Final Interconnection Facilities Study Report
Request # GI-2008-03

250 MW Wind Farm near Genoa, Colorado

Public Service Company of Colorado
Transmission Planning

May 25, 2010

I. Executive Summary

This Interconnection Facilities Study Report summarizes the analysis performed by Public Service Company of Colorado (PSCo) to specify and estimate the cost of the siting, engineering, equipment procurement and construction needed to interconnect 250 MW of new wind turbine generation at the planned Missile Site switching station in Arapahoe County, Colorado. The Missile Site switching station will be connected to the Pawnee-Daniels Park 230 kV line. The proposed wind generating facilities will be located 45 miles southeast of the interconnection point and would be connected via a customer owned radial 230 kV line. The requested commercial in-service date is December 15, 2010. Customer comments on the Draft Facilities Study Report dated 4/19/10 are attached at the end of this report.

The total estimated cost for the facilities required for interconnection is estimated at **$0.862 million**[1] and includes one (1) 230 kV, 2000 A switch, metering, arrestors, relaying, communications and transmission tie line connection.

- $0.854 million for Customer-Funded Interconnection Facilities
- $0.008 million for PSCo Network Upgrades for Interconnection
- The estimated time required to site, engineer, procure and construct the facilities described above is at least 15 months.

A proposed Station One-Line diagram for the Missile Site Switching Station is shown in Figure 1.

There are no PSCo Network Upgrades for Delivery required for this Interconnection. However, the System Impact Study identified transmission facilities in the Tri-State Generation & Transmission (TSG&T) and Western Area Power Administration (WAPA) systems with overload concerns. These facilities are:

- Beaver Creek 230/115 kV 224 MVA transformer T3 owned by TSG&T
- Beaver Creek 115 kV TSG&T bus tie with WAPA

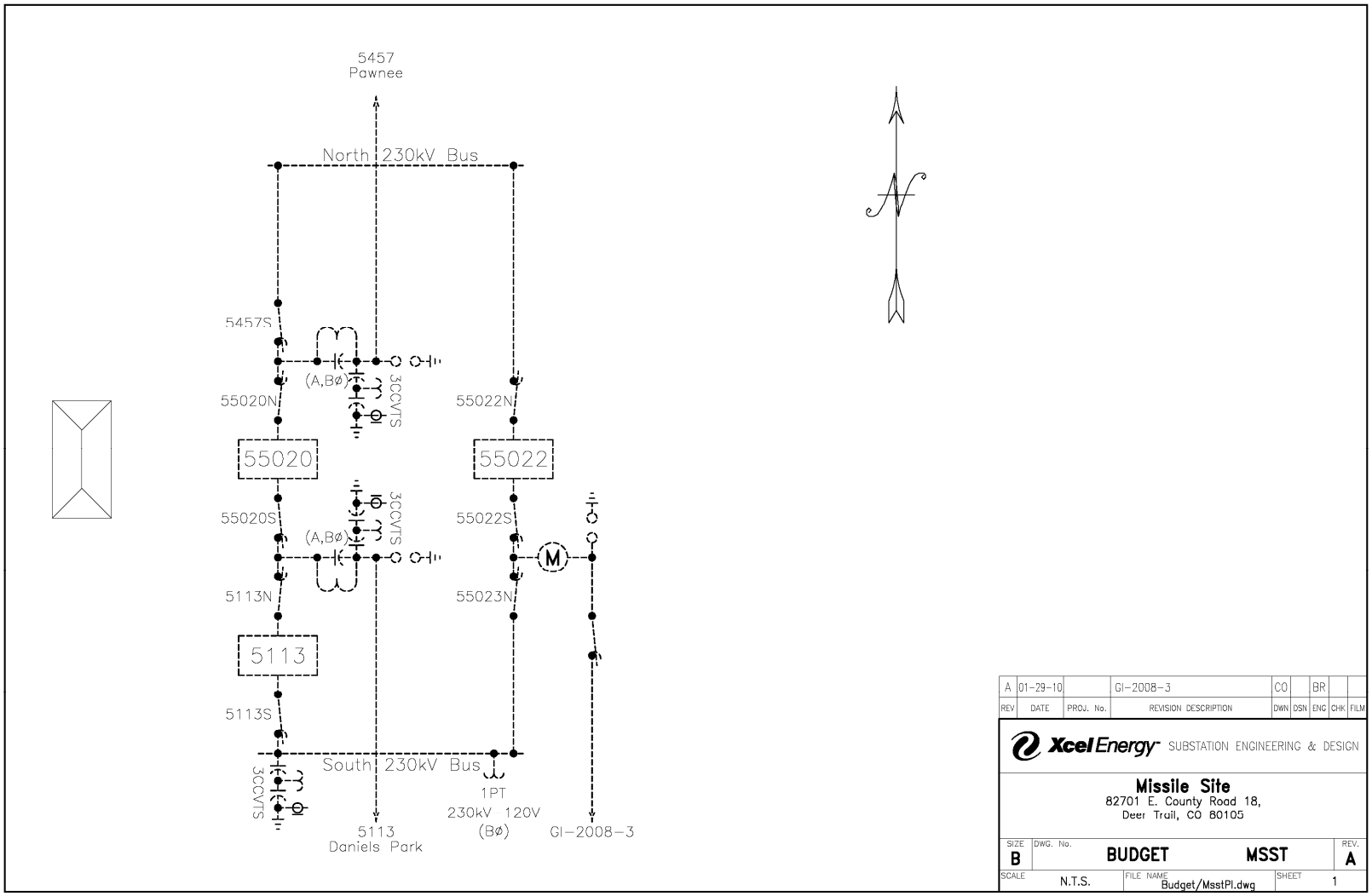
The customer is required to work with TSG&T and WAPA to resolve these concerns.

