



Interconnection Facilities Study

**GEN-2015-016
(IFS-2015-001-05)**

February 2016

Generator Interconnection



Revision History

Date	Author	Change Description
1/19/2016	SPP	Draft Interconnection Facilities Study Report Revision Issued
2/24/2016	SPP	Final Interconnection Facilities Study Report Revision Issued

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Interconnection Facilities Study Summary

Interconnection Facilities Study Introduction

This Interconnection Facilities Study for GEN-2015-016/IFS-2015-001-05 (Interconnection Request) is for a 200.0 MW wind farm facility located in Allen 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) and Network Resource Interconnection Service (NRIS) request. Since the posting of the DISIS-2015-001 Impact Study the Interconnection Customer has executed the Interconnection Facilities Study Agreement per Appendix 4 or Appendix 4A and provided deposit securities as required by the Section 8.9 of the Generator Interconnection Produce (GIP) to proceed to the Interconnection Facilities Study. 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 OATT, which covers new generation interconnections on SPP's transmission system.

Kansas City Power and Light Company (KCPL) and Westar Energy, Inc. (WERE) performed detailed Interconnection Facilities Studies at the request of SPP for the Interconnection Request. Interconnection Customer's original in service date for the Interconnection Request is December 31, 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 Interconnection Facilities Study (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 additional of the requested Interconnection Service into the SPP Transmission System at the specific 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 Generating Facility is currently proposed to consist of one hundred (100) 2.0 MW Vestas V110 VCSS Wind Turbines for a total generating nameplate of 200.00 MW. The 34.5kV collector system for this wind farm is planned to be connect to one (1) 161/34.5kV

Interconnection Customer owned and maintained transformer at the Interconnection Customer owned substation. A four (4) mile overhead 161kV transmission circuit will connect the Generating Facility from the Interconnection Customer owned substation to the Point of Interconnection (POI) at the a new KCPL owned and maintained 161kV bus at a new substation. This new substation will tap and tie into the existing Centerville (KCPL) – Marmaton (WERE) 161kV transmission circuit. The location of the new substation will be approximately ten (10) miles from Marmaton Substation in Allen County, Kansas on the Centerville – Marmaton 161kV 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 10.9 Mvar¹ of reactors or install and utilize an equivalent means to compensate for injection of reactive power into the transmission system under no/light 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, KCPL, will need to construct a new substation including a three (3) breaker ring bus, three (3) 2000A continuous ampacity rated 161kV circuit breakers, disconnect switches, structure, and any associated terminal equipment for the acceptance of the Interconnection Customer’s Interconnection Facilities. Currently, KCPL estimates an Engineering and Construction (E&C) lead time of approximately eighteen (18) months after a fully executed Generator Interconnection Agreement (GIA) for the completion of Transmission Owner Interconnection Facilities and Non-Shared Network Upgrades. Interconnection Customer is responsible for \$8,080,000 of KCPL Transmission Owner Interconnection Facilities (TOIF) and Non-Shared Network Upgrade(s). Additionally, WERE will need to update relay settings and replace a relay panel at Marmaton 161kV Substation for the interconnection of the Generating Facility. Currently, WERE estimates an Engineering and Construction (E&C) lead time of approximately six (6) weeks after a fully executed Generator Interconnection Agreement (GIA) for the completion of the WERE Non-Shared Network Upgrades. Interconnection Customer is responsible for \$110,000 of WERE Non-Shared Network Upgrade(s). At this time, Interconnection Customer is responsible for \$8,190,000 of KCPL and WERE 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).

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

TOIF and Non-Shared Network Upgrades Description	Allocated Cost (\$)	Allocated Percent (%)	Total Cost (\$)
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¹ This approximate minimum reactor amount is needed for the current configuration of the wind farm as studied in Appendix C.

