Generator Interconnection Request # GI-2014-6
System Impact Study

100 MW Solar Photovoltaic (PV) Generation
Pueblo County, Colorado

Public Service Company of Colorado
Transmission Planning
June 30, 2015

A. Executive Summary

On May 22, 2014, Public Service Company of Colorado (PSCo) received an interconnection request (GI-2014-6) for a 100 MW ac solar photovoltaic (PV) generation facility in Pueblo County, Colorado. The proposed Point of Interconnection (POI) is the PSCo-owned Midway 115 kV bus within the Midway 345/230/115 kV transmission substation (see Figure 1). The Commercial Operation Date (COD) requested by the Interconnection Customer is July 1, 2016, and accordingly the approximate target Backfeed Date is assumed to be April 1, 2016.

The solar photovoltaic generating facility will consist of 60 Eaton Power Xpert dc/ac inverters, each rated 1835 kVAac, 1670 kWac, 355 Vac, 0.91 lead – 0.91 lag adjustable power factor. Each inverter will be connected to a pad-mounted step-up transformer (SUT) which provides voltage transformation for integration of the inverter and its associated PV source circuits with the medium voltage (15, 25 or 35 kV class) power collection system within the generating plant. One main generation step-up transformer will provide the final transformation to allow the generating facility to interconnect to the Midway 115 kV bus POI via an overhead 115kV transmission line owned by the Interconnection Customer.

Based on the inverter's technical specifications provided by the Interconnection Customer, it is expected that the 0.91 lead – 0.91 lag adjustable power factor capability of the inverters will enable the GI-2014-6 generating plant to be operated in either the voltage control mode or the power factor control mode to follow the voltage schedule at the POI (Midway 115 kV bus) specified by the Transmission Operator.

The System Impact Study consists of the power flow (steady-state) contingency analysis and the short-circuit analysis. These analyses did not identify any thermal or voltage violations or any over-dutied circuit breakers that may be attributed to the GI-2014-6 interconnection. However, the power flow analysis did identify some pre-existing thermal overloads on Colorado Springs Utilities' (CSU) 115 kV transmission facilities for which PSCo and CSU have agreed to use an operating procedure as the planned mitigation solution. The transmission capacity provided by this planned mitigation solution is sufficient to accommodate the 100 MW rated output of GI-2014-6.

No stability analysis was performed since the dynamic performance of the solar generation facility for normally cleared faults was expected to be satisfactory based on the information on Voltage Ride Through (VRT) capability of the Eaton Power Xpert dc/ac inverters provided by the Interconnection Customer. Furthermore, it is the responsibility of the Interconnection Customer to ensure that its generating facility is capable of meeting the voltage ride-through and frequency ride-through (VRT and FRT) performance specified in the NERC Reliability Standard PRC-024-1.

Based on the System Impact Study results, it is concluded that the 100 MW rated output of the GI-2014-6 interconnection qualifies for both Network Resource Interconnection Service (NRIS)[1], as well as Energy Resource Interconnection Service (ERIS)[2] without requiring any Network Upgrades for Delivery. However, until the planned mitigation solution for the thermal overloads (i.e. Operating Procedure) is implemented, the GI-2014-6 generation output would be deliverable only as Energy Resource Interconnection Service (ERIS) using the existing firm/non-firm transmission capacity on an as-available basis.

Cost Estimates

The total estimated cost of the required interconnection facilities at PSCo's Midway Station (in 2014 dollars) is **$1.215 million** and includes:

