1/2017
Electrical Construction End	Duke Energy Beckjord Storage	10/31/2017
In-Service Date	DEO	11/30/2017
Civil Engineering Issue	DEO	9/1/2018
Structural Engineering Issue	DEO	9/27/2018
Civil Construction Start	DEO	1/31/2019
Structural Construction Start	DEO	7/20/2019
Major Electrical Component Delivery	DEO	8/17/2019
Circuit Breaker Installation	DEO	12/10/2019

Network Impacts

The Queue Project AB2-178 was evaluated as a 19.8 MW (Capacity 0.0 MW) injection at the Beckjord 138kV substation in the DEO area. Project AB2-178 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AB2-178 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis - 2020

Generator Deliverability

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

None

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

None

Contribution to Previously Identified Overloads

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

None

Steady-State Voltage Requirements

None.

Short Circuit

(Summary of impacted circuit breakers)

None.

Affected System Analysis & Mitigation

LGEE Impacts:

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

MISO Impacts:

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

OVEC Impacts:

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

Delivery of Energy Portion of Interconnection Request

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

Only the most severely overloaded conditions are listed. 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 will study all overload conditions associated with the overloaded element(s) identified.

None

Light Load Analysis - 2020

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

System Reinforcements

Short Circuit

None.

Stability and Reactive Power Requirement

None.

Summer Peak Load Flow Analysis Reinforcements

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.

Light Load Load Flow Analysis Reinforcements

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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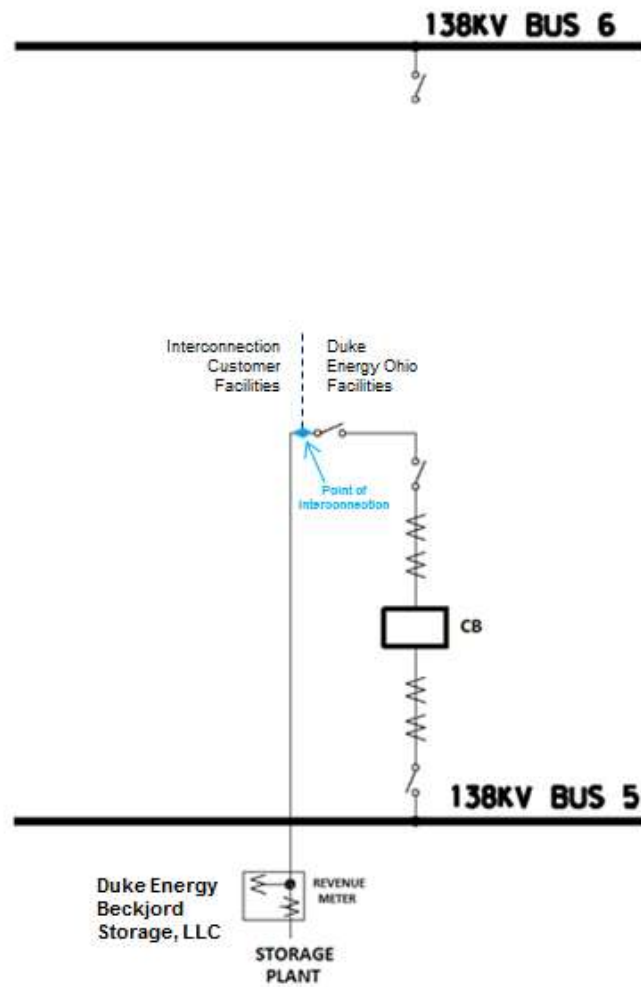
Appendix 1

Facility Location



Appendix 2

Simplified Interconnection Single Line Diagram (SLD)



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For

***PJM Generation Interconnection Request
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Beckjord 138 kV

August 2016

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General

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Point of Interconnection

AB2-178 generating facility will interconnect with the DEO transmission system at the take-off structure between busses 5 and 6 inside Beckjord Substation. Refer to the one-line diagram in Appendix 2 for system configuration.

Costs Summary

Interconnected Transmission Owner facilities and network upgrades as well as related costs estimates required for this interconnection project are listed below. Contributions in Aid of Construction (CIAC) tax gross-up is not included.

(a.) Attachment Facilities, \$ 901,100, detailed as follows:

(a.1) Replace the existing 138kV breaker and its associated disconnect switches and jumpers, and install revenue metering and relaying.

