

Final
Request # GI-2010-11
Generation Interconnection Facility Study Report

52 MW Photovoltaic Facility, San Luis Valley, Colorado

PSCo Transmission Planning
November 4, 2014

Executive Summary

This Interconnection Facilities Study Report summarizes the analysis performed jointly by Tri-State G&T and Public Service Company of Colorado (PSCo) under GI-2010-11 to specify and estimate the cost of the equipment, engineering, procurement, and construction needed to interconnect a 52 MW solar generation facility at San Luis Valley (SLV) substation, located in Alamosa County, Colorado. The primary point of interconnection (POI) is on the 230 kV bus at SLV substation.

The Customer's solar generation facility would connect to the POI via a 750 feet of 230 kV transmission line. It is the responsibility of the Customer to construct the radial transmission line up to the last dead-end structure outside the San Luis Valley substation. The project has been asked to fast track based on the accelerated back-feed date of 9/1/2015 and an accelerated commercial operation date that will be phased in from 9/1/2015 through 12/31/2015.

The GI-2010-11 Feasibility and System Impact Study determined that the Customer can provide the full 52 MW of injection without major network upgrades. The Customer is expected to install a 6.0 MVAR of static capacitor banks to ensure that the required reactive power range can be supplied at the point of interconnection. The Customer is also expected to follow all model parameters adjustments identified as part of the systems impact addendum/re-study.

The cost for the transmission interconnection (in 2014 dollars)

The total estimated cost to interconnect the project is approximately **\$2,085,000** and includes:

- \$1,650,000 for PSCo-Owned; Customer-Funded Transmission Provider Interconnection Facilities
- \$435,000 for PSCo-Owned; PSCo-Funded Interconnection Network Facilities

