



Generation Interconnection Facilities Study Report Request # GI-2013-4

19.9 MW Hybrid Generation
Jefferson County, Colorado

Public Service Company of Colorado
Transmission Planning

March 28, 2014



I. Executive Summary

This Interconnection Facilities Study Report summarizes the analysis performed by Public Service Company of Colorado (PSC) to specify and estimate the cost of the siting, engineering, equipment procurement and construction needed to interconnect a 19.9 MW hybrid wind/solar/energy storage generation facility in Jefferson County, Colorado.

- \$0.97 million for Customer-Funded Interconnection Facilities
- \$5.637 million for PSC Network Upgrades for Interconnection

A proposed Station One-Line diagram for the New 115kV NREL Substation is shown in Figure 2.

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

Figure 1a: Network Diagram with Proposed POI at New NREL Substation

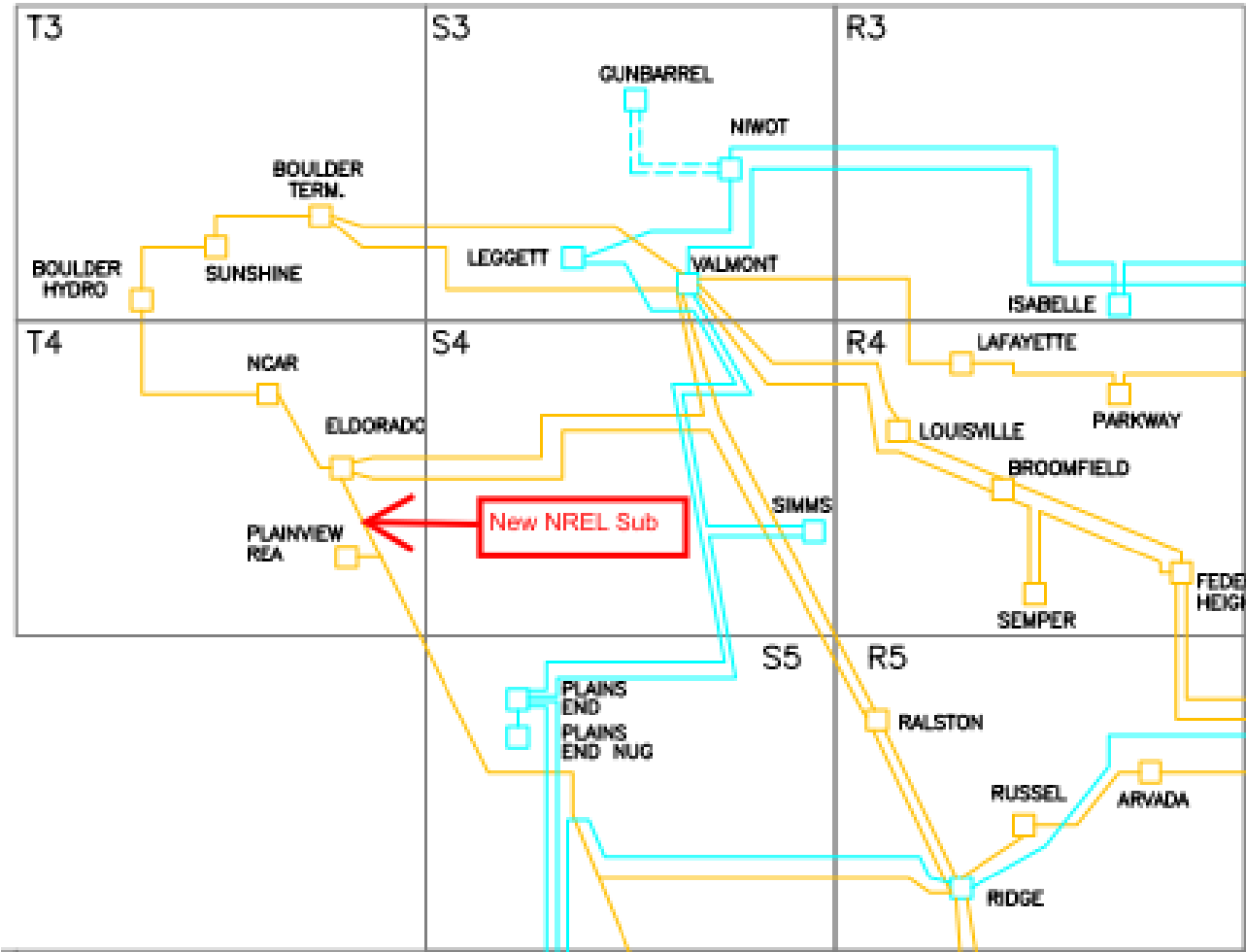


Figure 1b: New 115kV NREL Substation Operating Diagram (Continued on Figure 1c)

