Summary

West Plains Electric (d/b/a Aquila Networks West Plains) performed the following Study under the West Plains Tariff. The request will now be transferred to the Southwest Power Pool OATT and the SPP Large Generation Interconnection Procedures (LGIP) will now apply. The Customer's original request date will be honored and the request received SPP GI identification #GEN-2003-006A. This study is being posted on the SPP OASIS.

Summary of Facility Study and Interconnection Restudy for Aquila Interconnection Queue Customer

Generation Addition: 200 MW Wind Farm near Concordia, Kansas

September 2006

Introduction

This report summarizes the results of a Generation Interconnection Facilities Study performed by Aquila, Inc to evaluate a generation interconnection request by a customer of the Aquila generation interconnection queue for 200 MW of wind-powered generation on the Aquila, Inc. transmission system near Concordia, Kansas. Prior to this Facilities Study, a Feasibility Study and a Generation Interconnection Study were completed. Included in this study was an evaluation of the customer's proposed use of a Vestas V80 turbine rather than the turbine model studied previously.

Project Description

The proposed project consists of 112, 1.8 MW Vestas V80 wind turbines. The output of the project will flow into the Aquila system via a new 230 kV switching station located approximately 10 miles from the Concordia West Substation along the Concordia West to East Manhattan 230 kV line. The customer will own, operate, and maintain a 230 kV transmission line from the project substation to the new interconnection switching station. The customer will also be responsible for any required step down transformation and the project substation. Figure 1 illustrates where the proposed project electrically interconnects with the Aquila system. Figures 2 shows where the proposed project interconnection will be located geographically.

