SPP Southwest Power Pool

Feasibility Study For Generation Interconnection Request GEN-2006-003

SPP Tariff Studies
(#GEN-2006-003)

September, 2006

Executive Summary

<OMITTED TEXT> (Customer) has requested a Feasibility Study for the purpose of interconnecting 50MW of generation within the service territory of Aquila (AQU) in Atchison County, Missouri. The proposed point of interconnection is a new switching station on the 69kV normally open loop between Aquila's Maryville and Midway 161kV substations. The proposed in-service date is December 31, 2007.

Power flow analysis has indicated that for the powerflow cases studied, it is possible to interconnect the 50MW of generation with transmission system reinforcements within the local transmission systems. In order to maintain an acceptable power factor at the point of interconnection, the customer will need to install a 5MVar capacitor bank in the Customer's collector substation on the 34.5kV bus. Dynamic Stability studies performed as part of the impact study will provide additional guidance as to whether the required reactive compensation can be static or a portion must be dynamic (such as a SVC).

The requirements for interconnection consist of building a new 69kV 2-breaker substation in the 69kV normally open loop between the distribution substations of Tarkio and Burlington Jct. In addition, the entire 69kV loop between Maryville and Midway substations (approximately 75 miles) will need to be rebuilt with 477MCM ACSR conductor to accommodate the 50MW of output from the wind facility.
The Customer did not propose a specific 69kV line extending to serve its 69-34.5kV facilities. It is assumed that obtaining all necessary right-of-way for the new switching station will not be a significant expense.

The total cost for building the new 69kV substation and reconductoring of the 69kV loop between Midway and Maryville, the required interconnection facility, is estimated at $33,900,000. Other Network Constraints in the SPP system that may be verified with a transmission service request and associated studies are listed in Table 3. These Network Constraints are in the local area of the new generation when this generation is sunk throughout the SPP footprint for the Energy Resource (ER) Interconnection request. With a defined source and sink in a Transmission Service Request (TSR), this list of Network Constraints will be refined and expanded to account for all Network Upgrade requirements. This cost does not include building 69kV line from the Customer substation into the new 69kV substation bus. This cost does not include the Customer's 69-34.5kV substation or the 34.5kV, 5Mvar capacitor bank.

In Table 4, a value of Available Transfer Capability (ATC) associated with each overloaded facility is included. These values may be used by the Customer for future analyses including the determination of lower generation capacity levels that may be installed. When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. If the loading of a facility is higher, the level of ATC will be lower. These contingency analyses will have to be re-evaluated as part of a transmission service request.

The Customer may choose to reduce this generation request to 36MW, in which case the 69kV loop from Maryville to Midway substations will not have to be reconductored. If the Customer chooses to lower the generation of this request, the total Interconnection Facilities cost will be the cost of the substation, $1,100,000. The Customer will need to advise whether or not they wish to pursue this reduction of the request before they enter into an Impact Study agreement.

Introduction

<OMITTED TEXT> (Customer) has requested a feasibility study for the purpose of interconnecting 50MW of generation within the service territory of Aquila Networks (AQU) in Atchison County, Missouri. The proposed method of interconnection is to build a new 69kV switching station in the existing Tarkio-Burlington Jct. 69kV line. Under normal conditions, this line is radially fed from Aquila's Maryville 161/69kV substation. The proposed in-service date is December 31, 2007.

Interconnection Facilities

The primary objective of this study is to identify the system problems associated with connecting the plant to the area transmission system. The Feasibility and other subsequent Interconnection Studies are designed to identify attachment facilities, Network Upgrades and other direct assignment facilities needed to accept power into the grid at the interconnection receipt point.

The requirements for interconnection consist of building a new 69kV switching station in the existing Tarkio-Burlington Jct. 69kV transmission line. This transmission line is owned by AQU. It is assumed that obtaining all necessary right-of-way for the substation construction will not be a significant expense.

The Tarkio-Burlington Jct. 69kV line is part of a normally open loop. Under normal conditions, the proposed wind farm will be interconnected radially out of Maryville substation. Under other conditions, switches may be opened and closed and the wind farm substation will be interconnected radially out of Midway substation. The entire 69kV loop is rated at approximately 35MVA. To accommodate the entire wind farm output, the entire loop will need to be rebuilt/reconductored both because of thermal limits of the conductor and because of high voltages near the wind farm caused by the wind farm generation. Reconductoring the 69kV loop will alleviate both the overloading conditions and the high voltage conditions. The 69kV loop line lengths are listed below.