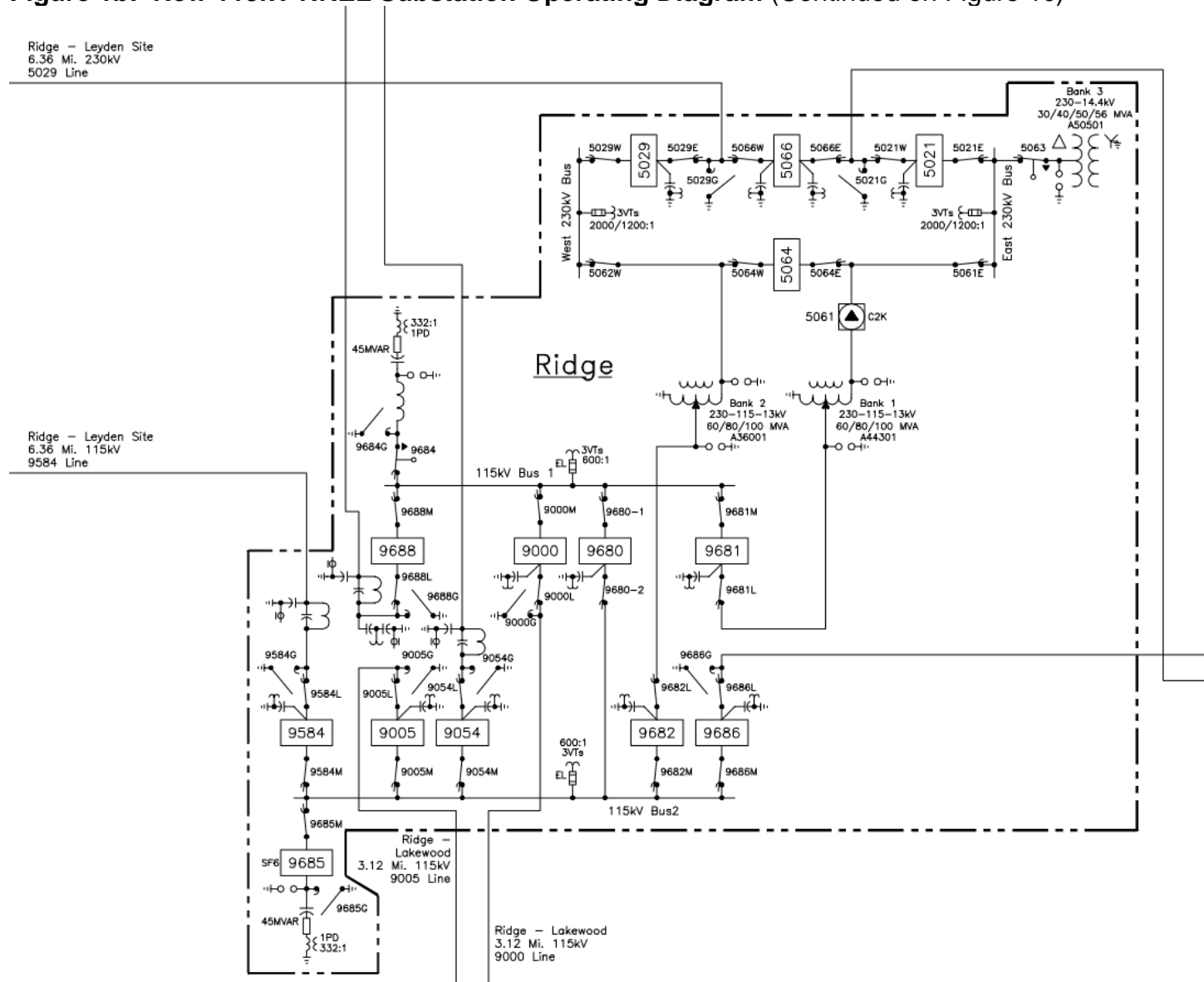


Figure 1c: New 115kV NREL Substation Operating Diagram (Continued on Figure 1b)

