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Generation Interconnection Facilities Study Report
Request # GI-2011-02 (200 MW) and GI-2011-07 (additional 200 MW)

400 MW Wind Turbine Generation
Near Limon, Colorado

Public Service Company of Colorado
Transmission Planning

January 23, 2012

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 2 x 200 MW wind turbine generation farm near Limon, Colorado.

The new wind generation is proposed to interconnect to the planned Missile Site 345 kV Substation near Deer Trail, Colorado (see Figure 1). This substation is being constructed by PSCo as a part of its SB 07-100 obligation to build new transmission to accommodate potential new renewable generation. The wind generating facilities are located approximately 40 miles from the interconnection point and would be connected via a customer owned radial 345 kV line. The requested commercial in-service date is December 31, 2012.

The total estimated cost for the facilities required for interconnection is $3.970 million[1] and includes three (3) 345 kV, 3000 A circuit breakers and switches, bus work, metering, communications and transmission line bus tie connection.

- $1.77 million for Customer-Funded Interconnection Facilities
- $2.20 million for PSCo Network Upgrades for Interconnection

The estimated time required to site, engineer, procure and construct the facilities described is at least 10 months from the date the Customer meets all applicable Milestones as agreed to in any future LGIA. An Engineering & Procurement Agreement was executed to facilitate completion of the interconnection facilities by the requested in-service date of December 31, 2012.

A proposed Station One-Line diagram for the Missile Site Switchyard is shown in Figure 2.

There are no PSCo Network Upgrades for Delivery required for this Interconnection.