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

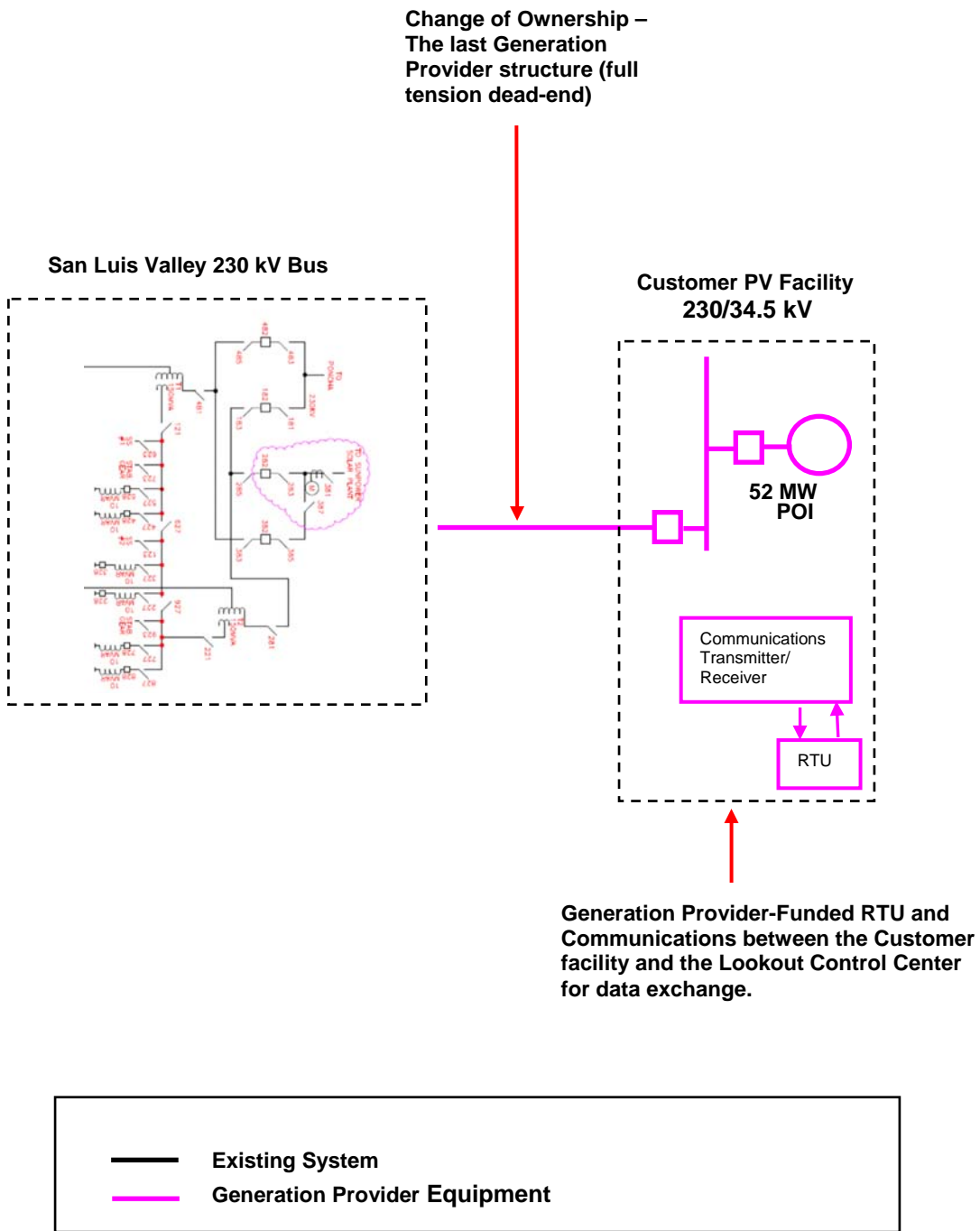


Figure 1: Diagram of the GI-2010-11 Interconnection



I. Introduction

This Interconnection Facilities Study Report summarizes the analysis performed jointly by Tri-State G&T and Public Service Company of Colorado (PSCo) under GI-2010-11 to specify and estimate the cost of the equipment, engineering, procurement, and construction needed to interconnect a 52 MW solar generation facility at San Luis Valley (SLV) substation, located in Alamosa County, Colorado. The primary point of interconnection (POI) is on the 230 kV bus at SLV substation.

II. General Interconnection Facilities Description

A. Project Purpose and Scope

The Interconnection Customer requested a primary Point of Interconnection (POI) at the San Luis Valley Substation 230 kV ring bus. The generation facility will be located approximately 0.5 miles from the San Luis Valley Substation and will be connected to the POI using a 230 kV line.

The request was studied as a Network Resource and Energy Resource, stand-alone project only, with no evaluations made of other potential new generation requests that may exist in the Large Generator Interconnection Request (LGIR) queue, other than the generation projects that are already approved and planned to be in service by the summer of 2016. It should be noted that the original requested back-feed date was 9/1/2016 with a commercial operation date of 12/1/2016. However, this project has been asked to fast track based on the accelerated back-feed date of 9/1/2015 and an accelerated commercial operation date that will be phased in from 9/1/2015 through 12/31/2015.

Background

The San Luis Valley substation is a jointly owned facility by Tri-State Generation and Transmission and Public Service Company of Colorado (PSCo) with a 50/50 cost sharing split under the Utility Services Agreement (USA). PSCo is initiating the project but TSG&T will be involved in the design of the interconnection issues that affect the equipment and devices presently owned and maintained by TSG&T. Final testing and commissioning for equipment operated and maintained by TSG&T will be performed by TSG&T personnel.

B. Right of Way

The permitting activities for this project are expected to be minimal because all of the work will be performed inside of the substation fence or on USA property. Any costs for a new transmission line easement will be the responsibility of the customer to determine.



C. Electrical Features

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

The new 230kV line will utilize a 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 (2014)		2262
Future Fault Currents (2015 w/new generation online)		2262	2801

Electrical Removals & Relocations

No removals or relocations will be required for this installation.

Electrical Installations (Major Equipment)

- 1) The 230kV ring bus yard will consist of four (4) 230kV breakers (and associated disconnects, CCVT's, etc.) for the line to Poncha, San Luis Valley Transformer #1, and San Luis Valley Transformer #2 as shown on the one-line. The above will be arranged in a ring bus configuration with provisions for future expansion into either a larger ring bus or a breaker and a half.
- 2) Note that the GI-2010-11 52 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)

A new EEE will not be required.



