FEASIBILITY STUDY FOR -

320 MW Wind Farm On Circuit K53
Carson County, Texas
SPP #GEN-2002-019

Xcel Energy Services, Inc.
Transmission Planning

February 14, 2003

Executive Summary

>Omitted Text< (Customer) has requested a feasibility study for the purpose of interconnecting 320 MW (in blocks of 80 MW) of wind generation in Carson County, Texas within the service territory of Southwestern Public Service Company. The proposed interconnection is on the 230 kV transmission circuit K53, originating from Nichols Station near Amarillo, Texas and terminating at Grapevine Interchange in Texas. The interconnection point on the 230 kV transmission circuit is located east of Amarillo, where the 115 kV transmission circuit V60.1 crosses it.

Power flow analysis has indicated that for the powerflow cases studied, it is feasible to interconnect the 320 MW wind farm, but there will be significant transmission system reinforcements within the local Xcel Energy transmission system. However, 160 MW of generation could be connected to the 230 kV circuit K53 without significant improvements to the local transmission system. In order to maintain acceptable bus voltage at the interconnection facility, reactive power compensation will be required on the 230 kV transmission line terminating at this interconnection facility (see Figure 1). It is estimated that for each 80 MW of wind generation added, 30 MVARs needs to be added to the 230 kV system in addition to the 15 MVAR being added by the Customer on the 34.5 kV for each 80 MW of generation. This 160 MW does not address reinforcements deemed necessary as a result of the outcome of a Dynamic Stability Analysis. Stability Analysis may determine a need for system reinforcements that could not be determined by power flow analysis and this type of analysis is typically performed during the System Impact Study.

The requirements for interconnection consist of tapping the Xcel Energy 230 kV transmission circuit and building a 230 kV interconnection facility configured in a ring-bus. The facility will have at least five 230 kV breakers: three for the ring bus configuration, one for the interconnection to the Customer wind farm substation and one for the reactive power compensation facility. The new 230 kV transmission line that will interconnect with the wind farm will be located in close proximity from the new Xcel Energy 230 kV interconnection facility. A Certificate of Convenience and Necessity from the Public Utility Commission of Texas would not be required if this new 230 kV line is less than one mile.

The total cost for this 230 kV interconnection facility is estimated at $ 3.39 million dollars, which is based on estimates provided by our engineering department. The cost includes the new 230 kV interconnection facility tapping circuit K53, 1/2 mile of 230 kV transmission line from the interconnection facility to the wind farm interconnection point, and right-of-way. This cost does include 2-28.8 MVARs capacitor banks on the 230 kV for 160 MW. Dynamic Stability studies will provide guidance as the whether the reactive compensation can be static or must be dynamic (such as a SVC).

This feasibility study takes into account static system reinforcements triggered by other generation projects that are positioned ahead in the queue. In the event that these generation projects and the system reinforcements triggered by these projects are not built, this feasibility study may have to be revisited, potentially changing the requirements necessary for interconnecting this Customer’s 320 MW wind farm.

This study examines the feasibility of interconnecting this additional wind generation on the local Xcel Energy transmission system and does not address any issues that exist in determining the available transmission capacity. In order to determine the available transmission capacity, the customer needs to request transmission service through the Southwest Power Pool (SPP) OASIS.

Introduction

The Customer is proposing the interconnection of a 320 MW wind farm in Carson County, Texas that will be situated approximately 20 miles northeast of the City of Amarillo, Texas. The proposed wind generating facility has a scheduled in-service date of November 30, 2004. This farm will interconnect to an existing 230 kV transmission line currently owned by Xcel Energy, Inc. The interconnection point being located approximately 1/2 mile from the wind farm substation. The wind farm will consist of approximately 80 individual wind turbine generators for each block of 80 MW having a net generation capacity of 1.0 MW each.

The primary objective of this study was to determine the feasibility of interconnecting the facility and the level of acceptable generation (up to 320 MW in blocks of 80 MW) that could be added to the system without causing adverse impacts to the local Xcel Energy transmission system. In addition, this study addresses the issues of required construction inclusive of estimated costs, which are associated with the interconnection of this additional generation to the Xcel Energy transmission system.

Study Approach

This study uses the 2004 Summer Peak Model as presented to the SPP in January of 2002. The 2004 Summer Peak Model was developed using the 2003 Summer Peak Model. In the 2004 model the load in Area 526 (SPS) was scaled to develop the models. In addition, modifications to these models include all the new proposed generation projects along with the necessary system reinforcements triggered by these projects, which in relation to this project are positioned ahead in the queue.

