

Interconnection Feasibility Study Report Request # GI-2006-2

200 MW Wind Expansion of Peetz-Logan, near Peetz, Colorado

Xcel Energy Transmission Planning
November 17, 2006

Executive Summary

PSCo Transmission received a generation request to determine the feasibility of interconnecting 200 MW of new Customer wind turbine generation into the PSCo transmission system at the Pawnee Station 230 kV bus. The Customer proposed commercial operation date is October 1, 2008 with a back feed date of April 1, 2008. This request was studied as both an Energy Resource (ER) and a Network Resource (NR). The request was assuming the projects from GI-2006-1 being implemented.

The ER portion of this study determined that the Customer could not provide any energy without the construction of network reinforcements. Non-firm transmission capability may be available depending on marketing activities, dispatch patterns, demand levels and the status of transmission facilities.

As an NR request, PSCo evaluated the network to determine the upgrades required to deliver the full 200 MW of the wind facility to PSCo native load customers. The total estimated cost of the recommended system upgrades to accommodate the project is approximately **\$718,000** and includes:

- \$23,000 for Customer Funded PSCo Interconnection Facilities at Pawnee Station
- \$0 for PSCo Network Upgrades for Interconnection
- \$695,000 for PSCo Network Upgrades for Delivery

As a stand-alone project, the basic upgrades would consist of:

- Upgrade the 114 mile PSCo 230 kV line from Pawnee Station to Daniels Park from 340 MVA to 637 MVA.

The regional transmission system is shown in Figure 1 along with the recommended upgrades. A partial one-line of Pawnee Station can be found in Figure 2. There will not be any upgrades required for interconnection since the Customer is using its existing interconnection. The estimated time required to engineer, permit, and construct PSCo Network Upgrade facilities for delivery is 12 months.

Additional details of the studies can be found under the Power Flow Study Results.