Figure 1: Modified Aquila Switch Map to Include Proposed Project

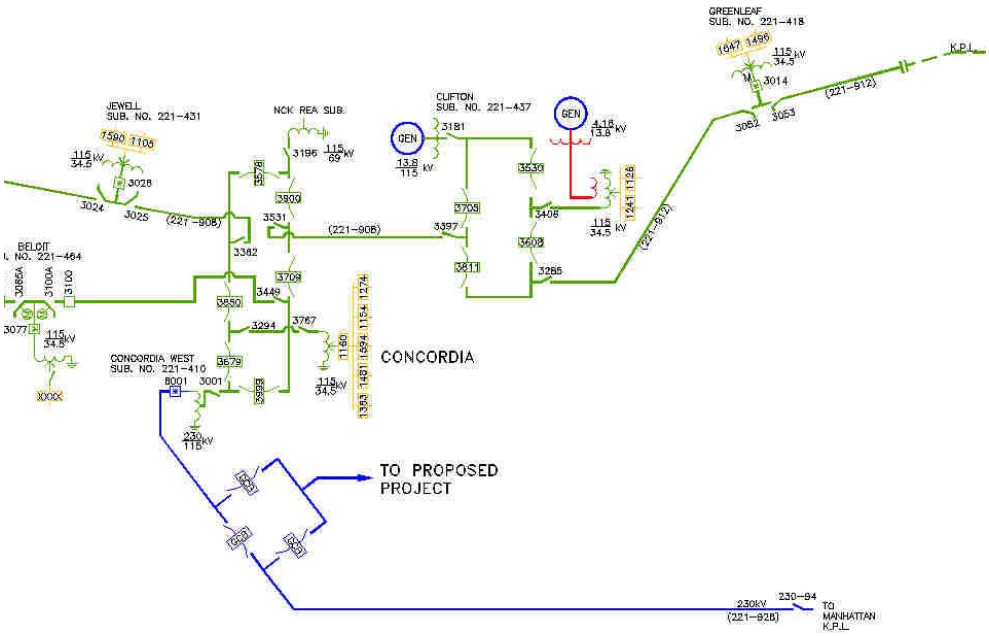
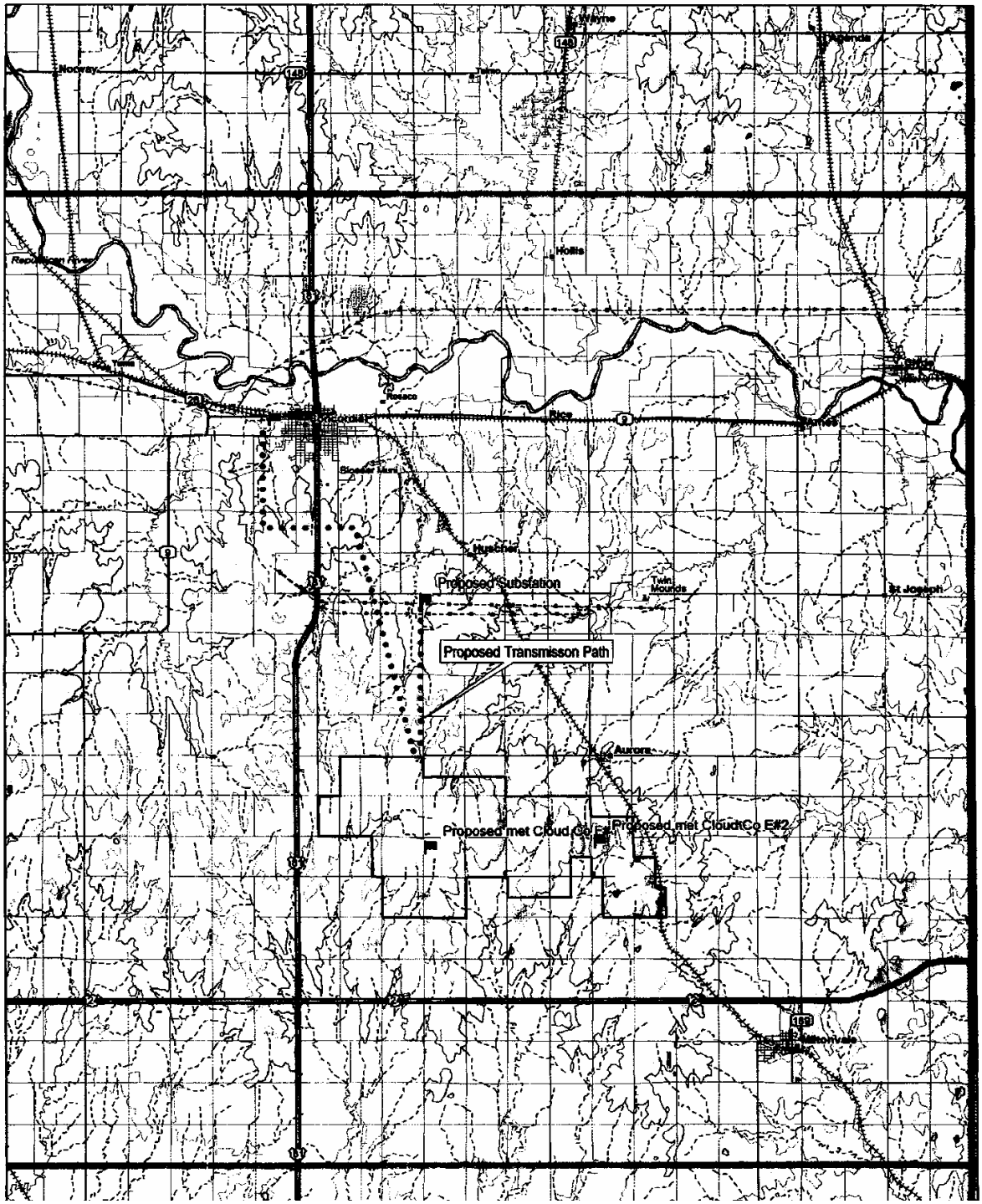


Figure 2: Geographical Location of Proposed Interconnection



Re-Study of Project with Vestas V80 Turbines

The original Generation Interconnection Study was performed utilizing GE 1.5/70.5 wind turbines. The customer has subsequently requested that the project be evaluated using a Vestas V80 wind turbine. The customer has indicated willingness to maintain the reactive output capability and nature studied in the original interconnection study in order to maintain queue position. As such, this request was honored without impacting the customers queue position.

Given that the customer will maintain reactive power capabilities equivalent to the original proposal, load flow analysis was not updated. All load flow analysis conclusions from the original Feasibility and Generator Interconnection studies were considered to remain valid. Also, as short circuit impacts on the Aquila system as documented in the original Generator Interconnection study are not significantly altered due to the new proposal, short circuit analysis was not updated. Assessment of the impact of the new turbine proposal on the angular stability analysis is required. To assess the stability impact of the change of wind turbine, the new wind turbine model was inserted in the original study data files in place of the original models. The AG04 turbine option was included in the model and will also be required for implementation. The transient stability analysis was subsequently reviewed with the modified system models.

Table 1 summarizes the disturbance definitions for the stability analysis. Figure 3 illustrates the location of the disturbances studied in the vicinity of the proposed project. Additional disturbances (disturbances 5 and 6) further west in Aquila's system were also simulated as a proxy for the impact on the remainder of Aquila's system as well. Results for stability simulations are summarized in Table 2 and Table 3.