The System Impact Study showed that wind plant operation can have a detrimental impact on the voltage regulating capability of the generating units connected at the Pawnee 230 kV substation. To mitigate this impact, the Customer will need to include reactive support within the wind farm. Our study shows that a 65 Mvar capacitor bank at the main 230/34.5 kV transformer low side bus will mitigate this problem. This will also bring the POI voltage to within the ideal voltage range for non-regulating buses. The Customer will need to perform additional detailed studies to determine the optimum types and locations for the reactive correction equipment.

[1] Appropriation estimates considered to have an accuracy of +/- 20%.

Line charging from wind plant facilities is expected to be approximately 25 Mvar injected into the POI when the wind plant is off-line. This will also have an adverse impact on area generator reactive resources. Shunt reactors or other reactive compensation should be installed within the wind plant to mitigate the line charging.

Figure 1: Missile Site Budget One-Line Diagram



I. Introduction

On June 30, 2008 PSCo Transmission Planning received an interconnection request to perform a combined Feasibility/System Impact Study that would evaluate the proposed installation of a 250 MW wind farm near Genoa, Colorado to be connected to PSCo facilities at the planned Missile Site Switching Station in Arapahoe County, Colorado. The results of the Feasibility/System Impact Study (GI-2008-03) were issued on June 30, 2009. On September 14, 2009, PSCo Transmission received a request to perform a Facilities Study for the equipment identified in the Feasibility/System Impact Study that is required to interconnect the 250 MW of generation at Missile Site.

II. General Interconnection Facilities Description

1. Interconnection & Network Upgrades for Interconnection

Requirements for interconnection can be found in the Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater than 20 MW – Version 3.0[3], last revised in December 2006. Xcel Energy requires the interconnection customer to construct the Interconnection Facilities in compliance with this document. The guidelines describe the technical and protection requirements for connecting new generation to the Xcel Energy Operating Company transmission system and also requires that the Interconnection Customer be in compliance with all applicable criteria, guidelines, standards, requirements, regulations, and procedures issued by the North American Electric Reliability Council, Public Utility Commission or their successor organizations.

a) Fault Current

Three-phase and SLG fault currents will be 6724A and 4159A respectively at the proposed Missile 230 kV bus. These fault current values do not include the contributions of the customer-proposed windfarm to the system. These values will increase as additional generators and transmission lines are added to the system.

Refer to fault study included with feasibility/system impact study report.

b) Right of Way

For purposes of the facility study substation estimate, it is assumed that there is adequate land and all appropriate easements are in place. It is the customer's responsibility to obtain Right of Way for the interconnection transmission line into the Missile substation.

[3] Guidelines can be found at www.xcelenergy.com.

c) High Voltage Electrical Installations

The Missile 230kV switching station will be arranged in a breaker-and-a-half (BHHB) configuration, but it will initially be operated in a ring configuration. The initial build out of Missile Sub will already have the breakers and switches in place to handle the interconnection from the new wind farm. Therefore no additional utility (PSCo) funded equipment will be required.

