GENERATION INTERCONNECTION
REQUEST # GI-2014-2

FACILITY STUDY REPORT
35 MW PV SOLAR, ALAMOSA COUNTY, COLORADO

XCEL ENERGY – PSCO TRANSMISSION PLANNING WEST

July 22, 2016

A. Executive Summary

This Interconnection Facility Study Report summarizes the analysis performed by Public Service Company of Colorado (PSCo), designated as GI-2014-2, to specify and estimate the cost of the siting, engineering, equipment procurement and construction needed to physically and electrically connect the GI-2014-2, 35 MW photovoltaic (PV) generation facility (GF) in Alamosa County, Colorado.

The requested primary point of interconnection (POI) is at the San Luis Valley 115 kV bus. The Customer's GF will connect 35 MW of solar photovoltaic generation to the SLV 115 kV bus via a 0.5 mile generator tie line. A total of 23 Power Conversion Stations (PCS) and associated PV modules will be connected to a common 34.5 kV collector bus. The GF will include a substation that combines two collector system feeders, 23 PCS, and one 34.5/115 kV step-up transformer (GSU) for delivery.

Figure 1 shows the general area of SLV area. Figure 2, in Appendix A, shows the budgeted one-line of the SLV substation. The proposed commercial operation in-service date is August 1, 2016 with an assumed back feed date of six months prior to Commercial Operation Date (COD[1]).

This request was studied both as an Energy Resource Interconnection Service (ERIS)[2] and a Network Resource Interconnection Service (NRIS)[3]. The Feasibility/System Impact Study consisted of power flow (steady-state) contingency, dynamics, and short circuit analyses. The

[1] **Commercial Operation Date** of a unit shall mean the date on which the Generating Facility commences Commercial Operation as agreed to by the Parties pursuant to Appendix E to the Standard Large Generator Interconnection Agreement.

[2] **Energy Resource Interconnection Service** shall mean an Interconnection Service that allows the Interconnection Customer to connect its Generating Facility to the Transmission Provider's Transmission System to be eligible to deliver the Generating Facility's electric output using the existing firm or non-firm capacity of the Transmission Provider's Transmission System on an as available basis. ERIS in and of itself does not convey transmission service

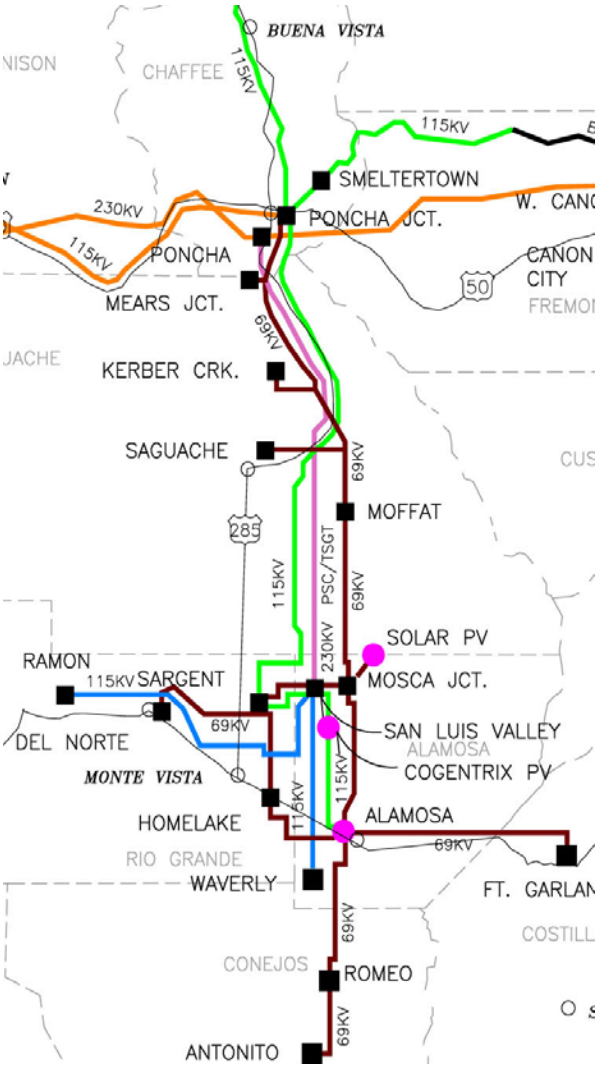
[3] **Network Resource Interconnection Service** shall mean an Interconnection Service that allows the Interconnection Customer to integrate its Large Generating Facility with the Transmission Provider's Transmission System (1) in a manner comparable to that in which the Transmission Provider integrates its generating facilities to serve native load customers; or (2) in an RTO or ISO with market based congestion management, in the same manner as all other Network Resources. NRIS in and of itself does not convey transmission service.