Initial simulations utilized a +/-12 Mvar STATCOM at the interconnection, with the remainder of the reactive requirements supplied from capacitor banks (column A for Tables 2-3). The initial modeling of the STATCOM assumed use of typical manufacturer parameters. Under these conditions, unstable responses for the proposed project were observed for faults at the point of interconnection. Also, sustained oscillations of the proposed project were observed for faults further out on the Aquila system. Further simulations were performed varying STATCOM control parameters and size (columns B, C, and D in Tables 2-3). These simulations demonstrated that increasing the size of the STATCOM was not necessary to eliminate the instability. These simulations also demonstrated that tuning of the STATCOM will be necessary prior to operation in order to achieve adequate performance. Therefore, reactive requirements for the project will include +/12 MVAR of dynamic capability similar to that provided by a STATCOM along with 25 MVAR of static capacitor banks, sized appropriately for switching with the dynamic device(s).

Developers of the model for the Vestas turbine were consulted regarding the sustained oscillations observed. It is believed that these oscillations are a product of the model and may not necessarily be indicative of real performance. In order to protect against these oscillations until it can be demonstrated that they are not, in fact, a product of real performance, out of step tripping relays will be necessary. These can be applied at the point of interconnection or at the project collector substation.

TABLE 1

DISTURBANCE DEFINITIONS FOR STABILITY STUDY

Case ID	Description (Time in cycles after fault)
F01-3PH	3-phase fault at Concordia on 115 kV line to Clifton Time Fault Clearing 7 Trip breaker at Concordia for line 58757[CONCORD3]-58756[CLIFTON3] 9 Clear fault
F01-SLG	SLG fault at Concordia on 115 kV line to Clifton, Breaker failure at Concordia, [CB3900] Time Fault Clearing 9 Trip breaker at Clifton for line 58757[CONCORD3]-58756[CLIFTON3] 30 Trip line 58793[SMITH-C3]-58769[JEWELL 3] Trip line 58793[SMITH-C3]-58763[GLENELD3] Trip line 58758[CONCORD6]-59356[CLOUDTAP] Clear fault
F02-3PH	3-phase fault at Concordia on 230 kV line to Cloud Tap Time Fault Clearing 5 Trip breaker at Concordia for line 58758[CONCORD6]-59356[CLOUDTAP] 7 Clear fault
F02-SLG	SLG fault at Concordia on 230 kV line to Cloud Tap, Interrupter failure at Concordia, [#6001] Time Fault Clearing 7 Trip breaker at Cloud Tap for line 58758[CONCORD6]-59356[CLOUDTAP] 16 Trip line 58793[SMITH-C3]-58769[JEWELL 3] Trip line 58793[SMITH-C3]-58763[GLENELD3] Trip line 58757[CONCORD3]-58756[CLIFTON3] Clear fault
F03-3PH	3-phase fault at Cloud Tap on 230 kV line to East Manhattan Time Fault Clearing 5 Trip breaker at Cloud Tap for line 59356[CLOUDTAP] -56861[EMANHAT6] 12 Clear fault
F03-SLG	SLG fault at Cloud Tap on 230 kV line to East Manhattan, Breaker failure at East Manhattan Time Fault Clearing 5 Trip breaker at Cloud Tap for line 59356[CLOUDTAP] -56861[EMANHAT6] 30 Trip line 56861[EMANHAT6]-56852[JEC 6] Clear fault

TABLE 1

DISTURBANCE DEFINITIONS FOR STABILITY STUDY (CONT'D)