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

Figure 1: Network Diagram with Proposed POI at Missile Site Substation

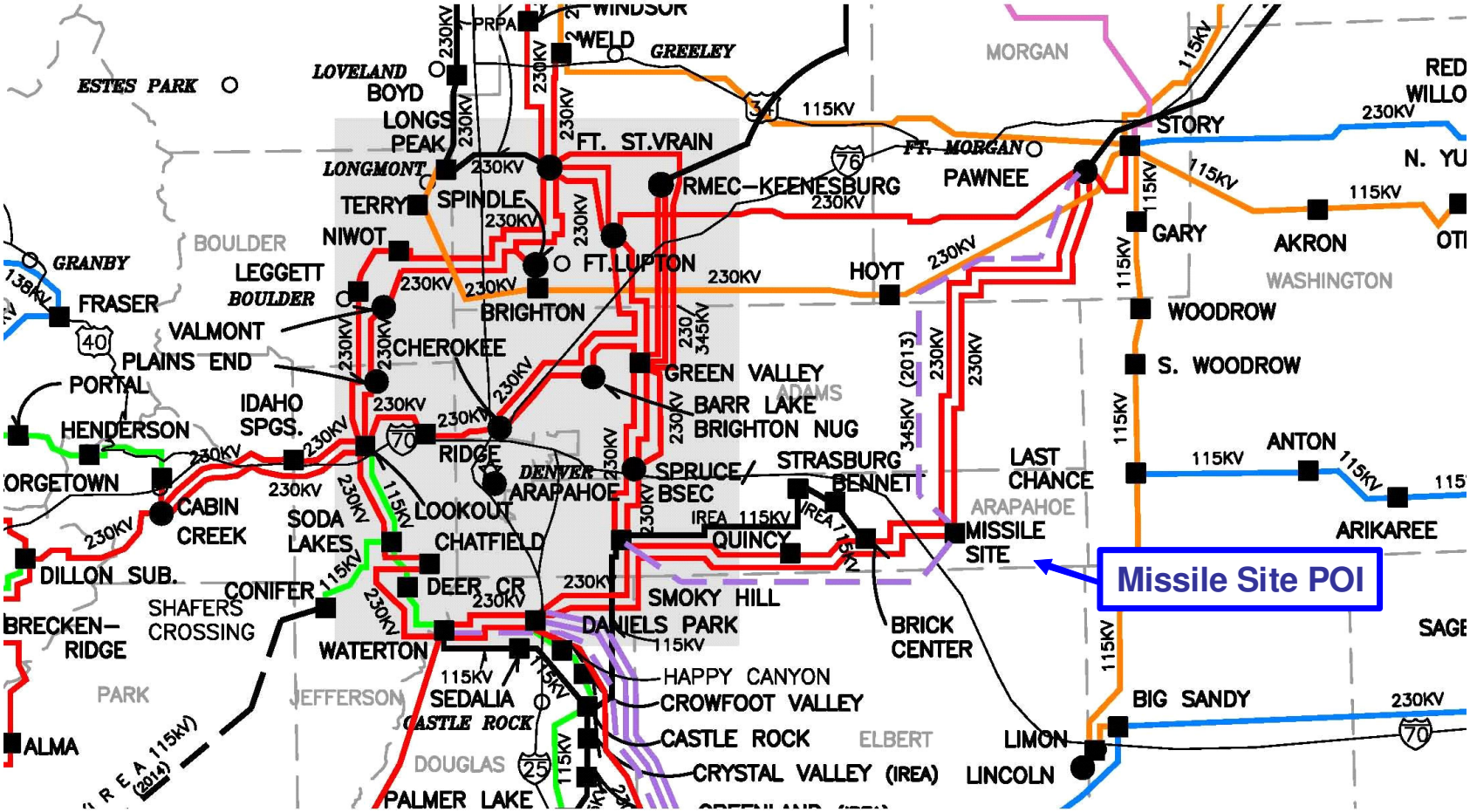
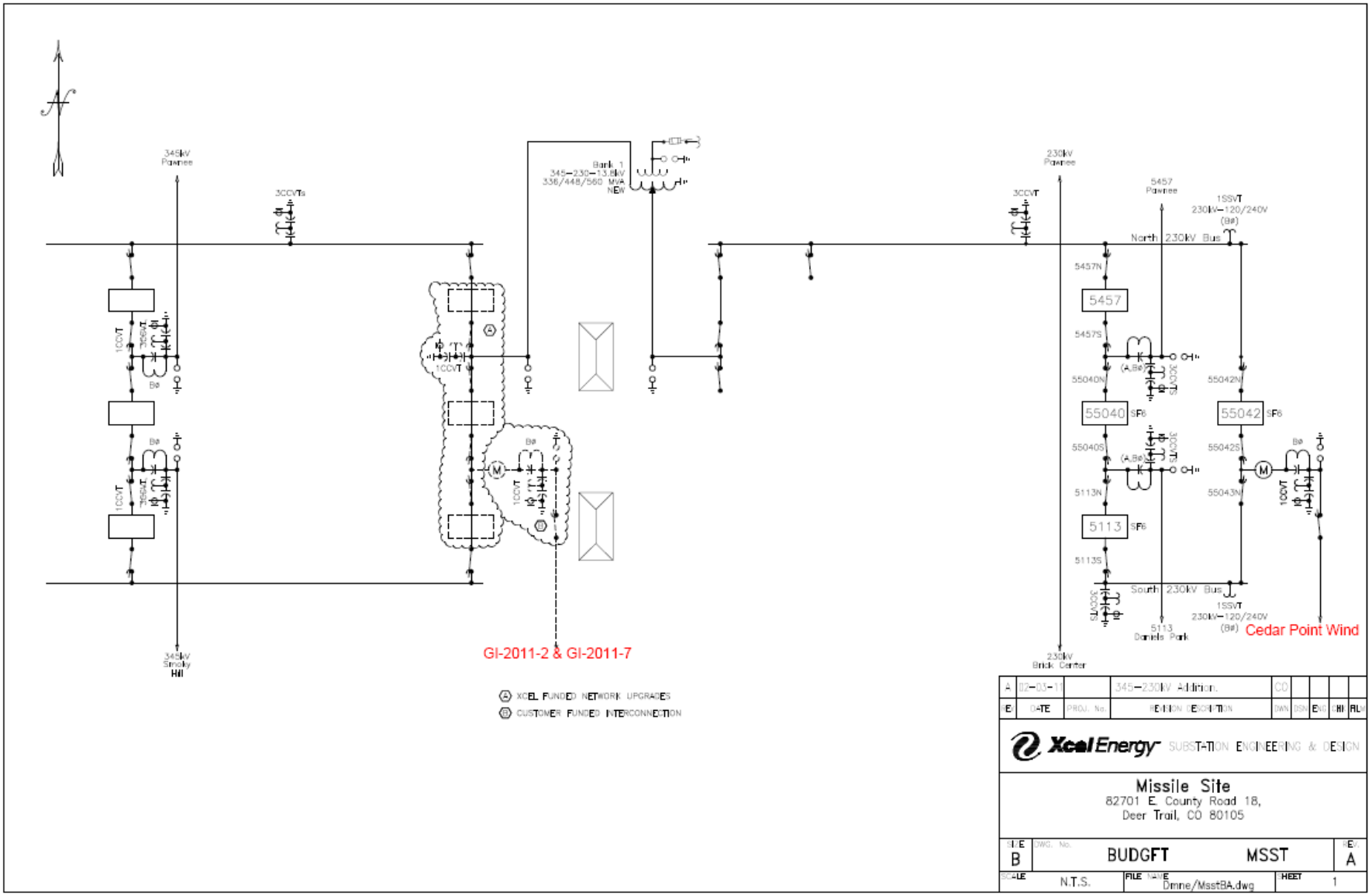


