Generator Interconnection Request # GI-2016-5
Feasibility Study

200 MW Solar Photovoltaic (PV) Generation at Midway 115 kV
Pueblo County, Colorado

Public Service Company of Colorado
Transmission Planning
August 19, 2016

A. Executive Summary

On April 5, 2016 Public Service Company of Colorado (PSCo) received an interconnection request (GI-2016-5) for a 200 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 December 31, 2019 and accordingly the approximate target Backfeed Date is assumed to be six months prior to the COD - June 30, 2019.

The proposed solar photovoltaic generating facility would consist of 50 GE dc/ac inverters, each rated 2310 kVAac, 4000 kWac, 550 Vac. Each inverter would 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 generator step-up transformer (GSUT) would 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.

The Feasibility Study consisted of power flow (steady-state) contingency analysis and short-circuit analysis. The power flow contingency analysis identified several thermal overloads as a result of the 200 MW injection from GI-2016-5, but did not identify any voltage violations. The short circuit analysis did not identify any over-dutied circuit breakers.

For this interconnection request, the potential Affected Parties are Black Hills Colorado Electric (BHCE), Tri-State Generation & Transmission (TSGT) and Colorado Springs Utilities (CSU).

Based on the Feasibility Study results, it is concluded that Network Upgrades are required for the 200 MW rated output of GI-2016-5 interconnection to qualify for Network Resource Interconnection Service (NRIS)[1]. Without Network Upgrades, GI-2016-5 interconnection qualifies for Energy Resource Interconnection Service (ERIS)[2] to deliver up to 200 MW output using the existing firm or non-firm capacity on an as available basis.

Without Network Upgrades: NRIS = 0 MW and ERIS = 0 – 200 MW on an as-available basis

With Network Upgrades: NRIS = 200 MW

Cost Estimates

The total estimated cost of the required Interconnection Facilities and Network Upgrades at PSCo's Midway Station (in 2016 dollars) is **$10.633 million** and includes:

- $ 0.543 million for PSCo-Owned, Customer-Funded Interconnection Facilities
- $ 6.193 million for PSCo-Owned, PSCo-Funded Interconnection Facilities
- $ 3.897 million for PSCo Network Upgrades for Delivery

Siting and Land Rights activities required for Transmission Provider's Interconnection Facilities are not included in the estimates.