Case ID	Description (Time in cycles after fault)
F04-3PH	3-phase fault at East Manhattan on 230 kV line to Cloud Tap Time Fault Clearing 7 Trip breaker at Cloud Tap for line 59356[CLOUDTAP] -56861[EMANHAT6] 10 Clear fault
F04-SLG	SLG fault at East Manhattan on 230 kV line to Cloud Tap, Breaker failure at Cloud Tap Time Fault Clearing 10 Trip breaker at East Manhattan for line 59356[CLOUDTAP] -56861[EMANHAT6] 16 Trip line 58758[CONCORD6]-59356[CLOUDTAP] Clear fault
F05-3PH	3-phase fault at Mullergren on 230 kV line to Spearville Time Fault Clearing 6 Trip breaker at Mullergren for line 58779[MULGREN6] -58795[SPEARVL6] 7 Clear fault
F05-SLG	SLG fault at Mullergren on 230 kV line to Spearville, Breaker failure at Mullergren, [CB6012] Time Fault Clearing 7 Trip breaker at Spearville for line 58779[MULGREN6] -58795[SPEARVL6] 16 Trip line 58779[MULGREN6]-56871[CIRCLE6] Clear fault
F06-3PH	3-phase fault at Spearville on 230 kV line to Mullergren Time Fault Clearing 5 Trip breaker at Spearville for line 58779[MULGREN6] -58795[SPEARVL6] 7 Clear fault
F06-SLG	SLG fault at Spearville on 230 kV line to Mullergren, Breaker failure at Mullergren, [CB6012] Time Fault Clearing 5 Trip breaker at Spearville for line 58795[SPEARVL6]-58779[MULGREN6] 16 Trip line 58779[MULGREN6]-56871[CIRCLE6] Clear fault

FIGURE 3
FAULT LOCATIONS NEAR CLOUD COUNTY WIND FARM

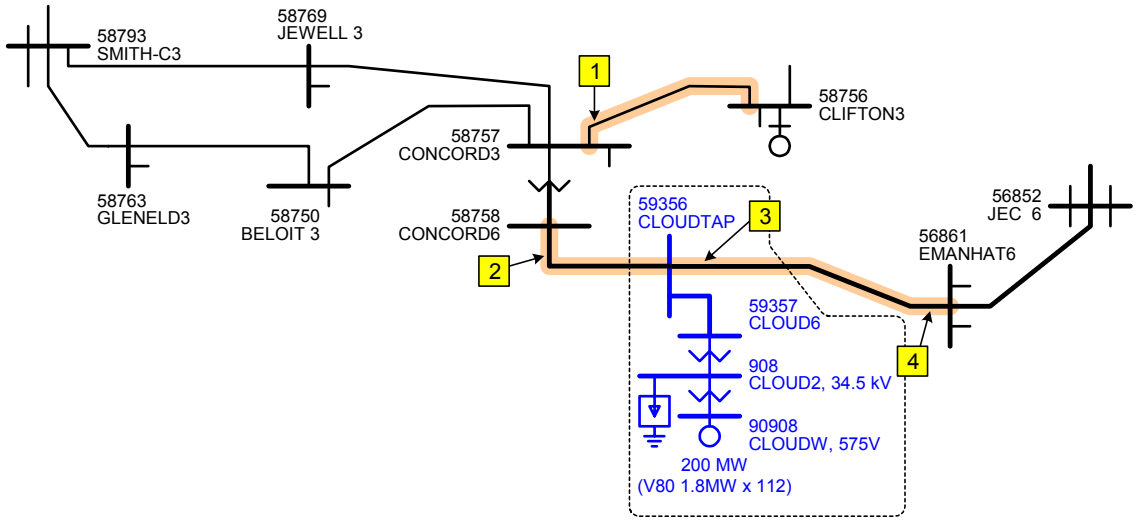


TABLE 2

STABILITY SIMULATION RESULTS – 2004 WINTER PEAK CASE

	A				B				C				D			
Parameter	K=50, 12 MVar				K=20, 12 MVar				K=20, 18 MVar				K=20, 24 MVar			
Wind Farm	GC	KW	FO	CC	GC	KW	FO	CC	GC	KW	FO	CC	GC	KW	FO	CC
F01-3PH																
F01-SLG																
F02-3PH																
F02-SLG																
F03-3PH				S				S								
F03-SLG				U												
F04-3PH				S				T				U				
F04-SLG				T				T				T				T
F05-3PH	S			S	S			S	S			S	S			S
F05-SLG	U			S	U			S	U			S	U			S
F06-3PH	T		T	S	T		T	S	T		T	S	T		T	S
F06-SLG	S			S	S			S	S			S	S			S