Figure 2: Missile Site Substation Budget One-Line Diagram



II. Introduction

On March 9, 2011 PSCo Transmission received a generation interconnection request for 200 MW of wind generation injecting into the future Missile Site 345 kV substation near Dear Trail, Colorado. On August 24, 2011 PSCo Transmission received an additional generation interconnection request for 200 MW of wind generation injecting into the same point of interconnection utilizing the same transmission line. The results of the Feasibility/System Impact Study (GI-2011-02 and GI-2011-07) were issued January of 2012. In January of 2012 PSCo Transmission and the Customer agreed to combine the two facilities studies into one study report for the total of 400 MW of wind generation interconnection at Missile Site 345 kV substation. The requested in-service date for both generation interconnection requests is December 31, 2012. This report documents the results of PSCo's Facility Study efforts.

III. General Interconnection Facilities Description

A. Project Purpose & Scope

The purpose of the project is to interconnect 2 x 200 MW of wind generation at the planned Missile Site 345 kV Substation. The customer proposes to bring the 400 MW into Missile Site via a customer owned 40 mile 345 kV line. Three new circuit breakers and associated facilities are required to interconnect the proposed generation at Missile Site. See Figure 2 for the interconnection details.

B. Background

Missile Site 345 kV Substation is planned to be a 3 breaker ring with two 345 kV lines to Pawnee and Smoky Hill, respectively, and a 345/230 kV transformer connected to the Missile Site 230 kV substation. This substation will be near Deer Trail, Colorado. The new interconnection facilities will result in a breaker and a half substation configuration.

Future Considerations

On the 345 kV side, the substation will be arranged in a breaker and a half configuration with 4 elements and 2 complete bays. This will allow operational flexibility for bus outages as needed to accommodate future expansion.

On the 230 kV side, the autotransformer connection to the new 345 kV yard will be the 4th element. The substation will be left in a ring configuration. The tie to the autotransformer will require building out the North bus. Switches off of the North bus will be added to facilitate the next round of expansion. CCVT's will be installed on the north bus to provide potentials on the 230 kV side of the autotransformer and positioned such that they can remain as bus pots when the 230 kV yard is converted to a breaker and a half.

IV. 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. FERC and/or NERC Compliance Requirements

Critical Infrastructure Protection (CIP) Asset

This is a new substation, and it is not defined as a CIP Critical Asset location.

Facility Ratings

The substation will meet the new facility rating methodology.

B. Right of Way

All land needed for the 345 yard has been purchased and developed. A 1041 permit is under review by Arapahoe County

C. Electrical Features

Transmission Lines: Current Carrying Capacity of Affected/Tapped/New

The new 345 lines will be double bundled 1272 ACSR and rated at 2890 amps. The substation bays will be rated at least 3000 amps.

Fault Current

All equipment is being designed to withstand a 40 kA fault.