Figure 1: Regional Transmission Network with Recommended Upgrades

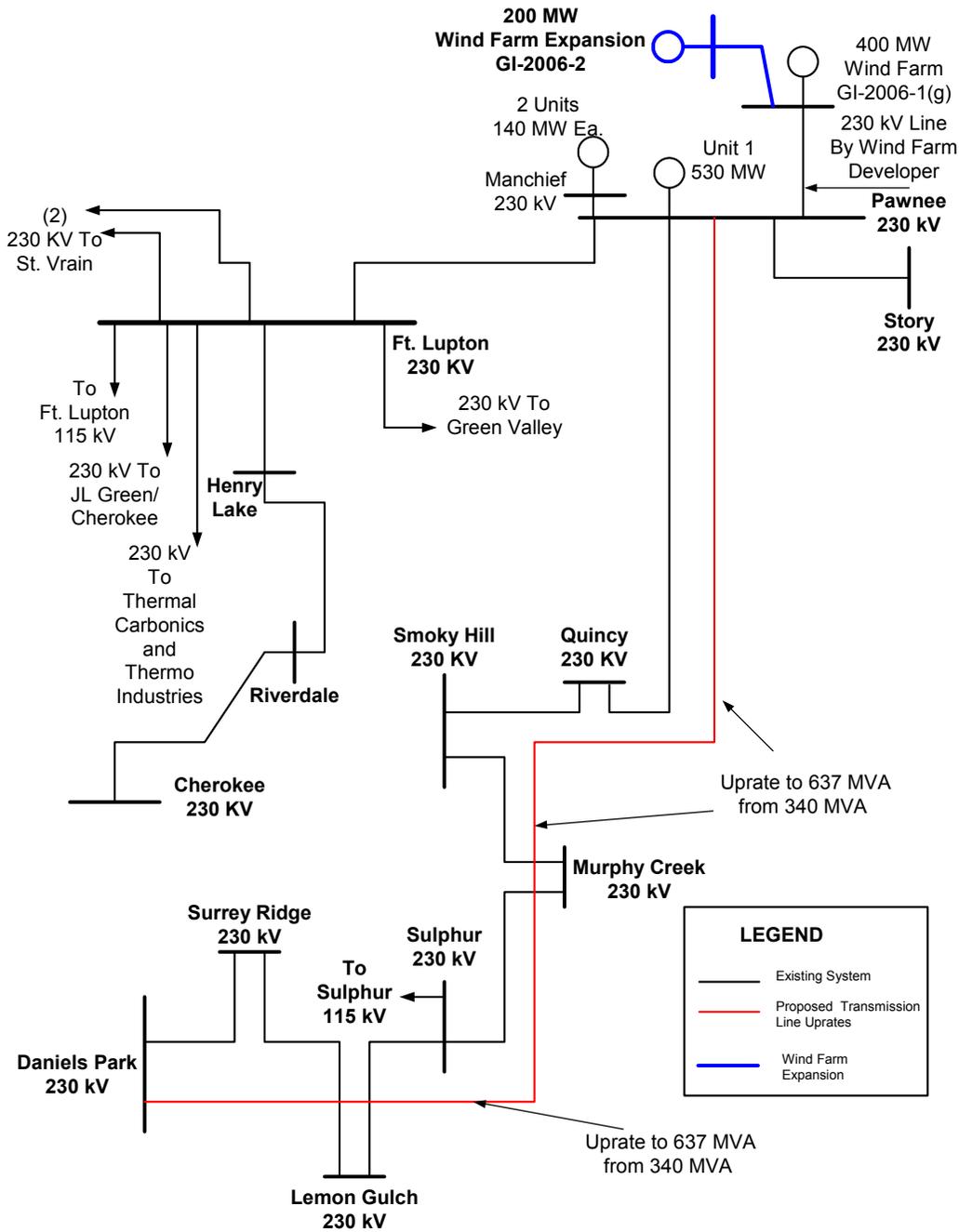
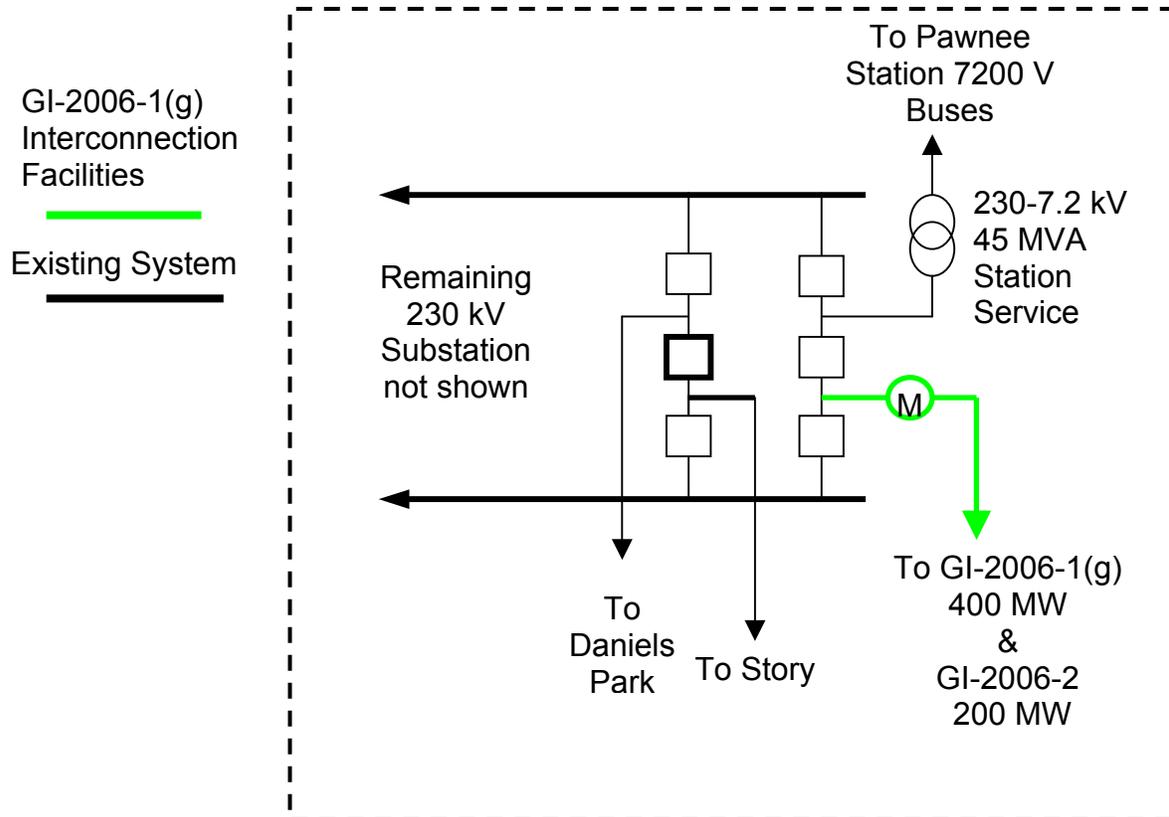