KCPL Interconnection Substation: Transmission Owner Interconnection Facilities 161kV Substation work for one (1) new line terminal, line switch, dead end structure, line relaying, and revenue metering.	\$600,000	100%	\$600,000
KCPL Interconnection Substation - Non-Shared Network Upgrades 161kV Substation work for a new three (3) breaker ring bus, three (3) 2000A circuit breaker, line relaying, disconnect switches, communication, and associated equipment. Work for substation land, and transmission line cut-in.	\$7,330,000	100%	\$7,330,000
KCPL Centerville Substation - Non-Shared Network Upgrades 161kV Substation work Centerville line relaying. and replacing relay panel.	\$150,000	100%	\$150,000
WERE Marmaton Substation - Non-Shared Network Upgrades 161kV Substation work to replace relay panel and relay settings for the acceptance of the new generation	\$110,000	100%	110,000
Total	\$8,190,000	100	\$8,190,000

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) and Network Resource Interconnection Service (NRIS) request. 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) Currently no Other Network Upgrades are assigned

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 \$8,190,000 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 Network Upgrades have been placed into service, Interconnection Service for 200.00 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 \$8,190,000.

Appendices

A: KCPL Transmission Owner Interconnection Facilities Study Report

See next page for KCPL Interconnection Facilities Study Report.



**Kansas City Power & Light Company
Facility Study for Southwest Power Pool
Generation Interconnection Request
GEN-2015-016**

Prepared by: Kansas City Power & Light Transmission Planning
October 29, 2015

Executive Summary

Pursuant to the Southwest Power Pool (SPP) Open Access Transmission Tariff (Tariff) and at the request of SPP, Kansas City Power & Light Company (KCP&L) performed the following Facility Study to satisfy the Facility Study Agreement executed by the requesting customer for SPP Generation Interconnection request Gen-2015-016. The request for interconnection was placed with SPP in accordance the Tariff, which covers new generation interconnections on SPP member's transmission system. The customer requests interconnection service for a 200-MW wind farm to tap the existing Centerville-Marmaton 161kV transmission line in southeast Kansas. The customer has proposed a commercial operation date of December 31, 2017. The requirements for interconnection consist of construction of a new 161kV substation on the Centerville-Marmaton 161kV transmission line in Allen County, near Moran, Kansas.

The total cost for KCP&L to construct the new 161kV substation, the interconnection facility, is estimated at \$8,080,000. This estimate is accurate to +/- twenty (20) percent, based on current prices, in accordance with Attachment A of Appendix 4 of the Interconnection Facilities Study Agreement. However, recent cost fluctuations in materials are very significant and the accuracy of this estimate at the time of actual procurement and construction cannot be assured.

This Facility Study does not guarantee the availability of transmission service necessary to deliver the additional generation to any specific point inside or outside the SPP transmission system. The transmission network facilities may not be adequate to deliver the additional generation output to the transmission system. If the customer requests firm transmission service under the SPP Tariff at a future date, Network Upgrades or other new construction may be required to provide the service requested under the SPP Tariff.

Interconnection Facilities

The primary objective of this study is to identify the transmission owner network upgrades for interconnection facilities. The customer desires to interconnect a 200-MW wind farm using VESTA V110 wind turbines (2.0 Mw each) to the existing Centerville-Marmaton 161 kV transmission line near Moran, Kansas. The proposed commercial operation date is December 31, 2017. In accordance with KCP&L Facility Connection Standards, the requirements for interconnection consist of adding a new 161kV substation on the Centerville-Marmaton transmission line in Allen County Kansas. This 161kV substation shall be constructed, owned, and maintained by KCP&L. A one-line diagram of the proposed substation is shown in Figure 1 on page 6. The customer will be responsible to construct, own and maintain all facilities on the customer's side of the point of interconnection. Because the Centerville-Marmaton line is a tie line between KCP&L and Westar, it is necessary to coordinate this study and construction work with Westar. The major components of the transmission owner network upgrades and their estimated costs are shown below.

KCP&L substation land	\$ 152,000
KCP&L substation	\$6,448,000
KCP&L transmission line cut-in	\$ 495,000
KCP&L microwave communications	\$ 100,000
KCP&L Centerville line relaying	\$ 150,000
KCP&L AFUDC & contingencies	\$ 735,000
Total	\$8,080,000

Description of transmission owner network upgrades

KCP&L substation land: KCP&L will require 7 acres for substation site next to Centerville-Marmaton transmission line. The Customer may opt to convey necessary land rights for substation site to KCP&L. The Customer is responsible for acquiring the right of way required from the customer's wind farm to the KCP&L substation.

KCP&L substation: KCP&L will grade site to level and construct 161kV ring bus substation with three 161kV breakers and three line terminal positions. Includes all bus work, line and disconnect switches, ground grid, security fence, control house, system protection relaying, communications equipment, and station power equipment. The substation shall have a 2000 amp continuous rating and have the capability of interrupting 40,000 amps of fault current. A disturbance monitoring device shall be installed that is capable of recording faults, frequency swings and other system disturbances. This device shall be equipped with a GPS time clock and shall be capable of using existing telephone systems.