power flow analysis results identified two contingency violations that can be attributed to the GI-2014-2 facility. PSCo has yet to determine the network upgrades for delivery to mitigate the criteria violations and accommodate the new generation interconnection. There is an ongoing joint transmission study effort between PSCo and Tri-State Generation and Transmission (TSGT) for the SLV area through the Colorado Coordinated Planning Group (CCPG).

The total estimated cost of the recommended system upgrades to interconnect the project is approximately **$ 1.370 million** and includes:

- $1,370 million for PSCo Owned, Customer Funded Interconnection Facilities.
- $0.000 million for PSCo Owned, PSCo Funded Interconnection Facilities.
- $0.000 million for PSCo Network Upgrades for Delivery.

Figure 1. San Luis Valley region



B. Introduction

On November 5, 2015, Public Service Company of Colorado (PSCo) and a Generation Provider (Customer) signed an Interconnection Facility Study request (GI-2014-2) to provide cost estimates, a project schedule, and to address the impacts, as identified in the Feasibility/System Impact Study, of interconnecting a 35 MW PV generation facility to the 115 kV bus at PSCo's San Luis Valley substation. The Customer's GF will consist of 23 Power Conversion Stations (PCS) and associated PV modules will be connected to a common 34.5 kV collector bus. The GF will include a substation that combines two collector system feeders, 23 PCS, and one 34.5/115 kV step-up transformer for delivery. The proposed commercial operation in-service date is August 1, 2016 with an assumed back feed date of six months prior to Commercial Operation Date (COD). However, based on results of the Feasibility/System Impact Study, the COD for Network Resource Interconnection Service cannot be met until after the overloads have been mitigated in the San Luis Valley and additional transmission line(s) constructed to export additional generation out of the San Luis Valley to the Denver Metro area.

There is an ongoing joint transmission study effort between PSCo and Tri-State Generation and Transmission (TSGT) for the SLV area through the Colorado Coordinated Planning Group (CCPG). The Phase 1 of the SLV Coordinated Planning Study has been completed and the study report can be found on the WestConnect website. The Phase 2 has just been kicked off and the study is underway to analyze different transmission alternatives beyond Poncha substation.

The purpose of Interconnection Facility Study is to specify and estimate the cost of the equipment, engineering, procurement and construction work needed to implement the conclusions of the Interconnection System Impact Study in accordance with Good Utility Practice to physically and electrically connect the GI-2014-2 large generating facility to PSCo's transmission system at the SLV 115 kV Substation.

C. General Interconnection Facilities Description

PSCo's requirements for interconnection can be found in the Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW – Version 8.0,

last revised in August 2015. 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.

I. FERC and/or NERC Compliance Requirements

Critical Infrastructure Protection (CIP) Asset

The CIP status of this substation has not been verified at this time.

Facility Ratings

The substation will meet the new facility rating methodology.

II. Right of Way/Permitting

The expansion of this substation will not require the purchase of any additional land. All land needed for the expansion is currently owned by either Xcel Energy or Tri-State.

Any costs for a new transmission line easement will be the responsibility of the customer to determine.

III. Electrical Features

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

The new 115 kV line will utilize a single 795 ACSR conductor and be rated at 910 amps. The new substation bay will be rated at least 2000 amps.

Fault Current

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

Electrical Installations (Major Equipment)

- The new position for the solar interconnection will consist of new 115 kV dead-end structures, breaker, associated disconnects, line disconnect, arresters, metering CT units, and CCVTs.
- Note that the GI-2014-2 35 MW Solar 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)

Based on existing site photos and Tri-State drawings of the existing EEE there is adequate space for the two new relay panels required for the interconnection.