AC System

The existing AC system for the 230kV yard consists of two (2) three phase 75 kVA Station Service Voltage Transformer's (Padmount). It is assumed that the existing AC system is adequate for the either of the new additions. This has not been verified at this time.

DC System

A new battery set will not be installed as part of this project.

Grounding

The existing ground grid will be checked to verify it meets standard requirements. Since all new equipment will be inside the existing footprint, so changes to the ground grid are not expected to be necessary.

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 cable trench will not be required. New conduit will be run to the breaker and CT/PT junction boxes.

D. Civil Features

Grading & Fencing

Grading will not be required.

Storm Water Permit

A SWMP will not be required.

Foundations & Structural

Foundations for the new circuit breaker, switch stands, and CT/PT stands will be required.

Civil Removals & Relocations

No foundation removals or relocations will be required.



Civil Installations

Standard designs are anticipated.

Electrical Equipment Enclosure (EEE) or Switchgear Building

A EEE will not be required.

E. Control Features

Transmission Breaker Protection

One new 230kV breaker will be installed as an expansion of the existing ring bus configuration. This breaker will have breaker failure protection. The tripping will initiate a lockout relay and will key DTT.

- SEL351

Transmission Line Protection (230 kV)

The primary relaying will consist of an SEL-311L differential line relay configured in a communication based line differential transfer-trip scheme. Reclosing and sync/voltage checking will also be provided. Direct run fibers from the solar plant will be used for communication.

- SEL311L

The secondary relaying will consist of another SEL-311L differential relay configured in the same way as the first.

- SEL311L

Control Panel Locations

The existing control building has enough free space to accommodate the new panels.

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.



F. Communications

LF/AGC RTU

A new RTU for LF/AGC (Load Frequency Control/Automatic Generator Control) will be installed by Xcel Energy at the Interconnection Customer's substation. The LF/AGC equipment shall provide information to the PSCo Control Center. The Interconnection Customer shall supply all necessary AC and DC station service and space for the required equipment. The Interconnection Customer will need to supply a communication circuit from the RTU located at the Customer's facility to the PSCo Control Center. The protocol for this connection has yet to be determined (typically DNP 3.0 protocol). Data points to be supplied may include, but are not limited to the table listing below. The Interconnections Customer is responsible for providing these Data Points to the RTU and shall coordinate with Xcel Energy to discuss additions to or removal of data points.

DATA POINT
Real Power (MW)--POI
Reactive Power (MVAR)--POI
Real Power (MW)--Generator Collector
Reactive Power (MVAR)--Generator Collector
Line Voltage (kV)--POI
Line Voltage (kV)--Generator Collector
Line Current (Amperes)--POI
Neutral Line Current (Amperes)--POI
Panel Generation (kW)
Solar Concentration (irradiance)
Panels Producing (#)
Panels Available (#)
Total Panels (#)
Ambient Temperature
Breaker Status (#)
MW Setpoint (MW)
Farm Potential(#)
Remote/Local (bit)
VAR Setpoint/Voltage Setpoint (MVAR/kV)
MW Setpoint Echo (MW)
VAR Setpoint/Voltage Setpoint Echo (MVAR/kV)
Power Factor Setpoint (#)
Maximum VAR Output Available (MVAR)
Maximum VAR Intake Available



(MVAR)
Slew Rate (MW/second)
AGC control on/off
Regulation up/down
Ramp rate up/down

LF/AGC RTU Connections

The Interconnection Customer shall supply at least one (1) communication circuits related to the LFAGC RTU. One (1) circuit will be from the RTU located at the Customer's substation and will allow reliable and secure communications to the PSCo Control Center EMS. Any copper or metallic conductors used for this connection must be protected from GPR.

A second communication circuit may be required between the Interconnection Customer's facility and the San Luis Valley substation. This connection would be utilized to communicate between the LF/AGC RTU and the San Luis Valley RTU.