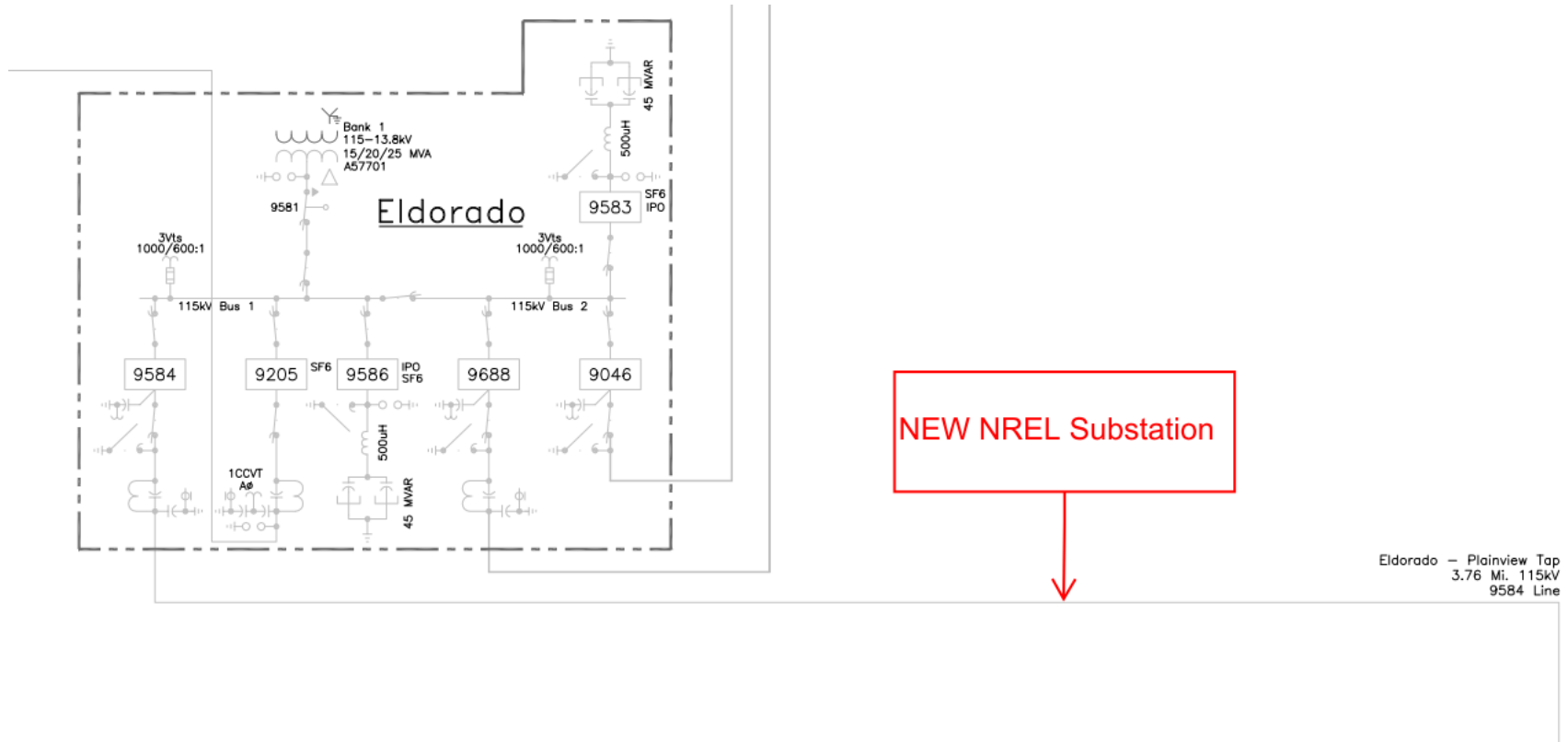
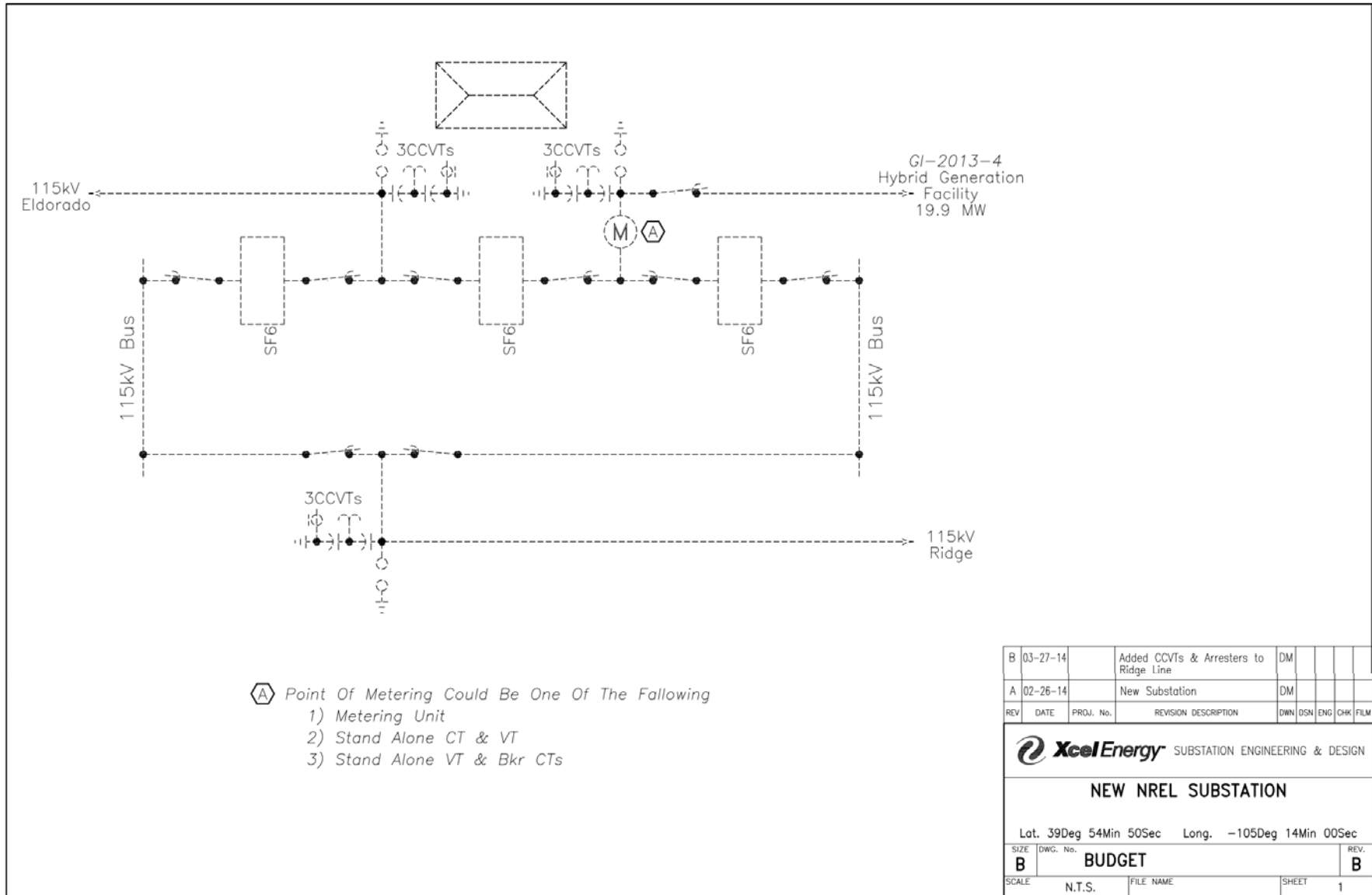


Figure 2: New 115kV NREL Substation Budget One-Line Diagram



II. Introduction

Public Service Company of Colorado (PSC) received an interconnection request (GI-2013-4) for a 19.9 MW hybrid wind/solar/energy storage generation facility in Jefferson County, Colorado. The interconnection request was received on June 6, 2012.