AC System

The existing AC system for the 115 kV yard consists of two (2) three phase 75 kVA Station Service Voltage Transformer's (padmount). It is assumed that the existing station service is adequate to handle the minimal added heater load required as part of the interconnection. Additional calculations will be performed during design to confirm the adequacy of the system.

DC System

DC calculations show that the existing battery is not adequate for the existing equipment per the Xcel Energy 12 hour discharge standard. The added load under this interconnection project will increase burden on the system. A new battery bank will be installed to bring the system up to standard. The existing battery charger is adequate and will not need to be replaced.

Grounding

New ground grid and ground leads will be installed as required for the substation expansion.

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

Existing cable trench will be utilized and direct burry conduits will be installed to accommodate the new main and transfer bus expansion.

IV. Civil Features

Grading & Fencing

Site grading will not be required as all work will take place within the existing substation fence.

Storm Water Permit

A SWMP will not be required for the work involved on this project. Only a small area of the yard will be disturbed by construction.

Foundations & Structural

Foundations for the new circuit breakers, switch stands, bus supports, dead-end structures, lightning arresters, and metering stands will be required.

Civil Removals & Relocations

No civil removals or relocations will be required as part of this project.

Civil Installations

Standard designs are anticipated (drilled piers, slabs, etc.)

The following concrete slab foundations will be installed:

Quantity	Description
1	115 kV breaker foundation

The following galvanized steel structures with drilled pier foundations will be installed:

Structure Quantity	Steel Description	Pier Quantity
18	115 kV Low Bus Support	18
3	115 kV CCVT	3
4	115 kV Switch Stand	8
2	115 kV Dead-End	4
3	115 kV Lightning Arrestor Stands	3
3	115 kV Metering CT Unit Stands	3

No removals required.

V. Control Features

Transmission Breaker Protection

The existing protection for BKR 9191 is provided by an SEL-351 relay. This protection is adequate and will not be upgraded during this project.

The existing protection for BKR 9431 is provided by an SEL-351 relay. This protection is adequate and will not be upgraded during this project.

The existing protection for BKRs 862, 762, 662, and 566 is unknown at this time. These breakers are owned by Tri-State and they will need to decide if the protection will be upgraded during this project.

The breaker failure protection for the new solar interconnect breaker will be provided by a new SEL-351S relay.

Transmission Line Protection

The existing protection for TL9191 from San Luis Valley to Iberdrola Solar is provided by an SEL-311L Primary protection system and an SEL-311C Secondary protection system. This protection is adequate and will not be upgraded during this project.

The existing protection for TL9431 from San Luis Valley to Blanca Peak is provided by an SEL-311C Primary protection system and an SEL-321 Secondary protection system. This protection is adequate and will not be upgraded during this project.

The existing protection for TL662 from San Luis Valley to Waverly is provided by an SEL-311C Primary protection system and an SEL-311C Secondary protection system. This protection is adequate and will not be upgraded during this project. This equipment is Tri-State owned and may be upgraded if requested.

The protection for the new TLXXXX from San Luis Valley to the Solar Farm will be provided by an SEL-411L Primary protection system and an SEL-311C Secondary protection system.

Transmission Bus Protection

The existing protection for 115 kV Bus 2 is provided by a GE-PVD relay. This protection will remain and the new breaker will be added to the existing scheme.

Transformer Protection

No changes to the existing transformer protection will take place as part of this project.

RTU

There is currently a project to replace the RTU at San Luis Valley and it is assumed that this project will be complete prior to the new interconnection. Status and control points for the interconnection will be added to the RTU that will be installed as part of this project.

A new LFAGC RTU will be installed by the customer for all customer owned and operated equipment.

Control Panel Locations

Two new control panels will be installed in the existing EEE.

Fiber Optic cable

The new line from San Luis Valley substation to customer's substation will have 48 strand single mode OPGW. The fiber will be utilized for line protection and communications to the existing control building. Standard ST connectors will be used wherever possible.

