



## Request # GI-2010-4 Generation Interconnection Facility Study Report

30 MW Photovoltaic Facility, San Luis Valley, Colorado

PSCo Transmission Planning  
March 8, 2011

### Executive Summary

This Interconnection Facilities Study Report summarizes the analysis performed by Public Service Company of Colorado (PSCo) in GI-2010-4 to specify and estimate the cost of the equipment, engineering, procurement, and construction needed to interconnect a 30 MW solar generation facility in Alamosa County, Colorado. The primary point of interconnection (POI) is approximately 3 miles south of San Luis Valley substation on the 115 kV line between San Luis Valley and Alamosa Terminal. A 3-breaker ring bus substation called Blanca Peak will be built underneath the line to accommodate the interconnection.

The Generation Provider's solar generation facility would connect to Blanca Peak substation via a short radial (couple spans) of 115 kV transmission line. The Generation Provider would be responsible for construction of the radial transmission line to the last dead-end structure right outside of Blanca Peak substation. A detailed design guide is included in the body of this report. The requested commercial operation date (COD) of this project is April 1, 2012 with a requested back-feed date of November 1, 2011.

The GI-2010-4 Feasibility/System Impact Study determined that the Customer can provide 30 MW without major network upgrades. The existing SLV – Alamosa Terminal 115 kV line has adequate capacity for an additional 30 MW of injection.

The cost for the transmission interconnection (in 2011 dollars)

The total estimated cost to interconnect the project is approximately **\$4,882,000** and includes:

- \$895,000 for PSCo-Owned; Customer-Funded Transmission Provider Interconnection Facilities
- \$3,402,000 for PSCo Owned; PSCo Funded Interconnection Network Facilities
- \$585,000 for PSCo Network Upgrades for Delivery

One-line of the Interconnection is shown in Figure 1 below.