The Interconnection Customer requested a primary Point of Interconnection (POI) at the Plainview Substation 115kV bus. A secondary POI involves intersecting the Plainview-Eldorado 115kV line near the Plainview Substation with a new substation. The hybrid facility will be located approximately two miles from the Plainview Substation and connected to the POI using a 115kV line. The requested in-service date is June 1, 2015. The assumed backfeed date is January 1, 2015. Based on the construction schedule in Table 3, the Interconnection will not be able to meet the proposed back feed date of January 2015. This time period is primarily driven by an estimated time for obtaining siting and land rights, and also includes design, procurement, construction, testing and commissioning.

III. General Interconnection Facilities Description

A. Project Purpose & Scope

The Interconnection Customer requested a primary Point of Interconnection (POI) at the Plainview Substation 115kV bus. A secondary POI involves a new substation intersecting the Plainview-Eldorado 115kV line near the Plainview Substation. The hybrid generation facility will be located approximately 2 miles from the Plainview Substation and will be connected to the POI using a 115kV line.

The purpose of the project as primarily described on this facilities study is a 19.9 MW injection from the hybrid generation facility into the alternate POI and delivering the additional generation to native PSC loads. See Figure 2 for the interconnection details.

B. Background

The new 115kV NREL Substation will be arranged in a three breaker ring expandable to a breaker and a half configuration. The substation will have 3 elements and 2 complete bays with two 115 kV lines to Ridge and Eldorado, and also the hybrid generation facility interconnection. This substation will be near Golden, Colorado.

Current configuration will allow operational flexibility for bus outages as needed to accommodate future expansion.

IV. Interconnection & Network Upgrades for Interconnection

Requirements for interconnection can be found in the [Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation 20 MW or less – Version 1.0](#), last revised in June 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 expected to be defined as a CIP Critical Asset location.

Facility Ratings

The substation will meet the new facility rating methodology.

Remote ends Eldorado and Ridge line bays ratings have been verified and considered to be adequate:

- 115kV breaker 9584 bay at Ridge substation has 2000A capacity based of the breaker's rating as the weakest element.
- 115kV breaker 9584 bay at Eldorado substation has 1600A capacity based of the line trap rating as the weakest element.

B. Right of Way

An estimated range of the cost to acquire a five-acre parcel is \$650,000 and \$1.3 million. This is based on the price that the property owner requests for the parcel in Candelas. The difference being the Candelas parcel is part of a development plan with design guidelines and partial improvements. The parcel in question is unimproved without the benefit of a development plan. The parcel in question also lacks access to an existing major thoroughfare. The proposed site contains several parcels, some of which are over 23 acres. Siting a substation in the interior, away from the road, should reduce the cost.

The estimated cost for a 2,000x75 transmission line easement would be approximately \$375,000 based on 50-percent of fee value.

Substation estimate \$3.00- \$5.00/sf

Transmission easement: \$1.50 - \$2.5/sf

C. Electrical Features

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

The new 115kV lines will utilize single 795 ACSR conductor and be rated at 907 amps. The substation bays will be rated at least 2000 amps.

Fault Current

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

Location \ Type of fault	Three Phase (A)	Single-Line-to-Ground (A)
Existing Fault Currents (2013)	1,316	5,969
Future Fault Currents (2014 w/NO switch 9584-1 closed)	7,624	11,641
Future Fault Currents (2014 w/NO switch 9584-1 closed and new generation online)	8,546	12,389

Electrical Installations (Major Equipment)

- The 115kV yard will consist of three (3) 115kV breakers (and associated disconnects, CCVT's, etc) for the lines to Eldorado, 19.9 MW Hybrid Generation Facility and Ridge substations as shown on the one-line. The above will be arranged in a ring bus configuration with provisions for future expansion in to the breaker and a half (BAAH) scheme.
- Note that the GI-2013-4 19.9 MW Hybrid Generation Facility line side equipment will be customer funded and covered in the Customer Upgrades portion of the estimate.