VI. Project Operating Concerns and Outages

Outages/Temporary Configurations

Since the Main and Transfer busses will be extended to accommodate the new solar interconnection, much of this work can be completed without taking equipment outages. There will be outages required to connect the new breaker position into the main and transfer bus, the general construction sequence is outlined below.

- Pour new foundations and install structures in the clear.
- An outage on 115 kV Main Bus #2 will be required to extend the bus and connect the new position into the bus. The transfer bus will require an outage to connect the new position in as well.
- While the transfer bus is out of service the shield wire can be installed between the new and existing dead-end structures.

VII. Material Staging Plan

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

D. Cost 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 Table 1 below.

Appropriation level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 20% accuracy) were developed by Public Service Company of Colorado (PSCo) / Xcel Energy (Xcel) Engineering. The cost estimates are in 2016 dollars with escalation and contingency factors included. AFUDC is not included. Estimates are developed assuming typical construction costs for previous completed projects. These estimates include all applicable labor and overheads associated with the siting support, engineering, design, material/equipment procurement, construction, testing and commissioning of these new substation and transmission line 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 $1,370,000. 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 San Luis Valley Transmission Substation	Interconnect Customer to tap at the San Luis Valley Transmission Substation (into the 115 kV bus). The new equipment includes: • One 115 kV circuit breaker • Ten 115 kV gang switches • Three 115 kV arresters • One set (of three) high side CT/PT metering units • Station controls • Associated bus, wiring and equipment • Associated site development, grounding, foundations and structures • Associated transmission line communications, relaying and testing	**$1.085**
	Transmission line relocation and tap into substation. Structures, conductor, insulators, hardware and labor.	**$0.265**
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction.	**$0.020**
	Total Cost Estimate for PSCo-Owned, Customer-Funded Interconnection Facilities	**$1.370**
Time Frame	**Site, design, procure and construct**	**18 Months**

Table 2: PSCo Owned; PSCo Funded Interconnection Network Facilities

Element	Description	Cost Estimate (Millions)
PSCo's San Luis Valley 115 kV Transmission Substation	Interconnect Customer to tap at the San Luis Valley Transmission Substation (into the 115 kV bus). The new equipment includes: Not applicable. See assumptions below.	**TBD**
	Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities	
Time Frame	**Site, design, procure and construct**	

Table 3: PSCo Owned; PSCo Funded Network Upgrades for Delivery

Element	Description	Cost Est. (Millions)
PSCo's San Luis Valley 115 kV Transmission Substation	Interconnect Customer to tap at the San Luis Valley Transmission Substation (into the 115 kV bus). The new equipment includes: Not applicable. See assumptions below.	**TBD**
	Total Cost Estimate for PSCo Network Upgrades for Delivery Facilities	
Time Frame	**Site, design, procure and construct**	