Voice Dispatch Circuit/Auto Ring-Down Circuit

There shall be a voice communications circuit between the Interconnection Customer's facility and/or Interconnection Customer's dispatch center and the Xcel Energy System Control Center. If the facility plant operators are not located on the plant site, then the circuit must be terminated at the actual location of the plant operators. The circuit is to be ordered by the Interconnection Customer. This circuit shall be a type 428 non-dialable pair, also known as an OSPA two-wire circuit. In addition to the auto ring-down line, a backup manual dial circuit must also be available in the event the ring-down line is not operational.

Telephone Protection

If the telephone circuits being delivered to the Interconnection Customer substation and facility are provided by the local service provider via copper or other metallic wires, they shall be protected utilizing a Positron Power POTS line isolation shelf. This device shall provide high voltage isolation (HVI) for the delivered telephone line copper paired circuits. The coordination and completion of Form 48 (High Voltage Study) must be performed by the Interconnection Customer.

Wide Area Network (WAN):

Wide Area Network connections from San Luis Valley substation to Xcel's corporate network have not yet been assessed and the addition of an RX-1500 has yet to be determined.



Fiber Optic Cable

Fiber optic ground wire (OPGW) shall be installed between the Interconnection Customer and the San Luis Valley Substation. The length of the line is approximately one-half of a mile. The fiber optic cable shall have ITU-T G.652 compliant single mode optics, 48 strands in 3 buffer tubes. The initial protection recommendation indicates the OPGW will be utilized for redundant current differential protection (SEL-311L's) and Direct-Transfer Trip (DTT). Fiber optic connections may also be utilized for communications between the LF/AGC RTU at the Interconnection Customers facility and the RTU at the San Luis Valley substation.

Fiber Optic splice boxes will be located on the dead-end tower where the new 230kV line will be terminated and in the San Luis Valley control house. A similar installation shall be required at the Interconnection Customer substation and facility.

IRIG-B GPS Timing

A GPS antenna shall be installed and connected to a SEL-2407 Satellite-Synchronized Clock (or suitable GPS time synchronization device with demodulated outputs). The SEL-2407 will distribute an IRIG-B timing signal to the relays, data aggregators, and RTUs via coaxial cables and T-splitters. Each SEL-3530/SEL-2032 or other relay communication processor will receive IRIG timing from the GPS clock and distribute timing to each connected relay via the established serial connections. All open T-splitter connections will have a 50 ohm terminator attached to them. This shall be required at the San Luis Valley substation for all new equipment and at the Interconnection Customer substation and facility. The Interconnection Customer is required to provide this equipment at their substation.

Release of Communication Information and Connections

To ensure proper communications and physical connections between the Interconnection Customer's facility and San Luis Valley substation, transparency regarding the communications will be needed. The Interconnection Customer shall provide documentation on all fiber and communications connections, along with any other documentation needed to complete the interconnection. This information shall be documented in Data Flow diagrams and Communication One-Lines for future reference and use.

G. Metering

Revenue Metering

Revenue metering will be provided according to the Transmission System Interconnection Guidelines and/or other contract provisions. The Customer interconnection revenue metering will be added to the current energy imbalance accounting with PSCo.



PSCo will be installing Nexus 1262 for the revenue metering portion of this project, which will be in series with Tri-State and Load Control's SEL 735. A port off the existing telephone line sharing switch will need to be extended to the Nexus meter location for dial-up access to the revenue metering data.

Load Control Metering

Metering will be at the 230kV point of interconnection and will be metered with extended range 150:5 metering accuracy CT/PT combo units connected to an SEL 735 for Tri-State G&T and SEL 735 for PSCo. Plant generation and load will both be metered at this point. All load measured at this point will be provided by SLVREC through a contract directly between SunPower and SLVREC.

Power Quality Metering

Tri-State G&T's 735 will be used to monitor Power Quality. SunPower will be responsible to resolve any PQ issues they create at their cost.