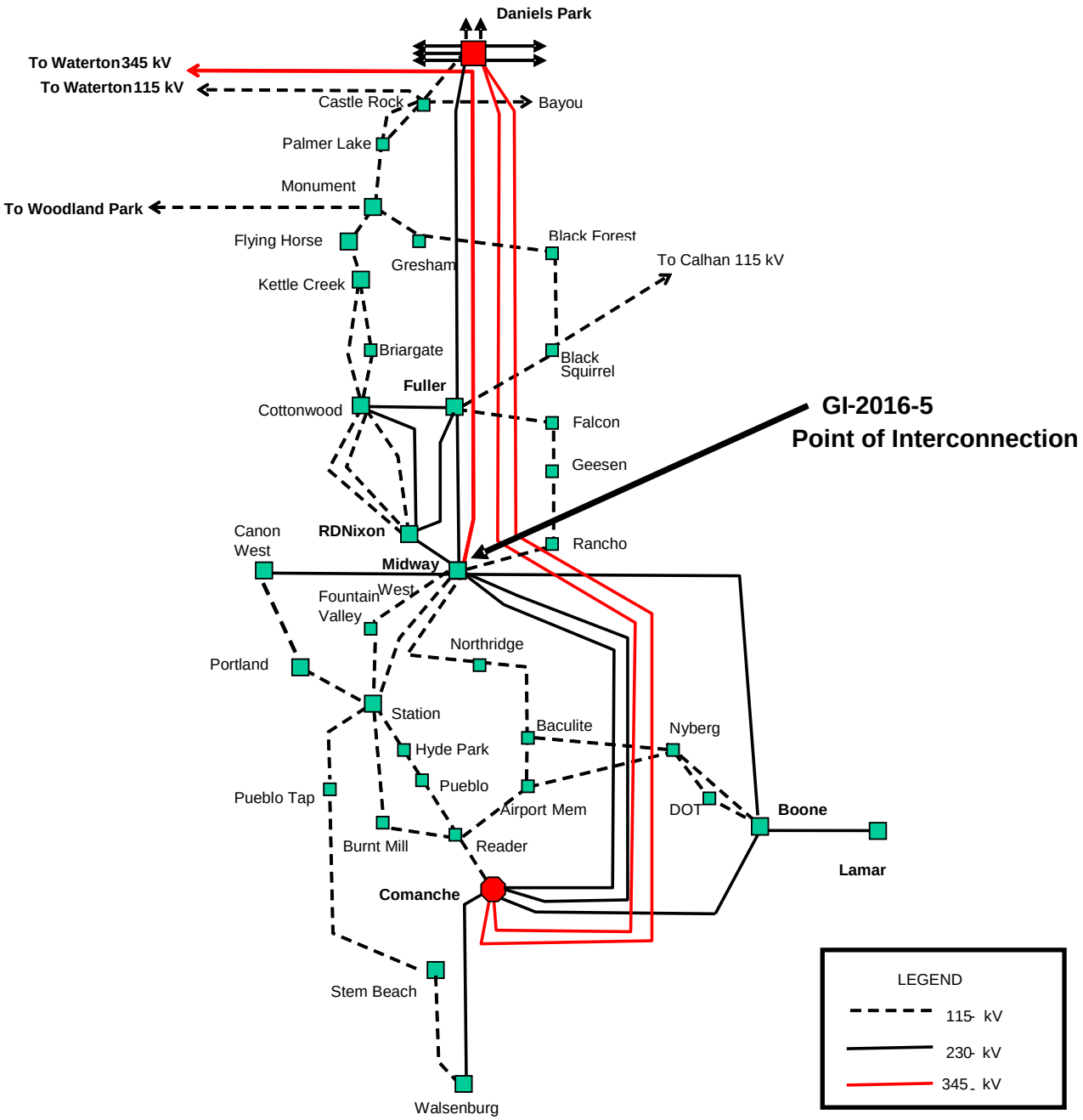
The estimated time frame to site, design, procure and construct these Interconnection Facilities and Network Upgrades is 24 months. If a CPCN is required for Network Upgrades then additional time will likely be required.

The Interconnection Customer will need to coordinate with the Affected Party Black Hills Colorado Electric (BHCE) whose facilities were determined to be overloaded as a result of GI-2016-5 to determine the estimated cost and timeframe for Network Upgrades needed on their transmission system.

[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 April 5, 2016 Public Service Company of Colorado (PSCo) received an interconnection request (GI-2016-5) for a 200 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 December 31, 2019 and accordingly the approximate target Backfeed Date is assumed to be six months prior to the COD - June 30, 2019.

The proposed solar photovoltaic generating facility would consist of 50 GE dc/ac inverters, each rated 4000 kWac, 2310 kVAac, 550 Vac. Each inverter would 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 generator step-up transformer (GSUT) would 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.

For this interconnection request, the potential Affected Parties are Black Hills Colorado Electric (BHCE), Tri-State Generation & Transmission (TSGT), and Colorado Springs Utilities (CSU).

C. Study Scope and Analysis

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

The Feasibility Study 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. The Feasibility Study scope also consisted of short-circuit analysis to determine any over-dutied circuit breakers due to the proposed generator

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

[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.

interconnection. Together these analyses help to identify potential Network Upgrades required to deliver the 200 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 power flow studies were based on the PSSE CCPG 2020HS_r7 case (dated Sept. 16 2015). The following Area 70 loads in the case were adjusted to reflect the most recent PSCo load forecast for 2020: PSCo, WAPA, and PSCo's wholesale customers. The transmission system topology was also updated to reflect current project plans for PSCo. Some of the notable updates included the New Alamosa Terminal 69/115 kV transformer replacement and the planned Wolcott Reactor addition. The taps on TSGT's Monument 1 and 2 69/115 kV transformers were changed to 1.0 pu to mitigate voltage issues inherent in the CCPG case.