The transmission system of primary concern in this feasibility study includes the Texas Panhandle including the Amarillo Metro area and all the Xcel Energy transmission system south of the Amarillo Metro area. In addition, adverse impacts on the transmission systems of other companies, although located in close proximity to this project site, will not be evaluated in this feasibility study.

This powerflow study was performed using the Power Technologies, Inc. (PTI) Power System Simulator/Engineering (PSS/E) program and contains a steady-state analysis using AC Contingency Checking (ACCC) with a Fixed Slope Decoupled Newton–Raphson (FDNS) solution. Thermal and voltage limit checks are set in accordance with SPP criteria, which state that for system intact conditions bus, voltages must be maintained between 0.95 – 1.05 per-unit of their nominal value. Under single element contingencies, the voltages are allowed to deviate between 0.90 – 1.05 per-unit of their nominal value. Thermal limit checks are comprised of both an A-rating and a B-rating. The A-rating is for system intact conditions, while the B-rating is an emergency rating under single element contingencies.

A comparative study approach was used in determining impacts caused by the interconnection of the 320 MW (in blocks of 80 MW) wind farm. The base case model included both the proposed new generation projects and the system reinforcements associated with those projects, which are positioned ahead in the queue, for the respective year/season studied. The cases have the Customer wind farm of 80 MW, 160 MW, 240 MW and 320 MW in service, and single element contingency violations within these cases were compared to the base case.

Results

The results from this study include general findings from the interconnection of the requested 320 MW (in blocks of 80 MW) and the steps taken to determine the level of generation (160 MW) that the local transmission system would permit, without the need for major additional transmission system reinforcements. The addition of 320 MW of additional generation resulted in numerous low bus voltage violations and thermal overloading on the 230 kV and 115 kV during system intact conditions. Single element contingencies produced countless low bus voltage conditions in the presence of numerous thermal violations. The more detrimental contingencies were those that resulted in non-convergence due to voltage collapse in the several areas. As a result, there were 16 single element contingencies triggered non-convergent results. There was not any inexpensive solution to interconnect the 320 MW of generation. The best solutions pointed towards the construction of new transmission lines. The lack of “highway” lines emanating from this part of the Xcel Energy transmission system will need to be addressed in order to accommodate the additional generation.

Interconnection Requirements

The minimal requirements for the interconnection of the wind farm are the construction of a new 230 kV interconnection facility and approximately 1/2 mile of 230 kV transmission line from the proposed wind farm to the Xcel Energy interconnection facility. In addition, reactive power compensation at the 230 kV interconnection facility will be required in order to maintain acceptable bus voltage on the 230 kV (see Figure 1). Additional reactive compensation will be required for generation above 160 MW.

Conclusion

Based on the results of this study, it is feasible to interconnect a 160 MW wind farm to the existing Xcel Energy transmission system without causing new thermal overloads within the local transmission system.

Estimated Costs

Table 1 lists the costs associated with the interconnection of the Customer's 160 MW wind farm.

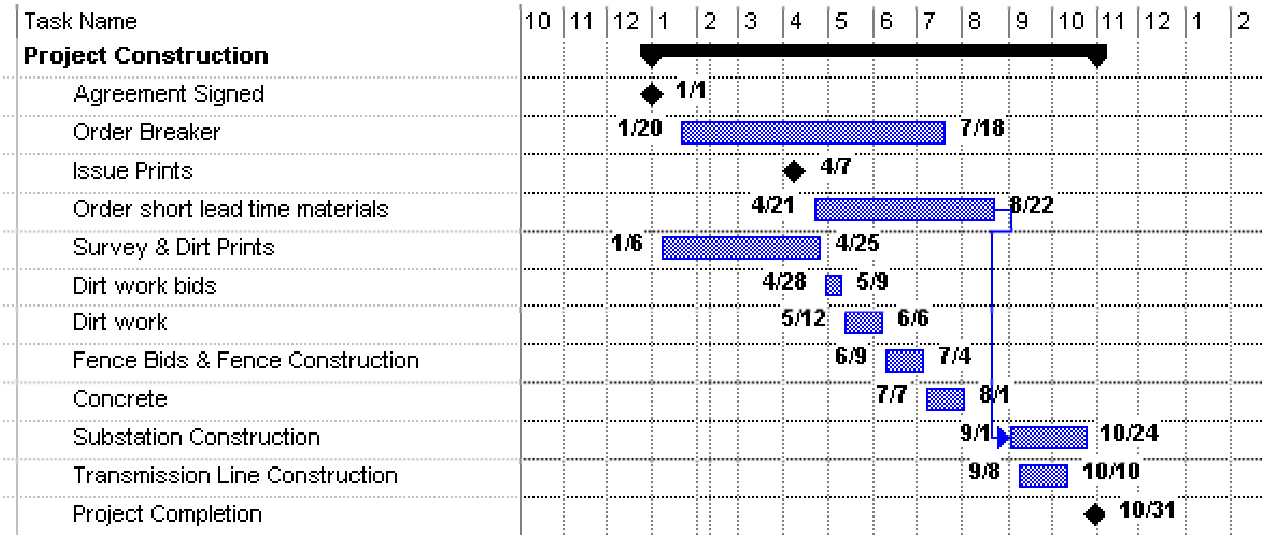
Table 1, Wind Farm Interconnection Costs