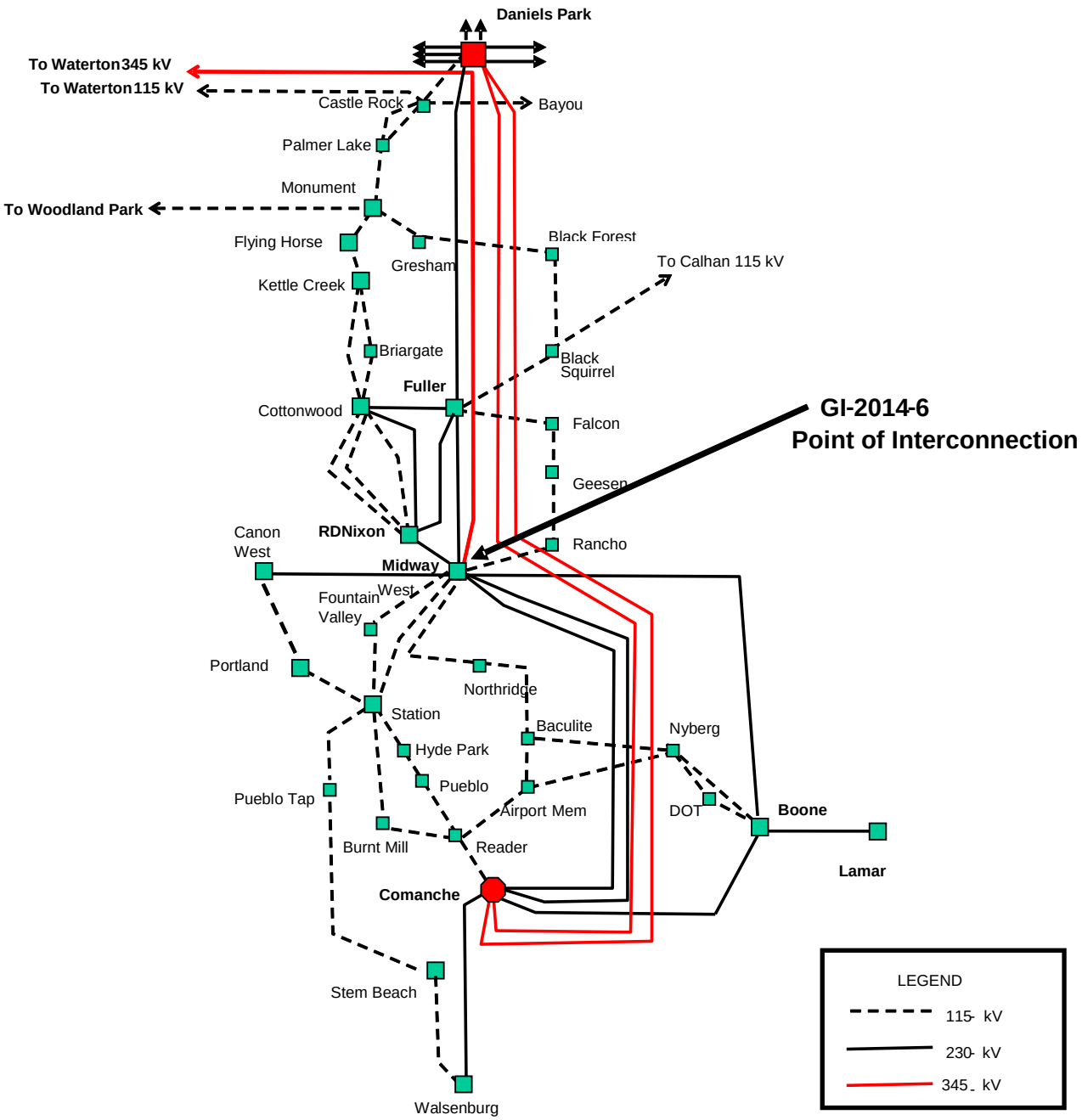
- $ 0.651 million for PSCo-Owned, Customer-Funded Interconnection Facilities
- $ 0.564 million for PSCo-Owned, PSCo-Funded Interconnection Facilities

PSCo Engineering estimates that it will need 12 months to complete the Interconnection Facilities (Customer-Funded and PSCo-Funded) in the Midway 115 kV switchyard.

[1] 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. Network Resource Interconnection Service in and of itself does not convey transmission service.

[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. Energy Resource Interconnection Service in and of itself does not convey transmission service.

Figure 1 Midway Station and Surrounding Transmission System (2016)



B. Introduction

On May 22, 2014, Public Service Company of Colorado (PSCo) received an interconnection request (GI-2014-6) for a 100 MWac solar photovoltaic (PV) generation facility in Pueblo County, Colorado. The proposed Point of Interconnection (POI) is the PSCo-owned Midway 115 kV bus within the Midway 345/230/115 kV transmission substation (see Figure 1). The Commercial Operation Date (COD) requested by the Interconnection Customer is July 1, 2016, and accordingly the approximate target Backfeed Date is assumed to be April 1, 2016.