H. Outages

Outages will be coordinated with system operations personnel. It will be difficult to take major outages during the summer peak in the San Luis Valley, but PSCo and TSG&T will do the best to meet the requested back feed and COD dates. If outages cannot be taken without jeopardizing the reliability of the system, the requested milestone dates for the project will have to be moved out.

I. Material Staging Plan

All major materials will be delivered directly to the fenced substation yard and stored. Other materials will be delivered to the Alamosa Service Center.

J. Project and Operating Concerns

No major concerns have been identified.

III. Costs Estimates and Assumptions

Appropriation level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (at a +/- 20% accuracy) were developed by Tri-State Generation and Transmission Association (TSGT) and Public Service Company of Colorado (PSCo) Engineering. The cost estimates are in 2014 dollars with escalation and contingency included; AFUDC 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, 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 **\$2,085,000**. Figure 1 below represents a conceptual one-line of the proposed interconnection into the 230 kV bus at the San Luis Valley transmission substation. 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)
San Luis Valley 230 kV Transmission Substation	Interconnect Customer to tap at the San Luis Valley 230 kV Transmission Substation (into the 230 kV bus). The new equipment includes: <ul style="list-style-type: none"> • One 230 kV gang switch • Three 230 kV arresters • One set (of three) 230 kV CT/PT metering units • Associated bus, wiring and equipment • Associated site development, grounding, foundations and structures • Associated transmission line communications, relaying and testing 	\$1.200
	Transmission line-tap into substation. Structure, conductor, insulators, hardware and labor.	\$0.170
Customer's Hooper 230 kV Substation	Load Frequency/Automated Generation Control (LF/AGC) RTU and associated equipment.	\$0.260
	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	\$1.650

Time Frame	Design, procure and construct	15 Months
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Note* - PSCo Owned; Customer Funded Interconnection Facilities Cost estimates are lower than reported in the System Impact Study Report mainly due to the elimination (need) to relocate a section of the Poncha-SLV 230kV Line (3006).

Table 2 – PSCo Owned; PSCo Funded Interconnection Network Facilities

Element	Description	Cost Estimate (Millions)
San Luis Valley 230 kV Transmission Substation	Interconnect Customer to tap at San Luis Valley 230 kV Transmission Substation (into the 230 kV bus). The new equipment includes: <ul style="list-style-type: none"> • One 230kV circuit breaker • Two 230kV gang switches • Associated bus, miscellaneous electrical equipment, cabling and wiring • Associated foundations and structures • Associated road and site development, fencing and grounding 	\$0.415
	Siting and Land Rights support for substation land acquisition and construction.	\$0.020
	Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities	\$0.435
Time Frame	Site, design, procure and construct	15 Months

Note* - PSCo Owned; PSCo Funded Interconnection Facilities Cost estimates are lower than reported in the System Impact Study Report due to the elimination (need) of future build out for proposed/planned substation expansion, including a third gang switch, new station battery system, new Electric Equipment Enclosure (control building), communications, supervisory and SCADA equipment and line relaying and testing.