Four power flow cases were created for evaluating the system impact of the proposed generator interconnection. The first two cases were a Benchmark Case (without GI-2016-5) and a Study Case (with GI-2016-5). The other two cases were the exact same as the Benchmark and Study Cases, however the Palmer Lake-Monument line was opened to reflect an operating procedure put into place that will occur during certain outage conditions to mitigate thermal overloads on CSU 115kV transmission facilities (see Appendix A).

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 accomplished by adopting a generation dispatch that accounts for future known generation plans, including planned retirements, additions, as well as current Purchase Power Agreements. PSCo generation was dispatched according to PSCo Transmission Planning's internal GI dispatch methodology.[5] The resulting PSCo Area 70 generation dispatch can be found in Appendix B.

[5] *Variable Energy Resource (VER) Dispatch Assumptions used in PSCo Transmission Planning's System Impact/Performance Studies – specifically in Generator Interconnection & Deliverability Studies for PSCo Designated Network Resources (DNR) [Feb 24 2015]*

E. Power Flow Study Process

Contingency power flow studies were completed on the Benchmark Case and the Study Case using PTI's PSSE Ver.33.6.0 program and PSSE Ver. 33.6.0 ACCC contingency analysis. The study area was defined as Zones 700, 703, 704, 705, 709, 710, 712, 754 and 757. Results from the two cases were compared and notable results are analyzed. The PSCo outage analysis was performed using contingency definitions that reflect breaker to breaker outages. In addition the presumed most significant N-2 contingency (loss of both 345 kV Daniels Park – Comanche lines) was analyzed. In addition to these analyses the following outages were also performed for the entirety of Areas 70 and 73:

- Single branch outages for each line and transformer
- Tie line outages
- Single machine unit outages

Note: Comanche 2 GSU thermal violations were ignored since Comanche 2 was the swing generator for Area 70.

F. Power Flow Contingency Analysis Results

Thermal Analysis: New thermal overloads did occur as a result of the GI-2016-5 interconnection and are shown in Tables A.1 and A.2 in Appendix A.

The remaining overloads that appeared in the Study Case already existed in the Benchmark Case and were ignored.

Voltage Analysis: No new voltage violations occurred as a result of the GI-2016-5 interconnection.

Many of the voltage violations that appeared in the Study Case already existed in the Benchmark Case and were ignored.

As defined in Section C above, Energy Resource Interconnection Service (ERIS) allows the Customer to deliver a 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. Therefore, until Network Upgrades to mitigate overloads due to GI-2016-5 are placed in-service, the GI-2016-5 output would be deliverable only as ERIS using the existing firm/non-firm transmission capacity on an as available basis. After the Network Upgrades are placed in-service, the GI-2016-5 rated output would be deliverable as Network Resource Interconnection Service (NRIS).

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.transmission.xcelenergy.com/Interconnections). Wind and Solar generating plant interconnections (Non-Synchronous Generation) must also conform to the performance requirements in FERC Order 827. Accordingly, the following voltage regulation and reactive power capability requirements are applicable to this interconnection request:

- To ensure reliable operation, all Generating Facilities interconnected to the PSCo transmission system should adhere to the Rocky Mountain Area Voltage Coordination Guidelines. Accordingly, since the POI for this interconnection 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.
- In accordance with FERC Order 827, all Interconnection Customers shall design their Generating Facility to maintain a composite power delivery at continuous rated power output at the high-side of the generator substation at a power factor within the range of 0.95 leading to 0.95 lagging.
- Generating Facilities interconnected to the PSCo transmission system must meet the POI voltage schedule specified by the Transmission Operator, as long as the Generating Facility is on-line and producing power. In accordance with FERC Order 827, the Generating Facilities are expected to achieve this by providing dynamic reactive power proportionate to the actual power (MW) output within the 0.95 leading to 0.95 lagging power factor range.
- In accordance with FERC Order 827, the Interconnection Customer has the responsibility 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 Facility in order to provide the level of dynamic reactive power capability to meet the 0.95 leading to 0.95 lagging power factor standard. The Interconnection Customer may need to perform additional studies for this purpose.
- The Interconnection Customer has the responsibility 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.
- Prior to commercial operation, the Interconnection Customer must demonstrate to the satisfaction of PSCo Transmission Operator that the Generating Facility 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-2016-5 Interconnection	12,038	11,075	Z1(pos) = 0.73579 + j5.46595 Z2(neg) = 0.76217 + j5.46448 Z0(zero) = 0.34623 + j6.95924
After GI-2016-5 Interconnection	12,038	11,894	Z1(pos) = 0.73579 + j5.46595 Z2(neg) = 0.76217 + j5.46448 Z0(zero) = 0.28454 + j5.72137