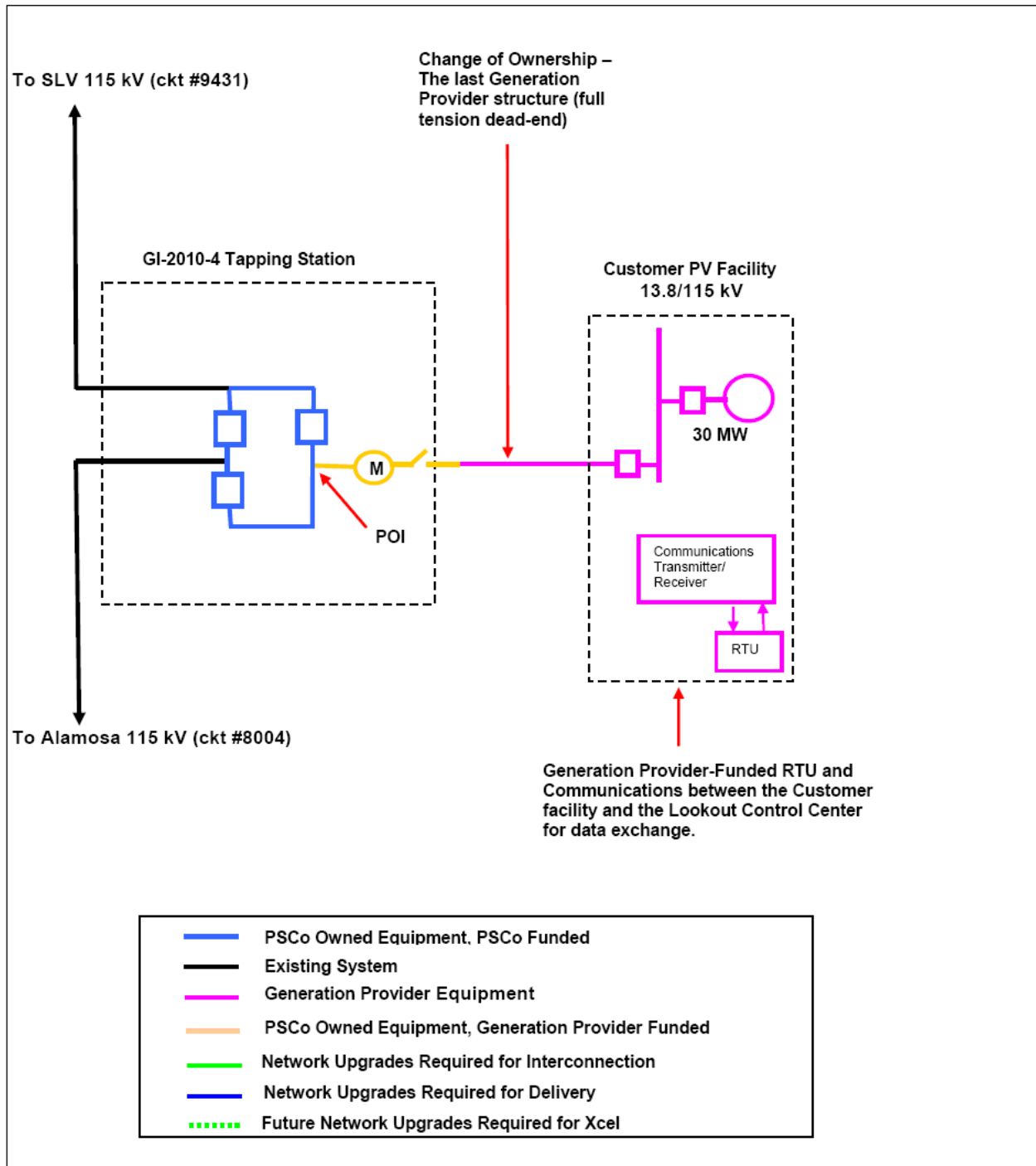


Figure 1: Diagram of the GI-2010-4 Interconnection



## I. Introduction

This Interconnection Facilities Study Report summarizes the analysis performed by Public Service Company of Colorado (PSCo) in GI-2010-4 to specify and estimate the cost of the equipment, engineering, procurement, and construction needed to interconnect a 30 MW solar generation facility in Alamosa County, Colorado. The primary point of interconnection (POI) is approximately 3 miles south of San Luis Valley substation on the 115 kV line between San Luis Valley and Alamosa Terminal. A 3-breaker ring bus substation called Blanca Peak will be built underneath the line to accommodate the interconnection.

## II. General Interconnection Facilities Description

### A. Project Purpose and Scope

A new 115 kV three-position transmission substation will be provided along Public Service Company of Colorado's (PSCo) 115 kV San Luis Valley – Alamosa Terminal 115 kV transmission line (formerly ckt #8004). The new Blanca Peak substation will be located approximately 3 miles south of the San Luis Valley substation. The existing 115 kV transmission line will be broken and will have each end terminated in one line position of the substation. The third line position in this substation will serve as the Point of Interconnection (POI) for a new 30 MW solar photovoltaic facility. The Customer has requested a back feed date of November 1, 2011 and a commercial operation date of April 1, 2012. The substation will be built on a greenfield site within the generation facility property.

#### Background

Refer to the “Combined Generation Interconnection Feasibility/System Impact Study Report,” request number GI-2010-4 dated 08/31/2010 for background information.

#### Future Considerations

A three-position ring bus configuration is being installed initially for this project. Future considerations include equipment and structures that would allow the bus configuration to be modified to a breaker-and-a-half bus configuration. The design of the ring bus will accommodate future expansions as much as possible throughout the detailed design phase of this project. Gang operated disconnect switches will be installed to accommodate installation of additional breakers in the future.

