



# **Special Study Report**

**2009 PSCo Solar RFP**

**March 10, 2010**

## **Solar Bids in San Luis Valley**

Bid SC04 – 125 MW (San Luis Valley 230 kV Bus) ISD 7-2013

Bid SP06 – 30 MW (Alamosa – Mosca 69 kV Line) ISD 12-2013

Bid SP19 – 30 MW (San Luis Valley 115 kV Bus) ISD 12-2011

Bid SP20 – 30 MW (San Luis Valley - Alamosa 115 kV Line) ISD 12-2011

**PSCo Transmission Planning**

March 10, 2010



**Executive Summary**

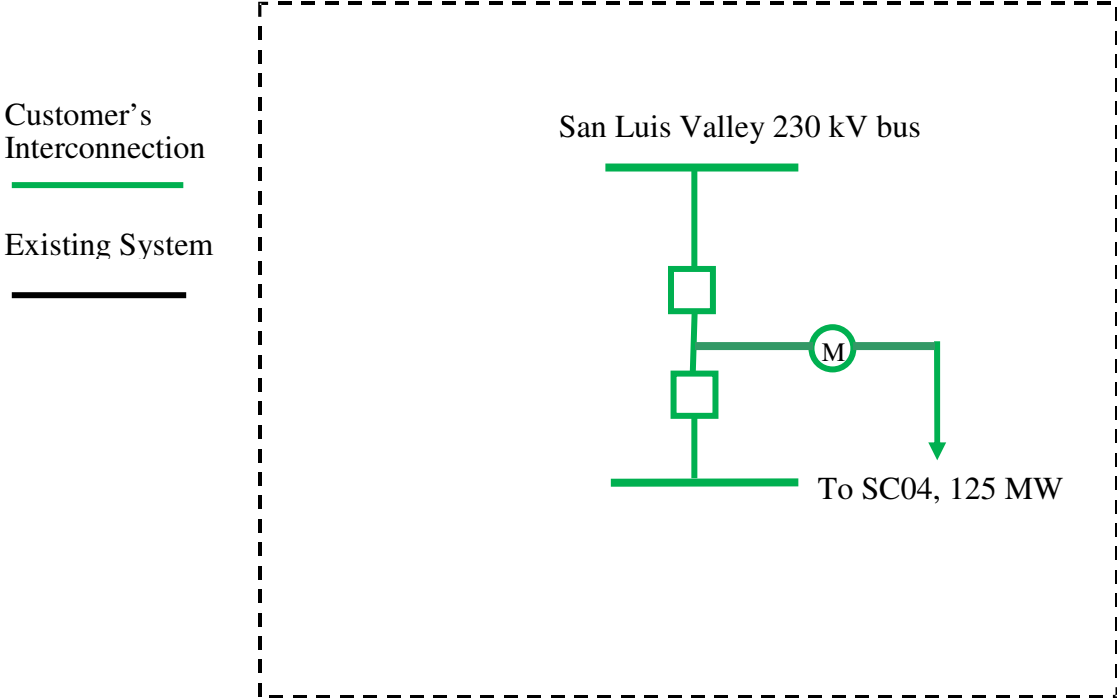
Public Service Company of Colorado (PSCo) Transmission Planning received a special study request on January 11, 2010 to determine the feasibility of interconnecting four different solar bids, with different combinations, in the San Luis Valley of Colorado. See table 1 for list of generation combinations. For all combination runs, the Alamosa combustion turbines in the valley were turned off and the existing 25 MW of solar photovoltaic facilities at Mosca remain on. The Customer’s proposed commercial operation date is 2011-2013 timeframe. The request was studied as both an Energy Resource and a Network Resource and it was conducted primarily as a “stand-alone” project with no consideration of higher queue projects. Based on Energy Resource study, PSCo has determined that it is feasible to interconnect each individual bid but the requested in-service dates may not be achievable depending on construction schedule. For Network Resource study, scenario 1 and 3 are not feasible with the system as is in the San Luis Valley without the installation of new 23 miles of 69 kV transmission line from Alamosa to Mosca to San Luis Valley. This line would most likely require a CPCN determination by the PUC. The scenario 2 would be feasible under all loading conditions. Scenario 4 works under heavy loading conditions which are typically the four summer months in which irrigation load is in service. A light loading condition was created on scenario 4 to further verify the feasibility. The scenario 4 (with 65 MW of load) has resulted in an overload of greater than 10 percent on the Poncha – Sargent 115 kV line (128 MVA conductor rating) with an outage of Poncha – San Luis Valley 230 kV line. In conclusion, the full 185 MW of generation plus the existing 25 MW cannot be all running simultaneously under light loading conditions, which would be the 8 months in which there is no irrigation load. These months are January through April and Sept through December. . There is a potential capital budget project to upgrade the Poncha – Sargent 115 kV line; the rating of the line will increase from approximately 128 MVA to 155 MVA. This would require 90 phase risers along the line. There are concerns about the project due to the age of the poles. The line was installed in 1955. The project will need more scrutiny between Engineering, planning and operations.