KCP&L transmission line cut-in: KCP&L will install two new 161-kV transmission dead-end towers and conductor spans to substation bus work. Customer

is responsible for all facilities, including 161kV transmission elements, on the customer's side of the interconnection point.

KCP&L microwave communications: Engineering, licensing, radio and multiplex hardware, tower construction, and labor for microwave communications for system protection system, voice communications, and data telemetry.

KCP&L Centerville line relaying: New relays and relay panels at Centerville substation.

Engineering, Procurement, and Construction Schedule: A nominal schedule for KCP&L to design, procure equipment and construct a 161kV substation of this type is approximately 18 months. According to good business practice, the KCP&L engineering and procurement process cannot begin until the parties have executed a mutually agreeable Generation Interconnection Agreement.

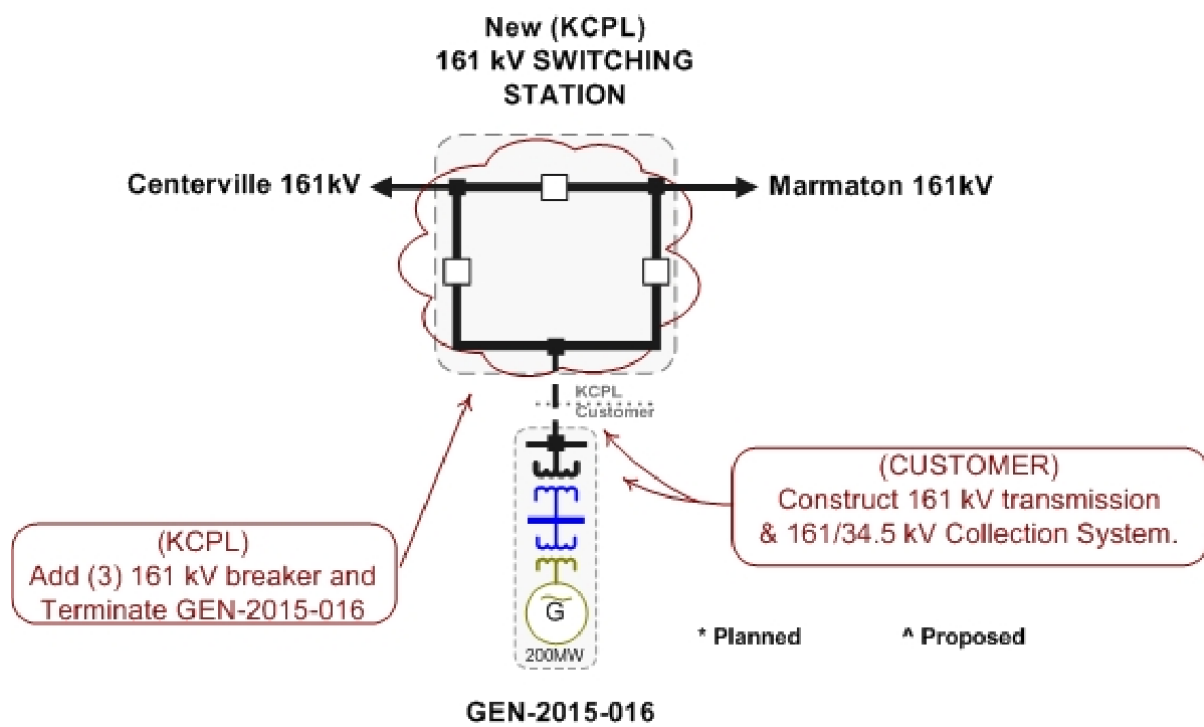
Short Circuit Fault Duty Evaluation

KCP&L engineering staff reviewed short circuit analysis performed by SPP for the proposed Dakota 161 kV substation to determine if the added generation would cause the available fault currents to exceed the interrupting capability of any existing KCP&L circuit breakers. The calculated fault currents were within KCP&L's circuit breaker interrupting capability with the addition of the Gen-2015-016 wind farm.