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 115kV control and protection equipment will be installed.

AC System

The existing AC system for the 115kV yard consists of two (2) single phase 50 kVA Station Service Voltage Transformer's (SSVT's).

DC System

A new battery set will be installed in the 115kV EEE.

Grounding

New ground grid will be installed to cover the entire substation.

Lightning Protection

Surge arresters will be installed on all incoming lines. Static wires will be installed as needed on new transmission towers and substation dead ends. Substation dead –end (DE) structures will be furnished with the shield spikes on each side of the structure.

Trenching & Cable

New duct bank will be installed for the 115kV yard.

D. Civil Features

Grading & Fencing

New Grading will be required. A chain-link fence will be installed around the new 115kV yard.

Storm Water Permit

A SWMP will be required for the new 115kV yard. No delays or complications are anticipated.

Foundations & Structural

Significant foundation work will be required to install all equipment as seen on the General Arrangement.

Civil Removals & Relocations

None.

Civil Installations

Standard designs are anticipated.

The following concrete slab foundations will be installed:

Quantity	Description
3	115kV breaker foundation

The following foundation will be installed for large or medium EEE:

Quantity	Description
1	Large or medium EEE foundation: perimeter wall and basement.

Install the following galvanized steel structures with drilled pier foundations included in the Network Upgrade estimate:

Structure Quantity	Steel Description	Pier Quantity
18	115kV High Bus Support	18
6	115kV CCVT	6
12	115kV Switch Stand	24
2	115kV Dead-End	4
29	115kV Low Bus Support	29
6	115kV S.A. Single Phase Support	6

Install the following galvanized steel structures with drilled pier foundations included in the Customer Upgrade estimate:

Structure Quantity	Steel Description	Pier Quantity
6	115kV High Bus Support	6
3	115kV CCVT	3
1	115kV Switch Stand	2
1	115kV Dead-End	2
3	115kV Metering Unit	3
3	115kV S.A. Single Phase Support	3

Electrical Equipment Enclosure (EEE) or Switchgear Building

A large or medium EEE will be installed for the 115kV protection and control equipment with double prefab construction with a basement.

E. Control Features

Control Schemes

Transmission Breaker Protection (69-500kV)

Three new 115kV 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.

- SEL351 (Pkg-BF/25/79)

Transmission Line Protection (69-500kV)

The primary relaying will consist of an SEL-421 distance relay configured in a permissive overreaching transfer-trip (POTT) scheme. A T1 tone circuit and FOCUS chassis will provide the pilot channel for both primary relaying and primary transfer-trip.

- SEL421 (Pkg-PRI/21P)

The secondary relaying will consist of an SEL-311C distance relay.

- SEL311C (Pkg-SEC/21S)

RTU

- A new Novatech Orion based RTU will be installed in the 115kV EEE.

Control Panel Locations

- New EEE will have enough space to house all new panels.

Fiber Optic cable

The new line from new NREL to customer's substation will have 48 strand single mode OPGW. The fiber will be utilized for line protection and communications to the 115kV EEE. Standard ST connectors will be used wherever possible.

F. Outages

The 115kV yard can be constructed independent of the system up to energization.

The following steps will require outages on the 115kV Eldorado to Ridge line:

- The 115kV line will require a clearance in order to install Transmission Structure foundations.
- A clearance to install the Transmission Structures with post insulator bypasses.
- A clearance to install switches at the transmission structure.

G. Material Staging Plan

All major equipment will be shipped directly to site and stored in the existing 115kV yard. Ample space is available for staging.

