Southwest Power Pool

Feasibility Study For Generation Interconnection Request GEN-2006-024S

SPP Tariff Studies
(#GEN-2006-024S)

October, 2006

Executive Summary

<OMITTED TEXT> (Customer) has requested a Feasibility Study for the purpose of interconnecting 19.8MW of wind generation within the control area of Western Farmers Electric Cooperative (WFEC) in Harper County, Oklahoma. The proposed interconnection point is 6 miles south of the Buffalo 69kV substation along the Fort Supply-Buffalo 69kV line. This line is owned by WFEC. 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 19.8MW of generation with transmission system reinforcements within the local transmission system. At this time, it is not clear whether the Customer will need to install reactive compensation in order to account for reactive losses in the transformer and the wind turbine collector circuits. Dynamic Stability studies performed as part of the impact study will provide additional guidance as to whether reactive compensation will be necessary and if it can be static or a portion must be dynamic (such as a SVC).

The requirements for interconnection consist of building a new 138kV substation, consisting of a three breaker ring bus with line terminals to Fort Supply, Buffalo, and the Customer substation. The new addition will be operated at 69kV. This 138kV addition shall be constructed and maintained by WFEC. 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 substation will not be a significant expense.

The total cost for building the 138kV substation, the required interconnection facility, is estimated at $2,080,000. Other Network Constraints in the WFEC, American Electric Power (AEP), West Plains Electric (WEPL), and Oklahoma Gas & Electric (OKGE) transmission systems 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 Energy Resource (ER) interconnection service. With a defined source and sink in a Transmission Service Request, this list of Network Constraints will be refined and expanded to account for all Network Upgrade requirements. This cost does not include the Customer's 69-34.5kV substation.

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.

There are several other proposed generation additions in the general area of the Customer's facility. It was assumed in this preliminary analysis that these other projects within the WFEC and OKGE service territories will be in service. Those previously queued projects that have advanced to nearly complete phases were included in this Feasibility Study. In the event that another request for a generation interconnection with a higher priority withdraws, then this request may have to be re-evaluated to determine the local Network Constraints.

Introduction

<OMITTED TEXT> (Customer) has requested a Feasibility Study for the purpose of interconnecting 19.8MW of wind generation within the control area of Western Farmers Electric Cooperative (WFEC) in Harper County, Oklahoma. The proposed interconnection point is along the WFEC Fort Supply-Buffalo 69kV line, 6 miles south of Buffalo 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 138kV three breaker ring bus substation with line terminals to Fort Supply, Buffalo, and the Customer substation. This 138kV substation shall be constructed and maintained by WFEC. These facilities will be initially operated at 69kV. The Customer did not propose a route of its 69kV line to serve its 69-34.5kV facilities. It is assumed that obtaining all necessary right-of-way for the new WFEC 138kV switching station will not be a significant expense.

The total cost for WFEC to build a new 138kV three breaker ring bus substation, the required interconnection facility, is estimated at $2,080,000. Other Network Constraints in the existing WFEC, AEP, WEPL, and OKGE systems that were identified are listed in Table 3. These estimates will be refined during the development of the impact study based on the final designs. This cost does not include building the 69kV line from the Customer substation to the new WFEC substation. The Customer is responsible for this 69kV line up to the point of interconnection. This cost does not include the Customer's 69-34.5kV substation. That cost estimate should be determined by the Customer.

The costs of interconnecting the facility to the WFEC transmission system are listed in Table 1 and Table 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.

Table 1: Direct Assignment Facilities

Facility	ESTIMATED COST (2006 DOLLARS)
Customer – 69-34.5 kV Substation facilities,	*
Customer – 69kV line between Customer substation and WFEC three breaker ring bus station	*
Customer - Right-of-Way for Customer Substation & Line.	*
Total	*****

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

Table 2: Required Interconnection Network Upgrade Facilities

Facility	ESTIMATED COST (2006 DOLLARS)
WFEC – Build 138kV three breaker ring bus substation with terminals to Buffalo, Fort Supply and the Customer substation. Facility to be initially operated at 69kV	$2,080,000
Total	