**Table 1.** List of scenario runs

Scenarios (plus existing 25 MW PV at Mosca)	SLV 230 kV (125 MW)	Alam-Mosca 69 kV (30 MW)	SLV 115 kV (30 MW)	SLV-Alam 115 kV (30 MW)
BM				
1		x	x	
2			x	x
3	x	x	x	
4	x		x	x



**SC04 – 125 MW**



**Figure 1:** Customer's interconnection at the San Luis Valley 230 kV bus.

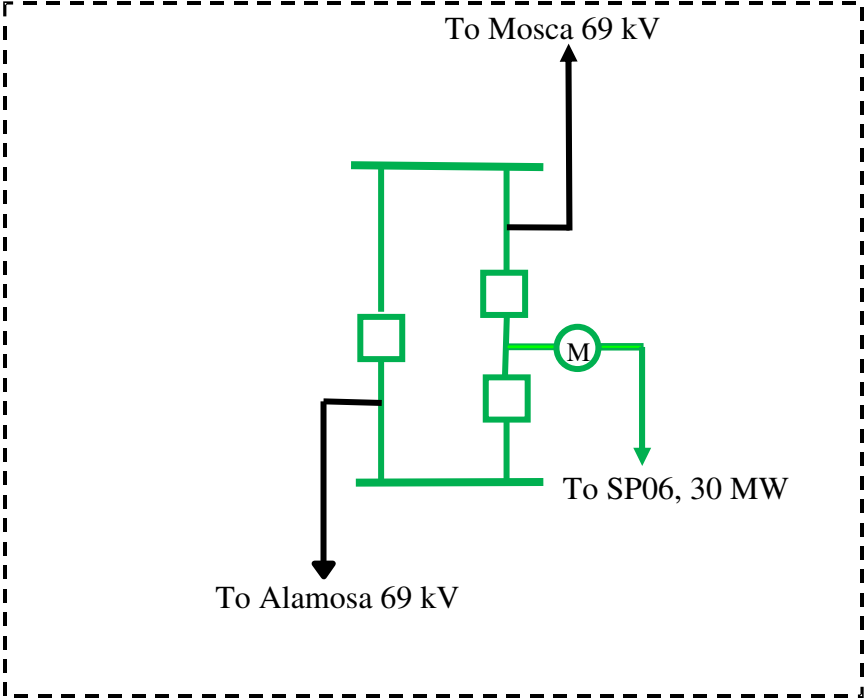


**SP06 – 30 MW**

Customer's Interconnection



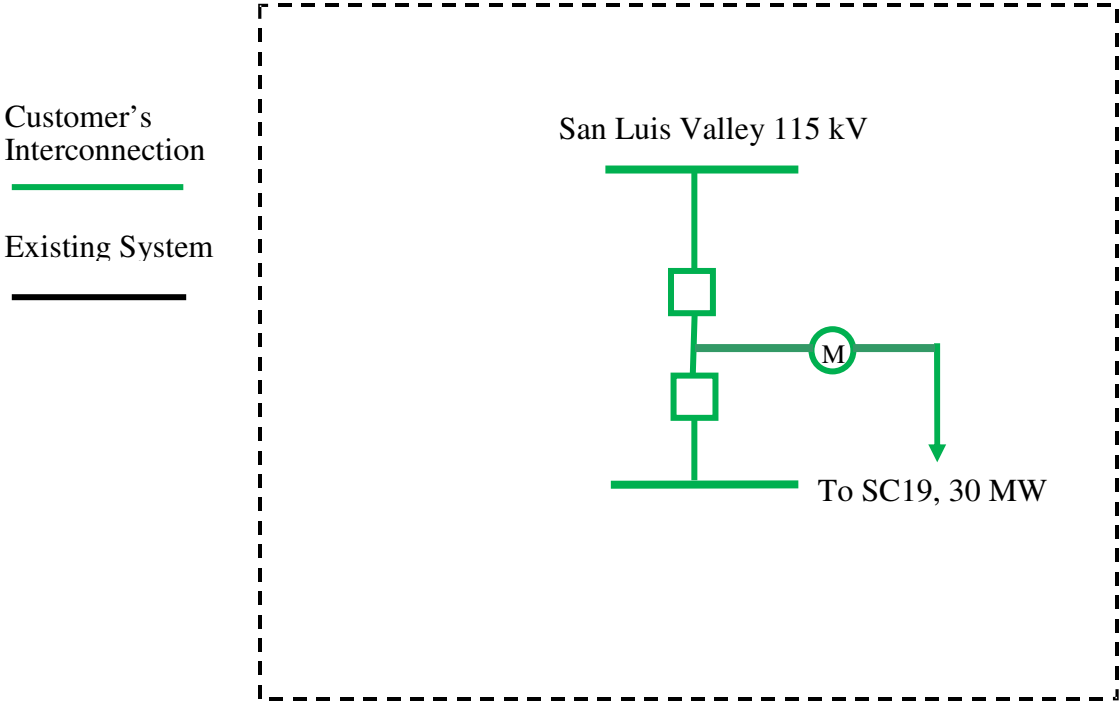
Existing System



**Figure 2:** Customer's interconnection tapping the Alamosa - Mosca 69 kV with a 3-breaker ring bus.



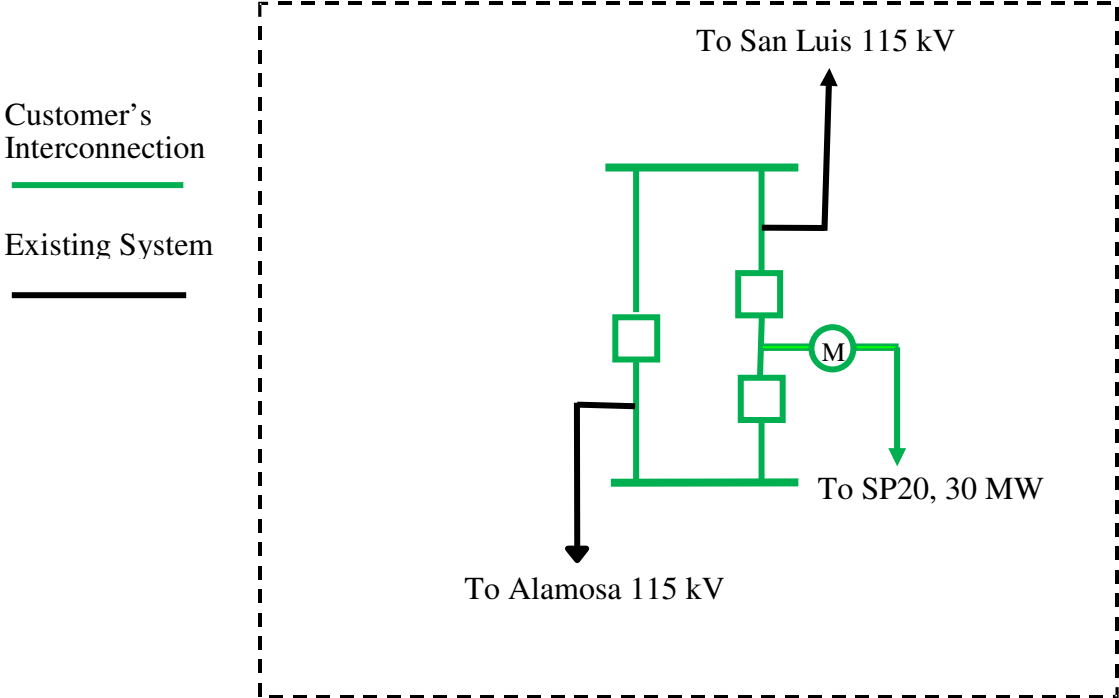
**SP19 – 30 MW**



**Figure 1:** Customer's interconnection at the San Luis Valley 115 kV bus.



**SP20 – 30 MW**



**Figure 1:** Customer's interconnection tapping the San Luis Valley – Alamosa 115 kV with a 3-breaker ring bus.



## **Introduction**

Public Service Company of Colorado (PSCo) Transmission Planning received a special study request on January 11, 2010 to determine the feasibility of interconnecting four different solar bids, with different combinations, in the San Luis Valley of Colorado. See table 1 for list of generation combinations. For all combination runs, the Alamosa combustion turbines in the valley were turned off and the existing 25 MW of solar photovoltaic facilities at Mosca remain on. The Customer's proposed commercial operation date is 2011-2013 timeframe. The request was studied as both an Energy Resource and a Network Resource and it was conducted primarily as a "stand-alone" project with no consideration of higher queue projects.