Other Required Interconnection Facilities

The Definitive Interconnection System Impact Study for Generation Interconnection Requests (DISIS-2015-001) dated July 2015, included power factor analysis for this Customer. The Power Factor Analysis shows that GEN-2015-016 has a power factor range of 0.971 to 0.997 leading (absorbing) for the 2015 Summer Peak conditions, a power factor range of 0.968 to 0.996 leading (absorbing) for the 2015 Winter Peak conditions, and a power factor range of 0.975 to 0.997 leading (absorbing) for the 2025 Summer Peak conditions. These power factors are within the acceptable range for KCP&L facility connection standards.

Figure 1: Preliminary One-Line Diagram Dakota 161kV Substation



B: WERE Transmission Owner Interconnection Facilities Study Report

See next page for WERE Interconnection Facilities Study Report.



Generation Interconnection Facility Study

For

**Generation Interconnection Request
SPP-GEN-2015-016**

December 3, 2015

Introduction

This report summarizes the results of a Generation Interconnection Facilities Study performed for the Southwest Power Pool (SPP) by Westar Energy (WR) to evaluate a generation interconnection request for 200 MW of wind-powered generation in eastern Kansas, to the KCPL transmission system. Although the proposed interconnection does not tie directly into a WR owned substation, it will affect the WR owned substation on the end of the KCPL owned line. A System Impact Study has been completed for this project. The requested in-service date of the generating facility is December 31, 2017.

Project Location and Existing Facilities

The project is located in Allen County in eastern Kansas. The proposed interconnection will be approximately 4 miles east of this location by way of the existing KCPL owned Centerville-Marmaton 161kV line. Figure 1 shows the approximate location of the project.

DISIS Study Review

WR has reviewed the steady-state, short-circuit, and dynamic study results for GEN-2015-016 included within SPP DISIS-2015-001 assessing the reliability impact of the proposed generation interconnection. WR agrees with the study approach and findings of the DISIS as posted by SPP.

Interconnection Facilities

Interconnection to the WR transmission system will be by way of the existing KCPL owned Centerville-Marmaton 161kV line to the WR owned Marmaton 161kV substation. No additional infrastructure will be required at the existing Marmaton 161kV substation. Relaying settings changes will be required.

161 kV Substation Work

- The estimated cost includes a new relay panel and relaying settings at the Marmaton 161kV substation after applicable protection data is received from GEN-2015-016.

The total cost estimate for the Stand Alone Network Upgrades (161 kV Substation Relay Work at Marmaton 161kV) is:

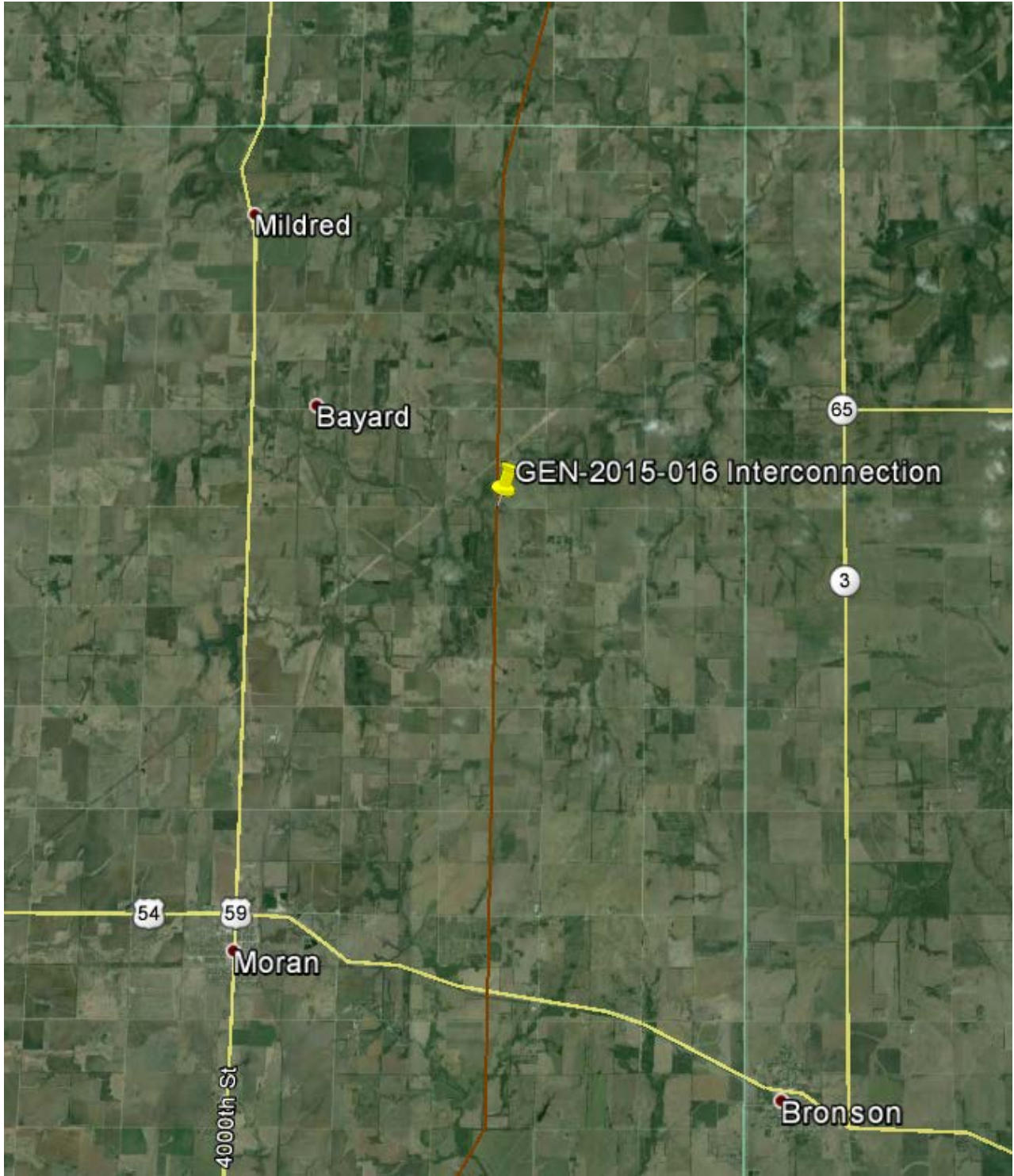
\$ 110,000 161 kV Substation Work

This estimate is accurate to +/- twenty (20) percent, based on current prices, in accordance with Attachment A of Appendix 4 of the Interconnection Facilities Study Agreement. However, recent cost fluctuations in materials are very significant and the accuracy of this estimate at the time of actual settings cannot be assured.

3 weeks	Engineering Time
0 weeks	Procurement Time
3 weeks	Construction Time
6 weeks	Total

Westar Energy also maintains its own Facility Connection Requirements, which may be found at (<http://www.oasis.oati.com/WR/index.html>).

Figure 1 – Interconnection Map



The proposed interconnection project is 10 miles from Marmaton 161kV substation.

Results of Short Circuit Analysis

As a part of this Facility Study, a short circuit study was performed to determine the available fault current at the interconnection bus (GEN-2015-016 Interconnection 161 kV) using PSS/E's activity ASCC. The 2015 and 2020 Summer Peak cases from the 2015 Series MDWG Classical, Max Fault Short-Circuit models were used. All GEN-2015-016 Wind Farm generation was taken out of service for this analysis and all other transmission facilities are in service. As a result, the numbers generated represent the available utility interconnection fault current:

2015 Summer:

- For a 3-Phase fault at the GEN-2015-016 Interconnection, the fault current is estimated to be 5796 Amps.
- For a Phase-to-Ground fault at the GEN-2015-016 Interconnection, the fault current is estimated to be 4062 Amps.

THEVENIN IMPEDANCE, X/R (OHM) Z+:2.737+j15.801, 5.77354 Z-:2.735+j15.800, 5.77778 Z0:9.032+j35.507, 3.93113

2020 Summer:

- For a 3-Phase fault at the GEN-2015-016 Interconnection, the fault current is estimated to be 5795 Amps.
- For a Phase-to-Ground fault at the GEN-2015-016 Interconnection, the fault current is estimated to be 4061 Amps.

THEVENIN IMPEDANCE, X/R (OHM) Z+:2.736+j15.804, 5.77576 Z-:2.734+j15.803, 5.78002 Z0:9.031+j35.513, 3.93217

C: Low Wind Analysis Report

See next page for Low Wind Analysis Report.