### B. Right of Way

As stated in the Combined Generation Interconnection Feasibility/System Impact Study Report (request # GI-2010-4), all land acquisitions and required permitting will be completed by the Customer. PSCo will require a 320' x 280' area of land for the substation yard and the land will be acquired through a subdivision process. Easements to interconnect to PSCo's existing 115 kV San Luis Valley – Alamosa Terminal transmission line will be coordinated as required.



**C. Electrical Features**

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

Per the Combined Generation Interconnection Feasibility/System Impact Study Report (request # GI-2010-4) for this installation, there are no required upgrades to the surrounding transmission network. The existing SLV-Alamosa 115 kV line has adequate capacity for the additional current flow from the solar PV generation facility interconnection.

Fault Current

Per the Combined Generation Interconnection Feasibility/System Impact Study Report (request # GI-2010-4) for this installation, the addition of the new 30 MW, 115 kV solar PV generation facility along the SLV-Alamosa 115 kV transmission line will require no changes to existing equipment within the surrounding areas in the network. The additional generation interconnection will add less than 200 A to the fault current due to the inverter’s limited fault contribution of approximately rated current. Existing equipment is adequately rated for increased current loading and fault duty.

Location	Type of fault	
	Three Phase (A)	Single-Line-to-Ground (A)
Mid-line node of SLV-Alamosa 115 kV line – Ckt #8004 (3 miles from SLV substation)	5299	5400
Mid-line node of SLV-Alamosa 115 kV line – Ckt #8004 (5 miles from SLV substation)	4733	4609
Alamosa Terminal 115 kV Bus	2352	2072
Blanca Peak substation (installed for this project)	4837	4905

Electrical Removals & Relocations

There will be no electrical equipment removals or relocations for this greenfield site.

Electrical Installations (Major Equipment)

The existing 115 kV transmission line between Alamosa Terminal and San Luis Valley substations (existing ckt # 8004) will be broken and terminated on a new dead end transmission pole. The line to San Luis Valley substation will be renumbered to ckt # 9431 and the Alamosa Terminal line will retain ckt # 8004. These two lines will slack span into the Blanca Peak substation on a two-bay dead end H-frame structure. These two line positions will have surge arresters mounted on the structure tapping into the line and three CCVTs located underneath the dead end structure. These line positions will tie directly into the rigid bus network in the substation.