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

Type of fault / Location	Three Phase (A)	Single-Line-to-Ground (A)
Missile 345 – current model	10,145	7,930
Missile 345 – 2017 model.	12,276	9,705

Electrical Installations (Major Equipment)

- The 345 kV yard will consist of 3x 345 kV breakers (and associated switches, CCVT's, etc) for the lines to Pawnee and Smoky Hill, and the 345/230 kV 560 MVA autotransformer as shown on the one-line. The above will effectively be arranged in a 3 breaker ring.
- The 230 kV additions will consist of a single breaker and bus to feed the autotransformer as the 4th element of the existing ring bus. Switches off of the North bus will be provided to facilitate the next planned expansion of the 230 kV yard.

- By introducing a 4th element to the 345 kV yard, there is sufficient justification for a breaker and a half configuration. As a result, the Network Upgrades associated with the interconnection will consist of the 3x 345 kV breakers (and associated switches, CCVT's, etc) and bus differential panels.
- Note the line side equipment will be customer funded on a yet to be determined work order.

Mobile Substation or Transformer

A mobile is not expected to be needed as part of the construction.
Electrical Equipment Enclosure (EEE)

A new EEE for the 345 kV control and protection equipment will be installed north of the existing 230 kV EEE. The autotransformer protection panel will be installed in the 345 kV EEE.

AC System

The existing AC system for the 230 kV yard consists of two single phase 100 kVA Station Service Voltage Transformers (SSVT's).

The primary source for both the 230 kV and 345 kV yard will be a padmount transformer fed from the tertiary of the new autotransformer. The system will be designed as a single phase supply in order to be backed up by the existing single phase SSVT source. Provisions will be supplied for 3 phase loads (if any) supplied off of the autotransformer tertiary.

DC System

A new battery set will be installed in the 345 kV EEE. The existing battery set in the 230 kV EEE is suitable for the 230 kV expansion.

Grounding

The existing ground grid will be extended to cover the new equipment.

Lightning Protection

Arrester will be installed on all incoming lines and the autotransformer. Static wires will be installed as needed on new transmission towers and substation dead ends.

Trenching & Cable

New duct bank will be installed for the 345 kV yard and as needed on the 230 kV side.

D. Civil Features

Grading & Fencing

All site grading has been completed. A chain-link fence with privacy slats will be installed around the new 345 kV yard.

Storm Water Permit

A SWMP will be required for the new 345 kV yard. No delays or complications are anticipated.

Foundations & Structural

Significant foundation work will be required as seen on the General Arrangement. In addition to the major equipment, the 230 kV and 345 kV busses will be expanded to nearly the ultimate planned design.

Oil containment for the new autotransformer will be required.

Civil Removals & Relocations

The west fence will have to be moved to accommodate the 345 kV yard.

Civil Installations

The soil boring report from the 230 kV construction contains all needed information for this project. Standard designs are anticipated.

Note the transformer foundation will be designed to accommodate the largest design from currently approved suppliers.

The following concrete slab foundations will be installed:

Quantity	Description
1	Large EEE foundation
1	560 MVA autotransformer foundation
6	345 kV breaker foundation
1	230 kV breaker foundation
1	Padmount station service transformer

Install the following galvanized steel structures with drilled pier foundations:

Structure Quantity	Steel Description	Pier Quantity
84	345 kV Bus support	1
57	230 kV Bus support	1
9	345 kV CCVT	1
4	230 kV CCVT	1
1	230 kV SSVT	1
12	345 kV switch stand	2
5	230 kV switch stand	2
5	345 kV dead-end	2
3	230 kV dead-end	2

Electrical Equipment Enclosure (EEE) or Switchgear Building

A large EEE will be installed for the 345 kV protection and control equipment. It will be similar in design to the existing 230 kV EEE (double prefab construction with a basement).

