Generation Interconnection Feasibility Study Report-Web Version

For

PJM Generation Interconnection Request Queue Position Z1-079

Todhunter-Foster 345 kV Project

March 2014

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Feasibility Study Report

Todhunter-Foster 345 kV Project

Introduction

This Feasibility Study report provides the documentation of an assessment that has been performed by PJM Interconnection LLC (PJM) and Duke Energy Ohio (DEO) in response to a request made by Interconnection Customer (IC) for the interconnection proposed by Interconnection Customer for the installation of a combined-cycle natural gas generating facility in Middletown, Ohio. The IC requested the interconnection to be studied as a 540 MW Capacity injection into the Duke Energy Ohio (DEO) system by tapping into the existing Foster-Todhunter 345 kV circuit.

Direct Connection Facilities

The interconnection facilities to be constructed by DEO shall include a 345 kV switching substation and the necessary 345 kV line work required to redirect the Foster-Todhunter 345 kV line through the new substation. For the purposes of this report, the 345 kV switching substation shall be referred to as the Interconnection Substation. The existing Foster-Todhunter 345 kV circuit shall be looped through the Interconnection Substation. The 345 kV line work shall consist of the installation of steel pole structures to intercept and redirect Foster-Todhunter 345 kV circuit to the Interconnection Substation, and the necessary 345 kV conductors to connect the new structures to the termination structures in the Interconnection Substation. Circuit breakers and their associated protection and control equipment shall be installed in the Interconnection Substation to split the circuit into two separate circuits, Todhunter to Interconnection and Interconnection to Foster. The Interconnection Substation bus and switching configuration shall consist of a 3-breaker ring bus which will have positions to terminate the two newly established circuits, and a position to connect to the Interconnections Customer's direct connection facilities. System protection and control work will also be required in the existing Todhunter and Foster substations to establish the two new 345 kV circuits.

In addition to the above facilities that are needed to connect the Interconnection Customer project to the DEO transmission system, it has been determined that the additional fault current contributed by the Interconnection Customer project will result in a number of 138 kV circuit breakers at the DEO Todhunter Substation experiencing fault current in excess of their capabilities. Therefore, the cost to replace 13 138 kV circuit breakers at Todhunter with circuit breakers rated 80 kA interrupting is included in this Direct Connection cost estimate.

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The total cost to install the facilities summarized in above is estimated by DEO as follows:

345 kV Line work:		$ 2,954,014
IC Interconnection Substation work:	$ 5,537,494	
Todhunter Substation work (345 kV line relays and 138 kV circuit breaker replacements):		$ 6,643,353
Foster Substation work:		$ 311,542
Total Estimated Cost of work to be performed by Duke Energy-Ohio:		$15,443,319

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PJM Interconnection Study Results

The following are the results of the analysis performed by PJM engineers with respect to the transmission system impacts.

Network Impacts

The Queue Project #Z1-079 was studied as a 540.0 MW (Capacity 540.0 MW) injection as a tap of the Todhunter – Foster 345 kV line in the DEOK area. Project #Z1-079 was evaluated for compliance with reliability criteria for summer peak conditions in 2017. 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).

Multiple Facility Contingency

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

1. (DEO&K - DEO&K) The 08TDHNTR-08NICKEL 138 kV line (from bus 250105 to bus 250138 ckt 1) loads from 72.94% to 102.76% (**DC power flow**) of its emergency rating (201 MVA) for the tower line contingency outage of 'CIRCUIT5381&4515FOSTERTODHUNTER_A'. This project contributes approximately 59.96 MW to the thermal violation.

CONTINGENCY 'CIRCUIT5381&4515FOSTERTODHUNTER_A'
OPEN BRANCH FROM BUS 250098 TO BUS 250149 CKT 1 / 250098 08SHAKER 138 250149 08TP5381 138 1
OPEN BRANCH FROM BUS 250121 TO BUS 250149 CKT 1 / 250121 08UNION 138 250149 08TP5381 138 1
OPEN BRANCH FROM BUS 250139 TO BUS 250149 CKT Z1 / 250139 08ROCKIE 138 250149 08TP5381 138 1

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OPEN BRANCH FROM BUS 250003 TO BUS 250121 CKT 1 / 250003 08CRLISL 138 250121 08UNION 138 1
OPEN BRANCH FROM BUS 249566 TO BUS 916330 CKT 1 / 249566 08FOSTER 345 249574 08TDHNTR 345 1
END

Please refer to Appendix 1 for a table containing the generators having contribution to this flowgate.

