Interconnection Facilities Study

GEN-2010-048
(IFS-2015-001-06)

December 2016

Generator Interconnection

SPP Southwest Power Pool

Revision History

Date	Author	Change Description
12/20/2016	SPP	Draft Interconnection Facilities Study Report Revision 0 Issued

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Interconnection Facilities Study Summary

Interconnection Facilities Study Introduction

This Interconnection Facilities Study (IFS) for GEN-2010-048/IFS-2015-001-16 (Interconnection Request) is for a 70.00 MW wind farm facility located in Graham County, Kansas. The Interconnection Request was studied in the DISIS-2015-001 Impact Study and DISIS-2015-001-1 Impact Restudy as an Energy Resource Interconnection Service (ERIS) only request. The Interconnection Request was provided updated Cost Allocation in DISIS-2015-001-2 Impact Restudy. Since the posting of the DISIS-2015-001 Impact Study the Interconnection Customer has executed the IFS Agreement per Appendix 4 or Appendix 4A and provided deposit securities as required by Section 8.9 of the Generator Interconnection Procedures (GIP) to proceed to the IFS. The GIP is covered under Attachment V of the Southwest Power Pool (SPP) Open Access Transmission Tariff (OATT). The request for interconnection was placed with SPP by the requesting customer (Interconnection Customer) in accordance with the OATT, which covers new generation interconnections on SPP's transmission system.

Midwest Energy Inc. (MIDW) performed a detailed IFS at the request of SPP for the Interconnection Request. Interconnection Customer's original in-service date for the Interconnection Request is December 30, 2017. SPP has proposed the full Interconnection Service will be available after the assigned Transmission Owner Interconnection Facilities and Non-Shared Network Upgrade(s) are completed. Full interconnection service will require Network Upgrade(s) listed in the "Other Network Upgrade(s)" section.

The primary objective of the IFS is to identify necessary Transmission Owner Interconnection Facilities, network upgrade(s), other direct assigned upgrade(s), and associated upgrade lead times needed for the addition of the requested Interconnection Service into the SPP Transmission System at the specified Point of Interconnection (POI).

Phase(s) of Interconnection Service

It is not expected that Interconnection Service will occur in phases. However, Interconnection Service will not be available until all Interconnection Facilities and Network Upgrade(s) can be placed in service.

Credits/Compensation for Amounts Advanced for Network Upgrade(s)

Interconnection Customer shall be entitled to either credits or potentially Long Term Congestion Rights (LTCR), otherwise known as compensation, in accordance with Attachment Z2 of the SPP Tariff for any Network Upgrades, including any tax gross-up or any other tax-related payments associated with the Network Upgrades, and not refunded to the Interconnection Customer.

Interconnection Customer Interconnection Facilities

The Interconnection Request's Generation Facility is currently proposed to consist of twenty - eight (28) 2.5 MW Nordex N100 wind generators for a total generating nameplate of 70.00 MW. The 34.5kV collector system for this wind farm is planned to be connect to one (1) 115/34.5kV Interconnection Customer owned and maintained transformer at the Interconnection Customer owned substation. A short (<1) mile overhead 115kV transmission circuit will connect the

Generating Facility from the Interconnection Customer owned substation to the Point of Interconnection (POI) at a new MIDW owned and maintained 115kV bus at a new substation tapping the MIDW Beach – Redline 115kV transmission circuit. This new substation, currently referred to as GEN-2010-048 Tap, will be approximately five (5) miles from the Beach Substation along the Beach – Redline 115kV transmission circuit. The Interconnection Customer will be responsible for all of the transmission facilities connecting the Interconnection Customer owned substation to the Point of Interconnection (POI).

The Interconnection Customer will be responsible for any equipment located at the Customer substation necessary to maintain a power factor of 0.95 lagging to 0.95 leading at the POI, including approximately 1.98 Mvar[1] of reactors or install and utilize an equivalent means to compensate for injection of reactive power into the transmission system under no/reduced wind conditions. Also, the Interconnection Customer will need to coordinate with the Transmission Owner for relay, protection, control, and communication system configurations.

Transmission Owner Interconnection Facilities and Non-Shared Network Upgrade(s)

To facilitate interconnection, the interconnecting Transmission Owner, MIDW, will need to construct a new GEN-2010-048 Tap 115kV Substation. Constructing new substation includes acquiring and preparing land, tapping the Beach – Redline 115kV transmission circuit and looping in both ends for re-termination at the new substation. Additionally, a three (3) breaker ring bus will be constructed including three (3) 2000A continuous ampacity rated 115kV circuit breaker, disconnect switches, structure, acquiring land, and any associated terminal equipment for the acceptance of the Interconnection Customer's Interconnection Facilities. Knoll Substation line relay settings will need to be updated for the addition of GEN-2010-048. Currently, it's estimated an Engineering and Construction (E&C) lead time of approximately twenty-four (24) months after a fully executed Generator Interconnection Agreement (GIA) for the completion of Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades.