Figure 2: Simple Diagram of the Pawnee Interconnection



Introduction

PSCo Transmission received a large generator interconnection request (GI-2006-2) to interconnect one hundred thirty-three 1.5 MW, GE doubly fed induction generator (DFIG) wind turbines, for a total of 200 MW generation, with a commercial operation date of October 1, 2008 and a back feed date of April 1, 2008. The proposed wind farm (Project) would be located near Peetz, Colorado and would interconnect into the PSCo transmission system via the planned 72-mile radial 230 kV line terminating at the PSCo Pawnee Station. This line is part of GI-2006-1(g) with the 200 MW being an expansion of the proposed 400 MW GI-2006-1(g) facility. The Customer has requested that this Project be evaluated as a Network Resource (NR) and an Energy Resource (ER) with the energy going to PSCo customers.

Study Scope and Analysis

The Interconnection Feasibility Study evaluated the transmission requirements associated with the proposed interconnection to the PSCo Transmission System. It consisted of power flow and short circuit analyses. The power flow analysis provided a preliminary identification of any thermal or voltage limit violations resulting for the

interconnection, and for a NR request, a preliminary identification of network upgrades required to deliver the proposed generation to PSCo loads. The short circuit analysis identified any circuit breaker short circuit capability limits exceeded as a result of the Interconnection and for a NR request, the delivery of the proposed generation to PSCo loads.

PSCo adheres to NERC / WECC Reliability Criteria, as well as internal Company criteria for planning studies. During system intact conditions, criteria are to maintain transmission system bus voltages between 0.95 and 1.05 per-unit of system nominal / normal conditions, and steady state power flows within 1.0 per-unit of all elements' thermal (continuous current or MVA) ratings. Operationally, PSCo tries to maintain a transmission system voltage profile ranging from 1.02 per-unit or higher at generation buses, to 1.0 per-unit or higher at transmission load buses. Following a single contingency element outage, transmission system steady state bus voltages must remain within 0.90 per-unit to 1.10 per-unit, and power flows within 1.0 per-unit of the elements continuous thermal ratings.

Based on the results of other generator interconnection studies, impacts to TOT3 and the neighboring utilities are considered minimal. Should the Customer continue this request and move on to the System Impact Study, more detailed impacts may be identified. For this project, potentially affected parties could include Western Area Power Administration (WAPA), and Tri-State Generation and Transmission (TSGT).

Power Flow Study Models

The power flow studies were based on a PSCo developed 2010 heavy summer base case that originated from the Western Electricity Coordinating Council (WECC) 2011 heavy summer base model. The 200 MW wind farm was modeled as one 200 MW conventional generator with a 0.95 per unit (p.u.) lagging power factor (overexcited) and a 0.95 p.u. leading power factor (under-excited) capability to simulate the VAR capabilities of the generators, which the Customer has stated to be the GE 1.5 MW model SLE Double Fed Induction Generator. The project generation was scheduled to the southern PSCo system by reducing generation in that area.

The Point of Interconnection (POI) between the Customer and PSCo is assumed to be the point at which the 72-mile transmission line connects to the Pawnee Substation bus. The 72-mile line was modeled per the Customer provided information:

- A single-circuit 72-mile, 230 kV line using a combination conventional 230 kV “H-frame” wood pole and single steel pole construction with a two conductor bundled 795 ACSR per phase, with a 700 MVA rating.
- One 230-34.5 kV, 133/177/222 MVA Customer GSU transformer, located at the Customer collector site.

To evaluate the capabilities and system requirements for firm transfer levels, the powerflow model was modified to simulate reasonably high TOT3 path flows at 1340 MW. Efforts were made to include in the models all transmission projects expected to

be in service for the 2010 heavy summer season. The studies assumed 2010 peak summer demand conditions in the PSCo system and in other utility systems

Power Flow Study Results and Conclusions

Energy Resource (ER) Study Results

The results of the ER study indicate that with the existing system, there is no available capacity at Pawnee Station; therefore the ER is zero MW. Non-firm transmission capability may be available depending on marketing activities, dispatch patterns, demand levels, and the status of transmission facilities.

Network Resource (NR) Study Results

The NR study determined the network upgrades that would be required to accept the full 200 MW from the proposed wind farm for the conditions studied. At 200 MW of generation, there were few contingency overloads. Table 1 shows the contingency overloads.