H. Interconnection

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

- \$0.97 million for Customer Interconnection Facilities at New 115kV NREL Substation (Customer funded)
- \$5.637 million for PSC Network Upgrades for Interconnection (PSC funded)

Total Estimated cost of Interconnection = \$6.607 million

The estimated costs shown above are “scoping estimates” with an accuracy of +/-30%. 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 south side of the substation where PSC’s facilities are located, although it will be a subject to change depending on the property purchased for this facility.

I. Delivery

There are no PSC 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.

Scoping level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 30% accuracy) were developed by Xcel Energy/PSC Engineering staff. The cost estimates are in 2014 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 PSC 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 **\$6,607,000**. 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 – PSC Owned; Customer Funded Transmission Provider Interconnection Facilities

Element	Description	Cost Est. (Millions)
PSC's New NREL 115kV Transmission Substation	Interconnect Customer into PSC's New NREL 115kV Transmission Substation. The scope includes all switches, arresters, instrument transformers, bus, wiring, foundations, structures and relaying.	\$0.71
Customer's 115kV Substation	Load Frequency/Automated Generation Control (LF/AGC) RTU and associated equipment.	\$0.185
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction.	\$0.075
	Total Cost Estimate for PSC-Owned, Customer-Funded Interconnection Facilities	\$0.97
Time Frame	<u>To site, design, procure and construct after receiving authorization to proceed.</u>	18 Months

Table 2: PSC Owned; PSC Funded Interconnection Network Facilities

Element	Description	Cost Est. (Millions)
PSC's New 115kV NREL Transmission Substation	Construct new 115kV NREL Substation. The scope includes: the complete construction of a new 3 position 115kV substation with all associated breakers, switches, arrestors, bus, wiring, site development, foundations and relaying.	\$3.712
	Transmission line tap into substation. Structures, conductor, hardware and installation labor.	\$0.850
PSC's 115 kV Ridge and Eldorado Transmission Substation	Upgrade the Ridge and Eldorado 115kV Substations line relaying and communications equipment.	\$0.400
PSC's New 115kV NREL Transmission Substation	Siting and Land Rights activities for substation land acquisition and permits.	\$0.675
	Total Cost Estimate for PSC-Owned, PSC-Funded Interconnection Facilities	\$5.637
Time Frame	<u>To site, design, procure and construct after receiving authorization to proceed.</u>	36 Months

Table 3 – PSC Network Upgrades for Delivery

Element	Description	Cost Est. (Millions)
	Not Applicable	
	Total Cost Estimate for PSC Network Upgrades for Delivery	\$0
	Total Project Estimate	\$6.607

Cost Estimate Assumptions

- Referenced Interconnection Guidelines for 20 MW or less.
- Radially fed generation interconnection customer at the new 115kV NREL Substation. Customer is responsible to fund all interconnection facility upgrades. (See Table 1)
- Scoping level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 30% accuracy) were developed by PSC Engineering.
- Estimates are based on 2014 dollars (appropriate contingency and escalation applied).
- AFUDC has been excluded.
- Labor is estimated for straight time only – no overtime included.
- Lead times for materials were considered for the schedule.
- The Hybrid Generation Facility is in PSC's retail service territory. Therefore, costs for retail load metering are included in these estimates.
- PSC (or it's Contractor) crews will perform all construction, wiring, testing and commissioning for PSC owned and maintained facilities.
- The estimated time to site, design, procure and construct the network upgrades for delivery is approximately 36 months after authorization to proceed has been obtained.
- A CPCN will not be required for the interconnection facilities construction.
- Customer will string optical ground wire (OPGW) cable into the substation as part of the transmission line construction scope.
- The new substation land will need to be acquired.

V. Engineering, Procurement & Construction Schedule

Figure 3: GI-2013-4 Estimated Schedule

Activity	Duration (months)
Permitting and Land Acquisition	10
Substation Design And Engineering	10
Material Procurement	12
Substation Civil Construction	1
Substation Physical/Electrical Construction	1
Relay SCADA/RTU work	1
Final Commissioning and Energization	0.5
Backfeed customer's line	0.5
Total	36

GI-2013-4
Facility Study
Estimated Project Schedule
NREL 115kV Substation

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