The DISIS-2015-002-1 analysis determined the need to mitigate a thermal constraints observed during contingency for Beach – GEN-2010-048 Tap 115kV. MIDW identified the limitation for the thermal constraint is a wave trap at the Beach Substation. New Optical Ground Wire (OPGW) installation from Beach to the new substation will remove the need of the wave trap at Beach Substation and mitigate the thermal constraints observed on Beach – GEN-2010-048 Tap 115kV by achieve an emergency rating of 99 MVA.

At this time, Interconnection Customer is responsible for $5,121,835 of MIDW Transmission Owner Interconnection Facilities (TOIF) and Non-Shared Network Upgrade(s). **Table 1** displays the estimated costs for TOIF and Non-Shared Network Upgrade(s).

[1] This approximate minimum reactor amount is needed for the current configuration of the wind farm as studied in The Midwest Energy Inc. Facilities Study.

Table 1: Interconnection Customer TOIF and Non-Shared Network Upgrade(s)

TOIF and Non-Shared Network Upgrades Description	Allocated Cost ($)	Allocated Percent (%)	Total Cost ($)
MIDW Interconnection Substation: Transmission Owner Interconnection Facilities 115kV Substation work for one (1) new line terminal, line switch, dead end structure, line relaying, communications, revenue metering, and line arrestors.	$980,762	100%	$980,762
MIDW Interconnection Substation - Non-Shared Network Upgrades 115kV Substation work for a new 115kV three (3) breaker ring bus, three (3) new line terminal, three (3) 2000A circuit breakers, control panel replacement, line relaying, disconnect switches, and associated equipment. Work for acquiring land for a new substation, land preparation, transmission line cut in and re-termination, OPGW installation, and Beach Substation wave trap removal.	$4,116,073	100%	$4,116,073
MIDW Knoll Substation - Non-Shared Network Upgrades Change line relay settings at Knoll for the Redline/Beach 115kV transmission line.	$25,000	100%	$25,000
Total	$5,121,835	100%	$5,121,835

Shared Network Upgrade(s)

The Interconnection Request was studied in the DISIS-2015-001 Impact Study and DISIS-2015-001-1 Impact Restudy as an Energy Resource Interconnection Service (ERIS) only request. The Interconnection Request was provided updated cost allocation in DISIS-2015-001-2 Impact Restudy. At this time, the Interconnection Customer is allocated $0 for Shared Network Upgrades. If higher queued Interconnection Request(s) withdraw from the queue, suspend or terminate their GIA, restudies will have to be conducted to determine the Interconnection Customers' allocation of Shared Network Upgrades. All studies have been conducted on the basis of higher queued Interconnection Request(s) and the Network Upgrade(s) associated with those higher queued Interconnection Requests being placed in service. At this time, the Interconnection Customer is allocated the following cost listed in **Table 2** for Shared Network Upgrade.

Table 2: Interconnection Customer Shared Network Upgrades

Shared Network Upgrades Description	Allocated Cost ($)	Allocated Percent (%)	Total Cost ($)
Currently not allocated Shared Network Upgrades	$0	n/a	$0
Total	$0	n/a	$0

Other Network Upgrade(s)

Certain Other Network Upgrades are currently not the cost responsibility of the Interconnection Customer but will be required for full Interconnection Service.

1) Arnold – Ransom 115kV circuit #1 terminal equipment replacement assigned to DISIS-2014-002 Interconnection Customer(s)
2) Buckner – Spearville 345kV circuit #1 terminal equipment replacement assigned to DISIS-2010-002 Interconnection Customer(s)
3) Mingo 345/115/13kV Transformer Project – assigned from the 2015 Integrated Transmission Plan 10 year assessment (2015 ITP10) per SPP-NTC-200325. This project currently has an anticipated in-service date of 7/15/2016.

Depending upon the status of higher or equally queued customers, the Interconnection Request's in-service date is at risk of being delayed or their Interconnection Service is at risk of being reduced until the in-service date of these Other Network Upgrades.

Conclusion

Interconnection Service for the Interconnection Request will be delayed until the Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades are constructed. The Interconnection Customer is responsible for $5,121,835 of Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades. At this time, the Interconnection Customer is allocated $0 for Shared Network Upgrades. After all Interconnection Facilities and Non-Shared Network Upgrades have been placed into service, Interconnection Service for 70.00 MW, as requested by the Interconnection Customer can be allowed.

At this time the total allocation of costs assigned to Interconnection Customer for interconnection Service are estimated at $5,121,835.

