GENERATION INTERCONNECTION
REQUEST # GI-2016-9

FEASIBILITY STUDY REPORT
480 MW PV SOLAR, ALAMOSA COUNTY, COLORADO

XCEL ENERGY – PSCO TRANSMISSION PLANNING WEST

November 11, 2016

A. Executive Summary

On June 14th, 2016 Public Service Company of Colorado (PSCo) received a generation interconnection request (IR) for 480 MW photovoltaic generation facility (GF) at the San Luis Valley 230 kV Substation. The IR has been entered into PSCo's queue as GI-2016-9. The requested a Commercial Operation Date (COD)[1] is December 1, 2018 with Back-Feed date of six months prior to COD. The study request indicated that the generation would be delivered to PSCo native load customers.

As requested by the Customer, this generation interconnection was studied for both Network Resource Interconnection Service (NRIS)[2] and Energy Resource Interconnection Service (ERIS)[3]. These investigations included steady-state (power flow) and short-circuit studies. The power flow analyses were performed using two base cases created from Western Electricity Coordinating Council (WECC) models: a 2018 heavy summer (2018HS) base case and 2018 light spring base case.

The request was studied as a stand-alone project only, with no evaluations made of other generation ahead in the queue.

[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] **Network Resource Interconnection Service (NRIS)** allows Interconnection Customer's Large Generating Facility to be designated as a Network Resource, up to the Large Generating Facility's full output, on the same basis as existing Network Resources interconnected to Transmission Provider's Transmission System, and to be studied as a Network Resource on the assumption that such a designation will occur. (*section 3.2.2 of Attachment N in Xcel Energy OATT*)

[3] **Energy Resource Interconnection Service (ERIS)** allows Interconnection Customer to connect the Large Generating Facility to the Transmission System and be eligible to deliver the Large Generating Facility's output using the existing firm or non-firm capacity of the Transmission System on an "as available" basis. Energy Resource Interconnection Service does not in and of itself convey any right to deliver electricity to any specific customer or Point of Delivery. (*section 3.2.1 of Attachment N in Xcel Energy OATT*)

Energy Resource

The results of this feasibility study indicate that firm transmission capacity for the entire 480 MW photovoltaic generation facility is not available. Up to 30 MW may be delivered using the existing transmission system under the study assumptions outlined in this study report without transmission network upgrades. The ability to deliver additional generation on a non-firm basis may be available depending on marketing activities, dispatch patterns, generation levels, demand levels, import path levels (TOT5, etc.) and the operational status of transmission facilities.

Network Resource

Based on the evaluation process for a Network Resource request, a contingency analysis was performed to determine if the transmission system would be adversely impacted and, if so, the network upgrades that would be required to deliver the entire output of GI-2016-9. Delivery of the full 480 MW is not feasible, unless network upgrades are implemented. The Colorado Coordinated Planning Group (CCPG) is in the process of developing transmission plans for the San Luis Valley that would improve reliability, increase load-serving capability, and provide for additional resource accommodation. Those studies are planned to be complete in 2016, but preliminary analysis completed during the course of this Feasibility Study indicates that network upgrades would consist of additional high-voltage transmission out of the San Luis Valley. Studies indicate that a 230 kV transmission line from San Luis Valley – Poncha and Poncha – W.Canon – Midway Substation would to alleviate the system intact and single contingency overloads and could allow for delivery of the entire 480 MW request. The San Luis Valley – Poncha 230 kV line #2 has been identified by PSCo and Tri-State to improve reliability in the San Luis Valley and be the first of transmission to deliver resources out of the Valley. Tri-State has indicated a potential in-service date of 2022, and PSCo intends to be a joint participant in that project. The Poncha – W. Canon – Midway 230 kV line is not a planned project, but is also being used to illustrate the potential costs and schedule for implementation of transmission that could meet the requirements for the proposed generation to become a Network Resource.

