



***Facility Study
For
Generation Interconnection
Request
GEN-2007-053***

SPP Tariff Studies

(#GEN-2007-053)

February 2010

Summary

Kansas City Power & Light (KCPL) performed the following Study at the request of the Southwest Power Pool (SPP) for Generation Interconnection request Gen-2007-053. The request for interconnection was placed with SPP in accordance SPP's Open Access Transmission Tariff, which covers new generation interconnections on SPP's transmission system.

Pursuant to the tariff, KCPL was asked to perform a detailed Facility Study of the generation interconnection request to satisfy the Facility Study Agreement executed by the requesting customer and SPP.

Interconnection Customer Interconnection Facilities

The Interconnection Customer will be responsible for the 161kV transmission line from the point of interconnection to its 161/34.5kV substation that will contain its 161/34.5kV transformer(s) and wind turbine collector feeders. In addition, the Customer will be required to maintain a +/- 99% power factor at the point of interconnection (Maryville – Midway 161kV line). Using the studied Gamesa wind turbines, additional capacitors will be necessary.

Transmission Owner Interconnection Facilities and Non Shared Network Upgrades

Per the following Facility Study, the Interconnection Customer is responsible for \$700,000 of Transmission Owner Interconnection Facilities and non shared Network Upgrades.

Shared Network Upgrades

The GEN-2007-053 Interconnection Customer is included in the 1st Cluster Study approved in FERC Docket #ER09-262. Due to its isolated location, the request was studied separately from the cluster. However, GEN-2007-053 is dependent upon several higher queued interconnection requests located in the same general area. If these higher queued customers withdrawn from the queue or have their LGIA terminated, the cost allocation to the customer may change to account for these changes.



KCP&L Greater Missouri Operations Company
Facility Study for SPP
Generation Interconnection Request
GEN-2007-053

Prepared by: KCP&L Greater Missouri Operations Transmission Planning
January 5, 2010

Executive Summary

The customer requests interconnection service for a 150-MW wind farm that is tentatively located near Maryville 161/69 kV sub-station. The existing Maryville sub-station does not have room for expansion. For this reason, the interconnection is planned to occur at the proposed, new switching station located between the existing Maryville 161 kV and Midway 161 kV sub-stations.

The Gen-2007-053 wind farm has a peak capacity of 150 MW. However, the Impact Study for Generation Interconnection Request Gen-2007-053 states that only 110 MW may be generated due to the lack of voltage stability margin at the interconnection point. Therefore, this study shall model Gen-2007-053 as a 110 MW generator. The expected in service date is December 2012.

The Southwest Power Pool evaluated the request to interconnect the 150 MW of generation into the Maryville - Midway 161 kV. The System Impact Studies were complete in October 2009. The Southwest Power Pool did not conduct a Feasibility study for this generator interconnection. In response to the System Impact Study, this facility study reports the results of a short circuit study conducted on the proposed Wind Farm Switching Station 161 kV bus.

There are four wind farm projects scheduled for the Maryville – Midway 161 kV area which would result in 810 MW of generation potential. Currently, there is not enough available transmission capacity in the Maryville – Midway 161 kV area to accommodate this amount of generation. Therefore, transmission planning is performing numerous wind farm studies to determine the most cost effective solutions for interconnection to the existing transmission system. This facility study includes the wind farm generation projects Gen-2006-014, Gen-2006-017 and Gen-2007-017 and the results from their combined generation. If generation projects Gen-2006-014, Gen-2006-017 and Gen-2007-017 are removed from the queue, then the existing Maryville – Midway 161 kV transmission system can accommodate 150 MW of new generation.

Transmission planning studied three different wind mill manufacturing brands as described in the Gen-2007-017 and Gen-2007-053 Impact Studies. The wind mill brands are General Electric, Gamesa and Clipper. This study attempts to differentiate these three brands by allowing the General Electric and Gamesa wind mills to have the ability to operate either lagging or leading while the Clipper brand only operates leading.