The Customer is responsible for the costs of all equipment and material that carry the current contributions of the incoming interconnected transmission line. The items include the following:

- Slack span of interconnection transmission line into substation
- Substation dead-end structure and foundation for new line
- Revenue metering transformers and metering cabinet
- All associated foundations, steel, grounding, conduit, control cable, and relaying to tie this equipment into the substation.

At Lookout the windfarm will have to be added to the EMS system, and appropriate LFAGC/SCADA systems will have to be implemented.

The step-up transformers at the customer facility shall be designed to meet the interconnection guidelines mentioned above. The configuration shall be grounded-wye on the 230 kV side. The Customer must specify their transformer(s) to meet PSCo's requirements for an effectively grounded system.

d) AC & DC Systems

There should be sufficient room on both the AC and DC panels to tie in the new equipment.

e) Control Building

There should be sufficient room in the control building for the additional relay panel and metering.

f) Grounding

Additional grounding will have to be installed in the substation to effectively tie the new dead-end to the existing ground grid.

g) Lightning Protection

The static wire system will be tied to the new dead-end on the incoming transmission line.

h) Grading & Fencing

Fence will not have to be moved. Minimal grading will have to be performed.

j) Foundations & Structural

There will be new drilled pier foundations, and new dead-ends.

k) Removals & Relocations

None.

l) Control & Protection – Electrical Installations

Transmission line relaying will have to be installed on the Customer's new 230kV interconnect. Both the primary and secondary protection schemes will utilize a pilot system, and that both will have non pilot backup consisting of step-distance phase and ground function, with a directional ground distance time overcurrent function. For purposes of the estimate, it was assumed that the Customer would be installing OPGW on the transmission line, and that a line current differential scheme will be used for the primary protection.

Three terminal line configurations will not be permitted.

Additional interconnection requirements will need to be satisfied as stated in PSCo's interconnection Guidelines For Transmission Interconnected Producer-Owned Generation Greater Than 20 MW.

Existing RTU at Lookout control center has space to add the additional SCADA points for the additional wind turbines.

m) Outages

Short outages will be required on the south 230kV portion of the ring bus at the planned Missile Site switching station.

n) Project and Operating Concerns

There are no known project or operating concerns at this time.

o) Wind Farm RTU

The wind farm will install a Remote Terminal Unit (RTU) to provide real time data to the PSCo operations center including generation control using DNP protocol.

p) Related Substation & Transmission Projects

Refer to System Impact Study for required network upgrades, if any.

q) Assumptions for Customer's Site

Customer will provide reactive support equipment to meet voltage tolerances and power factor at the point of interconnection as required by Xcel Energy and FERC interconnection guidelines. If voltage support equipment is required to meet the interconnection requirements, then it should be noted that tapping the transmission line in a three terminal application is not acceptable. The customer must install breakers at the tap point in such a configuration that will not create a three terminal scenario.

Customer will engineer, procure, and construct all equipment up to and including the Missile 230 kV substation dead-end structure. Customer is responsible for transmission line relaying at their end of the line, and will coordinate protection design and settings with PSCo substation engineering.

The customer will need to arrange for station service power through the local utility/service provider, as customer's site may not be in PSCO service territory.

PSCo needs approximately 4-6 weeks to test requirements of Interconnection Guidelines For Transmission Interconnected Producer-Owned Generation Greater Than 20 MW. Much of the testing can be performed in parallel with the construction schedule. A typical testing and commissioning procedure can be provided upon request.

Customer will comply with FERC Order 661-A and guidelines for Low Voltage Ride Through (LVRT) capability.

The Customer is responsible for providing the following information, *subject to change,* to the PSCo Control Center via a DNP-3 communication protocol.

- Breaker or automatic switchgear status for all devices in the Customer's substation.
- MW on breakers or automatic switchgear r
- MVAR on breakers or automatic switchgear
- Substation voltage
- MVAR control available (lead/lag)
- Substation Frequency
- Wind speed.
- Wind direction.

- High wind cutout/cutoff.
- Generation output per feeder/circuit into customer substation
- Total generation output
- Available generation.
- Amount of generation tethered by AGC action
- AGC status (on/off)
- AGC regulation available (up/down or increase/decrease)

Via this same link, PSCo will supply raise and lower pulses to control the load on the wind generators, if generation curtailment is required by the PSCo Control Center.

r) Communications

The customer will need to supply a communication circuit from their site to the PSCo Control Center for the information mentioned above.