The solar photovoltaic generating facility will consist of 60 Eaton Power Xpert dc/ac inverters, each rated 1835 kVAac, 1670 kWac, 355 Vac, 0.91 lead – 0.91 lag adjustable power factor. Each inverter will be connected to a pad-mounted step-up transformer (SUT) which provides voltage transformation for integration of the inverter and its associated PV source circuits with the medium voltage (15, 25 or 35 kV class) power collection system within the generating plant. One main generation step-up transformer will provide the final transformation to allow the generating facility to interconnect to the Midway 115 kV bus POI via an overhead 115kV transmission line owned by the Interconnection Customer.

A System Impact Study (SIS) Agreement was executed on March 31, 2015. The System Impact Study consists of steady-state power flow analyses to evaluate the thermal and voltage impact of the proposed generating plant on the transmission system, as well as determine the adequacy of the generating plant's power factor range (reactive power capability) at the POI. Based on the inverter technical specifications provided by the Interconnection Customer, it is expected that the inverters will have 0.91 lead – 0.91 lag adjustable power factor capability such that the PV solar generating plant's automatic voltage regulator will be capable of being operated in either voltage control or power factor control modes.

Recognizing the 0.91 lead – 0.91 lag adjustable power factor capability of the inverters, along with the information on Voltage Ride Through (VRT) capability of the inverters provided by the Interconnection Customer, a transient stability study to assess and/or verify the interconnecting generating facility's voltage ride-through for normally cleared faults was not deemed necessary. Further, since the inverters constitute an asynchronous interface of the PV solar generating plant to the transmission system, this interconnection does not contribute any electromechanical oscillations that may adversely impact the rotor-angle stability of existing synchronous generators.

For this interconnection request, the potential Affected Parties are Black Hills Colorado Electric (BHCE) and Colorado Springs Utilities (CSU).

C. Study Scope and Analysis

This interconnection request was studied both as a Network Resource Interconnection Service (NRIS)[3] and Energy Resource Interconnection Service (ERIS)[4].

The System Impact Study (SIS) scope consisted of performing power flow analysis to evaluate the steady-state thermal and/or voltage limit violations in the transmission system resulting from the proposed generator interconnection, as well as to determine the adequacy of the generating plant's power factor range (reactive power capability) at the POI. For evaluating NRIS feasibility, the entire 100 MW output of GI-2014-6 was assumed deliverable to PSCo loads. Whereas for evaluating ERIS feasibility, half of GI-2014-6 output (50 MW) was assumed deliverable to PSCo loads and the other half (50 MW) was assumed deliverable to BHCE loads. Note that this approach is in accordance with the mutually agreed upon study assumptions.

The System Impact Study (SIS) scope also consists of short-circuit analysis to determine any over-dutied circuit breakers due to the proposed generator interconnection. Together these analyses help identify the network upgrades required to deliver the 100 MW rated output of the proposed generation to load for both NRIS and ERIS.

PSCo adheres to NERC & WECC System Performance Criteria, as well as internal system performance criteria for transmission system planning studies. Operationally, PSCo attempts to maintain a transmission system voltage profile ranging from ≥1.02 per unit at regulating (generation) buses to ≥1.0 per unit at transmission load buses.

D. Power Flow Study Models

The study was based on the WECC 2015HS base case released on December 5, 2014 and was updated to reflect 2016 heavy summer modeling. The updates included topology, generation, load and facility rating updates to the PSCo, TSGT, BHCE, IREA and CSU transmission systems. The BHCE modeling updates included a fifth 90 MW Baculite Mesa generator connected to BHCE's Baculite substation plus additional updates provided by BHCE on May 11, 2015.