Therefore, for GI-2016-9 interconnection:

NRIS (before network upgrades) = 0 MW

NRIS (after network upgrades) = 480 MW

ERIS (before network upgrades) = up to 30 MW may be delivered using existing transmission system

ERIS (after network upgrades) = 480 MW

Cost Estimates

The total estimated cost to interconnect the project (in 2016 dollars) is approximately **$229.5M**. The cost to interconnect the project includes:

- $1.272M for PSCO-Owned, Customer-Funded interconnection facilities
- $3.22M for PSCO-Owned, PSCO-Funded interconnection facilities
- $225M for Network Upgrades for Delivery

The cost estimates and schedule are provided in Table 4, Table 5, and Table 6. Per PSCo's Engineering guidelines for a Feasibility Study, this is an indicative cost estimate with no implied accuracy.

B. Introduction

PSCo received a large generator interconnection request (GI-2016-9) on June 14, 2016 to interconnect 240 SMA Sunny Central 2200-US inverters, with a total generator nameplate capacity of 480 MW and a commercial operation date of December 31, 2018. The proposed generating facility would be located a mile east of the San Luis Valley Substation. The GI-2016-9 project would be connected with a new Generation Provider-owned and constructed, single circuit, 230 kV transmission line to PSCo's San Luis Valley Substation 230 kV bus. The Customer requested the primary Point of Interconnection (POI) to be the 230 kV bus at San Luis Valley Substation. This request will be evaluated as a stand-alone project with no other higher queued projects modeled.

The Customer has requested that this project be evaluated as a Network Resource Interconnection Service (NRIS) and an Energy Resource Interconnection Service (ERIS), with the energy delivered to PSCo's native load customers.

C. Study Scope and Analysis

This feasibility study evaluated the feasibility of providing 480 MW of energy from GI-2016-9 from the point of interconnection at San Luis Valley Substation to PSCo native load customers. This request was studied both as a NRIS and as an ERIS. This feasibility study consisted of both power flow analysis and short circuit analysis. For an ERIS request, the power flow analysis provides a preliminary identification of any thermal or voltage limit violations resulting from the interconnection using the existing transmission system, and for a NRIS request, a preliminary identification of network upgrades required to deliver the proposed generation to PSCo native load customers. The short circuit analysis identifies any circuit breakers with short circuit capability limits exceeded as a result of the interconnection.

PSCo adheres to NERC/WECC criteria as well as internal company criteria for planning studies. The following criteria were used for this study:

- For system intact conditions, transmission system bus voltages must be maintained between 0.95 and 1.05 per-unit of system nominal/normal conditions, and steady-state power flows must be maintained within 1.0 per-unit of all elements' thermal (continuous current or MVA) ratings.
- Per the Rocky Mountain Voltage Guidelines, PSCo maintains a transmission system voltage profile ranging from 1.02 per unit or greater at regulating buses, and 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.

For this project, the affected parties are Tri-State Generation and Transmission Association (TSGT), Black Hills Power, and Western Area Power Administration (WAPA). PSCo will provide TSGT, BHP, and WAPA with a copy of this Feasibility Study report and work with them throughout the study phases.

Interconnection Customers are required to interconnect their Large Generating Facility with Public Service of Colorado's (PSCo) Transmission System in accordance with *Xcel Energy Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater than 20 MW*[4]. In addition, PSCo System Operations conducts commissioning tests prior to the commercial in-service date for a Customer's facilities. Some of the requirements that a developer must complete include the following:

1. A generation plant shall maintain power factor within the range of 0.95 leading to 0.95 lagging, measured at the POI. The Transmission Provider's System Impact Study is needed to demonstrate that such a power factor requirement is necessary to ensure safety or reliability.

[4] Available: (available: http://www.transmission.xcelenergy.com/staticfiles/microsites/Transmission/Files/PDF/Interconnection/Interconnections-POL-TransmissionInterconnectionGuidelineGreat20MW.pdf)

2. The voltage at a POI shall be maintained in the ideal voltage range for the appropriate Rocky Mountain region and bus type (regulating[5] or non-regulating) as determined in the *Rocky Mountain Area Voltage Coordination Guidelines*[6]. The System Impact Study will investigate pertinent demand (on-peak or off-peak), season (summer or winter), dispatch, and outage scenarios based on the defined study area that includes the proposed POI. The study will conform to the NERC Transmission System Planning Performance Requirements (TPL standards).