III. Cost Estimates and Assumptions for the Project:

Interconnection

The estimated non-binding good faith total cost for the PSCo Interconnection Facilities and Network Upgrades to provide an Interconnection for the Customer requested generation is:

$0.854 million for Customer Interconnection Facilities at Missile Site Substation (Customer funded)

$0.008 million for PSCo Network Upgrades for Interconnection (PSCo funded)

Total Estimated cost of Interconnection = $0.862 million

The estimated costs shown above are “appropriation estimates” with an accuracy of ±20%. These estimates do not include any costs for any Customer-owned, supplied, and installed equipment and associated design and engineering for the Customer’s facilities.

Delivery

There are no PSCo Network Upgrades for Delivery required for this Interconnection. However, the Feasibility/System Impact Study identified transmission facilities in the Tri-State Generation & Transmission (TSG&T) and Western Area Power Administration (WAPA) systems with overload concerns. These facilities are:

- Beaver Creek 230/115 kV 224 MVA transformer T3 owned by TSG&T. The Beaver Creek T3 transformer was found to be overloaded at 118.9% of its 224 MVA rating versus 112.9% in the benchmark case.

- Beaver Creek 115 kV TSG&T bus tie with WAPA. The Beaver Creek 115 kV TSG&T-WAPA bus tie was found to be overloaded at 126.4% of its 200 MVA rating versus 119.9% in the benchmark case.

Both of these overloads are due to the contingency loss of the Beaver Creek 115 kV PSCo-WAPA bus tie. The customer is required to work with TSG&T and WAPA to resolve these concerns.

The System Impact Study showed that wind plant operation can have a detrimental impact on the voltage regulating capability of the generating units connected at the Pawnee 230 kV substation. To mitigate this impact, the Customer will need to include reactive support within the wind farm. Our study shows that a 65 Mvar capacitor bank at the main 230/34.5 kV transformer low side bus will mitigate this problem. This will also bring the POI voltage to within the ideal voltage range for non-regulating buses. The Customer will need to perform additional detailed studies to determine the optimum types and locations for the reactive correction equipment.

Line charging from wind plant facilities is expected to be approximately 25 Mvar injected into the POI when the wind plant is off-line. This will also have an adverse impact on area generator reactive resources. Shunt reactors or other reactive compensation should be installed within the wind plant to mitigate the line charging.

Cost estimates for the required reactive correction were not included in this study.

The cost responsibilities associated with the interconnection facilities shall be handled per current FERC guidelines. The estimated engineering, procurement & construction schedule can be found in Figure 2 below.

B. Costs Estimates and Assumptions
GI-2008-3 (Facility Study Report)
April 5, 2010

The estimated total cost for the required upgrades for GI 2008-3 is **$862,000.** The estimated costs shown are (+/-20%) estimates in 2010 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 siting, engineering, design, procurement and construction of these new Xcel Energy facilities. This estimate does not include the cost for any other Customer owned equipment and associated design and engineering.

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.

Table 1 – PSCo Owned; Customer Funded Interconnection Facilities

Element	Description	Cost Est. Millions
PSCo's Missile 230kV Substation	Interconnect Customer at PSCo's Missile 230kV Substation. New 230kV equipment required for interconnection includes: • one 230kV, 2000 amp gang switch • three, 230kV bi-directional metering • three, 230 kV arrestors • relaying, communication and associated equipment • foundations and structures	**$0.508**
	Transmission tie line into substation.	**$0.315**
	Generator Witness Testing.	**$0.021**
	Siting and Land Rights for required easements, reports, permits and licenses.	**$0.010**
	Total Cost Estimate for Customer Interconnection Facilities	**$0.854**
	2. To site, design, procure and construct	**15 Months**