Estimated Costs	Cost
New 230 kV Interconnection Facility[1]	$ 2,976,176
1/2 mile Of New 230 kV Transmission Line[2]	$ 380,000
Right-Of-Way	$ 35,000
Total	***$ 3,391,176***

Construction Schedule

In order to complete all construction for this project in a timely manner, the estimated construction schedule is shown below and is contingent on the date an Interconnection Agreement is signed. If the agreement is not signed and construction funds have not been provided or approved prior to the date indicated, a new construction schedule would have to be drafted to accommodate any additional projects awaiting construction.

Customer 160 MW Wind Farm Project Construction Schedule



[1] The cost includes five 230kV breaker line terminals and associated equipment (control house, relays, metering, labor, etc.)
[2] Transmission line from the wind farm to the new switching station. The cost is estimated for1/2 mile of 230 kV transmission line assuming no corner structures (i.e. straight line) are required. Cost to be adjusted accordingly pending exact configuration and location of site.

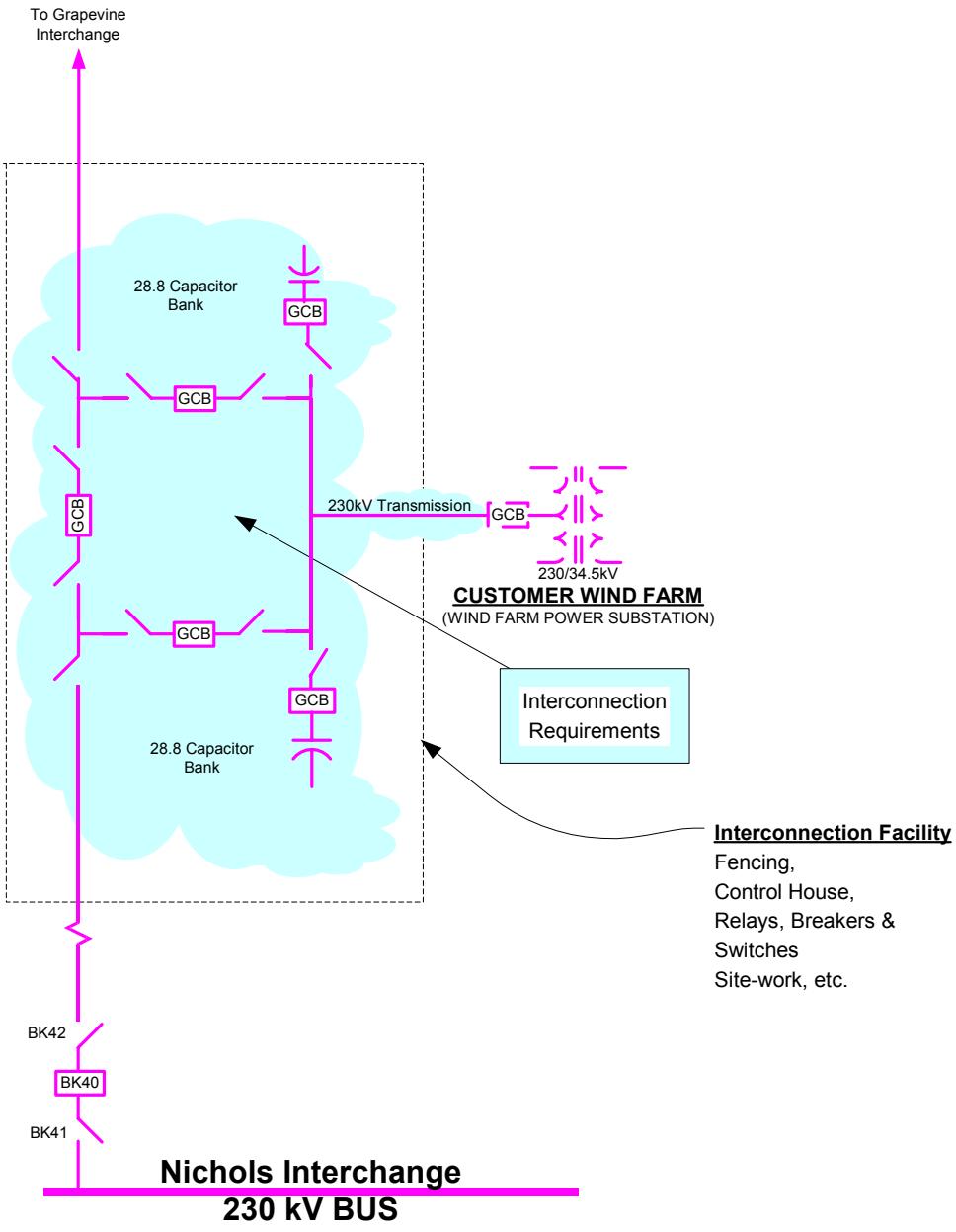


Figure 1, One-line Diagram of the 230 kV Interconnection Facility.

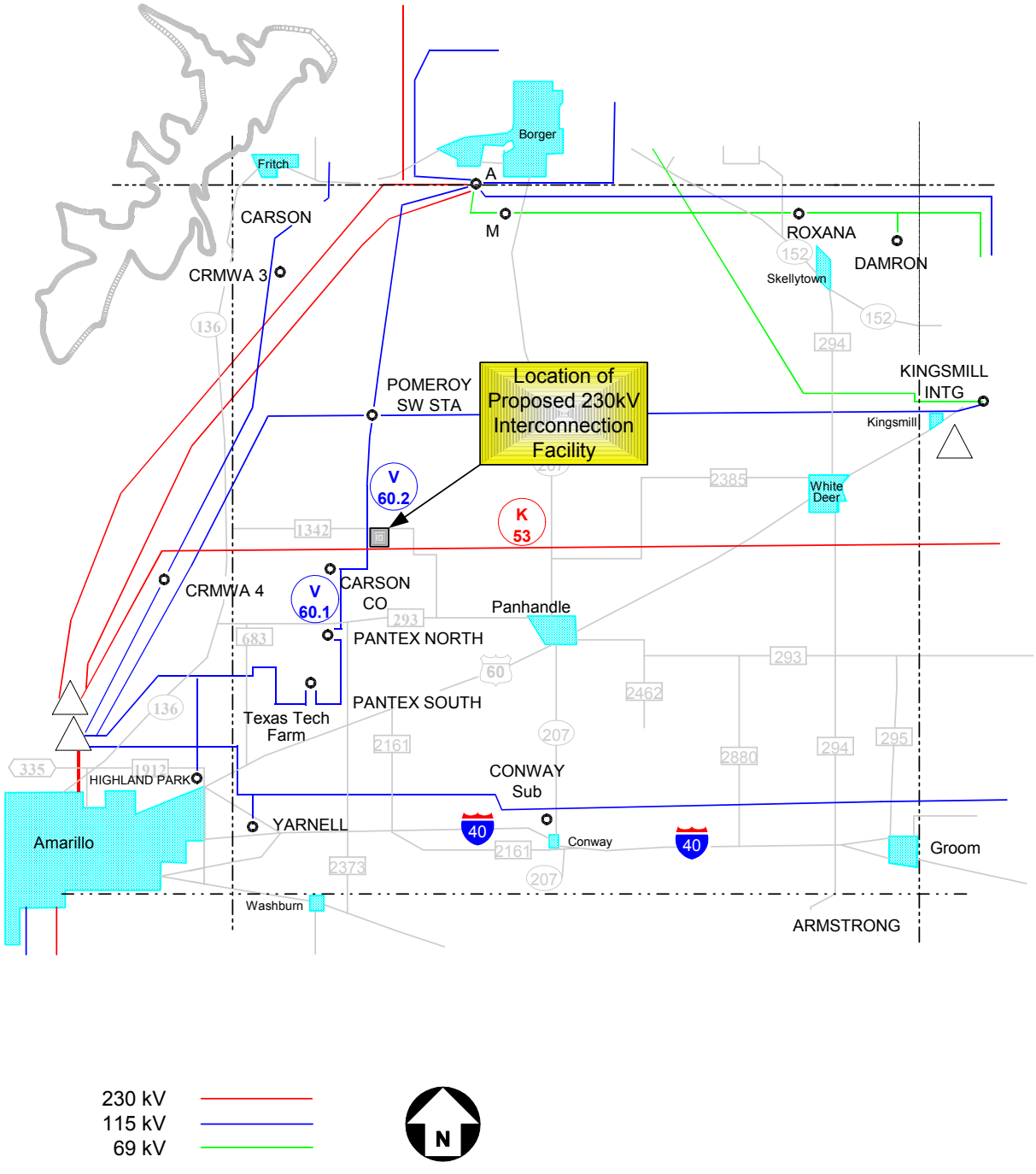


Figure 2. Local Transmission System