To assess the impact of the proposed generation on the interconnected transmission system, the generation dispatch in the reference case was adjusted to create a south to north power flow stress on the Comanche – Midway - Jackson Fuller – Daniels Park transmission path. This was

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[4] 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. Energy Resource Interconnection Service in and of itself does not convey transmission service.

accomplished by adopting the generation dispatch described in Appendix B below. PSCo generation in the study area (zones 700, 704, 710, 712, 752, 757, 790 and 791) is dispatched such that wind generation is at 85% name plate capacity, solar generation is at 80% name plate capacity and conventional non-coal generation is at 90% name palate capacity, coal generation is dispatched at 100% name plate capacity. The study did not include any generation in the Generation Interconnection queue but all resource acquisitions approved in PSCo's 2013 Energy Resource Plan (ERP) for which Power Purchase Agreements (PPA's) have been signed are included. The Lamar dc tie is dispatched at 100 MW import into PSCo and the Colorado Green / Twin Buttes wind generation (interconnected at Lamar) is dispatched to 190 MW such that flow on the Boone - Lamar 230 kV line is limited to 196 MW which is PSCo's ownership capacity. The resulting PSCo (Area 70) generation dispatch can be found in Appendix C.

Two power flow cases were created for evaluating the system impact of the proposed generator – the reference case and the study case. The study case includes the 100 MW generation dispatch at Midway 115 kV bus due to the proposed generator interconnection. Generation increase due to the proposed GI addition was sunk at Spindle #1 and #2 and is also shown in Appendix C.

E. Power Flow Study Process

Contingency power flow studies were completed on the reference power flow case and the study case (power flow case with GI 2014-6) using PTI's PSSE Ver. 33.4.0 program. Results from each of the two cases were compared and the monitoring criteria is to list any new thermal and voltage violations. Only the worst contingencies identified in previous studies (GI-2014-6 Feasibility Study and GI-2014-8 System Impact Study) were simulated, because the injections from GI-2014-6 and GI-2014-8 are in electrical proximity and both studies use the same benchmark case.

F. Power Flow Contingency Analysis Results

Network Resource Interconnection Service

The contingency analysis results for the Network Resource Interconnection Service (NRIS) evaluation are summarized in Appendix A. The results of the Category B contingency analysis in Table 5 show thermal overloads on three CSU owned 115 kV transmission facilities after the GI-2014-6 interconnection (that is, the study case). Since these three transmission facilities are also overloaded prior to the GI-2014-6 interconnection (that is, in the benchmark case), none of these thermal overloads may be attributed to the proposed 100 MW injection at Midway from GI-2014-6. Consequently, no network upgrades for delivery are needed. Table 6 in Appendix A shows the contingency analysis results after implementing the Operating Procedure as planned mitigation for the existing thermal overloads – the results demonstrate that the Operating Procedure is an adequate mitigation for the 100 MW injection of the GI-2014-6 interconnection.

Energy Resource Interconnection Service

Until the planned mitigation solution for the thermal overloads (i.e. Operating Procedure) is implemented, the GI-2014-6 output would be deliverable only as Energy Resource Interconnection Service (ERIS) using the existing firm/non-firm transmission capacity on an as available basis. This also applies to delivery of half the GI-2014-6 output (50 MW) to Black Hills Colorado Electric (BHCE) loads and the remaining 50 MW to PSCo loads. Table 7 in Appendix B shows the thermal overloads on three CSU-owned 115 kV transmission facilities when the GI-2014-6 output is delivered 50 MW each to BHCE and PSCo loads. After the mitigation solution is implemented, the contingency analysis did not identify any thermal constraints for the deliverability of GI-2014-6 output as ERIS.

G. Voltage Regulation and Reactive Power Capability

Interconnection Customers are required to interconnect their Large Generating Facilities with Public Service of Colorado's (PSCo) Transmission System in conformance to the *Xcel Energy Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW* (available at http://www.xcelenergy.com/staticfiles/xe/Regulatory/Transmission-Interconnection-Guidelines-Great-20MW.pdf). Wind and Solar generating plant interconnections (Variable Energy Resources) must also conform to the performance requirements in FERC Order 661-A. Accordingly, the following voltage regulation and reactive power capability requirements (at the POI) are applicable to this interconnection request:

- To ensure reliable operation, all Generating Facilities interconnected to the PSCo transmission system must adhere to the Rocky Mountain Area Voltage Coordination Guidelines. Accordingly, since the POI for this request is located within Southeast Colorado Region 4; the applicable ideal transmission system voltage profile range is 1.02 – 1.03 per unit at regulated buses and 1.0 – 1.03 per unit at non-regulated buses.
- Xcel Energy's OATT requires all Interconnection Customers to have the reactive capability to achieve +/– 0.95 power factor at the POI, with the maximum "full output" reactive capability available at all output levels. Furthermore, Xcel Energy requires all Interconnection Customers to have dynamic voltage control and maintain the voltage specified by the Transmission Operator within the limitation of +/– 0.95 power factor at the POI, as long as the generating plant is on-line and producing power.
- 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 locations (690 V, 34.5 kV or 230 kV bus) of any additional static reactive power equipment needed within the generating plant in order to have the reactive capability to meet the +/– 0.95 power factor and the 1.02 – 1.03 per unit voltage range standards at the POI. The Interconnection Customer may need to perform additional studies for this purpose.
- It is the responsibility of the Interconnection Customer to ensure that its generating facility is capable of meeting the voltage ride-through and frequency ride-through (VRT and FRT) performance specified in NERC Reliability Standard PRC-024-1.
- 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 and voltage ranges noted above.

H. Short Circuit Analysis Results

The calculated short circuit levels and Thevenin system equivalent impedances for the POI at the Midway 115kV bus are tabulated below. No circuit-breakers at Midway 115kV bus or at the neighboring buses were found to be over-dutied due to the proposed interconnection.

Table 1 – Short Circuit Levels at the Midway 115 kV POI

System Condition	Three-Phase Fault Level (Amps)	Single-Line-to-Ground Fault Level (Amps)	Thevenin System Equivalent Impedance R +j X (ohms)
Before GI-2004-6 Interconnection	11,902	10,998	Z1(pos) = 0.75129 + j5.52766 Z2(neg) = 0.77768 + j5.52607 Z0(zero) = 0.34656 + j6.95926
After GI-2004-6 Interconnection	11,902	11,538	Z1(pos) = 0.75129 + j5.52766 Z2(neg) = 0.77768 + j5.52607 Z0(zero) = 0.29216 + j6.11294

I. Study Conclusion

Based on the System Impact Study results, it is concluded that the 100 MW rated output of the GI-2014-6 interconnection qualifies for both Network Resource Interconnection Service (NRIS)[5], as well as Energy Resource Interconnection Service (ERIS)[6] without requiring any Network Upgrades for Delivery attributed to GI-2014-6. However, until the planned mitigation solution for the thermal overloads (i.e. Operating Procedure) is implemented, the GI-2014-6 generation output would be deliverable only as Energy Resource Interconnection Service (ERIS) using the existing firm/non-firm transmission capacity on as-available basis.

[5] 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. Network Resource Interconnection Service in and of itself does not convey transmission service.

[6] 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. Energy Resource Interconnection Service in and of itself does not convey transmission service.

Costs Estimates and Assumptions

Scoping level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 30% accuracy) were developed by PSCo Engineering. The cost estimates are in 2014 dollars with escalation and contingencies applied (AFUDC is not included) and are based upon typical construction costs for previously performed similar construction. These estimated costs include all applicable labor and overheads associated with the siting support, engineering, design, and construction of these new PSCo facilities. These cost estimates do 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 and the delivery of the Project. 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 – PSCo Owned; Customer Funded Interconnection Facilities

Element	Description	Cost Est. (Millions)
PSCo's Midway 115 kV Transmission Substation	Interconnect Customer to the 115 kV bus at the Midway 115 kV Substation. The new equipment includes: • Install one 115kV line position • Three 115 kV line arresters • Three 115kV Metering Units • One 115kV line switch • One 115kV deadend structure • New relaying for the new transmission line. • One relay panel • Associated communications, supervisory and SCADA equipment • Associated line relaying and testing • Associated bus, wiring and equipment • Associated foundations and structures • Associated transmission line communications, relaying and testing	**$0.446**
Customer's 115 kV Substation	Load Frequency/Automated Generation Control (LF/AGC) RTU and associated equipment. Install a new relay panel at the customer generation site. Connect SCADA from the site to the Lookout Control Center.	**$0.205**
	Total Cost Estimate for PSCo-Owned, Customer-Funded Interconnection Facilities	**$0.651**
Time Frame	**Site, design, procure and construct**	**12 Months**