3. It is the responsibility of the Interconnection Customer to determine the type (switched shunt capacitors and/or switched shunt reactors, etc.), the size (MVAR), and the electrical locations of any additional static reactive power compensation capability to meet the +/- 0.95 power factor standard at the POI.

4. The Interconnection Customer is required to demonstrate to the satisfaction of PSCo Transmission Operations prior to the commercial in-service date of the generating plant that it can safely and reliably operate within the required power factor.

5. The impact of the generating facility on the reactive power schedules of nearby generating units may need to be mitigated by the Customer if system studies demonstrate that the proposed wind generating facility causes nearby generating units to generate or absorb reactive power for voltage control[7]. It is understood that sufficient reactive power

[5] A regulating bus is defined in the *Rocky Mountain Area Voltage Coordination Guidelines* as any transmission or generation bus with controllable VAR's. This implies that the bus has a voltage schedule that is being regulated by a generating facility. Generating facilities include Static VAR Compensators (SVC's), synchronous generators, or synchronous condensers that can supply fast-acting reactive power (VAR) compensation to dynamically regulate voltage at a power system bus. Switchable capacitors, switchable reactors, load tap changing transformers, etc. are not defined as generating facilities as they do not provide controllable dynamic VARs'.

[6] The Voltage Coordination Guidelines Subcommittee (VCGS) of the Colorado Coordinated Planning Group developed the guidelines. The subcommittee consisted of representatives from major Colorado utilities including Colorado Springs Utilities, Platte River Power Authority, Tri-State Generation and Transmission, Public Service Company of Colorado, and Western Area Power Administration-Rocky Mountain Region. Other major utilities outside of Colorado were also involved in the development of these guidelines.

[7] The *Rocky Mountain Area Voltage Coordination Guidelines (July 2006)*, page 8 of 34, Item 6, states that "Static VAR sources (switched shunt capacitors, reactors) should be operated to control the voltage profile before relying on LTC or generator VAR output, and should be used in such a manner to keep LTC transformers near their nominal tap

reserve must be maintained on generating units to allow them to dynamically regulate voltage for extreme system conditions.

6. If a generating facility is interconnected to the bulk transmission system but is operating with its generation off-line and receiving power from the bulk transmission system for its station service requirements, that facility is acting as a load and will be required to maintain the power factor at the POI within 98% lagging or leading (when the station service load is greater than 85% of maximum) per the Xcel Energy document titled Interconnection Guidelines For Transmission Interconnected Developer Loads.

7. PSCo System Operations will require the developer to perform operational tests prior to commercial operation that would verify that the equipment installed by the developer meets operational requirements.

8. It is the responsibility of the developer to determine what type of equipment (DVAR, added switched capacitors, SVC, reactors, etc.), the ratings, and the locations of those facilities that may be needed for acceptable performance during the commissioning testing.

The Interconnection Agreement (IA) requires that certain conditions be met, as follows:

1. The conditions of the Large Generator Interconnection Guidelines[8] (LGIG) are met.

2. PSCo will require testing of the full range of 0 MW to 480 MW of the wind project. These tests will include, but not be limited to, power factor control, and voltage control as

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range and to keep reactive margin on generating equipment. The rationale for this goal is that the generator is a dynamic reactive source that can provide high-speed reactive support to the transmission system after a disturbance that results in low voltages, or conversely are in a position to reduce voltages after a contingency that results in high voltages. Keeping transformers near their mid-tap range also allows for maximum response to either boost or reduce voltages following a disturbance".

[8] Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater than 20 MW, version 3.0, 12/31/06

measured at the San Luis Valley POI for various generation output levels (0 to 480 MW) of the overall photovoltaic generation facility.

3. The developer must show that the power factor at the POI is within the required +/-0.95 power factor range at all levels of generation and that the voltage levels and changes are within reliability criteria as measured at the POI for the full range of testing (including generator off-line conditions).