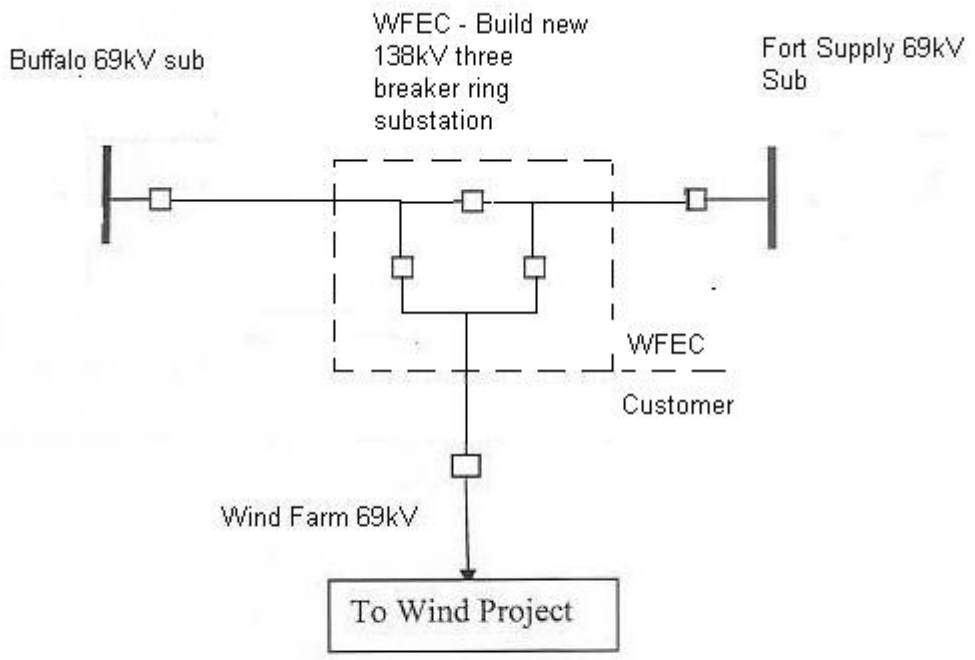

FIGURE 1. ONE-LINE OF THE INTERCONNECTION

Powerflow Analysis

A powerflow analysis was conducted for the request using modified versions of the 2007 winter, 2008, and 2011 summer and winter Peak, and the 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. The proposed in-service date of the generation is December, 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 19.8MW and location, additional criteria violations will occur on the existing WFEC, AEP, WEPL, and OKGE facilities under contingency conditions in the peak seasons. These Network Constraints 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 Energy Resource (ER) interconnection service. With a defined source and sink in a Transmission Service Request, this list of Network Constraints will be refined and expanded to account for all Network Upgrade requirements.

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 a facility is overloaded for more than one contingency, only the highest loading on the facility for each season is included in the table. Each facility may also overload for other contingencies as well. 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.

There are several other proposed generation additions in the general area of the Customer's facility. Local projects that were previously queued were assumed to be in service in this Feasibility Study. Those local projects that were previously queued and have advanced to nearly complete phases were included in this Feasibility Study.

With the information used for this study, it is unclear at this time whether any reactive compensation will be required for this generation interconnection request. At the time of the Impact Study, all wind turbines will be modeled with the detailed turbine collector feeder system. At that time, it will be clear how much capacitance may be needed to compensate for losses of the transformer and feeder system. At that time, the wind farm will be studied for FERC Order #661A compliance at which time it can be determined if the reactive compensation may need to be dynamic (SVC or STATCOM).

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 Western Farmers Electric, Oklahoma Gas & Electric, Sunflower Electric Power Cooperative, West Plains Energy, Southwestern Public Service, and American Electric Power 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