Appendices

A: MIDW Transmission Owner Interconnection Facilities Study Report

See next page for detailed IFS Report.

Midwest Energy Inc.

Facility Study for Generation Interconnection Request GEN-2010-048

March 10, 2016

Contents

Study Overview

At the request of Southwest Power Pool (SPP), Midwest Energy developed the following generation interconnection facility study for interconnection request GEN-2010-048. GEN-2010-048 consists of 70 MW of wind generation interconnecting at a Midwest Energy's line between Beach 115 kV and Redline 115 kV substation.

The purpose of this study is to identify network upgrades required on Midwest Energy's transmission system. Additional network upgrades required for facilities of other transmission owners are not included in this study. The wind collector system, collector substation, and the 115 kV transmission line required between the collector substation and point of interconnection are not addressed in this study and are considered the responsibility of the Interconnection Customer.

Interconnection Facilities and Network Upgrades

A 115 kV breaker station will be constructed approximately 5 miles from the Beach substation in the Beach-Redline 115 kV line to accommodate the generation interconnection. The breaker station will be owned and operated by Midwest Energy, and will be separate from the Interconnection Customer's collector substation facilities. Due to the close proximity of the proposed breaker station to Beach substation, it will be necessary to replace one of the existing static wires from Beach substation to the breaker station to new Optical Ground Wire (OPGW). New OPGW installation will remove the need of the wave trap at Beach substation, and will facilitate the use of line current differential protection on this short line segment. Line relaying at Beach substation will be replaced to accommodate the installation of new OPGW and upgrade of the relaying, along with the removal of the wave trap. Line relaying at Knoll Substatin for the Redline/Beach 115kV transmission line will also be required. Cost estimates for the facilities and equipment required for interconnection, including the Beach relaying and static wire replacement, can be found in Table 1.

Table 1-Interconnection Facility Cost Estimate

Facility	Estimated Cost
115 kV Line Terminal (Dead end structure, metering, relaying, etc.)	$980,762
115 kV Breaker Station (Breaker station site work, breakers, bus, OPGW, etc.)	$4,116,073
Knoll 115kV Substation (line relay work)	$25,000
Total	$5,121,835

The information currently available indicates that the Interconnection Customer's Interconnection Facilities might be located in close proximity to the proposed Transmission Owner's Interconnection Facilities at the new substation described above. In this regard, it should be noted that Midwest Energy will not allow the Interconnection Customer's Interconnection Facilities or collector system equipment to be located within the same substation fence as the facilities owned by Midwest Energy, Inc. for security reasons. The Interconnection Customer will remain responsible for all new facilities outside the Point of Interconnection to be established in the new substation, and the cost estimate above is predicated on this requirement.

A conceptual one-line diagram for the new Beach 115 kV and Redline 115 kV substation including GEN-2010-048 Interconnection Facilities can be found in Attachment A.

Thermal Overload Considerations

Steady State analysis was performed to evaluate the impact on thermal loading and voltage to the Midwest Energy's transmission system. The results showed that the interconnection of GEN-2010-048 overloaded Beach station to new tap 115 kV line. Beach station to new tap 115 kV line was overloaded with the Post Rock 345/230 kV transformer contingency (loading of 83 MVA which was 103.75% of line rating) in the 2025 Summer Peak case. The element that constraints the line rating of 80 MVA was a wave trap at Beach station. Since the wave trap will be removed and replaced with OPGW, Beach station to new tap 115 kV line normal operation rating would be 83 MVA and emergency rating would be 99 MVA. The new emergency rating (99 MVA) will be higher than the highest thermal loading (83 MVA) found from the steady state analysis.

Reactive Compensation Considerations

Reactor study was performed to evaluate the need of the reactor at the collector substation. The study was performed with the worst condition assumption when the Point of Interconnection was 1.05 p.u. and no wind scenario (the wind farm output was 0.0 MW and 0.0 MVar). The study result showed that the 1.98 MVar or higher reactor is necessary to compensate the Ferranti effect of the charging from the equivalent collector line. If the total charging of the collector lines and 115 kV line from the Point of Interconnection to the collector substation is different from the equivalent model, then different size of the reactor will be required.

Also, if there is any voltage or reactive power supply issue found during DISIS process, additional capacitors, reactors and switching/control equipment may be requested. Per tariff requirements, the Generating Facility will be required to meet the standard 95% power factor requirement at the Point of Interconnection.

Midwest Energy will require the Interconnection Customer to install:

a. The reactor has to be 1.98 MVar or higher to fully compensate the Ferranti effect of the equivalent collector line.
b. Sufficient capacitors, reactors and switching/control equipment to maintain the 1.05 p.u. at the Point of Interconnection.

Attachment A

Conceptual One-Line Diagram