Table 2: PSCo Owned; PSCo Funded Interconnection Facilities

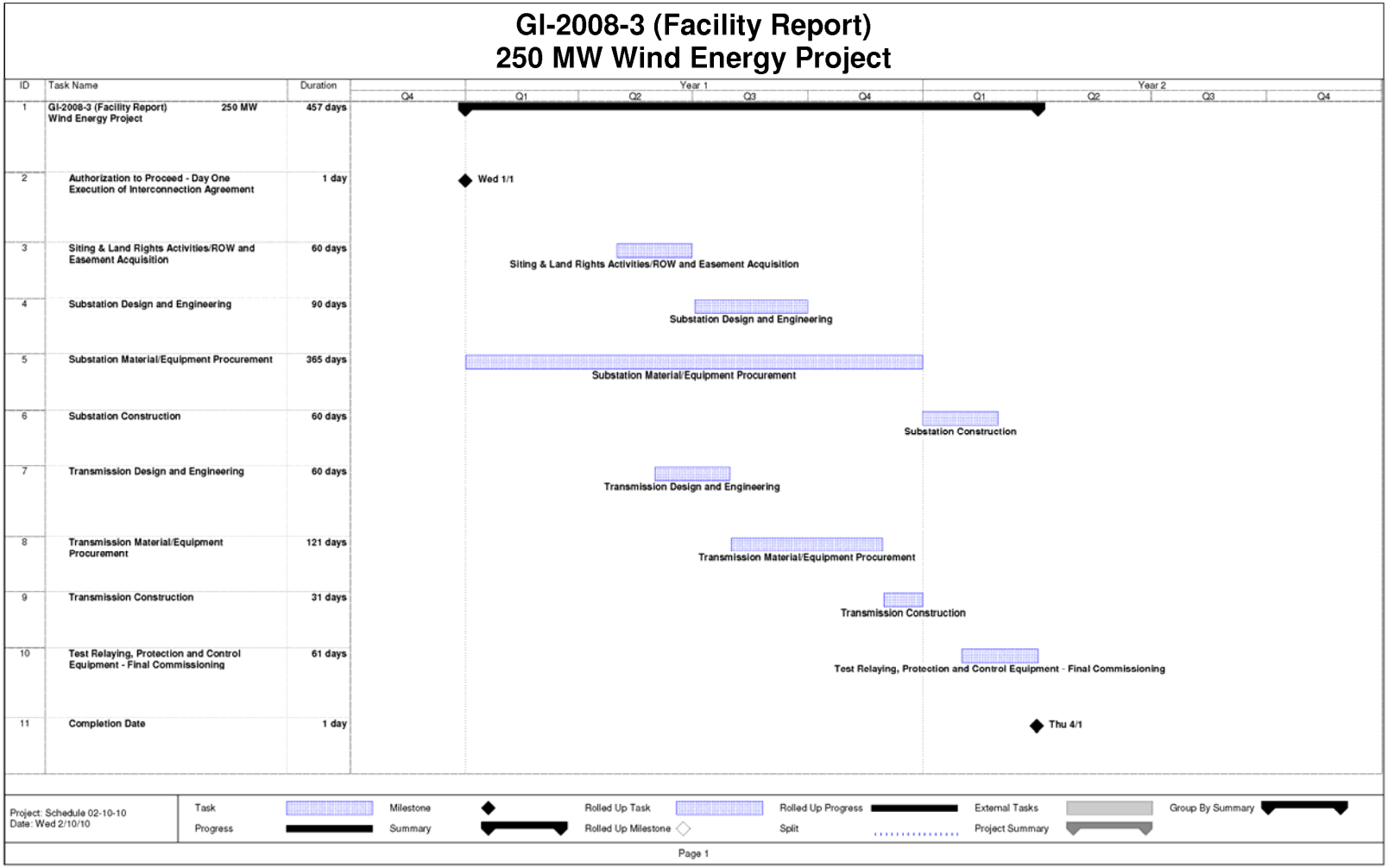
	Description	Cost
Daniels Park Substation	Relay setting changes	**$0.004**
Pawnee Substation	Relay setting changes	**$0.004**
	Total Cost Estimate for PSCo Interconnection Facilities	**$0.008**
	3. To design and schedule	**15 Month**

Assumptions for Interconnection Facilities:

- The cost estimates provided are "appropriation estimates" with an accuracy of +/- 20%.
- Estimates are based on 2010 dollars.
- AFUDC is excluded from all cost estimates.
- Labor is estimated for straight time only – no overtime included.
- PSCo (or it's Contractor) crews will perform all construction and wiring associated with PSCo owned and maintained facilities.
- The Generation Site is not in PSCo's service territory. The local utility will provide station service power to the generator.
- Contingency and escalation are included in the cost estimates.

IV. Engineering, Procurement & Construction Schedule

Figure 2: GI-2008-03 Preliminary / Draft Schedule



V. Customer Comments on Draft Facilities Study Report

The customer chose not to make any comments on the Draft Facilities Study report dated 4/19/10.