The third line position in the Blanca Peak substation will be for the Customer’s solar PV generation facility interconnection. The interconnection line position will be slack spanned



into a single-bay dead end H-frame structure with a three phase group operated vee-type disconnect switch and surge arresters mounted on the dead end structure. A set of three combined CT/PT metering units will be located underneath the dead end structure. After passing through the metering units, the line position will be tied to the rigid bus network in the substation.

Three 115 kV, 3000 A SF6 gas circuit breakers will be installed in the substation providing a ring bus configuration inside the substation yard. A line-breaker-line relative position will be maintained in the ring bus; refer to the preliminary general arrangement and relaying & metering one-line included with this design guide. Gang operated switches will be rated for 115 kV, 2000 A and located as indicated on the preliminary general plan included with this design guide.

Main bus will be 5 inch aluminum tube per PSCo electrical engineering substation standards. Rigid aluminum tubular bus will be rated to meet PSCo loading standards and structural deflection limits.

#### Mobile Substation or Transformer

No accommodations for a mobile transformer or substation will be installed for this project.

#### Electrical Equipment Enclosure (EEE)

A 30' x 15' prefabricated EEE with floor will be installed on drilled pier foundations. The enclosure will be located on the north side of the substation yard. The 30' wall of the EEE will be 10' from the northern fence line and the center of the EEE will be 110' from the western fence line. The prefabricated enclosure will include all relay panels and equipment (load centers, cable tray, etc.) mounted inside the enclosure. Minor installations will be required to finalize enclosure installation in the field. Battery spill containment will be only part of battery bank system prefabricated inside of the EEE. All cells will be installed after the enclosure is secured on the footing foundations.

#### AC System

A single phase station service voltage transformer (SSVT) will be installed inside the substation yard for this project. A secondary station service source will be provided by the local utility. The required size of the SSVT will be calculated during the detailed design phase. Conductors from the SSVT to the AC load centers in the control house will be rated for required service load and to minimize voltage drop to appropriate levels.

#### DC System

A new DC system will be installed in the EEE. The system will include battery bank, battery rack, battery charger, main disconnect switch and DC load centers. Spill prevention measures for the battery bank will be included in the EEE. Battery sizing calculations will be performed to determine the required sizing of the battery charger and battery bank.



### Grounding

A new ground mat will be installed as required on the greenfield site to meet PSCo grounding criteria. All equipment will be solidly connected to the ground mat per standard PSCo grounding practices. Current estimates and schedules assume full cooperation by the Customer to provide PSCo with site specific soil resistivity data.

### Lightning Protection

Lightning protection will be installed for the site. Overhead ground wires will be used to protect substation equipment from direct strokes.

### Trenching & Cable

Precast cable trenching will be installed as indicated on the preliminary general plan included with this design guide. Road crossing trench will be installed as required at road crossings.

New power and control cabling will be installed for this greenfield site.

## **D. Civil Features**

### Grading & Fencing

The plot of land for Blanca Peak substation is located within the boundaries of the solar PV generation facility. Assuming initial grubbing and clearing of the site was performed during earthwork for the solar PV generation facility, earthwork and grading will be required for this project. Additionally, a Grading, Erosion and Sediment Control (GESC) permit will be required for this project. Current schedule and estimates assume full cooperation by the Customer to provide PSCo site specific topographic data, soil borings/geotech, ultimate site plan views, etc.

New fencing will be installed as required to match PSCo standard practices.

### Storm Water Permit

A storm water permit will be required during the installation of Blanca Peak substation. Permitting activities will be coordinated with the Customer and PSCo land permitting department.

### Foundations & Structural

Large diameter drilled pier foundations will be installed for the static mast, two-bay and single bay H-frame dead end structures. Small diameter drilled piers will be installed for single phase bus support, three phase bus support, switch support, instrument transformer support, metering unit support structures as well as footings for the pre-fabricated electrical equipment enclosure. Slab on grade foundations will be installed for SF6 gas circuit breakers. No foundation or structural removals are required. Estimated foundation diameters are contingent on soil and/or steel design requirements. Current schedule and



estimates assume full cooperation by the Customer to provide PSCo site specific topographic data, soil borings/geotech, ultimate site plan views, etc.

Oil containment will not be required for this installation.

#### Civil Removals & Relocations

No civil removals or relocations will be required for this greenfield site.

#### Civil Installations

Estimated foundation sizes may vary depending on detailed steel design and/or soil report information. It is expected that the Customer will provide PSCo, a comprehensive site specific geotechnical investigation report as soon as requested. Depths of drilled piers cannot be estimated presently without a geotechnical investigation to reference for preliminary soil conditions.