E. Control Features

Control Schemes

Transmission Breaker Protection (69-500kV)

Three new 345-kV breakers will be installed in a ring-bus configuration. All breakers will have breaker failure protection, Pkg-BF/25/79. The Pkg-BF will also be used for synchronizing (sync/DB-DL/LB-DL/DB-LL) and reclosing (for t-line

only). A 12-cycle delay will be used for breaker failure tripping initiated by the primary and backup relays for each respective zone of protection. The tripping will initiate a lockout relay and will key DTT.

- SEL354 (Pkg-BF/25/79

Transmission Bus Protection (69-500kV, sometimes 34.5kV)

The present construction will consist of a breaker and a half with 4 elements. The primary bus protection will be done with BE1-87B Basler relay. The secondary protection will be done with a GE B-90 relay.

Transformer Protection (69-500kV high voltage winding)

The new 560, 345-230kV transformer with a de-energized tap position changer (362, 354, 345, 336, 328kV) on the high side will be protected by dual percent current differential relays with nondirectional ground time overcurrent backup protection. The transformer will also be protected by a sudden pressure relay in the main-tank. The backup protection will provide 1-zone of directional phase distance protection on the high side of the transformer. All CTs should utilize a separate current restraint input and high side CTs should be set at 2000/5, low side at 2000/5, and tertiary CTs wired in parallel should be set at 2000/5.

- SEL387 (Pkg-TP, 87T)
- T60 (Pkg-TS, 87T, 21P)

RTU

- A new D20 will be installed in the 345 EEE. The existing 230 RTU has sufficient capacity for the planned expansion.

Auto-sectionalizing/Auto-transfer

- The 345 yard will be arranged in a breaker and a half configuration with automatic bus voltage transfer.

Control Panel Locations

- Panels will be added to the 230 kV EEE in line with the existing protection panels. The 345 EEE will house line panels for Pawnee, Smoky Hill, the Wind NUG, Metering and Load control, transformer protection, and bus differentials.

Digital Fault recorder

- A DFR for the 345 kV yard will be installed.

Fiber Optic cable

The lines to Pawnee and Smoky Hill will have 48 strand single mode OPGW. The fiber will be utilized for line protection and communications to the 345 kV EEE. Standard ST connectors will be used wherever possible.

F. Outages

The 345 yard can be constructed independent of the system up to energization. Construction power will be available from the existing 230 kV house power.

The following steps will require outages on the 230 kV side.

- The 230 kV expansion will require an outage on line 5457 to Pawnee in order to extend the bus.
- Momentary outages on line 5113 to Daniels Park and 55043 to Cedar Point may be required to change CT circuits.
- An outage on line and 55043 to Cedar Point will be required to move the south bus SSVT for reconfiguration as a 3 phase source.

G. Material Staging Plan

All major equipment will be shipped directly to site and stored in the existing 230 kV yard. Ample space is available for staging.

H. 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:

- $1.77 million for Customer Interconnection Facilities at Missile Site 345 kV Substation (Customer funded)
- $2.20 million for PSCo Network Upgrades for Interconnection (PSCo funded)

Total Estimated cost of Interconnection = $3.97 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. The estimates assume that the customer will interconnect to the north side of the substation where PSCo’s facilities are located.

I. Delivery

There are no PSCo Network Upgrades for Delivery required for this Interconnection.

J. Costs Estimates and Assumptions

The cost responsibilities associated with the facilities described in the following estimates shall be handled per current FERC guidelines. The estimated engineering, procurement & construction schedule can be found in Figure 3 below.

Appropriation level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 20% accuracy) were developed by Xcel Energy/PSCo Engineering staff. The cost estimates are in 2011 dollars with escalation and contingencies applied (AFUDC is not included) 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, material/equipment procurement and construction of these new PSCo facilities. This estimate does not include the cost for any other Customer owned equipment and associated design and engineering.

The estimated total cost for the required upgrades for is **$3,970,000.** These estimates do not include costs 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 generation output. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to change upon a more detailed and refined design.