- Maryville-Wind Farm 22 miles
- Wind Farm-Midway 55 miles

The total cost for building the new 69kV switching station, the required interconnection facility, is estimated at $1,100,000. The cost of rebuilding the entire 69kV loop from the wind farm from Maryville to Midway is $32,800,000. Other Network Constraints in the SPP systems that were identified are listed in Table 3. These estimates will be refined during the development of the Facility study based on the final designs. This cost does not include building the 69kV facilities from the Customer substation into the new AQU 69kV switching station. The Customer is responsible for these 69kV facilities, up to the point of interconnection. This cost also does not include the Customer's 69-34.5kV substation, which should be determined by the Customer.

The costs of interconnecting the facility to the AQU transmission system are listed in Table 1 & 2. **These costs do not include any cost that might be associated with short circuit study results or dynamic stability study results**. These costs will be determined when and if a System Impact Study is conducted.

A preliminary one-line drawing of the interconnection and direct assigned facilities are shown in Figure 1.

Optional Interconnection Configuration Facilities

Due to the rating of the Tarkio-Maryville 69kV loop, 35MVA; the Customer may elect to reduce their interconnection request to 36MW. In doing so, the overloads on the 69kV system will be alleviated and the high voltage situation caused by the generation will be more manageable.

For the optional configuration, Table 1 will not change as all Direct Assigned Facilities are the same. However, Table 2 will change in that the 69kV loop reconductor will not be necessary.

Table 1: Direct Assignment Facilities

Facility	ESTIMATED COST (2006 DOLLARS)
Customer – 69-34.5 kV Substation facilities.	*
Customer – 69kV transmission line facilities between Customer facilities and AQU 69kV switching station	*
Customer - Right-of-Way for Customer facilities.	*
Customer – 34.5kV, 5MVAR capacitor bank in Customer substation	
Total	*****

Note: *Estimates of cost to be determined by Customer.

Table 2: Required Interconnection Network Upgrade Facilities

Facility	ESTIMATED COST (2006 DOLLARS)
AQU – Build 69kV switching station. Station to include breakers, switches, control relaying, high speed communications, all structures and metering and other related equipment	$1,100,000
AQU- Reconductor 69kV loop from AQU Maryville 161/69kV substation to AQU Midway 161/69kV substation to 477MCM ACSR	$32,800,000
Total	**$33,900,000**

Table 3: Required Interconnection Network Upgrade Facilities Optional Confiuration (36MW Interconnection)

Facility	ESTIMATED COST (2006 DOLLARS)
AQU – Build 69kV switching station. Station to include breakers, switches, control relaying, high speed communications, all structures and metering and other related equipment	$1,100,000
Total	**$1,100,000**