Cost Estimate Assumptions

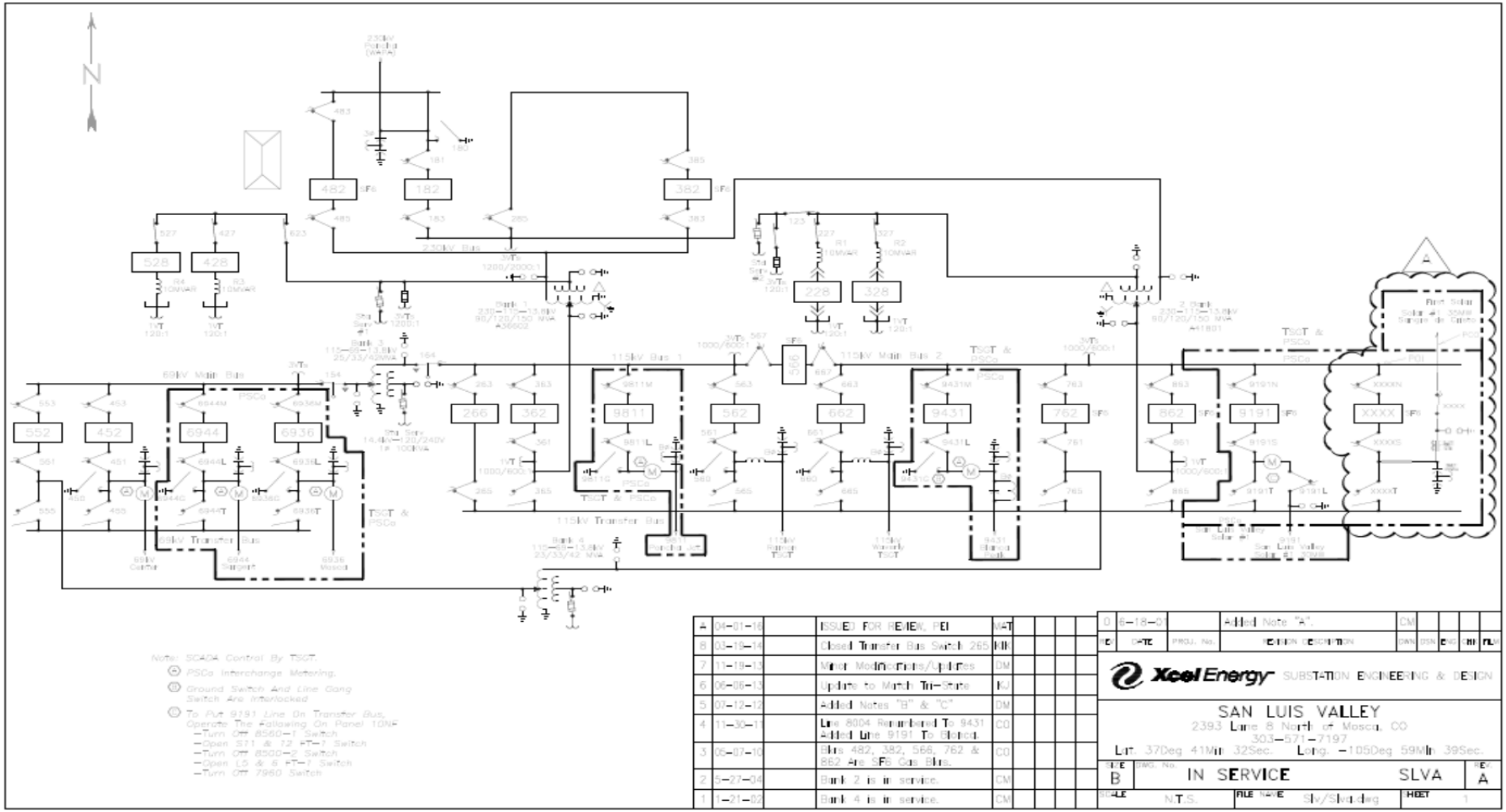
- Referenced Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW.
- Appropriations level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 20% accuracy) were developed by PSC Engineering.
- Estimates are based on 2016 dollars (appropriate contingency and escalation applied).
- Labor is estimated for straight time only – no overtime included. Assumes contracted construction for the majority of the work.
- Lead times for materials were considered for the schedule.

- The Solar 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, and testing and commissioning for PSC owned and maintained facilities.
- The estimated time to site, design, procure and construct the network upgrades for delivery for option 1 (Main & Transfer bus extension) 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 optical ground wire (OPGW) cable into the substation as part of the transmission line construction scope.