D. Power Flow Study Models

Western Electricity Coordinating Council (WECC) coordinates the preparation of regional power flow cases for transmission planning purposes. PSCo transmission developed a base case for the 2018 heavy summer and light spring peak load, from WECC approved models and modified for PSCo-approved projects and topology changes. In the 2018 case, the following items in Area 70 (PSCo Transmission) were changed to simulate stressed local area conditions.

- The existing in-service photovoltaic generation in Zone 710 (San Luis Valley) was set to 85% of nameplate ratings based on diversity and probability. The 85% is PSCo's Planning Guidelines for dispatching solar energy resource for GI studies.
- The aggregate load in Zone 710 (San Luis Valley) was set to 145 MW for the heavy summer Study Case and 45 MW for Light Spring Study Case. Historically, 45 MW is the least amount of loads observed when the solar generation reached 85% of their nameplate values.
- The additional generation supplied by GI-2016-9 was balanced via re-dispatch of generation in the PSCo balancing area (Comanche Units in Southern Colorado).

E. Power Flow Study Process

Automated contingency power flow studies were completed on all power flow models using the PSS®E program, switching out single elements one at a time for all of the elements (lines and

transformers) in Areas 70 (PSCo) and 73 (WAPA). Upon switching each element out, the program re-solves the power flow model with all transformer taps and switched shunt devices locked, and control area interchange adjustments disabled.

PSCo adheres to all applicable NERC Standards & WECC Criteria for Bulk Electric System (BES) acceptable performance, as well as its internal transmission planning criteria for all studies. During system intact conditions, PSCo's steady-state performance criteria require the transmission bus voltages remain within 0.95 – 1.05 per unit of nominal and the power flows stay below the applicable normal ratings of the transmission facilities. Following a single contingency, the steady state bus voltages must remain within 0.9 – 1.05 per unit of nominal, and the power flows must continue to stay below the applicable normal facility ratings. For N-1 post-contingency system conditions, the applicable normal ratings is the seasonal continuous rating of the transmission facility – but PSCo allows use of eight-hour facility ratings for transformers for which it is available. Further, PSCo does not rely on 30-minute emergency ratings of transmission facilities for meeting N-1 system performance in planning studies.

F. Power Flow Results

Thermal Overloads

The adverse impacts in terms of overloaded facilities resulting from the addition of GI-2016-9 and delivering 480 MW of generation to the 230 kV bus at the San Luis Valley Substation are shown in Table 1 for the High Load conditions. No additional thermal overloads occur in the light load case. Without any reinforcements, there are several lines in Areas 70 (PSCo) and 73 (WAPA) that become overloaded with the delivery of GI-2016-9 generation. Newer ratings that those found in the case exist in the Facilities Sheet for Xcel Energy Transmission Equipment and the thermal ratings are recalculated in Table 2. A single asterisk in Table 1 indicates a rating that dynamically changes due to ambient outside temperature. For these dynamically changing ratings, the average outdoor temperature during the summer and spring seasons determined that the ratings used are valid.

Table 1. Thermal Overloads with 480 MW GI-2016-9 at San Luis Valley Heavy Load

From Bus	To Bus	Voltage Class (kV)	Ckt	Branch Rating (MVA))	Branch Loading - % of Branch Rating			Contingency	Limiting Element
					Base Case	No Upgrades	Additional 230 kV Line		
70056 BNVSTATP	70312 RAY LEWI	115	1	91*	10.6	106.3	104.5	70327 PONCHA - 70394 SMELTER	T-Line Conductor
70056 BNVSTATP	70312 RAY LEWI	115	1	91*	9.7	133.9	139.0	73551 W CANON - 79054 PONCHABR	T-Line Conductor
70312 RAY LEWI	70327 PONCHA	115	1	124*	5.4	101.1	103.8	73551 W CANON - 79054 PONCHABR	T-Line Conductor / Switch
70327 PONCHA	70394 SMELTER	115	1	60	50.0	148.8	151.0	73551 W CANON - 79054 PONCHABR	Breaker CT and Secondary Elements
70374 SANLSVLY	70379 SARGENT	115	1	100	29.5	109.4	86.9	PONCHA 3 WINDING XFMR	Breaker CT and Secondary Elements