I. Study Conclusion

Based on the Feasibility Study results, it is concluded that Network Upgrades are required for the 200 MW rated output of GI-2016-5 interconnection to qualify for Network Resource Interconnection Service (NRIS). Without Network upgrades, GI-2016-5 interconnection qualifies for Energy Resource Interconnection Service (ERIS) to deliver up to 200 MW output using the existing firm or non-firm capacity on an as available basis.

Without Network Upgrades: NRIS = 0 MW and ERIS = 0 – 200 MW on an as-available basis

With Network Upgrades: NRIS = 200 MW

J. Cost Estimates and Assumptions

PSCo Engineering has developed Indicative level (IE) cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery. The cost estimates are in 2016 dollars with escalation and contingency applied (AFUDC is not included). Indicative Estimates are based upon typical construction costs for previously performed similar construction projects; however they have no specified level of accuracy. These estimated costs include all applicable labor and overheads associated with the siting support, engineering, design, and construction of these new PSCo facilities. The estimates do not include the costs for any other Customer owned equipment and associated design and engineering.

The estimated total cost of the facilities and upgrades for the interconnection is **$10,633,000**. Figure 2 in Appendix C below represents a conceptual one-line of the proposed interconnection of the Customer's 200 MW Solar Photovoltaic (PV) Generation at the Midway Substation 115 kV bus. 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 2: Transmission Provider's Interconnection Facilities – Interconnection Customer Funded

Element	Description	Cost Est. (Millions)
PSCo's Midway 115 kV Transmission Substation	Interconnect Customer to the 115kV bus at Midway Substation. The new equipment includes: • One 115kV, 3000 amp gang switch • Three 115kV CT/PT metering units • Three 115kV lightning arresters • Primary metering for Load Frequency/Automated Generation Control • Power Quality Metering • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing	**$0.468**
	Transmission line tap from Customer's last line structure outside of PSCo's yard into new bay position (assumed 300' span, conductor, hardware and labor).	**$0.075**
	Total Cost Estimate for PSCo-Owned, Customer-Funded Interconnection Facilities	**$0.543**
Time Frame	**Design, procure and construct**	**24 Months**

Table 3: Transmission Provider's Interconnection Facilities – PSCo Transmission Funded

Element	Description	Cost Estimate (Millions)
PSCo's Midway 115kV Transmission Substation	Interconnect Customer to the 115kV bus at Midway Substation. The new equipment includes: • Electrical Equipment Enclosure and Auxiliary Systems • Station Batteries and Battery Charger • Eight 115kV, 3000 amp circuit breakers • Twelve 115kV, 3000 amp gang switches • Three 115kV CCVTs • Associated station controls, • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated equipment and system testing • Associated fence and yard improvements	**$5.529**

	Communications, supervisory and SCADA equipment	**$0.579**
	Siting and Permitting activities to expand substation	**$0.085**
	Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities (not including Siting & Permitting Cost)	**$6.193**
Time Frame	**Site, design, procure and construct**	**24 months**

Table 4: PSCo Network Upgrades for Delivery - PSCo Funded

Element	Description	Cost Est. (Millions)
PSCo's Midway 115kV Transmission Substation	The new equipment includes: • One 230/115kV, 280MVA Transformer • Associated equipment and materials	**$3.897**
	Total Cost Estimate for PSCo Network Upgrades for Delivery	**$3.897**
	Design, procure and construct	**24 Months**
	Total Project Estimate	**$10.633**

The Interconnection Customer will need to coordinate with the Affected Party Black Hills Colorado Electric (BHCE) whose facilities were determined to be overloaded as a result of GI-2016-5 to determine the estimated cost and timeframe for Network Upgrades needed on their transmission system.