Table 3 – PSCo Owned; PSCo Funded Interconnection Facilities

Element	Description	Cost Estimate (Millions)
PSCo's Comanche 230kV Transmission Substation	Interconnect Customer to the 115 kV bus at the Midway 115 kV Substation. The new equipment includes: • Three 115kV disconnect Switches • One 115kV circuit breaker • One power quality panel • Associated communications, supervisory and SCADA equipment • Associated bus, wiring and equipment • Associated foundations and structures	**$0.564**
	Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities	**$0.564**
Time Frame	**Site, design, procure and construct**	**12 Months**

Table 4 – PSCo Network Upgrades for Delivery - PSCo Funded

Element	Description	Cost Est. (Millions)
	Not Required	
	Total Cost Estimate for PSCo Network Upgrades for Delivery	**N/A**
Time Frame	**Site, design, procure and construct**	**N/A**
	Total Project Estimate	**$1.215**

Assumptions

- Scoping level cost estimates for Interconnection Facilities and Network Upgrades for Delivery (+/- 30% accuracy) were developed by PSCo Engineering.
- Estimates are based on 2014 dollars (appropriate contingency and escalation applied).
- AFUDC has been excluded.
- Labor is estimated for straight time only – no overtime included.
- Installation contingency of 20%
- Equipment contingency of 10%
- Internal construction labor will be used
- Standard Hard Dollar labor and material prices will be used.
- PSCo (or its Contractor) crews will perform all construction, wiring, testing and commissioning for PSCo owned and maintained facilities.

- The estimated time to design, procure and construct the interconnection facilities is approximately 12 months after authorization to proceed has been obtained.
- This project is completely independent of other queued projects and their respective ISD's.
- A CPCN will not be required for the Interconnection Facilities construction.
- Line and substation bus outages will be authorized during the construction period to meet the backfeed date.
- The Interconnection Customer will string OPGW fiber into the substation as part of their 115 kV transmission line construction scope.
- The Interconnection Customer will only pay for equipment directly related to their 115 kV transmission line connection.
- Power Quality Metering (PQM) will be required on the Interconnection Customer's 115 kV transmission line terminating into Midway Substation.
- Soil conditions are suitable for typical foundation installations
- Soil parameters allow for typical ground grid installation
- There are only two 115kV Black Hills owned Transmission Lines currently at Midway substation.
- No new substation land required. Substation work to be completed within existing property boundaries.
- The GI-2014-6 Generation Facility is not in PSCo's retail service territory. Therefore, no costs for retail load metering are included in these estimates.

Appendix

A. Power Flow Thermal Results – 2016 Summer Heavy Load (16HS) – Colorado South-North Flow Stress

(NRIS)
Lamar DC Tie = 100 MW Import Colorado Green + Twin Buttes Wind Gen = 190 MW
PSCo 2013 Electric Resource Plan (ERP) Generation:
Gas Gen: Fountain Valley CTs = 216 MW (dispatched @ 90% of Installed Capacity)
Wind Gen: Jackson Fuller = 200 MW (dispatched @ 80% of Installed Capacity)
Solar PV Gen: Comanche = 102 MW, San Luis Valley = 50 MW (dispatched @85% of Installed Capacity)

With GI-2014-6: GI-2014-6 = 100 MW, Spindle 1 = 84 MW (-50 MW), Spindle 2 = 84 MW (-50 MW)

Table 5 – Category B Post-Contingency Loadings on Facilities with Highest Impact [7]