A switching station is required to connect the wind farms to the Maryville – Midway 161 kV line. The proposed switching station shall consist of a seven circuit breaker ring bus so that all four proposed wind farm projects have an interconnection point. The switching station cost estimate to accommodate all wind farm interconnections is \$10,150,000. However, to accommodate wind farm Gen-2007-053, the interconnection cost is estimated at \$700,000 for a single 161 kV sub-station terminal at the new switching station. This assumes that prior queued projects have caused construction of the initial switching station.

Discussion

General Description

The customer desires to interconnect a 150 MW wind farm generating facility to the existing Maryville – Midway 161 kV. However, due to voltage stability issues as defined by the Impact study conducted by the Southwest Power Pool, this customer's generation shall be limited to 110 MW. To accommodate this wind farm and other proceeding customer's wind farms, a switching station shall be constructed using a seven circuit breaker, ring bus configuration. Three other wind farms shall be connected to the switching station as described in Gen-2006-014, Gen-2006-017 and Gen-2007-017. The wind farm generation amount using the projects as described by Gen-2006-014, Gen-2006-017, Gen-2007-017 and Gen-2007-053 equate to 810 MW.

Disclaimer – This study does not convey any transmission service availability. Although GEN-2007-053 will be permitted to interconnect at 110 MW at the requested point of interconnection, there will be NO available transmission service assuming that all prior queued projects are in service due to thermal overloads beyond the point of interconnection (See Feasibility Study for GEN-2007-053 as part of FCS-2008-01 posted December 2008). Any transmission service must be requested through the Southwest Power Pool OASIS. Source – Southwest Power Pool, "Impact Study for Generation Interconnection Request GEN-2007-053," Page ii, October 2009.

General Description of Modifications at Midway, Maryville or Wind Farm Switching Station.

1. Modifications at Wind Farm Switching Station: See Figure 1, page 7.

1.1 Location: The switching station location is between Maryville 161 kV and Midway 161 kV sub-stations. The existing Maryville – Midway 161 kV transmission shall be used as transmission paths for the wind farm switching station.

1.2 Bus Design: Proposed 161 kV bus design uses a seven circuit breaker, ring bus configuration, with a minimum of three 161 kV transmission lines exiting the switching station. The switching station shall have a 2000 amp continuous rating and have the capability of interrupting 40,000 amps of fault current.

1.3 Transformer: A transformer is not required.

1.4 Controls: There are no planned changes.

1.5 Line Reactors: Line reactors are not required.

1.6 Security Fence: There are no planned changes.

1.7 Ground Grid: There are no planned changes.

1.8 Site Grading: There are no planned changes.

1.9 Station Power: There are no planned changes.

1.10 Relay and Protection Scheme: There are no planned changes.

1.11 Revenue Metering: There are no planned changes.

1.12 Disturbance Monitoring Device: 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.

- 2. Communications:** Communications equipment to transmit data from the switching station interconnection point, back to the wind farm generation, to the customer's control center shall be the customer's responsibility.
- 3. Transmission Line:** The customer proposed a 13-mile, 161 kV transmission line from Wind Farm Gen-2007-053 to the Maryville 161/69 kV sub-station at customer's expense. However, the Impact Study for Generation Interconnection Request GEN-2007-053 indicates that this customer shall interconnect at the proposed Maryville – Midway 161 kV switching station. It is estimated that this interconnection shall add another 4-miles of 161 kV transmission totaling 17-miles estimated.
- 4. Right of Way (ROW):** The customer is responsible for acquiring the right of way required from the customer's wind farm to the switching station.
- 5. Engineering and Construction Schedule:** The proposed in-service date for Wind Farm Gen-2007-053 is December, 2012.
- 6. Estimated Construction Costs:** The estimated interconnection construction costs for Gen-2007-053 is \$700,000. This cost includes circuit breakers, switches, control relaying, high speed communications, metering and other related equipment and structures. However, if projects Gen-2006-014, Gen-2006-017 and Gen-2007-017 are removed from the queue, then the interconnection cost becomes \$3,500,000 estimated.