The Customer's interconnection request is similar to previously studied interconnection requests at Pawnee Substation. The upgrades were determined to be comparable with the network upgrades identified for GI-2003-1 and others, but with slight changes. The basic recommended network upgrades to alleviate the overloads and accommodate the generation include the following:

- Upgrade the existing 230 kV line from Pawnee to Daniels Park from 340 MVA to 637 MVA.

The time frame for these upgrades is approximately 12 months from notice to proceed.

Table 1: Contingency Comparison Table of Most Significant Contingencies

Overloaded Element	Case	10-Budgetr1: TOT 3 = 1340 MW		10-Highwind Peetz-Lgn@ 200 MW+ TOT 3 = 1330 MW		Contingency						
		base pu	load	base pu	load	FROM NAME	TO NAME	KV	CKT #			
---name---	---name---	-kv-	ar ID [MVA]	load	load	FROM NAME	TO NAME	KV	CKT #			
"DANIELPK"	"PAWNEE "	230	"1 "	340	80%	108%	93%	125%	PAWNEE	BRICKCTR	230	"1 "

Short Circuit Study Results

The short circuit study results show that the fault current levels for all buses studied are within the interrupting ratings of the breakers; therefore, the Project and associated infrastructure will not cause fault current to exceed the circuit breaker ratings.

The faults currents at Pawnee are 22,527 Amps for a single-line to ground fault and 19,689 Amps for a three-phase fault. These values assume little to no fault current contribution from the proposed wind facility.

Costs Estimates and Assumptions

The estimated total cost for the required upgrades is **\$718,000**.

The estimated costs shown are (+/-30%) estimates in 2006 dollars and are based upon typical construction costs for previously performed similar construction. These estimated costs include all applicable labor and overheads associated with the engineering, design, and construction of these new PSCo facilities. This estimate does not include any costs for any Customer-owned, supplied, and installed equipment and associated design and engineering. This estimate also does not include any costs that may be required for other entities' systems.

The following tables list the improvements required to accommodate the interconnection and the delivery of the Project. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to change upon more detailed analysis.

Since the Customer intends to use its interconnection from the 400 MW Wind Facility GI-2006-1(g) at Pawnee Station, there will be only minimal costs of \$23,000 associated with the interconnection required for this 200 MW expansion project GI-2006-2. The customer is responsible for the construction of the 72-mile transmission line from the wind project location to the point of interconnection at Pawnee Station. This cost to the Customer has not been estimated by PSCo.

Table 2 PSCo Interconnection Facilities (Customer Funded)

Substation	Description	Cost
Pawnee 230kV Switchyard	Engineering and design review for: <ul style="list-style-type: none"> Transmission line relaying and testing 	\$23,000
Total Estimated Cost for PSCo Interconnection Facilities		\$23,000
Time Frame		3 Months

Table 3: PSCo Network Upgrades for Delivery

Element	Description	Cost
Pawnee 230kV Switchyard	Upgrades and modifications required at Pawnee Switchyard for line upgrading. The major equipment required includes: <ul style="list-style-type: none"> Four 230kV, 2000 amp gang switches One communication line trap, 2000 amp Transmission line relaying and testing 	\$290,000
Pawnee-Daniels Park 230kV Line	Transmission line upgrades (circuit 5457) required for 637 MVA rating	\$360,000
	Siting and Land Rights acquisition & permitting and Transmission Line Construction	\$45,000
Total Estimated Cost for PSCo Delivery Infrastructure Upgrades		\$695,000
Time Frame		12 Months

Assumptions

- The estimated costs provided are with an accuracy of +/- 30%.
- All applicable overheads are included. AFUDC has been included with the PSCo Transmission Network Upgrades and removed from the PSCo Interconnection Facilities.
- There is no contingency added to the estimates.
- Estimates have not been escalated. All estimates are in 2006 dollars.
- Labor is estimated for straight time only – no overtime included.
- The Generator is not in PSCo’s retail service territory. Therefore no costs for retail load metering are included in these estimates.

- PSCo (or its Contractor) crews will perform all work associated with PSCo owned and maintained equipment.
- All required transmission outages necessary to support construction will be obtained as needed.
- No additional land will be required.
- This additional wind generation will utilize the same transmission line as the proposed Peetz Table Wind Project.
- No additional metering or RTU equipment is required – use existing (proposed) equipment.