The following concrete slab foundations will be installed:

<u>Quantity</u>	<u>Description</u>	<u>Approx. Size</u>
3	115 kV GCB slab on grade foundation	5'-0" x 9'-0"

Install the following galvanized steel structures with drilled pier foundations:

<b>Structure Quantity</b>	<b>Steel Description</b>	<b>Steel Wt./ Structure</b>	<b>Drilled Piers</b>		
			<b>Pier Qty</b>	<b>Approx. Size</b>	
				<b>Dia.</b>	<b>Depth</b>
6	115 kV Single Phase CCVT Support		6	2'-6"	-
1	115 kV Single Phase SSVT Support		1	2'-6"	-
3	115 kV Single Phase Metering CT/PT Support		3		-
12	115 kV Low Bus Vertical Break Switch Support		24	2'-6"	-
12	115 kV Low Bus Single Phase Support Structure		12	2'-6"	-
1	115 kV 2-Bay H Frame Dead End Structure		3	5'-0"	-
1	115 kV H Frame Dead End Structure with Vee Disconnect Switches		2	5'-0"	-
2	115 kV Three Phase High Bus Supports		4	2'-6"	-
1	Prefabricated Electrical Enclosure		6	2'-6"	-
1	Static Mast Structure		1	5'-0"	-



Where possible, all structures will be master or previously designed structures. Dead ends will be designed for 20 degree line pull off angle and maximum wire tension of 2000 lbs per phase.

## E. Control Features

### Control Schemes

#### Protection of 8004, Blanca Peak to Alamosa Terminal

- The primary relay will be an SEL 311C using DCUB logic over power line carrier. (PLC). The PLC communication will be a dual channel RFL9780 communication package and shall implement a direct transfer trip (DTT) scheme for breaker failure trips. Stepped distance and ground overcurrent relaying shall also be implemented.
- The secondary protection will be an SEL321 implementing stepped distance and ground overcurrent.
- Typical settings of stepped distance elements will be used: 80% for Zone 1 ph and gnd, no delay, about 125% for Zone 2 ph, 20 cycles delay; long reach (to be determined) for Zone 3 ph, 40 cycles delay. Final reaches will be determined during setting analysis at a later date.
- Directional ground overcurrent (51/67N) looking into the line will be implemented in the SEL311C and SEL321. Instantaneous ground overcurrent will not be implemented.
- High speed line reclosing will be implemented in the SEL 351 BF/25/79 relay associated with breaker 9433.

#### Protection of 9431, Blanca Peak to San Luis Valley

- The primary relay will be an SEL 311C using DCUB logic over power line carrier. (PLC). The PLC communication will be a dual channel RFL9780 communication package and shall implement a direct transfer trip (DTT) scheme for breaker failure trips. Stepped distance and ground overcurrent relaying shall also be implemented.
- The secondary protection will be an SEL321 implementing stepped distance and ground overcurrent.
- Settings of stepped distance elements will be modified to account for the shortness of the line: 60% for Zone 1 ph and gnd, no delay, about 150% for Zone 2 ph, 20 cycles delay; long reach (to be determined) for Zone 3 ph, 40 cycles delay. Final reaches will be determined during setting analysis at a later date.
- Directional ground overcurrent (51/67N) looking into the line will be implemented in the SEL311C and SEL321. Instantaneous ground overcurrent will not be implemented.
- High speed line reclosing will be implemented in the SEL351 BF/25/79 relay associated with breaker 9431.

#### Protection of 9433, Blanca Peak to Customer Alamosa Solar Generating Facility Switchyard

- The primary relay will be an SEL 311L implementing line differential relaying. The 4 bit data channel in the 311L data channel will be used to transmit and receive DTT signals. Stepped distance and ground overcurrent relaying shall also be implemented.





- The secondary protection will be an SEL321 implementing stepped distance and ground overcurrent.
- Two zones of stepped distance will be implemented. Zone 1 phase and ground will reach into about 20% of the Blanca peak transformer impedance and trip with no delay. Zone 2 phase and ground will reach into about 75% of the Blanca peak transformer impedance and trip with 20 cycles delay.
- Directional ground overcurrent (51/67N) will be implemented in the SEL311L and SEL321, looking into the Blanca Peak transformer. Instantaneous ground overcurrent will not be implemented.
- There will be no reclosing on this line.
- Due to the short nature of the line, either multimode or single mode fiber is satisfactory. Xcel, for consistency in design of other substations, would prefer single mode fiber, but this will not be required.