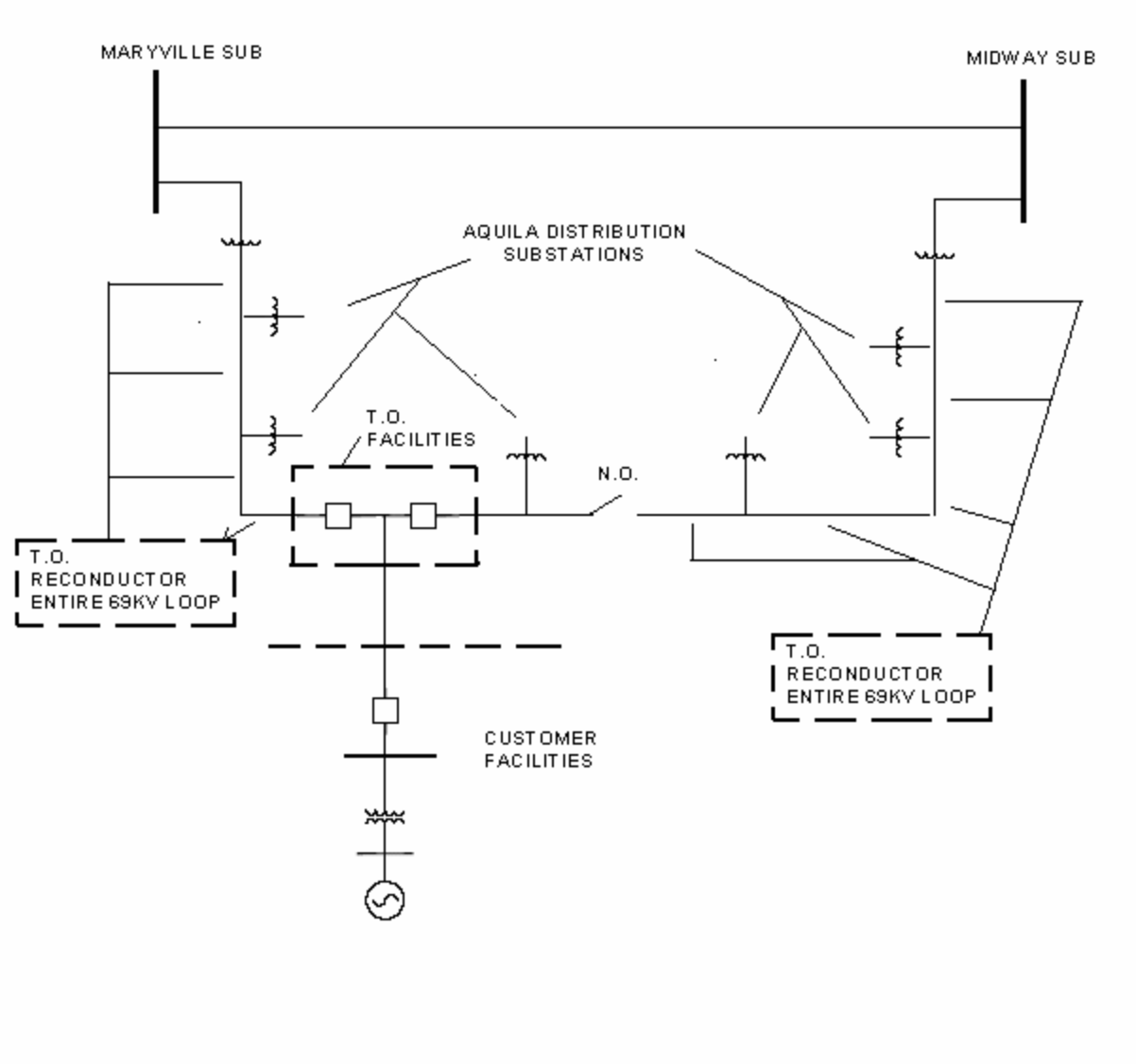

Figure 1: Proposed Interconnection
(Final substation design to be determined)

Powerflow Analysis

A powerflow analysis was conducted for the facility using modified versions of the 2007 Winter Peak, 2008 & 2011 Summer and Winter Peak, and 2016 Summer Peak models. The output of the Customer's facility was offset in each model by a reduction in output of existing online SPP generation. This method allows the request to be studied as an Energy Resource (ER) Interconnection request. The proposed in-service date of the generation is December 31, 2007. The available seasonal models used were through the 2016 Summer Peak of which is the end of the current SPP planning horizon.

The analysis of the Customer's project indicates that, given the requested generation level of 50MW and location, additional criteria violations will occur on the existing AQU 69kV network under steady state conditions. These violations include overloads on the 69kV loop between the Maryville and Midway substations and extremely high voltages at the Wind Farm, Burlington Jct., and Pickering substations. The existing 69kV loop from Maryville-Midway substation has a normal rating of 35MVA. Reconductoring the 69kV loop between the Wind Farm and Maryville (a total line length of 22 miles) and the Wind Farm and Midway (55 miles) will alleviate both the overloading in the immediate area and the high voltages.

Other network constraints are listed in Table 3. Contingency analysis is listed in Table 4. These contingency analyses will have to be re-evaluated as part of a transmission service request when the Customer requests transmission service.

In order to maintain adequate voltage in the area of the interconnection and to maintain a zero reactive power flow exchanged at the point of interconnection, additional reactive compensation is required at the point of interconnection. The Customer will be required to install 5MVAR of capacitor banks in their substation on the 34.5kV bus in the Customer substation. Dynamic Stability studies performed as part of the impact study will provide additional guidance as to whether the reactive compensation can be static or a portion must be dynamic (such as a SVC or STATCOM). It is possible that an SVC or STATCOM device will be required at the Customer facility because of FERC Order 661A Low Voltage Ride Through Provisions (LVRT) which went into effect January 1, 2006. FERC Order 661A orders that wind farms stay on line for 3 phase faults at the point of interconnection even if that requires the installation of a SVC or STATCOM device.