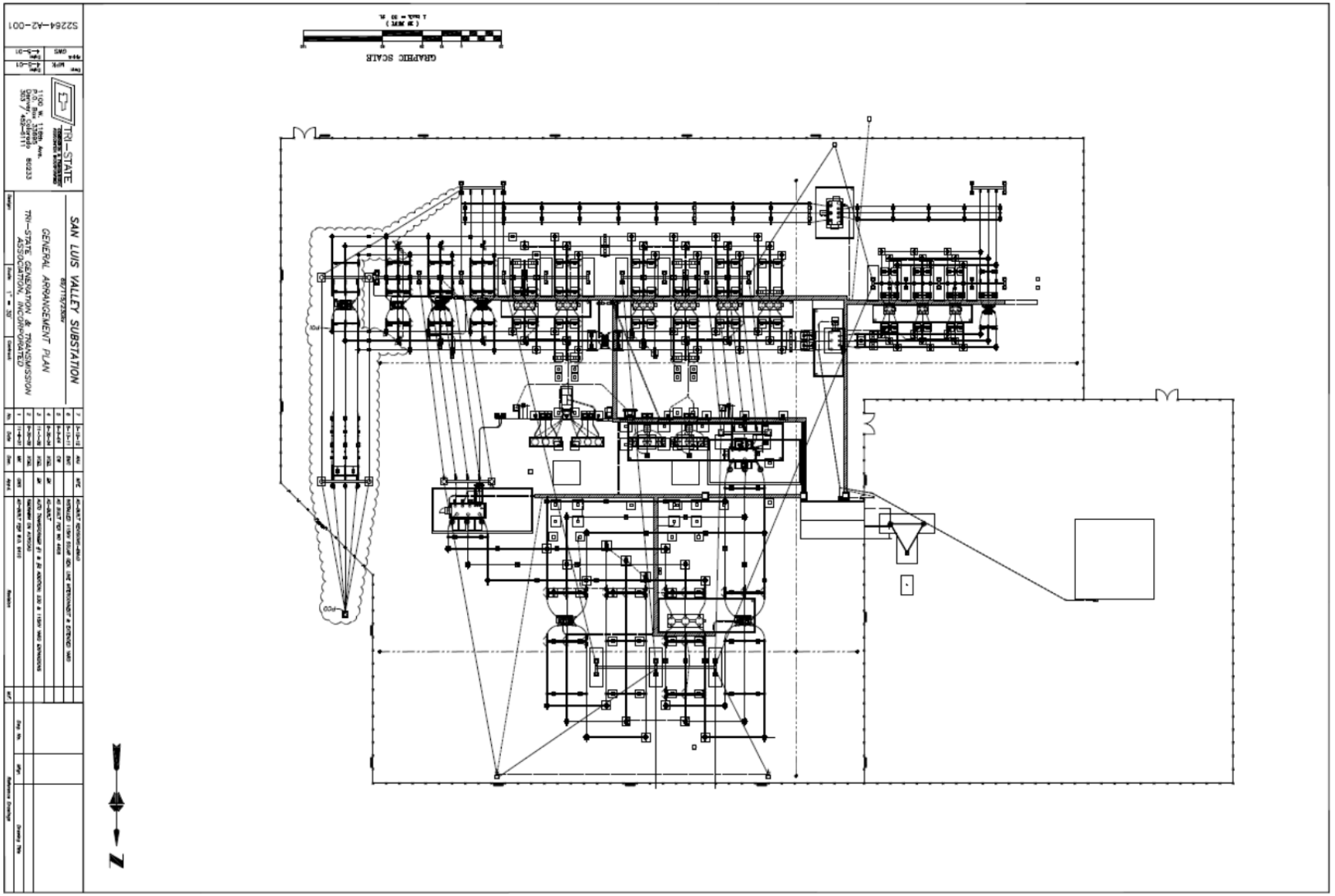
Appendix

Xcel Energy

A. Figure 2. Project One-Line of the San Luis Valley Substation



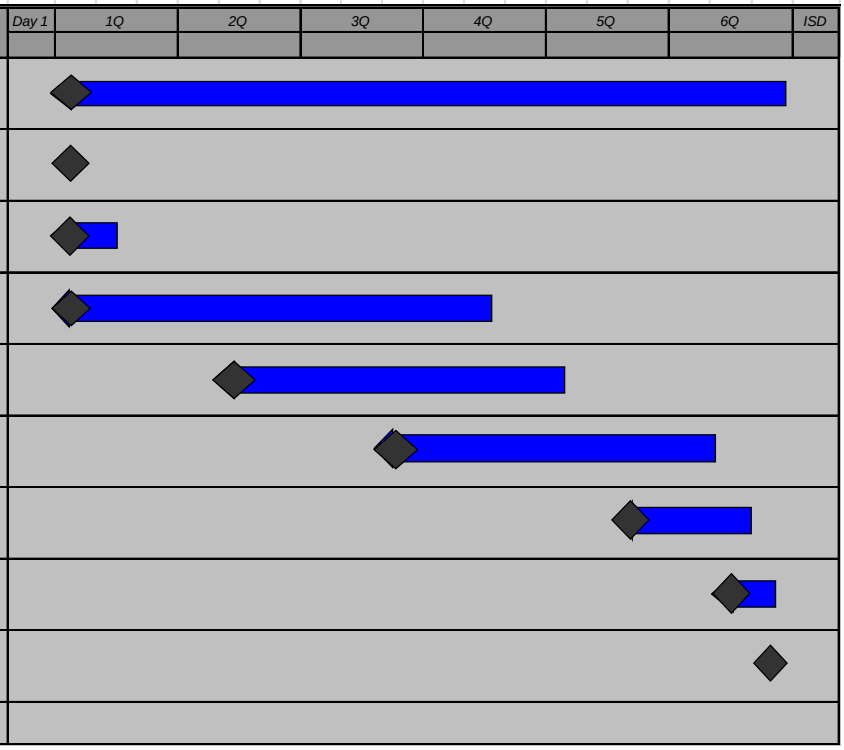
B. Figure 3. Project General Arrangement at San Luis Valley Substation



C. Figure 4. Preliminary Project Schedule

GI-2014-2 Facilities Study Report
35 MW Solar Generation Interconnection @ San Luis Valley 115kV Substation

ID	Task Name	Duration
1	GI-2014-2 Facilities Study Report 35 MW Solar Interconnection	78w
2	Authorization to Proceed: Execution of Interconnection Agreement	0w
3	Sighting & Land Rights and Permitting	6w
4	Substation Design/Transmission Line Design & Engineering	40w
5	Substation/Transmission Line Material Procurement	36w
6	Substation/Transmission line Construction	36w
7	Relay, Protection & Control Equipment Testing	10w
8	Final Commissioning	4w
9	Project Completion / Backfeed	0w
10		



D. Customer Questions and Comments

Question / Comments:

1) Customer has no comments.

2) Tri-State's comments below.

- There is adequate space inside the existing control building to install the requested 2 new panels for this solar interconnection. Recommend locations 7NF & 8NF. The report mentions that Xcel is expecting their RTU replacement to be complete before this project begins, so it is unclear if the new RTU requires more panel spaces.

- The existing 125V battery system is a 60 cell C&D KCR-9 (330Ahr @ 8 hr). Xcel can upgrade to a C&D KCR-11 (410Ahr @ 8 hr) without requiring more space in the battery room. If something larger is needed, an external battery enclosure can be used (FYI - Tri-State uses an 8 hour load profile for battery sizing).