				Branch Contingency Loading Without GI-2014-6		Branch Contingency Loading With GI-2014-6			
Monitored Facility (Line or Transformer)	Type	Line Owner	Branch Rating MVA (Norm/Emer)	Cat B Flow in MVA (Current Equiv)	Cat B Flow in % Current Equiv of Normal/Emer Rating	Cat B Flow in MVA (Current Equiv)	Cat B Flow in % Current Equiv of Normal/Emer Rating	% Change	NERC Category B Contingency Outage
Briar Gate – Cottonwood S 115 kV	Line	CSU	150 / 192	163.7	109.2% / 85.3%	169.0	112.9 / 88.0%	3.7% / 2.7%	Cottonwood N – Kettle Creek 115 kV
Cottonwood N – Kettle Creek 115 kV	Line	CSU	162 / 180	176.1	108.6% / 97.8%	182.4	112.6% / 101.3%	4.0% / 3.5%	Briar Gate – Cottonwood S 115 kV
Monument – Fly horse N 115 kV	Line	CSU	120 / 120	121.1	101.9%/101.9%	129.0	108.7% / 108.7%	6.8%	BLk SQMV- Jackson Fuller 115 kV Line
Jackson Fuller – Daniels Park 230 kV	Line	PSCo	478 / 478	332.7	68.8 / 68.8%	360.8	74.7% / 74.7%	5.9% / 5.9%	Midway – Waterton 345 kV or Midway 345/230 kV Xfmr

Note: Emergency Ratings are the Applicable Facility Ratings to determine acceptable post-contingency loading on CSU facilities.

[7] Includes facilities with an Impact Factor of 2% or more of the proposed 100 MW generation.

Table 6 – Category B Post-Contingency Loadings on Facilities with Highest Impact (with Monument-Palmer Lake line open) [8]

				Branch Contingency Loading Without GI-2014-6		Branch Contingency Loading With GI-2014-6			
Monitored Facility (Line or Transformer)	**Type**	**Line Owner**	**Branch Rating MVA (Norm/Emer)**	**Cat B Flow in MVA (Current Equiv)**	**Cat B Flow in % Current Equiv of Normal/Emer Rating**	**Cat B Flow in MVA (Current Equiv)**	**Cat B Flow in % Current Equiv of Normal/Emer Rating**	**% Change**	**NERC Category B Contingency Outage**
Briar Gate – Cottonwood S 115 kV	Line	CSU	150 / 192	130.3	86.8% / 67.9%	132.4	88.3 / 70.0%	1.5% / 2.1%	Cottonwood N – Kettle Creek 115 kV
Cottonwood N – Kettle Creek 115 kV	Line	CSU	162 / 180	135.4	83.3% / 75.2%	138.6	85.6% / 77.0%	2.6% / 1.8%	Briar Gate – Cottonwood S 115 kV
Monument – Fly horse N 115 kV	Line	CSU	120 / 120	76.9	64.5% / 64.5%	80.1	67.3% / 67.3%	2.8%	BLk SQMV- Jackson Fuller 115 kV Line
Jackson Fuller – Daniels Park 230 kV	Line	PSCo	478 / 478	373.6	77.3% / 77.3%	405.0	83.9% /83.9%	6.6% / 6.6%	Midway – Waterton 345 kV or Midway 345/230 kV Xfmr

Note: Emergency Ratings are the Applicable Facility Ratings to determine acceptable post-contingency loading on CSU facilities

[8] Includes facilities with an Impact Factor of 2% or more of the proposed 100 MW generation.

B. **Power Flow Thermal Results – 2016 Summer Heavy Load (16HS) – Colorado South-North Flow Stress**

(ERIS)

Lamar DC Tie = 100 MW Import Colorado Green + Twin Buttes Wind Gen = 190 MW

PSCo 2013 Electric Resource Plan (ERP) Generation:

Gas Gen: Fountain Valley CTs = 216 MW (dispatched @ 90% of Installed Capacity)

Wind Gen: Jackson Fuller = 200 MW (dispatched @ 80% of Installed Capacity)

Solar PV Gen: Comanche = 102 MW, San Luis Valley = 50 MW (dispatched @85% of Installed Capacity)

With GI-2014-6: GI2014-6 = 100 MW, Spindle 1 = 84 MW (-50 MW), Baculite Mesa = 40 MW (-50 MW)

Table 7 – Category B Post-Contingency Loadings on Facilities with Highest Impact [9]