Table 2. Thermal Overloads with 480 MW GI-2016-9 at San Luis Valley Heavy Load

From Bus	To Bus	Voltage Class (kV)	Ckt	Branch Rating (MVA))	Branch Loading - % of Branch Rating			Contingency	Limiting Element
					Base Case	No Upgrades	Additional 230 kV Line		

70312 RAY LEWI	70327 PONCHA	115	1	120	5.6	104.5	107.3	73551 W CANON - 79054 PONCHAB R	T-Line Conductor / Switch
70374 SANLSVL Y	70379 SARGEN T	115	1	105	28.1	104.2	82.8	PONCHA 3 WINDING XFMR	Breaker CT and Secondary Elements

In reviewing the results of the contingency analysis with GI-2016-9 for Area 70 (PSCo system), the following conclusions have been made:

The addition of GI-2016-9 causes thermal overloads on the San Luis Valley – Sargent 115 kV line with the loss of the Poncha 3-winding transformer.

Additionally, GI-2016-9 causes thermal overloads on the Poncha – Malta 115 kV line with the loss of the 230 kV line between Poncha and West Canon.

The new ratings for a partial list of the overloaded facilities do not change the feasibility of the project under the current system configuration.

With the addition of the conceptual extra network upgrades, the San Luis Valley thermal overloads cease; however, other thermal overloads to the North and the East occur, namely the Poncha – Malta 115 kV line as well as the Poncha – Smelter town 115 kV line.

Due to the unacceptable reliability performance, delivery of the GI-2016-9 resource is not feasible without network upgrades, such as new transmission that would connect the San Luis Valley to Midway. However, this is not a planned project. Preliminary studies from that group indicate that a second San Luis Valley – Poncha 230 kV line and a new Poncha – W.Canon – Midway 230 kV transmission line would provide the network upgrades that would allow the GI-

2016-9 generation to be delivered to the PSCo transmission system. The San Luis Valley – Poncha 230 kV line #2 has been identified by PSCo and Tri-State to improve reliability in the San Luis Valley and be the first of transmission to deliver resources out of the Valley. Tri-State has indicated a potential in-service date of 2022, and PSCo intends to be a joint participant in that project. The Poncha – W.Canon – Midway 230 kV line is not a planned project, but is also being used to illustrate the potential costs and schedule for implementation of transmission that could meet the requirements for the proposed generation to become a Network Resource.

Voltage Criteria Violations

Interconnecting to the PSCo bulk transmission system involves the developer adhering to certain interconnection requirements. These requirements are contained in the *Xcel Energy Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater than 20 MW*[5]. In addition, PSCo System Operations conducts commissioning tests prior to the commercial in-service date for a Customer's facilities. Some of the requirements that the developer must complete include the following:

1. A generating plant shall maintain a power factor within the range of 0.95 leading to 0.95 lagging, measured at the POI, if the Transmission Provider's Feasibility Study shows that such a requirement is necessary to ensure safety or reliability.
2. The Feasibility Study will investigate pertinent demand, dispatch, and outage scenarios based on the defined study area that includes the proposed POI. The study will conform to the NERC Transmission System Planning Performance Requirements (TPL standards).
3. The results of the Feasibility Study (mentioned in Item 1 and 2 above) do not absolve the developer from its responsibility to demonstrate to the satisfaction of PSCo System Operations prior to the commercial in-service date that it can safely operate within the required power factor and voltage ranges.
4. Reactive Power Control at the POI is the responsibility of the developer. Additional developer studies should be conducted by developer to ensure that the facilities can meet

the power factor control test and the voltage controller test when the facility is undergoing commissioning testing.