- Existing cable entrances to the building are full. Xcel can create a new wall penetration and install overhead cable tray to their new panels. Not preferred, but will probably need to be done.

- If this new installation is similar to the previous solar installations (Iberdrola Solar), Xcel will need six 125VDC breakers. The existing drawings only show 5 available. May need to install a new DC panelboard if unable to be flexible with the DC feeds.

- There are plenty of 120/240VAC breakers available.

- The number of 115kV switches in Table 1 does not match the one-line.

- A comment regarding the GA: It looks like the preliminary design may compromise large vehicle access to the 230kV equipment.

- Tri-State will require a PQ meter (SEL-735) in the metering CT string for this project.

- If First Solar's site is in SLVREC's service territory, they will need to coordinate with SLVREC for station service. This may require a SLVREC meter in the metering string.

- Page 13 of the study is the only place that mentions the use of CT/PT combo metering units. All other instances of metering devices state separate metering CTs and CCVTs.

- Tri-State requests that Xcel share their DC calculations. Tri-State's preferred battery for this location is Hoppecke with AquaGen recombiners.

- Protection devices for CB862, CB762, CB662, and CB566 are adequate and will not need to be upgraded.

- Additional analog inputs to the existing DFR will be needed.

- Page 15 states that Xcel will perform all construction, wiring, testing, and commissioning for Xcel owned and maintained facilities. Does this include co-owned Tri-State equipment upgrades (DC system)?

- Page 8 of the document states that there is no yard expansion. Please confirm this is correct under the scenario of replacing T2 as it looks pretty tight.