NETWORK CONSTRAINTS
AEP-WFEC '2002-05T 138 - ELK CITY 138KV CKT 1'
WFEC '2002-05T 138 - MOREWOOD SW 138KV CKT 1'
WFEC 'ALVA - CHEROKEE SW 69KV CKT 1'
WFEC 'BRANTLEY - MORWOOD 69KV CKT 1'
AEP 'CARNEGIE - HOBART JUNCTION 138KV CKT 1'
WFEC 'CARTER JCT - ERICK 69KV CKT 1'
WFEC 'FPL SWITCH - MOORELAND 138KV CKT 1'
WFEC 'FT SUPPLY - WOODWARD 69KV CKT 1'
WFEC-OKGE 'GLASS MOUNTAIN - MOORELAND 138KV CKT 1'
WFEC 'HAMON BUTLER - MOREWOOD 69KV CKT 1'
WEPL 'KNOBHILL (KNOBHIL4) 138/69/13.2KV TRANSFORMER CKT 1'
WFEC 'MOORELAND - MOREWOOD SW 138KV CKT 1'
WFEC 'MOREWOOD SW 138/69KV TRANSFORMER CKT 1'

Table 4: Contingency Analysis

ELEMENT	SEASON	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
2007 Winter Peak					
'2002-05T 138 - ELK CITY 138KV CKT 1'	07wp	130	127.1	0	'BASE CASE'
'2002-05T 138 - ELK CITY 138KV CKT 1'	07wp	158	124.4	0	'GEN:51442 1'
'FPL SWITCH - MOORELAND 138KV CKT 1'	07wp	93	192.0	0	'IODINE - WOODWARD 138KV CKT 1'
'MOREWOOD SW 138/69KV TRANSFORMER CKT 1'	07wp	56	112.2	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'FT SUPPLY - WOODWARD 69KV CKT 1'	07wp	61	117.9	0	'FT SUPPLY - IODINE 138KV CKT 1'
2008 Summer Peak					
'2002-05T 138 - ELK CITY 138KV CKT 1'	08sp	130	146.9	0	'BASE CASE'
'2002-05T 138 - ELK CITY 138KV CKT 1'	08sp	158	142.0	0	'GEN:51442 1'
'BRANTLEY - MORWOOD 69KV CKT 1'	08sp	38	114.3	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'CARTER JCT - ERICK 69KV CKT 1'	08sp	26	115.7	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'FPL SWITCH - MOORELAND 138KV CKT 1'	08sp	93	174.0	0	'IODINE - WOODWARD 138KV CKT 1'
'GLASS MOUNTAIN - MOORELAND 138KV CKT 1'	08sp	124	121.2	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'HAMON BUTLER - MOREWOOD 69KV CKT 1'	08sp	26	113.6	0	'MOORELAND - MOREWOOD SW 138KV CKT 1'
'KNOBHILL (KNOBHIL4) 138/69/13.2KV TRANSFORMER CKT 1'	08sp	67	102.4	0	'BUFFALO - WEST 69KV CKT 1'
'MOREWOOD SW 138/69KV TRANSFORMER CKT 1'	08sp	56	124.5	0	'2002-05T 138 - ELK CITY 138KV CKT 1'

Table 4: Contingency Analysis

ELEMENT	SEASON	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
'FT SUPPLY - WOODWARD 69KV CKT 1'	08sp	61	110.7	0	'FT SUPPLY - IODINE 138KV CKT 1'
2008 Winter Peak					
'2002-05T 138 - ELK CITY 138KV CKT 1'	08wp	130	130.0	0	'BASE CASE'
'2002-05T 138 - ELK CITY 138KV CKT 1'	08wp	158	126.3	0	'GEN:51442 1'
'BRANTLEY - MORWOOD 69KV CKT 1'	08wp	38	100.3	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'FPL SWITCH - MOORELAND 138KV CKT 1'	08wp	93	191.1	0	'IODINE - WOODWARD 138KV CKT 1'
'FT SUPPLY - WOODWARD 69KV CKT 1'	08wp	61	117.4	0	'FT SUPPLY - IODINE 138KV CKT 1'
'GLASS MOUNTAIN - MOORELAND 138KV CKT 1'	08wp	124	102.6	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'MOREWOOD SW 138/69KV TRANSFORMER CKT 1'	08wp	56	113.8	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
2011 Summer Peak					
'2002-05T 138 - ELK CITY 138KV CKT 1'	11sp	130	163.4	0	'BASE CASE'
'2002-05T 138 - ELK CITY 138KV CKT 1'	11sp	158	158.7	0	'GEN:51442 1'
'BRANTLEY - MORWOOD 69KV CKT 1'	11sp	38	131.5	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'FPL SWITCH - MOORELAND 138KV CKT 1'	11sp	93	170.7	0	'IODINE - WOODWARD 138KV CKT 1'
'FT SUPPLY - WOODWARD 69KV CKT 1'	11sp	61	110.3	0	'FT SUPPLY - IODINE 138KV CKT 1'
'GLASS MOUNTAIN - MOORELAND 138KV CKT 1'	11sp	124	123.5	0	'2002-05T 138 - ELK CITY 138KV CKT 1'