Table 1 – PSCo Owned; Customer Funded Transmission Provider Interconnection Facilities

Element	Description	Cost Est. (Millions)
PSCo's Missile Site 345 kV Transmission Substation	Interconnect Customer to the 345 kV bus at the Missile Site Substation. The new equipment includes: • One 345 kV, 3000 amp gang switch • Three 345 kV metering CT's • Three 345 kV metering CCVT's • Three 345 kV lightning arresters • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing.	**$1.77**
	Total Cost Estimate for PSCo-Owned, Customer-Funded Interconnection Facilities	**$1.77**
	Design, procure and construct	**10 Months**

Table 2: PSCo Owned; PSCo Funded Interconnection Network Facilities

Element	Description	Cost Estimate (Millions)
PSCo's Missile Site 345 kV Transmission Substation	Interconnect Customer to the 345 kV bus at the Missile Site Substation. The new equipment includes: • Three 345 kV, 3000 amp circuit breakers • Four 345 kV, 3000 amp gang switches • Associated station controls, communications, supervisory and SCADA equipment • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated equipment and system testing • Associated yard surfacing and fencing	**$2.20**

	Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities	**$2.20**
	Design, procure and construct	**10 months**

Table 3 – PSCo Network Upgrades for Delivery

Element	Description	Cost Est. (Millions)
	Not Applicable	
	Total Cost Estimate for PSCo Network Upgrades for Delivery	**$0**
	Total Project Estimate	**$3.97**

Cost Estimate Assumptions

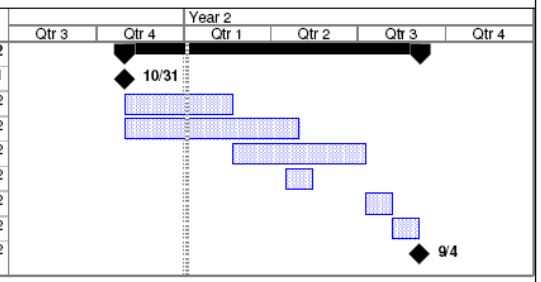
- Appropriation level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 20% accuracy) were developed by Xcel Energy/PSCo Engineering staff.
- Estimates are based on 2011 dollars (appropriate contingency and escalation applied).
- AFUDC has been excluded.
- Engineering will be performed in house.
- Lead times for materials were considered for the schedule.
- The Wind Generation Facility is not in PSCo's retail service territory.
- PSCo (or it's Contractor) crews will perform all construction, wiring, testing and commissioning for PSCo owned and maintained facilities.
- Construction labor is estimated for straight time only – no overtime included.
- Authorization to proceed is considered to be the Engineering & Procurement (E&P) Agreement between PSCo and the Customer, based on the assumption that the E&P Agreement will be approved by FERC.
- This project is completely independent of other queued projects and their respective ISD's.
- A CPCN is not required for the interconnection facilities construction.
- Line and substation bus outages will be authorized during the construction period to meet requested backfeed dates.

V. Engineering, Procurement & Construction Schedule

Figure 3: GI-2011-02 and GI-2011-07 Estimated Schedule

GI-2011-2 and GI-2011-7
Facilities Study
Estimated Project Milestone Schedule

ID	Task Name	Duration	Start	Finish
1	**Missile Site 345kV Substation**	**222 days**	**Mon 10/31/11**	**Tue 9/4/12**
2	E&P Agrmt approved by FERC	1 day	Mon 10/31/11	Mon 10/31/11
3	Substation Design & Engineering	16 wks	Tue 11/1/11	Mon 2/20/12
4	Material Procurement	26 wks	Tue 11/1/11	Mon 4/30/12
5	Substation Physical/Electrical Construction	20 wks	Tue 2/21/12	Mon 7/9/12
6	New 345/230 Auto installed	4 wks	Tue 4/17/12	Mon 5/14/12
7	Relay, SCADA/RTU & Communications Work	4 wks	Tue 7/10/12	Mon 8/6/12
8	Final Commissioning & Energization	4 wks	Tue 8/7/12	Mon 9/3/12
9	Substation Capable of Providing Backfeed to Customer from 345kV Bus	1 day	Tue 9/4/12	Tue 9/4/12



Project: GI-2011-2 & 7 Project Milesto
Date: Wed 1/4/12

Task
Split
Progress
Milestone
Summary
Project Summary
External Tasks
External Milestone
Deadline

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