Optional Configuration Powerflow Analysis

Due to the rating of the Tarkio-Maryville 69kV loop, 35MVA; the Customer may elect to reduce their interconnection request to 35MW. In doing so, the overloads on the 69kV system will be alleviated and the high voltage situation caused by the generation will be more manageable.

Powerflow Analysis Methodology

The Southwest Power Pool (SPP) criteria states that: “The transmission system of the SPP region shall be planned and constructed so that the contingencies as set forth in the Criteria will meet the applicable *NERC Planning Standards* for System Adequacy and Security – Transmission System Table l hereafter referred to as NERC Table l) and its applicable standards and measurements”.

Using the created models and the ACCC function of PSS\E, single contingencies in portions or all of the modeled control areas of Aquila, KCPL, Westar, KACY, and AECI were applied and the resulting scenarios analyzed. This satisfies the ‘more probable’ contingency testing criteria mandated by NERC and the SPP criteria.

Table 3: Network Constraints

ELEMENT
AQU – WIND FARM – BURLJCT 69KV CKT 1
AQU - BURLJCT - PICKRG 69KV CKT 1
AQU – MARYVILLE #2 –PICKRG 69KV CKT 1
AQU – WIND FARM-TARKIO 69KV CKT 1
AQU – TARKIO-FAIRFAX 69kV CKT 1
AQU – FAIRFAX-CRAIG 69kV CKT 1
AQU – CRAIG – MOUND CITY 69KV CKT
AQU – MOUND CITY – BROWNS CURVE 69kV CKT 1
WERE - JARBALO JUNCTION SWITCHING STATION - STRANGER CREEK 115KV CKT 1

Table 4: Contingency Analysis

OVERLOADED ELEMENTS	RATE	LOADING (%)	SEASON	ATC	CONTINGENCY
'WINDFARM-BURLJCT269 69KV CKT1'	34.6	107	ALL SEASONS	0	'BASE CASE'
'BURLJCT269.0 - PICKRG 269.0 69KV CKT 1'	34.6	100	ALL SEASONS	0	'BASE CASE'
WINDFARM-TARKIO 269.0 69KV CKT1'	34.6	125	ALL SEASONS	0	'BASE CASE/LOOP FED FROM MIDWAY'
'FAIRFAX269.0 - TARKIO 269.0 69KV CKT 1'	34.6	109	ALL SEASONS	0	'BASE CASE/LOOP FED FROM MIDWAY'
'CRAIG 269.0 - FAIRFAX269.0 69KV CKT 1'	34.6	104	ALL SEASONS	0	'BASE CASE/LOOP FED FROM MIDWAY'
'CRAIG 269.0 - MNDCITY269.0 69KV CKT 1'	34.6	102	ALL SEASONS	0	'BASE CASE/LOOP FED FROM MIDWAY'
'JARBALO JUNCTION SWITCHING STATION - STRANGER CREEK 115KV CKT 1'	240	103	11SP	0	'CRAIG - STRANGER CREEK 345KV CKT 1'
'JARBALO JUNCTION SWITCHING STATION - STRANGER CREEK 115KV CKT 1'	240	113	16SP	0	'ARNOLD - STRANGER CREEK 115KV CKT 1'

BUS WITH HIGH VOLTAGE	VOLTAGE (pu)	CONTINGENCY
'BURLJCT269.0 69KV'	1.074283	'BASE CASE'
'TARKIO 269.0 69KV'	1.107823	'BASE CASE'
'FAIRFAX269.0 69KV'	1.104583	'BASE CASE'
'CRAIG 269.0 69KV'	1.103648	'BASE CASE'

Note: When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. If the loading of a facility is higher, the level of ATC will be lower.

Conclusion

The minimum cost of interconnecting the Customer project is estimated at $33,900,000 for Aquila's Transmission Owner interconnection facilities listed in Table 2 excluding upgrades of other transmission facilities by other SPP transmission owners listed in Table 3 of which are Network Constraints. At this time, the cost estimates for Direct Assignment facilities including those in Table 1 have not all been defined by the Customer. In addition to the Customer's proposed interconnection facilities, the Customer will be responsible for installing a 34.5kV, 5 Mvar capacitor bank in the Customer substation for reactive support.

In Table 4, a value of Available Transfer Capability (ATC) associated with each overloaded facility is included. These values may be used by the Customer to determine lower generation capacity levels that may be installed. When transmission service associated with this interconnection is evaluated, the loading of the facilities listed in this table may be greater due to higher priority reservations. These contingency analyses will have to be re-evaluated as part of a transmission service request.