Cost Estimate Assumptions

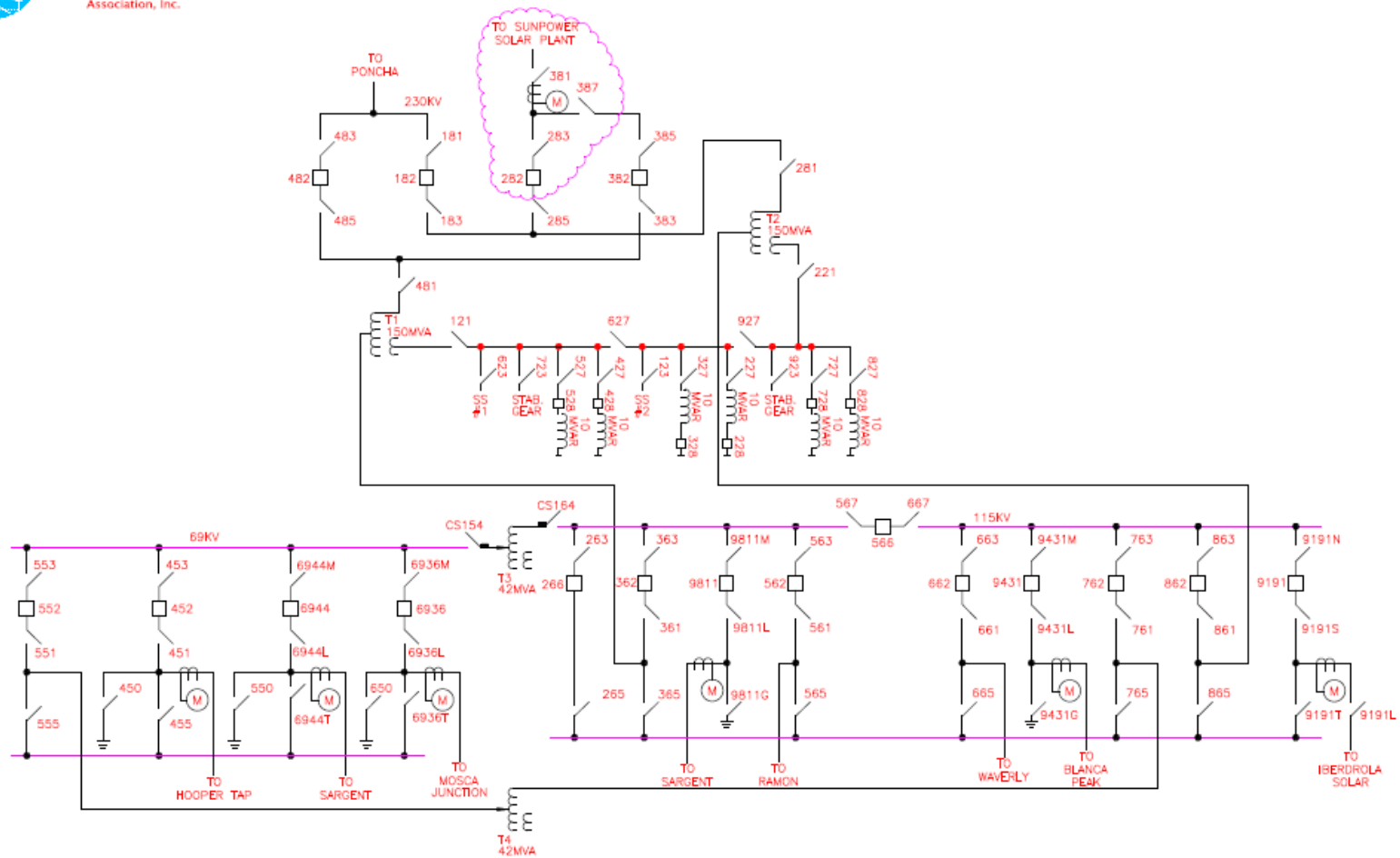
- Appropriation level project cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (at a +/- 20% accuracy) were developed by TSGT and PSCo Engineering.
- Estimates are based on 2014 dollars (appropriate contingency and escalation included).
- AFUDC has been excluded.
- 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, but in TSGT's Co-Op SLVREC's territory. No costs for retail load (distribution) facilities and metering required for station service are included in these estimates.
- TSGT will be responsible to site, design, procure material and construct all facilities at the San Luis Valley Substation.
- PSCo will be responsible to design, procure material and construct all facilities at the Customer's Hooper Substation.
- TSGT and/or PSCo (or our Contractor) crews will perform all construction, wiring, testing and commissioning for PSCo owned facilities.
- The estimated time to site, design, procure and construct the interconnection facilities is approximately 15 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.
- No new substation land will need to be acquired.
- Breaker duty study determined that no breaker replacements are needed in neighboring substations.