5. PSCo System Operations will require the developer to perform operational tests prior to commercial operation that would verify that the equipment installed by the developer meets operational requirements.
6. It is the responsibility of the developer to determine what type of equipment (DVAR, added switched capacitors, SVC, reactors, etc.), the ratings (MVAR, voltage--34.5 kV or 230 kV), and the locations of those facilities that may be needed for acceptable performance during the commissioning testing.
7. PSCo requires the developer to provide a single point of contact to coordinate compliance with the power factor and voltage regulation at the POI. The reactive flow at the end of 230 kV line near the POI will need to be controlled according to the Interconnection Guidelines.

According to WECC/NERC criteria, it is necessary to maintain voltages at all buses in the system between 0.95 per unit to 1.05 per unit under operating conditions.

In the *Rocky Mountain Voltage Coordination Guidelines* that were developed by the Voltage Coordination Guideline Subcommittee of the Colorado Coordinated Planning Group, the ideal voltage for a regulating bus must be greater than 1.02 per unit. At the POI, a preexisting switched reactor controls the voltage at the San Luis Valley substation. The additional 480 MW of photovoltaic generation provided by GI-2016-9 does not adversely affect the standard operating ranges for the San Luis Valley substation. Under N-1 Contingency scenarios, the additional 480 MW of generation imposes high voltages above the allowable 1.05 per unit limit. The loss of the Generator Step-Up (GSU) Transformer at the Generation Facility causes widespread high voltages in excess of the allowable limit. The additional regional planned network upgrades do help alleviate the high voltage violations, but still fail to maintain the voltage system performance criteria under N-1 conditions. Allowing the existing switched reactor to counteract this voltage spike allows the voltages in the area to be within operational standards, so no additional reactive VAR compensation devices are required to interconnect.

Additionally, the collector system has not been modeled for the feasibility study. In the system impact study, if such is pursued by the Developer, the detailed collector system needs to be represented to perform the stability analysis. Those modeling details may have some impact on the reactive power requirements. The voltage-tap settings on the main power transformers that connect the 34.5 kV system to the Customer's transmission line will impact the operating voltages and related reactive power capabilities and requirements for GI-2016-9. These issues should be considered by the Developer in determining the final equipment design and parameters.

Energy Resource Interconnection Service (ERIS):

The ERIS portion of this study indicates that the Customer could deliver up to 30 MW without network upgrades. Additional capacity may be available on a non-firm basis, depending upon marketing activities, dispatch patterns, generation levels, demand levels, import path flow levels and the operational status of the transmission facilities.

Network Resource Interconnection Service (NRIS):

The results of this study indicate that the 480 MW output from the GI-2016-9 generation project delivered to the San Luis Valley 230 kV bus could result in the overloading of facilities in the PSCo system. Therefore, the 480 MW NRIS value requested will require network upgrades in the San Luis Valley and beyond. After the required upgrades are complete, the entire output of the 480 MW generating facility could be considered a network resource.

G. Short Circuit Analysis

The design documentation submitted by the customer does not meet the interconnection guidelines. As such, the design will need to be modified before construction, which may lead to

significant changes in fault current values. The assumptions used in this study are detailed below:

- The customer-provided one-line indicated transformers with high-side windings connected in a delta configuration. This will not allow for an effectively grounded system at the point of interconnection. Assumed that the transformers would be connected in a grounded wye on the high-side, and delta on the low side. Used 11% impedance on the 80 MVA base specified in the one-line and assume X/R to be 30.
- The customer provided site map showed a proposed transmission line that appeared to be approximately one mile long. Modelled this as a 0.8 Ohms at 80 degrees in the positive sequence network, and roughly three times that with an angle of 70 degrees in the zero sequence network.
- Used a typical model developed at Xcel Energy to approximate the contribution from the inverters.

Table 3 shows the results of the above assumptions. No breakers appear to be over-dutied as a result of the addition of GI-2016-9.