Table 4: Contingency Analysis

ELEMENT	SEASON	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
'HAMON BUTLER - MOREWOOD 69KV CKT 1'	11sp	26	145.7	0	'MOORELAND - MOREWOOD SW 138KV CKT 1'
'KNOBHILL (KNOBHIL4) 138/69/13.2KV TRANSFORMER CKT 1'	11sp	67	101.9	0	'BUFFALO - WEST 69KV CKT 1'
'MOREWOOD SW 138/69KV TRANSFORMER CKT 1'	11sp	56	132.0	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'OKLA WIND ENERGY CENTER 138/34.5KV TRANSFORMER CKT 1'	11sp	112	113.2	0	'GEN:98954 1'
2011 Winter Peak					
'2002-05T 138 - ELK CITY 138KV CKT 1'	11wp	130	137.9	0	'BASE CASE'
'2002-05T 138 - ELK CITY 138KV CKT 1'	11wp	158	133.7	0	'DEWEY - SOUTHARD 138KV CKT 1'
'ALVA - CHEROKEE SW 69KV CKT 1'	11wp	34	103.6	0	'CEDARDALE - MOORELAND 138KV CKT 1'
'BRANTLEY - MORWOOD 69KV CKT 1'	11wp	38	114.0	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'FPL SWITCH - MOORELAND 138KV CKT 1'	11wp	93	189.5	0	'IODINE - WOODWARD 138KV CKT 1'
'GLASS MOUNTAIN - MOORELAND 138KV CKT 1'	11wp	124	113.6	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'KNOBHILL (KNOBHIL4) 138/69/13.2KV TRANSFORMER CKT 1'	11wp	67	104.1	0	'GLASS MOUNTAIN - MOORELAND 138KV CKT 1'
'MOREWOOD SW 138/69KV TRANSFORMER CKT 1'	11wp	56	121.1	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'FT SUPPLY - WOODWARD 69KV CKT 1'	11wp	61	114.8	5	'FT SUPPLY - IODINE 138KV CKT 1'
2016 Summer Peak					
'2002-05T 138 - ELK CITY 138KV CKT 1'	16sp	130	191.8	0	'BASE CASE'
'2002-05T 138 - ELK CITY 138KV CKT 1'	16sp	158	999.0	0	'GEN:99972 1'

Table 4: Contingency Analysis

ELEMENT	SEASON	RATE (MVA)	LOADING (%)	ATC (MW)	CONTINGENCY
'2002-05T 138 - MOREWOOD SW 138KV CKT 1'	16sp	158	103.1	0	'GEN:99940 1'
'BRANTLEY - MORWOOD 69KV CKT 1'	16sp	38	147.5	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'CARNEGIE - HOBART JUNCTION 138KV CKT 1'	16sp	143	102.0	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'GLASS MOUNTAIN - MOORELAND 138KV CKT 1'	16sp	124	122.8	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'HAMON BUTLER - MOREWOOD 69KV CKT 1'	16sp	26	192.3	0	'MOORELAND - MOREWOOD SW 138KV CKT 1'
'MOORELAND - MOREWOOD SW 138KV CKT 1'	16sp	130	109.5	0	'BASE CASE'
'MOREWOOD SW 138/69KV TRANSFORMER CKT 1'	16sp	56	136.3	0	'2002-05T 138 - ELK CITY 138KV CKT 1'
'TUCO INTERCHANGE (TUCO XX4) 345/230/13.2KV TRANSFORMER CKT 1'	16sp	560	109.7	0	'GEN:51973 1'
'FT SUPPLY - WOODWARD 69KV CKT 1'	16sp	61	114.2	6	'FT SUPPLY - IODINE 138KV CKT 1'
'ALVA - CHEROKEE SW 69KV CKT 1'	16sp	34	100.1	19	'FAIRVIEW - OKEENE 69KV CKT 1'