- 7. Short Circuit Study Results:** KCP&L Greater Missouri Operations personnel performed short circuit studies at the Midway – Maryville 161 kV switching station to determine if the added generation would cause the calculated fault currents using PSSE ANSI to exceed the interrupting capability of the smallest circuit breakers. The results are shown in Table 1 below:

Table 1: Short Circuit Results – 13 Mile Connection

Fault Location	Fault Current (Amps)				Impedance (Ohms)	
	Study Type	Fault Current Line - Ground	Fault Current Three-Phase	Interrupting Capability Smallest Circuit Breaker	Real	Reactive
Wind Farm Switching Station Bus Number 541382	ANSI	26,911	23,483	40,000	0.0005	0.0153

The fault currents as seen in Table 1 are within the circuit breaker interrupting capability with the addition of 110 MW contributed by Gen-2007-053. A 17-mile 161 kV transmission line results in less fault current than what is shown in Table 1.

8. Discussion Points – Other Items Considered:

- a. 161 kV Transmission line from customer generation to Point of Interconnection:** A 161 kV transmission line beginning from customer generation to the Maryville – Midway 161 kV switching station is modeled using 1192 ACSR. This 17-mile, 161 kV transmission path modeled a total impedance of 0.005797 + J0.04828 using a 100 MVA base. KCP&L Greater Missouri Operations Transmission Planning made the assumption that an extra 4-miles of conductor is required to connect to the proposed switching station instead of directly to the Maryville 161/69 kV sub-station.
- b. Static Reactive Volt Amp Reactive:** Table 2 below displays the amount of static reactive (capacitors) placed in the Maryville – Midway 161 kV area to accommodate the wind generation.

Table 2: Static Reactive Total

Wind Farm #	Proposed MVAR
Gen 2006-014	40
Gen 2006-017	40
Gen 2007-017	18
Gen 2007-053	30
Switching Station	32
Total	160

To comply with the Standard Large Generator Interconnection Agreement dated June 2, 2009, Page 36, Section 9.6.1, Power Factor Design Criteria, the generation must be able to accommodate 0.95 power factor both leading and lagging. To accommodate

800 MW of generation, 263 MVARs is required to meet the requirements found in section 9.6.1, Page 36, in the Standard Large Generator Interconnection Agreement. KCP&L Greater Missouri Operations Transmission Planning recommends these static MVAR requirements be reviewed to insure a balanced static and dynamic MVAR capability. The estimated dynamic reactive capability using a 0.95 power factor from three of the four wind farms is 164 MVAR. This estimate makes the assumption that 500 of the 810 MW produce lagging dynamic reactive MVARs. KCP&L Greater Missouri Operations Transmission Planning recommends that unit MW and MVAR (D-Curves) are referenced when optimizing the MVARs required maintaining adequate voltage conditions in the Maryville and Midway area.

- c. **Available Transmission Capacity:** Table 3 below displays the overloaded conductors from the Maryville – Midway 161 kV switching station. The simulation indicates that there is no available transmission capacity to accommodate all of the queued generation. Using these results displayed in Table 3, contingency analysis studies shall not be performed due to the significant conductor overloads using NERC Category A, steady state conditions. These conductor overloads also exceed their NERC Category B, emergency ratings.

Table 3: Conductor Overloads Using NERC Category A Steady State Conditions.

Line/XFMR Overload	MVA Rating	Current	% Normal	Overloaded Equipment	Low Voltage
Maryville - Maryville AEC 161 kV	200	250	125	Conductor	None
Maryville - Wind Farm 161 kV	153	449	294	Conductor	None
Midway - St. Joe 161 kV	153	241	157	Conductor	None
Midway - Wind Farm 161 kV	153	261	171	Conductor	None

- d. **Interconnect Location:** The Impact Study for Generation Interconnection Request GEN-2007-053, page16 displays a one-line diagram showing the GEN-2007-053 wind farm connected directly to the proposed Maryville – Midway 161 kV switching station. However, the Interconnection Facilities Study Agreement indicates that the proposed interconnection station is “NA – Existing Maryville Substation.” This may be seen on the Interconnection Facilities Study Agreement, “Original Sheet No. 445.

Figure 1: Preliminary One-Line Diagram Maryville Switching Station 161 kV