Short Circuit

(Summary form of Cost allocation for breakers will be inserted here if any)

In accordance with the RTEP process, a short circuit analysis was conducted by PJM and confirmed by the DEOK Protection staff. The analysis determined that thirteen (13) transmission circuit breakers will exceed their interrupting capability with the interconnection of the Todhunter-Foster 345 kV generation project.

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)

1. (OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 2) loads from 136.71% to 141.43% (**DC power flow**) of its emergency rating (971 MVA) for the single line contingency outage of '6430_B2_TOR22_WOMOAB_D'. This project contributes approximately 61.85 MW to the thermal violation.

CONTINGENCY '6430_B2_TOR22_WOMOAB_D'
OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242529 05TRISTA 345 248005 06KYGER 345 1
END

Please refer to Appendix 2 for a table containing the generators having contribution to this flowgate.

2. (OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 1) loads from 136.75% to 141.47% (**DC power flow**) of its emergency rating (971 MVA) for the single line contingency outage of '6430_B2_TOR22_WOMOAB_E'. This project contributes approximately 61.85 MW to the thermal violation.

CONTINGENCY '6430_B2_TOR22_WOMOAB_E'

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OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 2 / 242529 05TRISTA 345 248005 06KYGER 345 1
END

Please refer to Appendix 3 for a table containing the generators having contribution to this flowgate.

Steady-State Voltage Requirements
(Results of the steady-state voltage studies should be inserted here)

To be determined

Stability and Reactive Power Requirement
(Results of the dynamic studies should be inserted here)

In accordance with the RTEP Study process, the results of a dynamic analysis for the Todhunter-Foster 345 kV generation project will be included in the System Impact Study stage of the RTEP process.

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

1. (DEO&K - DEO&K) The 08TDHNTR-08NICKEL 138 kV line:
Reconductor the Todhunter – Nickel 138 kV line. Estimated Cost: $1.5M; Estimated Time: 2 years following the signing of an ISA.

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)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

1, 2. (OVEC - AEP) The 06KYGER-05SPORN 345 kV line:
Replace Kyger Riser. Estimated Cost: $100,000

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

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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.

Not Applicable

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Summary

This generation project's Interconnection will require the facility upgrades identified in this report above estimated at $17,043,319. This is broken down as follows:

Direct Connection Network Upgrades:

- 345 kV Line work: $ 2,954,014
- IC Interconnection Substation work: $ 5,537,494

Non-Direct Network Upgrades:

- Todhunter Substation work (345 kV relays,138 kV breaker replacement) $ 6,643,353
- Foster Substation work: $ 311,542
- Reconductor the Todhunter – Nickel 138 kV line.* $ 1, 500,000
- Replace Kyger Riser.* : $ 100,000

$17,043,319

Therefore, the total project cost estimate is $17,043,319 and the estimated 2 years to construct.

Estimated Time: 2 years following the signing of an ISA

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Project Location

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Proposed Interconnection Single Line Diagram

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Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. Although this information is not used "as is" for cost allocation purposes, it can be used to gage other generators impact.

It should be noted the generator contributions presented in the appendices sections are full contributions, whereas in the body of the report, those contributions take into consideration the commercial probability of each project.

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Appendix 1

(DEO&K - DEO&K) The 08TDHNTR-08NICKEL 138 kV line (from bus 250105 to bus 250138 ckt 1) loads from 72.94% to 102.76% (**DC power flow**) of its emergency rating (201 MVA) for the tower line contingency outage of 'CIRCUIT5381&4515FOSTERTODHUNTER_A'. This project contributes approximately 59.96 MW to the thermal violation.

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OPEN BRANCH FROM BUS 250139 TO BUS 250149 CKT Z1 / 250139 08ROCKIE 138 250149 08TP5381 138 1
OPEN BRANCH FROM BUS 250003 TO BUS 250121 CKT 1 / 250003 08CRLISL 138 250121 08UNION 138 1
OPEN BRANCH FROM BUS 249566 TO BUS 916330 CKT 1 / 249566 08FOSTER 345 249574 08TDHNTR 345 1
END

Bus Number	Bus Name	Full Contribution
251944	08D.CRK1	0.49
251945	08D.CRK3	0.07
251946	08D.CRK4	0.16
251963	08WSDLE2	0.32
251964	08WSDLE3	0.32
251965	08WSDLE4	0.32
251966	08WSDLE5	0.32
251967	08WSDLE6	0.32
252343	STCLAIR1	1.26
916331	Z1-079 OP1	59.96

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Appendix 2

(OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 2) loads from 136.71% to 141.43% (**DC power flow**) of its emergency rating (971 MVA) for the single line contingency outage of '6430_B2_TOR22_WOMOAB_D'. This project contributes approximately 61.85 MW to the thermal violation.