Appendix

A. Project One-Line of the Point of Interconnection



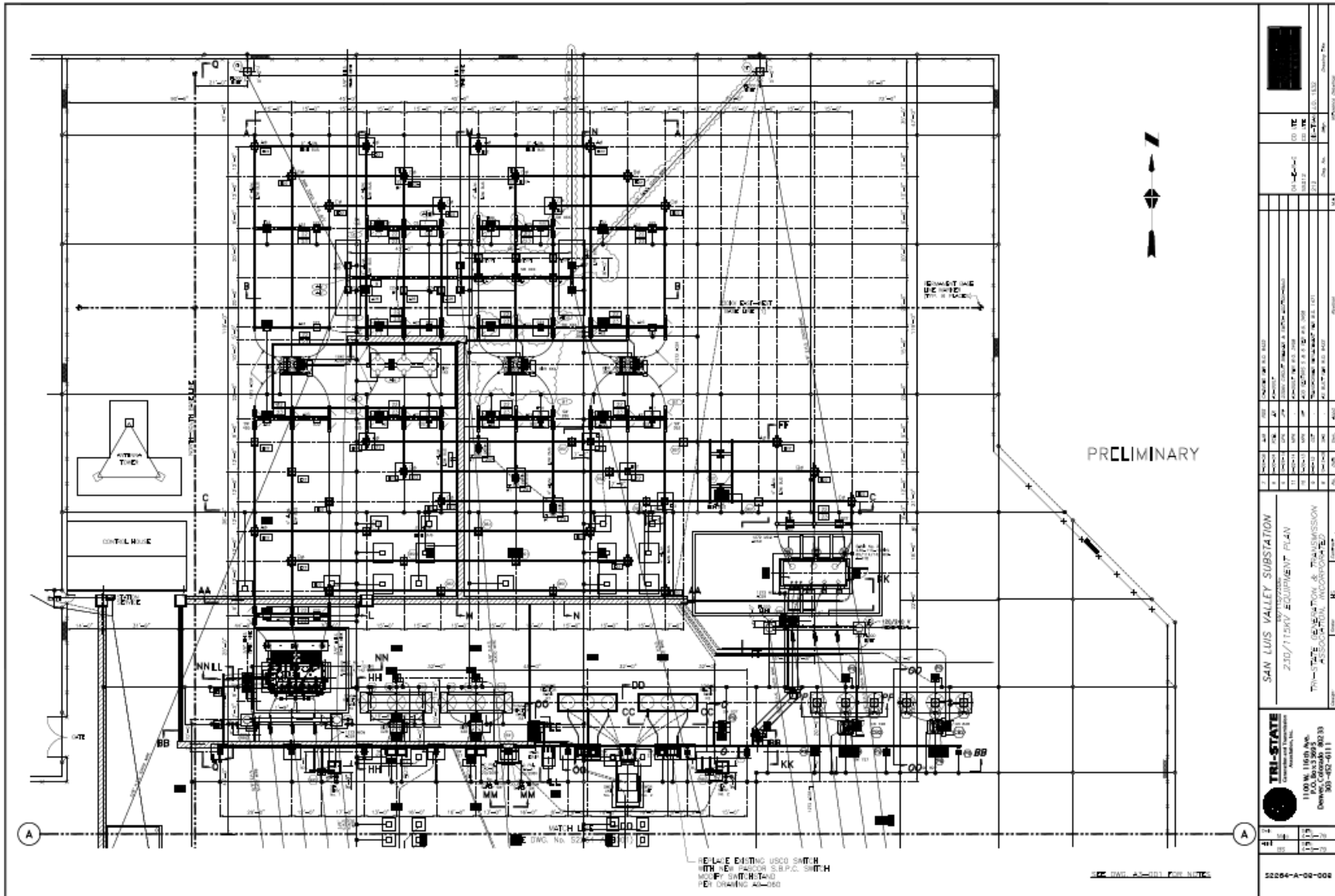
TRI-STATE
Generation and Transmission
Association, Inc.



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PROJECT	SAN LUIS VALLEY SUBSTATION	REV. NO.	6	DATE	9-17-14	REVISION	HOOPER SOLAR ADDITION	SCALE	N.T.S.	DRAWN	SM	APPROVED		S2264-B-15-001
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B. Project General Arrangement



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