#### Breaker Failure, Reclosing, Sync Check:

- An SEL351 relay will be used with each breaker for breaker failure, sync check, and reclosing applications. For all 3 breakers, breaker failure will initiate direct transfer trip to the remote ends via the communication paths described above (PLC for 8004 and 9431, and 311L data bits over fiber for 9433)

#### Other Design Elements

- Revenue and load control meters are required and will be installed on the line to the Customer's facility. The metering VT will also be used for relaying applications.
- Relay failure alarms will be monitored by SCADA.
- Communication channel failure in the line relays and in the RFL equipment will be monitored by SCADA.
- Line Watt and VAR monitoring will be via the SEL321 relays, connected to SCADA via an SEL2032 data processor.
- Breaker trip and close control will be via the normal SCADA interface.
- All substation CT ratios will be set 800:5, which approximately matches the line ampacity.

### **Local Annunciation**

Local annunciation will be provided through the Cooper/Cybectec SMP/16. This cabinet will be prefabricated and preprogrammed by the supplying vendor.

### **Auto-sectionalizing/Auto-transfer.**

Auto-sectionalizing/auto-transfer will not be required in this installation.

#### Control Panel Locations

A new EEE will be installed on the greenfield site and have adequate room for the required panel layout.



#### Digital Fault recorder

A Digital Fault recorder will not be installed in the Blanca Peak substation.

#### Telephone protection

One two-wire phone line will be installed for the telephone in the control house. Two four-wire leased lines will be installed for the substation RTU (at Blanca Peak substation) and load control RTU (at the Customer substation).

#### PLC (programmable logic controller)/Feeder Load Monitoring/Information-flow/ Others

An SEL-2032 will be used to poll analog data points for the San Luis Valley and Alamosa Terminal transmission lines and communicate with the PSCo EMS system. A SEL-734 EXM will be installed inside the Customer's control house to communicate metering information with PSCo's EMS system via a load control RTU. For SCADA, both the Blanca Peak substation RTU and load control RTU, installed on Customer's control house will communicate with PSCo's EMS system via 4-wire leased telephone lines. For the telephone system inside the Blanca Peak substation control house, a 2-wire phone line provided by the local telephone company will be used.

#### Fiber Optic cable

As stated above, either single or multi mode fiber with ST connectors will be installed between the Blanca Peak sub and the customer's solar plant for the line differential protection and DTT. It is undetermined at this time whether the installation will be OH via transmission shield wire or UG duct. Length is being estimated at 400-600 ft.

#### Equipment Details

#### Removals

No equipment removals will be required for this greenfield site.

#### Installations

- See above.

## **F. Outages**

Outages will be coordinated with system operations personnel. A minimum 6 week outage of the San Luis Valley - Alamosa Terminal 115 kV transmission line is the only major outage anticipated for this installation.



## G. Material Staging Plan

Major equipment (breakers, switches, etc.) will be stored at the substation location given that a fence is installed before delivery. Other materials will be stored at PSCo's Alamosa Service Center.

## H. Risk Check List

*Risk factors identified at the time the Design Guide Package was prepared are indicated below. Explanations, where applicable indicate the action, if any, taken in the estimate as a result, such as additional contingencies or multipliers that were applied.*

- Survey information is not available. Explain: A land survey will need to be acquired from the Customer or contracted out before detailed civil design.
- Soil boring results are not available. Explain: A geotechnical report will need to be acquired from the Customer or contracted out before detailed civil design.
- Unusual soils or environmental conditions exist. Explain:
- Key materials or items need decisions or approvals. Explain:
- Potential permitting delays or unusual requirements exist. Explain: We are expecting the Customer to reply to our requests in a timely manner.
- There are difficult or seasonal outage requirements. Explain:
- There are conflicting outage requirements. Explain:
- There are risks due to who will construct the project and their availability.  
Explain:
- Unusual construction techniques will be required. Explain:
- There are risks associated with plans to reuse existing material. Explain:
- There are potential alternatives still under consideration. Explain:
- Material prices are likely to change or volatile. Explain:
- Material lead times are likely to be longer than estimated. Explain: Given desired accelerated timeline for backfeed, major material lead times could influence construction completion timeline.
- Labor prices are likely to change. Explain:
- There are existing erosion problems. Explain:
- The existing oil containment may not be adequate. Explain:
- The existing lightning protection may not be adequate. Explain:
- The existing bus and equipment ampacity may not be adequate. Explain:

The existing drawings are incomplete and inaccurate. Explain:

### III. Costs Estimates and Assumptions

Scoping level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 30% accuracy) were developed by PSCo Engineering. The cost estimates are in 2011 dollars with escalation and contingency 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 siting support, engineering, design, 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 **\$4,882,000**. 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)
<b>PSCo's New Blanca Peak 115 kV Transmission Substation</b>	Interconnect Customer to tap at PSCo's Blanca Peak 115 kV Substation (sectionalizing the SLV-Alamosa 115 kV OH Line). The new equipment includes: <ul style="list-style-type: none"> <li>• One 115 kV gang switch</li> <li>• Three 115 V combination CT/PT metering units</li> <li>• Three 115 kV lightning arresters</li> <li>• One relay panel</li> <li>• Associated bus, wiring and equipment</li> <li>• Associated foundations and structures</li> <li>• Associated transmission line communications, relaying and testing</li> </ul>	<b>\$0.295</b>
	Transmission line tap into substation. Structure, conductor, hardware and installation labor.	<b>\$0.297</b>
<b>GI-2010-4 Customer's Facility</b>	Load Frequency/automated Generation Control (LF/AGC) RTU and associated equipment.	<b>\$0.193</b>
	Transmission line interconnection/tie (approximately 2,000') between PSCo's Blanca Peak and GI-2010-4 San Luis solar sub.	<b>\$0.110</b>
	<b>Total Cost Estimate for PSCo-Owned, Customer-Funded Interconnection Facilities</b>	<b>\$0.895</b>
<b>Time Frame</b>	<b>Design, procure and construct</b>	<b>12 Months</b>

**Table 2 – PSCo Owned; PSCo Funded Interconnection Network Facilities**

Element	Description	Cost Estimate (Millions)
<b>PSCo's New Blanca Peak 115 kV Transmission Substation</b>	Interconnect Customer to tap at PSCo's Blanca Peak 115 kV Substation (sectionalizing the SLV-Alamosa 115 kV OH Line). The new equipment includes: <ul style="list-style-type: none"> <li>• Three 115 kV circuit breakers</li> <li>• Eleven 115 kV gang switches</li> <li>• Six 115 kV CCVT's</li> <li>• One 115 kV SSVT (station service)</li> <li>• Associated communications, supervisory and SCADA equipment</li> <li>• Associated line relaying and testing</li> <li>• Associated bus, miscellaneous electrical equipment, cabling and wiring</li> <li>• Associated foundations and structures</li> <li>• Associated road and site development, fencing and grounding</li> </ul>	<b>\$3.392</b>
	Siting and Land Rights support for substation land acquisition and construction.	<b>\$0.010</b>
	<b>Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities</b>	<b>\$3.402</b>
<b>Time Frame</b>	<b>Site, design, procure and construct</b>	<b>12 Months</b>

**Table 3 – PSCo Network Upgrades for Delivery**

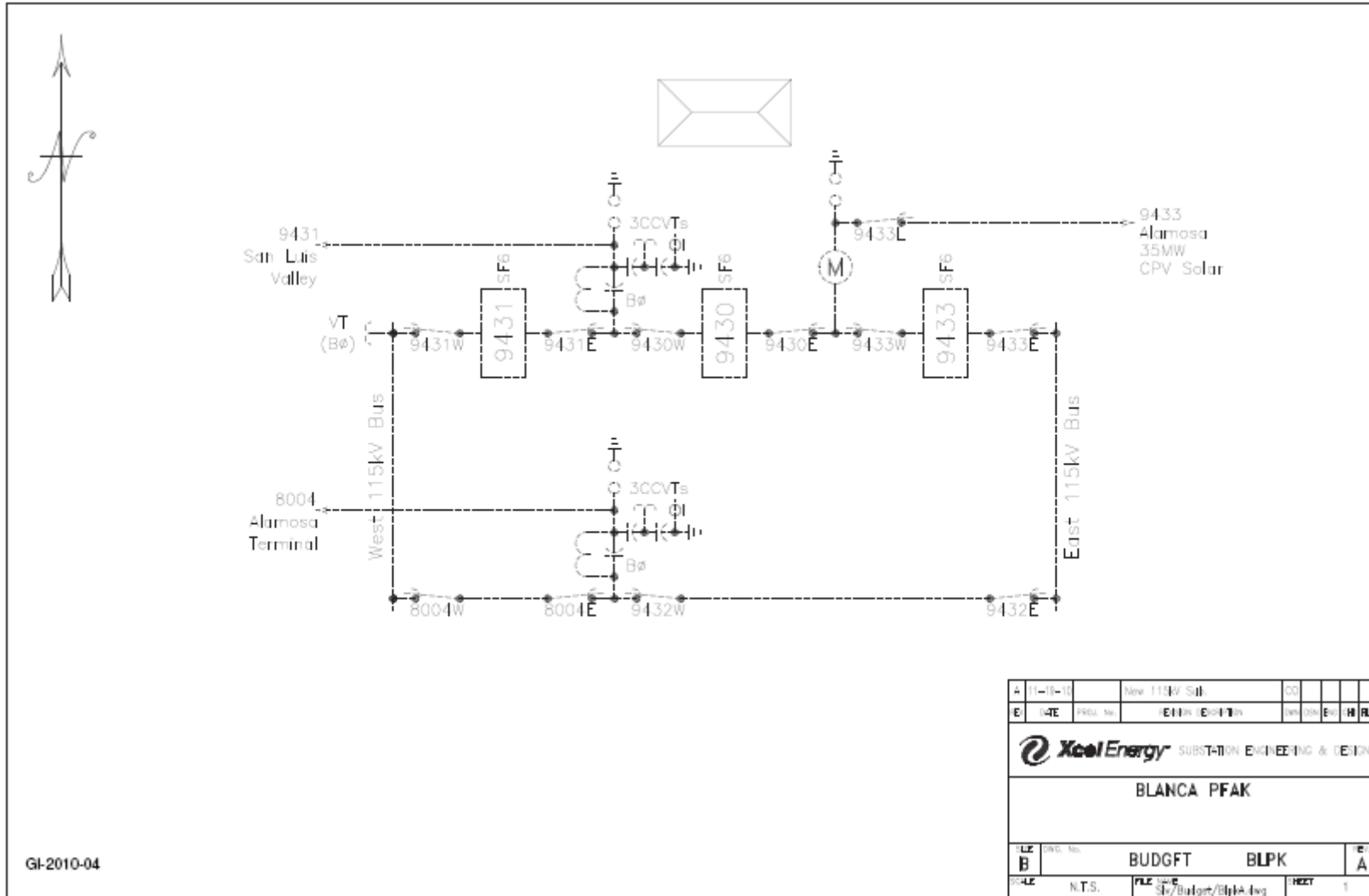
Element	Description	Cost Est. (Millions)
<b>PSCo's Alamosa Terminal 115 kV Substation</b>	Remote end relay replacements/end of life relaying.	<b>\$0.389</b>
<b>PSCo's San Luis Valley 115 kV Substation</b>	Remote end relay replacements/end of life relaying.	<b>\$0.186</b>
	Upgrade metering CT on line #8004 per FAC-009 (change tap ratio) (O&M)	<b>\$0.010</b>
	<b>Total Cost Estimate for PSCo Network Upgrades for Delivery</b>	<b>\$0.585</b>
	<b>Design, procure and construct</b>	<b>12 months</b>
	<b>Total Project Estimate</b>	<b>\$4.882</b>