The four potential solar bids are SC04, SP06, SP19, and SP20. The SC04 bid would interconnect 125 MW of solar generation on the existing San Luis Valley 230 kV bus. The requested in-service date for this bid is July, 2013.

The SP06 bid would interconnect 30 MW of solar generation on the existing PSCo Mosca - Alamosa 69 kV transmission line. The requested in-service date for this bid is December, 2013.

The S019 bid would interconnect 30 MW at the existing San Luis Valley 115 kV substation. The requested in-service date for this bid is December, 2011.

The S019 bid would interconnect 30 MW at the existing San Luis Valley 115 kV substation. The requested in-service date for this bid is December, 2011.

## **Study Scope and Analysis**

For this special solar study, Xcel Energy Resource Planning is only interested in the power flow studies and the associated costs. The power flow analyses provide a preliminary identification of any thermal or voltage limit violations resulting of the interconnection. PSCo did not evaluate any additional requirements or VAR support to maintain voltage within 0.95 – 1.05 per-unit at the point of interconnection.

PSCo adheres to NERC / WECC Reliability Criteria, as well as internal Company criteria for planning studies. During system intact conditions, criteria are to maintain transmission system bus voltages between 0.95 and 1.05 per-unit of system nominal / normal conditions, and steady state power flows within 1.0 per-unit of all elements' thermal (continuous current or MVA) ratings. Operationally, PSCo tries to maintain a transmission system voltage profile ranging from 1.02 per-unit or higher at generation buses, to 1.0 per-unit or higher at transmission load buses. Following a single contingency element outage, transmission system steady state bus voltages must remain within 0.90 per-unit to 1.10 per-unit, and power flows within 1.0 per-unit of the elements continuous thermal ratings.

## **Power Flow Study Models**

The power flow studies were based on a PSCo developed 2011 heavy summer base case that originated from the 2012 heavy summer budget case. The bid SC04 consisted of 125 MW of



solar, modeled as a lumped equivalent at the SLV 230 kV bus. The bid SP06 consisted of 30 MW of solar, modeled as a lumped equivalent tapping the Alamosa – Mosca 69 kV line. The bid SP019 consisted of 30 MW of solar, modeled as a lumped equivalent at the SLV 115 kV bus. The bid SP20 consisted of 30 MW of solar, modeled as a lumped equivalent tapping the SLV – Alamosa 115 kV line. The step up transformer for all these studies was assumed to be rated at least the size of the lumped equivalent generator. All studies were scheduled to the northern PSCo system by reducing generation in that area. There were four (4) study scenarios created: scenario 1 = SP06 + SP19, scenario 2 = SP19 + SP20, scenario 3 = SC04 + SP06 + SP19, and scenario 4 = SC04 + SP19 + SP20. The scenario 5 was a sensitivity scenario to examine the system under a light loaded condition.

### **Power Flow Study Results and Conclusions**

The ER portion of this study determined that the Customer could provide full output of energy for all four solar bids, non-simultaneously, in San Luis Valley without the construction of network reinforcements. Refer to Appendix A for the contingency comparison table detailing the equipment loading for San Luis Valley. The study results show that there were no thermal violation for scenario 2 and 4, thus, leading to a conclusion that the system is capable of handling these solar bids in San Luis Valley. Any changes to the bids are subjected to a re-study.

### **Costs Estimates and Assumptions**

The estimated total costs required for interconnection are:

- SC04 – 125 MW (San Luis Valley 230 kV)
- SP06 – 30 MW (Alamosa – Mosca 69 kV)
- SP19 – 30 MW (San Luis Valley 115 kV)
- SP20 – 30 MW (San Luis Valley - Alamosa 115 kV)

Scenario 1 (SP06 & SP19) = **\$7.44 Million** (included 23 miles of new 69 kV circuit for network upgrade at approximately \$200,000 per mile.)

Scenario 2 (SP19 & SP20) = **\$2.95 Million**

Engineering also included a cost estimate for a 30 MVA generator step-up transformer (GSU) as requested by the Customer.

The estimated costs shown are (+/-30%) estimates in 2009 dollars 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, and construction of these new PSCo facilities. This estimate did not include the cost for any other Customer owned equipment and associated design and engineering.

The following tables list the improvements required to accommodate the interconnection. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to change upon more detailed analysis.