Interconnection Facilities Study

Low Wind Analysis GEN-2015-016/IFS-2015-001-05

January 2016
Generator Interconnection



Revision History

Date	Author	Change Description
1/19/2016	SPP	Low Wind Analysis Completed

Low Wind Analysis

A low wind analysis has been performed for the GEN-2015-016 (200.0 MW/ Wind) Interconnection Request. SPP performed this low wind analysis for excessive capacitive charging current for the addition of the GEN-2015-016 facilities. The high side of the 161/34.5kV GEN-2015-016/IFS-2015-001-05 Interconnection Customer’s transformer will interconnect to The Point of Interconnection (POI). The POI will be at a new 161kV bus built for the new substation tapping Centerville – Marmaton 161kV by an approximately four (4) mile overhead 161kV transmission line.

The project generators and capacitors (if any) were turned off in the base case as show in **Figure 1**. The resulting reactive power injection into the transmission network comes from the capacitance of the project’s transmission lines and collector cables.

Shunt reactors were added at the study project substation 34.5 kV bus to bring the Mvar flow into the POI down to approximately zero as show in **Figure 2**. Final shunt reactor requirement for GEN-2015-016 is approximately 10.9 Mvars. The one-line diagram in **Figure 2** shows actual Mvar output at the specific voltages in the base case. The results shown are for the 2025SP case.

The other two cases (2016WP and 2017SP) were almost identical since the Interconnection Request facilities design is the same in all cases.

Figure 1: GEN-2015-016 with generator off and no shunt reactor(s)

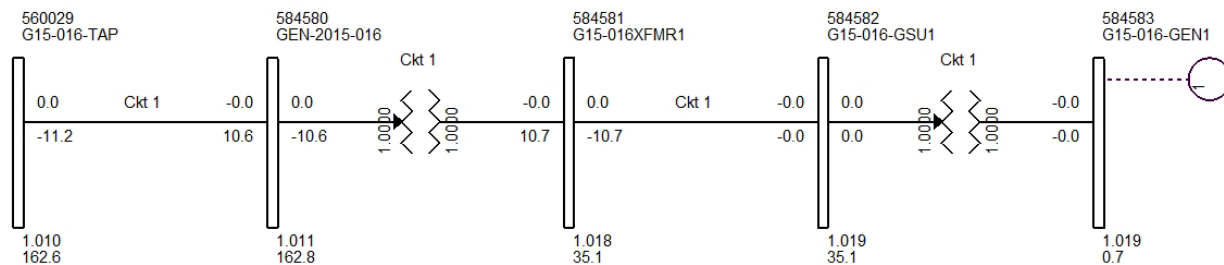


Figure 2: GEN-2015-016 with generators turned off and shunt reactors added to the low side of the GEN-2015-016 substation 161/34.5kV transformer

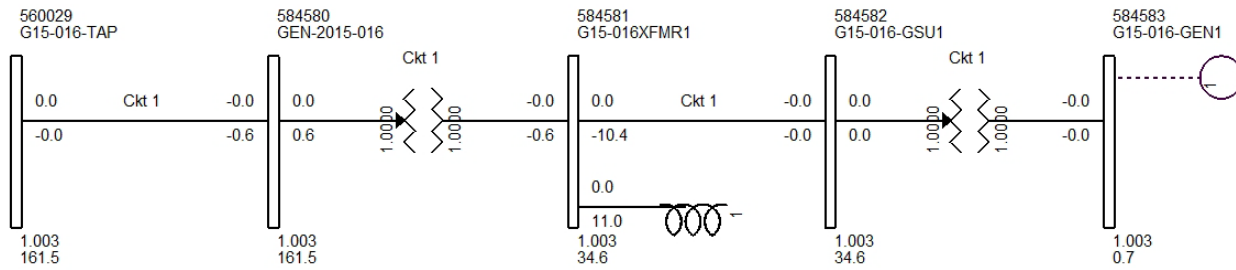


Table 1: Low Wind/No Wind Analysis

Request	Size (MW)	Point of Interconnection	Shunt Reactive Mvar Requirement
GEN-2015-016	200.00	Tap Centerville - Marmaton 161kV	10.9

Conclusion

A low wind analysis has been performed for the GEN-2015-016 Interconnection Request. SPP performed this low wind analysis for excessive capacitive charging current for the addition of the GEN-2015-016 facilities.

The low wind analysis has determined the need for the GEN-2015-016 Interconnection Request to install approximately 10.9 Mvars of reactor bank(s).