GC: Gray County, KW: Kiowa Co Project, FO: Ford Co Project, CC: Cloud County

T: wind turbines tripped, U: unstable oscillation, S: sustained oscillation

TABLE 3

STABILITY SIMULATION RESULTS – 2005 SUMMER PEAK CASE

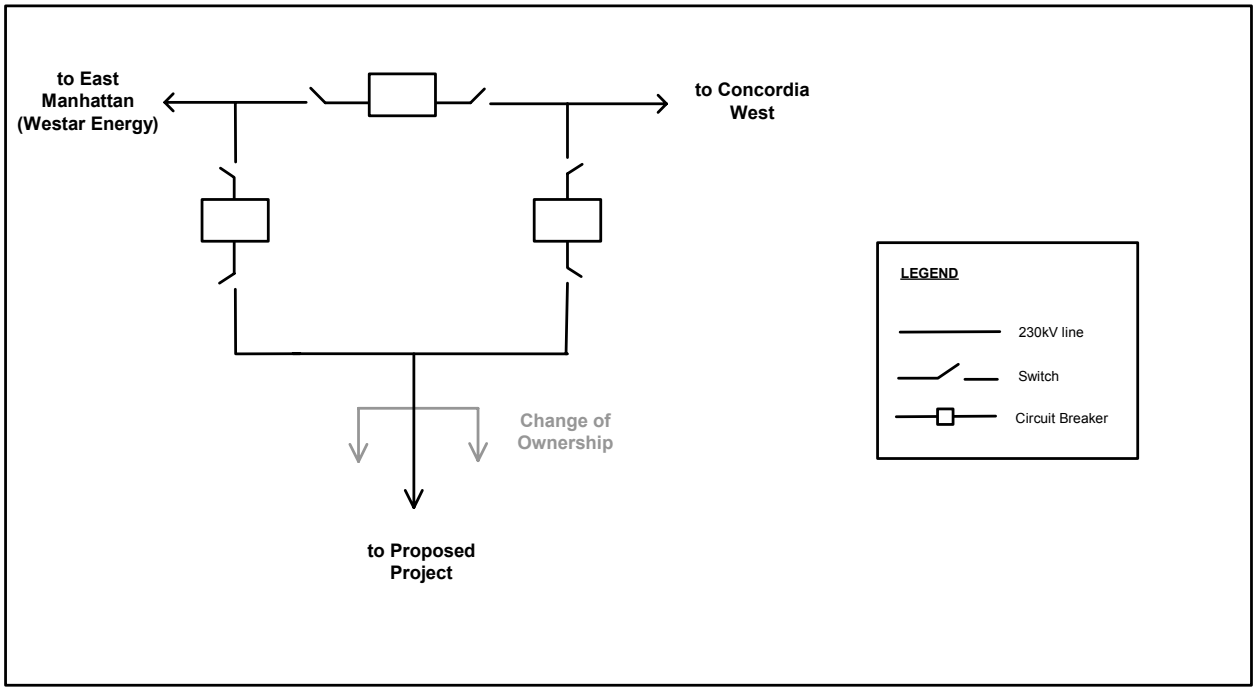
	A				B				C				D			
Parameter	K=50, 12 MVar				K=20, 12 MVar				K=20, 18 MVar				K=20, 24 MVar			
Wind Farm	GC	KW	FO	CC	GC	KW	FO	CC	GC	KW	FO	CC	GC	KW	FO	CC
F01-3PH																
F01-SLG																
F02-3PH																
F02-SLG																
F03-3PH				U												
F03-SLG																
F04-3PH				S												
F04-SLG				T				T				T				T
F05-3PH	S			S	S			S	S			S	S			S
F05-SLG	U			S	U			S	U			S	U			S
F06-3PH	T		T	S	T		T	S	T		T	S	T		T	S
F06-SLG	S			S	S			S	S			S	S			S

GC: Gray County, KW: Kiowa Co Project, FO: Ford Co Project, CC: Cloud County

T: wind turbines tripped, U: unstable oscillation, S: sustained oscillation

Interconnection Facilities
Interconnection to the Aquila transmission system will occur via a new 230 kV switching station inserted into the existing Concordia West to East Manhattan 230 kV line (see Figure 4). Construction of the new switching station will require acquisition of land.

Figure 4 – Diagram of Interconnection Switching Station



The Interconnection Study identified only the need for the interconnection switching station as necessary to accommodate the interconnection. The estimated cost of this project is $4,768,000. This estimated costs listed do not include any line work required for terminating the customer's transmission line. The estimate includes Kansas sales tax but no allowance for income tax consequences. It is understood at this time that there will be no income tax consequences. Should this change, the customer will be responsible for reimbursement of income tax consequences. Note that actual construction costs will be used for final billing.

Estimated work schedule
The interconnection facilities will require approximately 12 months to complete from signing of the interconnection agreement and with all easements obtained. This time line is based on Aquila's engineering time, average procurement time, good weather during construction, and favorable time of year for completing construction. If construction is commenced during times of the year when facility outages are more difficult to approve, some additional time may be required. Aquila reserves the right to utilize consultants to perform this work which may impact the estimated schedule.