CONTINGENCY '6430_B2_TOR22_WOMOAB_D'
OPEN BRANCH FROM BUS 242528 TO BUS 248005 CKT 1 / 242529 05TRISTA 345 248005 06KYGER 345 1
END

Bus Number	Bus Name	Full Contribution
243382	05TANNER	28.28
251934	08BCKJD2	12.65
251935	08BCKJD3	17.23
251936	08BCKJD4	20.32
251937	08BCKJD5	31.36
251938	08BCKJD6	67.32
251940	08BKJGT1	0.23
251941	08BKJGT2	0.23
251942	08BKJGT3	0.23
251943	08BKJGT4	0.23
251962	08WSDLE1	0.34
251963	08WSDLE2	0.34
251964	08WSDLE3	0.34
251965	08WSDLE4	0.34
251966	08WSDLE5	0.34
251967	08WSDLE6	0.34
253038	09KILLEN	3.03
253058	09OHH C.	9.77
253059	09OHH E.	8.61
247536	S-071 C	1.6
252343	STCLAIR1	2.81
247543	V3-007 C	1.9
247544	V3-008 C	1.9
247545	V3-009 C	1.9
247515	V4-033 C	2.94
W2-033	W2-033	74.35
247588	W4-004 C	0.91

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247589	W4-008 C	0.91
X1-056	X1-056	3.83
X1-057	X1-057	3.83
X1-058	X1-058	3.83
X2-042	X2-042	48.8
Y2-006	Y2-006	23.89
Y2-030	Y2-030	15.94
Y2-031	Y2-031	15.94
Y2-032	Y2-032	15.94
Y2-068	Y2-068	170.83
915791	Y3-031AC	1.86
915491	Y3-073	5.61
Z1-007	Z1-007	6.96
Z1-070A	Z1-070A	11.01
Z1-070B	Z1-070B	46.5
916331	Z1-079 OP1	61.85

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Appendix 3

(OVEC - AEP) The 06KYGER-05SPORN 345 kV line (from bus 248005 to bus 242528 ckt 1) loads from 136.75% to 141.47% (**DC power flow**) of its emergency rating (971 MVA) for the single line contingency outage of '6430_B2_TOR22_WOMOAB_E'. This project contributes approximately 61.85 MW to the thermal violation.

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251935	08BCKJD3	17.23
251936	08BCKJD4	20.32
251937	08BCKJD5	31.36
251938	08BCKJD6	67.32
251940	08BKJGT1	0.23
251941	08BKJGT2	0.23
251942	08BKJGT3	0.23
251943	08BKJGT4	0.23
251962	08WSDLE1	0.34
251963	08WSDLE2	0.34
251964	08WSDLE3	0.34
251965	08WSDLE4	0.34
251966	08WSDLE5	0.34
251967	08WSDLE6	0.34
253038	09KILLEN	3.03
253058	09OHH C.	9.77
253059	09OHH E.	8.61
247536	S-071 C	1.6
252343	STCLAIR1	2.81
247543	V3-007 C	1.9
247544	V3-008 C	1.9
247545	V3-009 C	1.9
247515	V4-033 C	2.94
W2-033	W2-033	74.35
247588	W4-004 C	0.91

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247589	W4-008 C	0.91
X1-056	X1-056	3.83
X1-057	X1-057	3.83
X1-058	X1-058	3.83
X2-042	X2-042	48.8
Y2-006	Y2-006	23.89
Y2-030	Y2-030	15.94
Y2-031	Y2-031	15.94
Y2-032	Y2-032	15.94
Y2-068	Y2-068	170.83
915791	Y3-031AC	1.86
915491	Y3-073	5.61
Z1-007	Z1-007	6.96
Z1-070A	Z1-070A	11.01
Z1-070B	Z1-070B	46.5
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