Table 3: Short Circuit Study Results

Conditions	Fault Currents	Thevenin Impedances
Existing – No changes	Three-Phase: 2664A Single-Line: 3286A	Z1 = 6.53786 + j49.4194 ohms Z2 = 6.54422 + j49.4229 ohms Z0 = 1.33352 + j21.5190 ohms
New – Including proposed generation	Three-Phase: 5726A Single-Line: 7388A	Z1 = 13.0998 + j19.1386 ohms Z2 = 13.1013 + j19.1379 ohms

		Z0 = 0.61510 + j8.50598 ohms

H. Cost Estimates and Assumptions

Indicative level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery have been developed by PSCo Engineering. The cost estimates are in 2016 dollars with escalation and contingencies applied 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 interconnection cost and network upgrades for delivery for GI-2016-9 is **$229.5 million**.

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.

Figure 1 shows a conceptual one-line of the proposed interconnection at the San Luis Valley 230 kV Substation

Figure 1. Preliminary One- Line Diagram for GI-2016-9 Interconnection at San Luis Valley

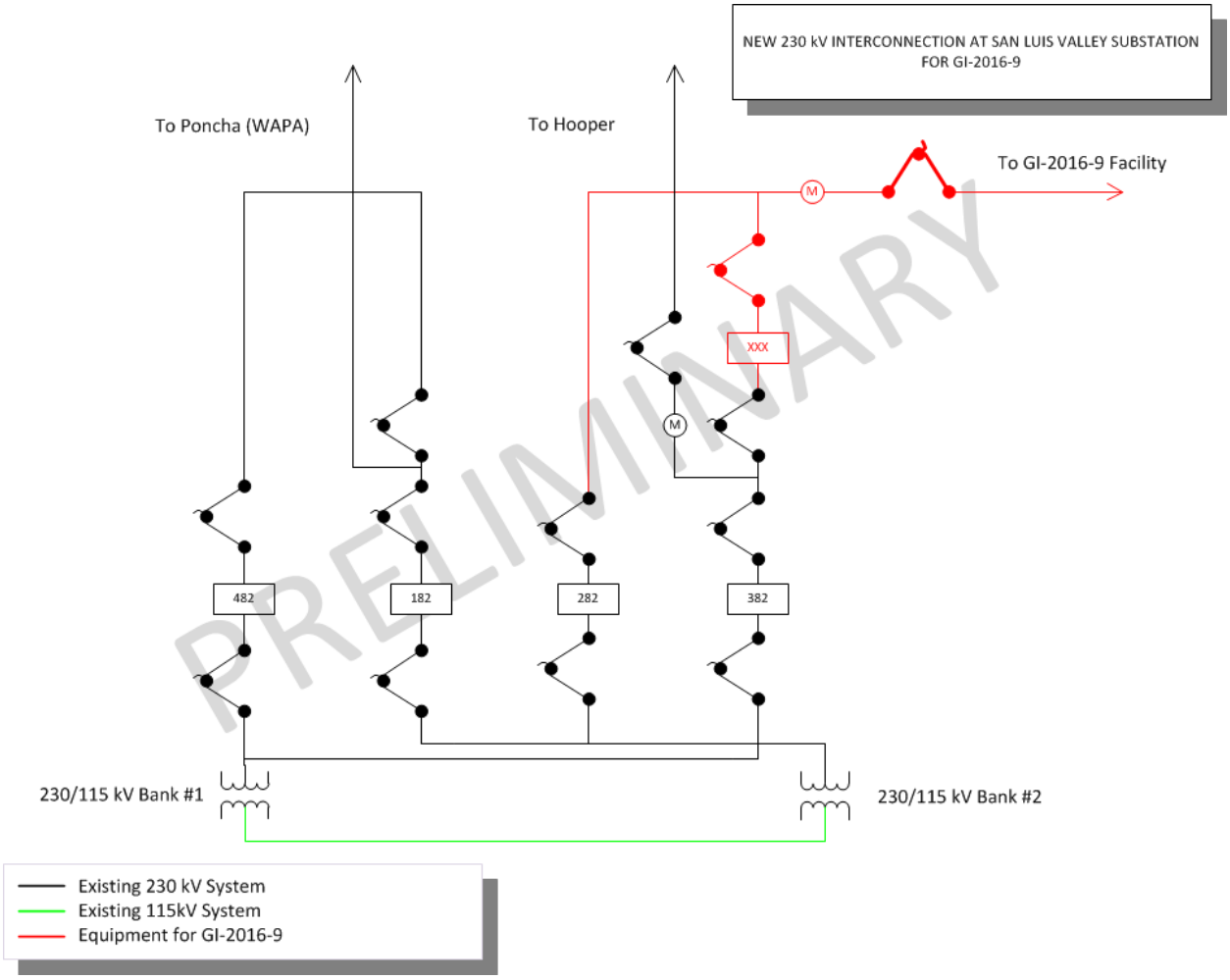

Table 4. PSCo Owned; Customer Funded Interconnection Facilities

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: • One 230 kV gang switch • Three 230 kV arresters • One set 23 0kV CT/PT metering units • Station controls • Instrument transformers • Associated bus, wiring and equipment • Associated site development, grounding, foundations and structures • Associated transmission line communications, relaying and testing	**$0.860**
	Transmission line relocation and tap into substation. Three spans, structures, conductor, insulators, hardware and labor.	**$0.205**
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction.	**$0.020**
Customer's 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: • Load Frequency/Automated Generation Control (LF/AGC) RTU	**$0.187**
	Total Cost Estimate for PSCo-Owned, Customer-Funded Interconnection Facilities	**$1.272**
Time Frame	**Site, design, procure and construct**	**18 Months**

Table 5. PSCo Owned; PSCo Funded Interconnection Facilities

Element	Description	Cost Est. (Millions)
San Luis Valley 230 kV Transmission Substation	Interconnect Customer to tap at San Luis Valley Transmission Substation (into the 230 kV bus). The new equipment includes: • One 230 kV circuit breaker • Three 230 kV gang switches • Three 230 kV arresters • Control Building (Electric Equipment Enclosure) • Station battery system upgrades • Station controls • Associated communications, supervisory and SCADA equipment • Associated line relaying and testing • Associated bus, miscellaneous electrical equipment, cabling and wiring • Associated foundations and structures • Associated road and site development, fencing and grounding	**$3.200**