Table 2 – SP06 Interconnection Costs (30 MW of Solar)

Element	Description	Cost Est. Millions
Alamosa -Mosca 69 kV	Construct new 69 kV 3-breaker-ring switchyard.	\$1.610
	Re-route transmission line into new substation.	\$0.121
	Install relaying at remote substation ends.	\$0.400
	Siting and Land Rights for required easements, reports, permits and licenses.	\$0.020
	<b>Total Cost for Interconnection Facilities</b>	<b>\$2.151</b>
<b>Time Frame</b>	<b>(To engineer, procure, and construct interconnection facilities – does not include GSU)</b>	<b>18 Mo.</b>
	Indicative (no implied accuracy) estimate for GSU – 69/34.5kV Y-Delta, 18/24/30MVA, 65 deg C, Z = 8%	\$1.00

Table 3 – SP19 Interconnection Costs (30 MW of Solar)

Element	Description	Cost Est. Millions
San Luis Valley 115 kV Substation	Add new 115 kV line termination at SLV substation.	\$0.685
	<b>Total Cost for Interconnection Facilities</b>	<b>\$0.685</b>
<b>Time Frame</b>	<b>(To engineer, procure, and construct interconnection facilities – does not include GSU)</b>	<b>18 Mo.</b>
	Indicative (no implied accuracy) estimate for GSU – 115/34.5kV Y-Delta, 18/24/30MVA, 65 deg C, Z = 8%	\$1.00

Table 4 – SP20 Interconnection Costs (30 MW of Solar)

Element	Description	Cost Est. Millions
San Luis Valley - Alamosa 115 kV	Construct new 115 kV 3-breaker-ring switchyard.	\$2.067
	Re-route transmission line into new substation.	\$0.123
	Siting and Land Rights for required easements, reports, permits and licenses.	\$0.020
	<b>Total Cost for Interconnection Facilities</b>	<b>\$2.210</b>
<b>Time Frame</b>	<b>(To engineer, procure, and construct interconnection facilities – does not include GSU)</b>	<b>18 Mo.</b>
	Indicative (no implied accuracy) estimate for GSU – 115/34.5kV Y-Delta, 18/24/30MVA, 65 deg C, Z = 8%	\$1.00



### *Assumptions*

- The cost estimates provided are “scoping estimates” with an accuracy of +/- 30%.
- Estimates are based on 2009 dollars (no escalation applied).
- There is no contingency or AFUDC included in the estimates.
- Labor is estimated for straight time only – no overtime included.
- Lead times for materials were considered for the schedule.
- The estimated time for PSCo to site, engineer, procure and construction the scope of work identified in Table 2 to Table 4 is **18 months** after authorization to proceed has been obtained. This is completely independent of other queued projects and their respective in-service dates.
- San Luis Valley is a jointly owned substation between PSCo and Tri-State.
- Build a new 23 miles of 69 kV would require PSCo to submit this project to the PUC for determination of the need for a CPCN



# Appendix A

## Contingency Results

**Table 5:** Contingency Comparison Table of Most Significant Contingencies

MONITORED ELEMENT	RATED (MVA)	BM	Scenario 1 (117 MW)	Scenario 2 (117 MW)	Scenario 3 (117 MW)	Scenario 4 (117 MW)	Scenario 4 - light loaded condition (65 MW)	CONTINGENCY ELEMENT
70292 MOSCA 69.0 70376 SANLSVLY 69.0	28.8	N/A	149.0%	N/A	149.0%	N/A	N/A	70024 ALMSA_ST 69.0 70953 SLVSOLAR 69.0
70292 MOSCA 69.0 70953 SLVSOLAR 69.0	26	N/A	103.9%	N/A	103.9%	N/A	N/A	70024 ALMSA_ST 69.0 70953 SLVSOLAR 69.0
70953 SLVSOLAR 69.0 70024 ALMSA_ST 69.0	26	N/A	139.0%	N/A	139.0%	N/A	N/A	70292 MOSCA 69.0 70376 SANLSVLY 69.0
70374 SANLSVLY 115 70379 SARGENT 115	128	N/A	N/A	N/A	N/A	N/A	1.13%	70375 SANLSVLY 230 79054 PONCHABR 230

Scenarios (plus existing 25 MW PV at Mosca)	SLV 230 kV (125 MW)	Alam-Mosca 69 kV (30 MW)	SLV 115 kV (30 MW)	SLV-Alam 115 kV (30 MW)
BM				
1		X	X	
2			X	X
3	X	X	X	
4	X		X	X