### Cost Estimate Assumptions

- Scoping level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 30% accuracy) were developed by PSCo Engineering.
- Estimates are based on 2011 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 Solar Generation Facility 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 construction, wiring, testing and commissioning for PSCo owned and maintained facilities.
- The estimated time to design, procure and construct the interconnection facilities is approximately 12 months after authorization to proceed has been obtained.
- A CPCN will not be required for the interconnection facilities construction.
- Customer will string OPGW fiber into substation as part of the transmission line construction scope.
- All land will be acquired and required permitting completed by the Customer. PSCo will require a 280' x 320' substation yard. A subdivision process will be required to acquire PSCo's substation land.
- Breaker duty study determined that no breaker replacements are needed in neighboring substations.
- Remote end relay replacements/end of life relaying on circuits 8004 and 6963.
- Estimated earth fill would level out a 2% grade across entire yard.
- Station service provided primarily from a station service VT and secondly by the local utility provider.

# Appendix



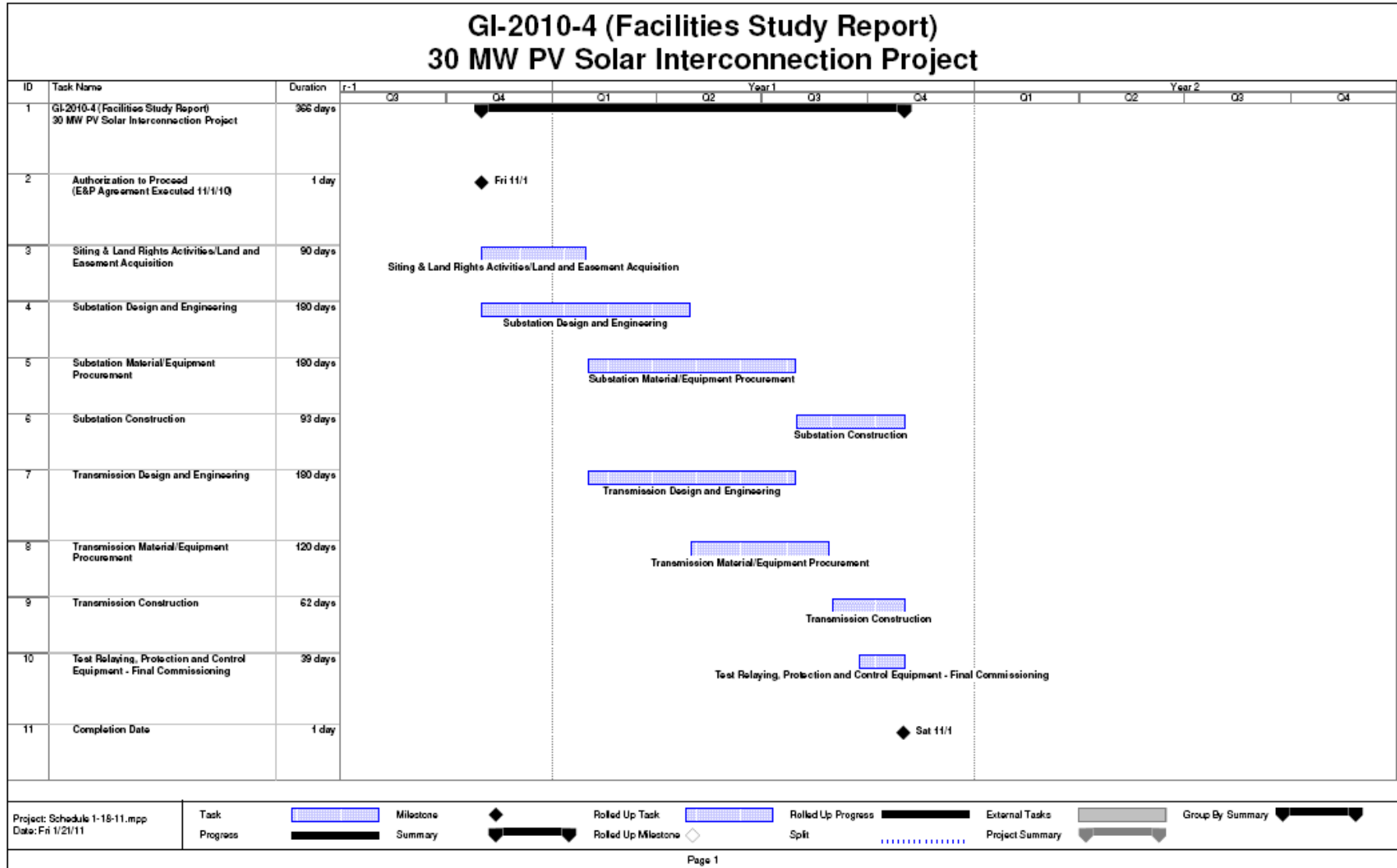
**A. Project One-Line of the Point of Interconnection**


GI-2010-04

A	11-10-10	New 115kV Sub.	CC			
E	DATE	PROJ. No.	ENTR. (E-11)	DR. (DR-11)	RE. (RE-11)	FL. (FL-11)
SUBSTATION ENGINEERING & DESIGN						
<b>BLANCA PFAK</b>						
FILE	DWG. No.	BUDGFT	BLPK	REV		
SCALE	N.T.S.	FILE NAME	Sub/Budget/Block.dwg	HEET	1	



C. Project Schedule PSCo (developed according to requested COD and back-feed dates)



## D. Solar Testing Procedures

Performance testing will be scheduled only after the following conditions have been met.

- 1) Interconnection Customer requests testing for a combined chosen capacity rating.
- 2) SCADA in place, including Lookout to Interconnecting Substation interconnection POI data points
- 3) Ring-down telephone from Lookout to Generator Operation Center in place to be used for test communications
- 4) PSCo meter shop crew at substation to witness testing.

Requirement	Specific Req.	Test	Pass	Conditions
Voltage control & Power Factor limits validation at Point of Interconnection (POI)	Maintain voltage setpoint	Set to, e.g., 1.02 p.u. voltage (~117.3 kV)	Voltage held within +/- 1%, subject to p.f. limits and available capacity. New voltage setpoint(s) may be selected. Log directives to Generator Operations Center.	0---full capacity rating, to follow solar availability (not curtailed).
	Fully compensate for changing transmission conditions.	Set voltage setpoint as necessary to bring power factor to net zero or inductive at POI	Mvar <=0, of available capacity	~0 MVAR output after LTC is adjusted several steps (+ or - 5% at 115 KV)
	Lead/Lag 0.95 limits	Set voltage to demonstrate 0.950 p.f. Lead	Meter shop test equipment indicates 0.95 or better	Collect data at 25%, 50%, 75% and >92.5% of available capacity rating.
		Set voltage to demonstrate 0.950 p.f. Lag	Meter shop test equipment indicates 0.95 or better	Collect data at 25%, 50%, 75% and >92.5% of available capacity rating.
	Raise/lower setpoint	Series selected at time of test, e.g., "raise 0.5 kV"	right direction, e.g., raise not lower, as requested, subject to p.f. limits	>50% P(rated)
		Volt raise test #2, as above	right direction, e.g., raise not lower, as requested, subject to p.f. limits	>50% P(rated)
		Volt lower test #1, as above	right direction, e.g., raise not lower, as requested, subject to p.f. limits	>50% P(rated)
		Volt lower test #2, as above	right direction, e.g., raise not lower, as requested, subject to p.f. limits	>50% P(rated)