	Siting and Land Rights support for substation land acquisition and construction.	**$0.020**
	Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities	**$3.220**
Time Frame	**Site, design, procure and construct**	**18 Months**

Table 6. Network Upgrades for Delivery

Element	Description	Cost Est. (Millions)
San Luis Valley - Poncha 230 kV line #2	Construct a new 62-mile, 230 kV single conductor overhead transmission line from San Luis Valley 230 kV Substation to Poncha 230 kV Substation rated for 631 MVA.	**$58**
Poncha – W.Canon – MidwayPS 230 kV	Construct approximately 88 miles of new single circuit 230kV and 115 kV OH transmission line. Will require new easements/ROW. New line terminations and associated equipment at Poncha, West Canon and Midway Substations.	**$167**
	Total Cost Estimate for PSCo Network Upgrades for Delivery	**$225**
Time Frame	**Regulatory, site, design, procure and construct**	**60 months**
	Total Cost of Project	**$229.5**

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 2016 dollars (appropriate contingency and escalation applied).
- Labor is estimated for straight time only – no overtime included.
- Lead times for materials were considered for the schedule.
- PSCo (or it's Contractor) crews will perform all construction, wiring, testing and commissioning for PSCo owned and maintained facilities.
- The estimated time to site, design, procure and construct the interconnection facilities is at least 18 months, The estimated time to site, design, procure and construct the Network/Infrastructure Upgrades is 60 months after authorization to proceed has be obtained. This is completely independent of other queued projects and their respective in-service dates.
- A CPCN will not be required for the interconnection facilities construction.
- A CPCN will be required for the network/infrastructure upgrades for delivery.
- Customer will string OPGW fiber into substation as part of the transmission line construction scope.
- All substation work and expansion will be completed within existing property boundaries. No new land is required.
- Substation trench and duct space is available.
- Existing bus ratings are adequate for the substation additions.