				Branch Contingency Loading Without GI-2014-6		Branch Contingency Loading With GI-2014-6			
Monitored Facility (Line or Transformer)	Type	Line Owner	Branch Rating MVA (Norm/Emer)	Cat B Flow in MVA (Current Equiv)	Cat B Flow in % Current Equiv of Normal/Emer Rating	Cat B Flow in MVA (Current Equiv)	Cat B Flow in % Current Equiv of Normal/Emer Rating	% Change	NERC Category B Contingency Outage
Briar Gate – Cottonwood S 115 kV	Line	CSU	150 / 192	163.7	109.2% / 85.3%	166.8	111.3 / 86.9%	2.1% / 1.6%	Cottonwood N – Kettle Creek 115 kV
Cottonwood N – Kettle Creek 115 kV	Line	CSU	162 / 180	176.1	108.6% / 97.8%	179.8	110.9% / 99.9%	2.3% / 2.1%	Briar Gate – Cottonwood S 115 kV
Monument – Fly horse N 115 kV	Line	CSU	120 / 120	121.1	101.9%/101.9%	125.6	105.7% / 105.7%	3.8%	BLk SQMV- Jackson Fuller 115 kV Line
Jackson Fuller – Daniels Park 230 kV	Line	PSCo	478 / 478	332.7	68.8 / 68.8%	348.8	72.2% / 72.2%	3.4% / 3.4%	Midway – Waterton 345 kV or Midway 345/230 kV Xfmr

Note: Emergency Ratings are the Applicable Facility Ratings to determine acceptable post-contingency loading on CSU facilities.

[9] Includes facilities with an Impact Factor of 2% or more of the proposed 100 MW generation.

C. Generation Dispatch

Before GI-2014-6

PSCo:

Bus	LF ID	MW
Comanche PV	S1	102
Comanche	C1	360
Comanche	C2	365
Comanche	C3	805
Lamar DC Tie	DC	100.0 Import
Fountain Valley	G1	36
Fountain Valley	G2	36
Fountain Valley	G3	36
Fountain Valley	G4	36
Fountain Valley	G5	36
Fountain Valley	G6	36
Colorado Green	1	68
Colorado Green	2	68
Twin Butte	1	54
Jackson Fuller	W1	200
RMEC 1	G1	145
RMEC 2	G2	145
RMEC 3	G3	292
Alamosa CT	G1	11.7
Alamosa CT	G2	2.6
Cogentrix	S1	25.5
Greater Sandhill	S1	14.5
Blanca Peak	S1	19.5
SLV Solar	S1	41.6

BHCE:

Bus	LF ID	MW
BUSCHWRTG1	G1	3.6

BUSCHWRTG2	G2	3.6
E Canon	G1	0
PP_MINE	G1	0
Pueblo Diesels	G1	0
Pueblo Plant	G1	0
Pueblo Plant	G2	0.0
R.F. Diesels	G1	0.0
Airport Diesels	G1	0.0
Canyon City	C1	0
Canyon City	C1	0
Baculite 1	G1	90
Baculite 2	G1	90
Baculite 3	G1	40.0
Baculite 3	G2	40.0
Baculite 3	S1	20
Baculite 4	G1	40.0
Baculite 4	G2	40.0
Baculite 4	S1	20
Baculite 5	G1	90

CSU:

Bus	LF ID	MW
Birdsale1	1	0.0
Birdsale 2	1	0.0
Birdsale 3	1	0.0
Nixon	1	225.39
Tesla	1	24.8
Drake 5	1	49.65
Drake 6	1	83.19
Drake 7	1	141.03
Nixon CT 1	1	0.0
Nixon CT 2	1	0.0
Front Range CC 1	1	120.4
Front Range CC 2	1	120.8
Front Range CC 3	1	120.0

After GI-2014-6 (NRIS)

Bus	LF ID	MW
GI-2014-6	S1	100
Spindle 1	G1	84 (-50 MW)
Spindle 2	G2	84 (-50 MW)

After GI-2014-6 (ERIS)

Bus	LF ID	MW
GI-2014-6	S1	100
Spindle 1	G1	84 (-50 MW)
Baculite 5	G2	40 (-50 MW)

D. One-Line of Proposed GI-2014-6 Interconnection at Midway 115kV Station