These interconnection costs do not include any cost that may be associated with short circuit or transient stability analysis. These studies will be performed if the Customer signs a System Impact Study Agreement.

The required interconnection costs listed in Table 2 and other upgrades associated with Network Constraints listed in Table 3 do not include all costs associated with the deliverability of the energy to final customers. These costs are determined by separate studies if the Customer requests transmission service through Southwest Power Pool's OASIS.

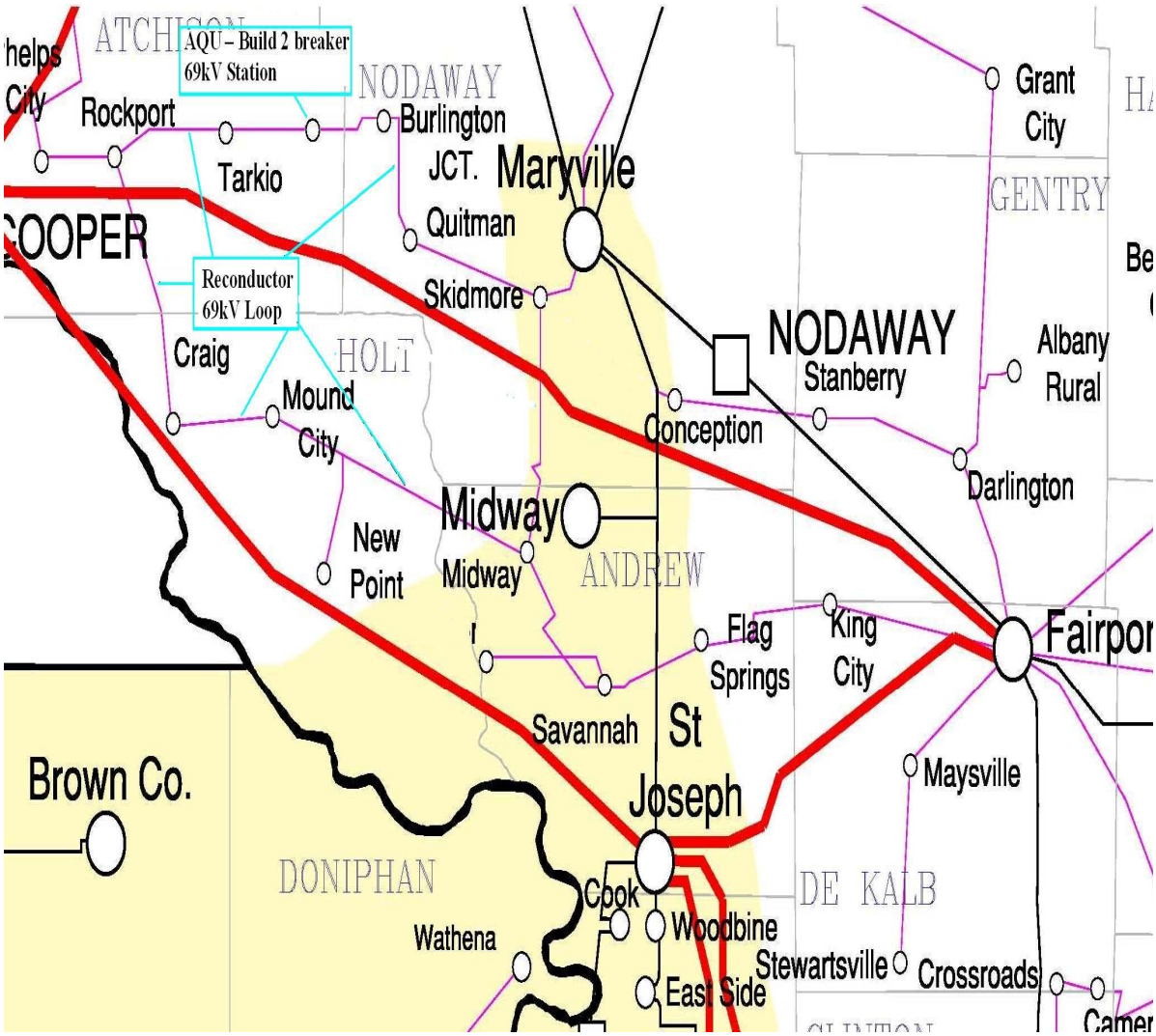

Figure 2: Map Of The Surrounding Area