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 $2,080,000 for WFEC's interconnection Network Upgrade facilities listed in Table 2 excluding upgrades of other transmission facilities by WFEC, AEP, OKGE, and WEPL listed in Table 3 of which are Network Constraints. At this time, the cost estimates for other Direct Assignment facilities including those in Table 1 have not been defined by the Customer. The need for reactive compensation of the request will be addressed in the Impact Study. As stated earlier, local projects that were previously queued are assumed to be in service in this Feasibility Study.

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. When a facility is overloaded for more than one contingency, only the highest loading on the facility for each season is included in the table.

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.

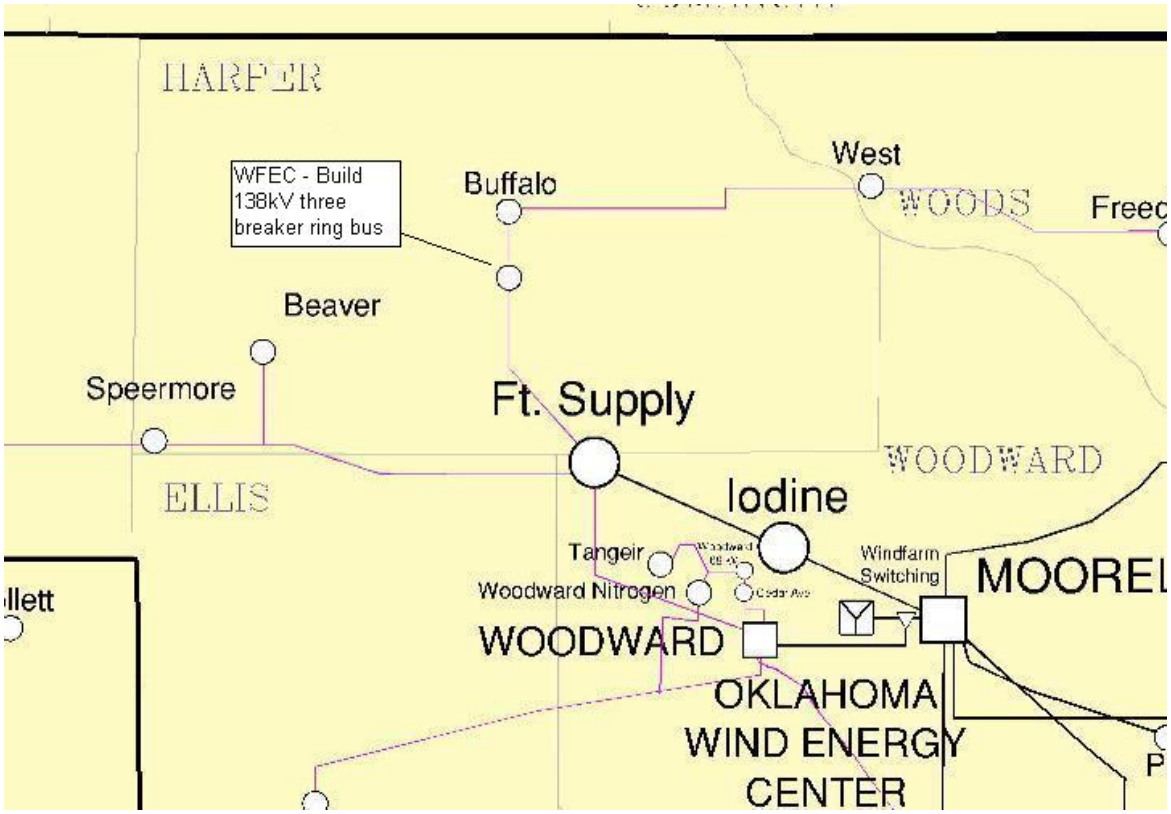

FIGURE 2. MAP OF THE LOCAL AREA