- *Estimated time to complete: 26 Months*
- *Network upgrade number: Not Required*
- *Cost estimate: \$ 901,100*

(b.) Direct Connection Network Upgrades, \$ 0 (None)

(c.) Non-Direct Connection Network Upgrades, \$ 0 (None)

(d.) Direct Connection Local Upgrades: \$ 0 (None)

(e.) Non-Direct Connection Local Upgrades: \$ 0 (None)

(f.) Contributions for Previously Identified Upgrades: \$ 0 (None)

(g.) Baseline Upgrades: \$ 0 (None)

(h.) Option to Build: \$ 0 (None)

Total costs (a.) to (h.): \$ 901,100

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Interconnection Customer shall engineer, procure and construct an overhead line connecting the storage plant to the take-off structure in the Beckjord substation. Work to be performed by Duke Energy Ohio.

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PJM Requirements

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

Schedule

Based on the extent of attachment facilities connection upgrades required support this project, it is expected to take a minimum of twenty-six (26) months from the date of a fully executed Interconnection Construction Service Agreement to complete the installation required for the Beckjord 138 kV (AB2-178) Project. This includes the requirement for Duke Energy Beckjord Storage, LLC to make a preliminary payment to DEO which funds the first three months of engineering design that is related to the construction of the attachment facilities.

Network Impacts

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None.

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(Summary of impacted circuit breakers)

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Affected System Analysis & Mitigation

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

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None

Light Load Analysis - 2020

Light Load Studies to be conducted during later study phases (as required by PJM Manual 14B).

System Reinforcements

Short Circuit

None.

Stability and Reactive Power Requirement

None.

Summer Peak Load Flow Analysis Reinforcements

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)

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New System Reinforcements

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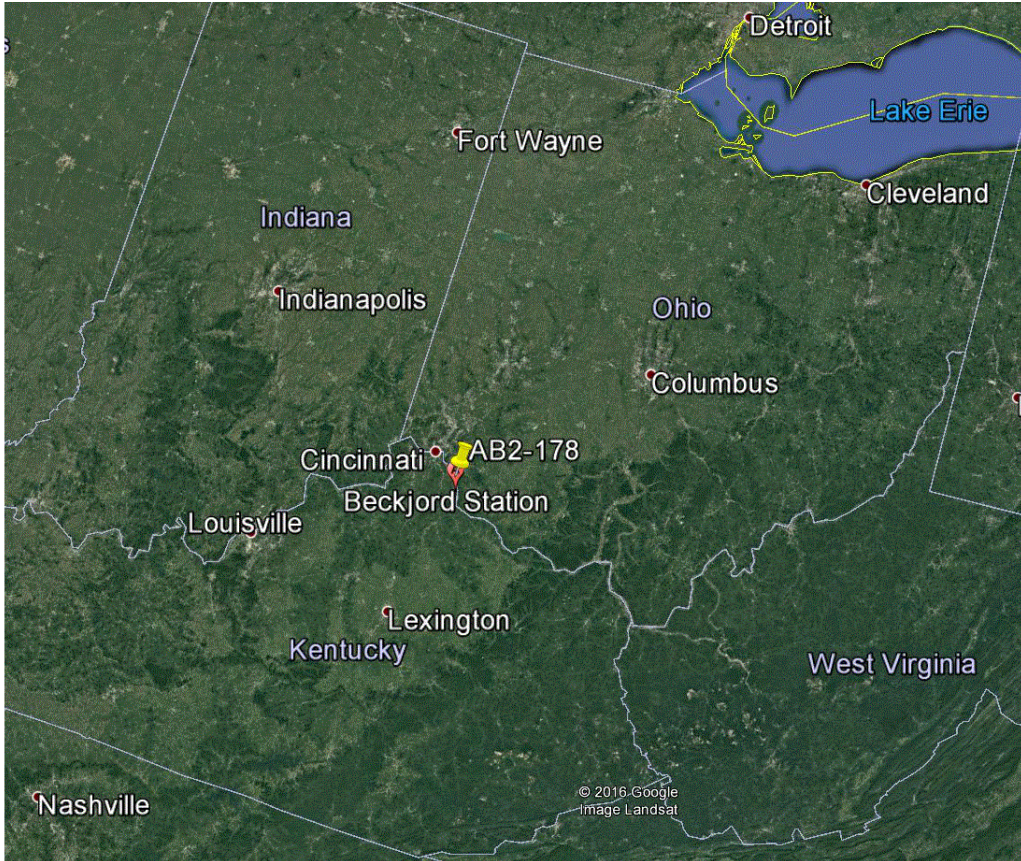
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Appendix 2

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