Cost Estimate Assumptions

- Indicative level project cost estimates (IE) for Interconnection Facilities were developed by PSCo Engineering. No level of accuracy is specified for IE's.
- Estimates are based on 2016 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 Generation Facility is not in PSCo's retail service territory. Therefore, no costs for retail load (distribution) facilities and metering required for station service are included in these estimates.

- Xcel Energy (or its Contractor) crews will perform all construction, wiring, testing and commissioning for PSCo Transmission owned and maintained facilities.
- A CPCN may be required to incorporate Network Upgrades which would affect the timeframe.
- Customer will string OPGW fiber into substation as part of the transmission line construction scope.
- Siting and Land Rights activities required for Transmission Provider's Interconnection Facilities are not included in the estimate.

Xcel Energy

Appendix A - Power Flow Thermal Results

GI-2016-5 (200 MW) Interconnection at Midway 115 kV POI
2020 Summer Heavy Load (2020) – Colorado South-North Flow Stress

Lamar DC Tie = 0 MW Colorado Green = 0 MW Twin Buttes Wind Gen = 15.8 MW
PSCo 2013 Electric Resource Plan (ERP) Generation:
- Gas Gen: Fountain Valley CTs = 216 MW (dispatched @ 90% of Installed Capacity)
- Wind Gen: Jackson Fuller = 100 MW (dispatched @ 40% of Installed Capacity)
- Solar PV Gen: Comanche = 102 MW (dispatched @ 85% of Installed Capacity)

Table A.1 – GI-2016-5 with Palmer Lake – Monument 115 kV line closed (normal operation)

				Facility Contingency Loading Without GI-2016-5 (Benchmark Case)		Facility Contingency Loading With GI-2016-5 (Study Case)			
Monitored Facility (Line or Transformer)	Type	Facility Owner	Branch Rating MVA (Norm/Emer)	Flow in MVA (Current Equiv)	Flow in % Current Equiv of Normal/Emer Rating	Flow in MVA (Current Equiv)	Flow in % Current Equiv of Normal/Emer Rating	% Change	Contingency Outage
Midway 115/230 kV	Txfm	PSCo	97 / 120	33.2	33.5 / 27.7	127.5	131 / 106	97.5 / 78.3	None – System Intact
Briar Gate S – Cottonwood S 115 kV	Line	CSU	150 / 192	146.2	95.6 / 76.0	155.9	104 / 81.2	8.4 / 5.2	Cottonwood N – Kettle Creek S 115 kV
Cottonwood N – Kettle Creek S 115 kV	Line	CSU	162 / 180	155.2	95.8 / 86.2	167.7	104 / 93.2	8.2 / 7.0	Briar Gate S – Cottonwood S 115 kV
Boone – La Junta Tap 115 kV	Line	TSGT	79 / 79	128.7	160 / 160	129	160 / 160	0 / 0	Boone – Lamar 230 kV
Midway (PSCo) – West Station 115 kV	Line	BHCE	80 / 80	19.5	24.3 / 24.3	142	173 / 173	149 / 149	Midway 115/230 kV
Midway 115/230 kV	Txfm	PSCo	97 / 120	32.5	31.7 / 27.1	168	170 / 140	138 / 113	Midway (PSCo) – West Station 115 kV
Midway 115/230 kV	Txfm	PSCo	97 / 120	84.9	87.5 / 70.8	191	197 / 159	110 / 88.2	2x Comanche – Daniels Park 345 kV Lines

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

GI-2016-5 (200 MW) Interconnection at Midway 115 kV POI

2020 Summer Heavy Load (2020) – Colorado South-North Flow Stress

Lamar DC Tie = 0 MW Colorado Green = 0 MW Twin Buttes Wind Gen = 15.8 MW

PSCo 2013 Electric Resource Plan (ERP) Generation:

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

Wind Gen: Jackson Fuller = 100 MW (dispatched @ 40% of Installed Capacity)

Solar PV Gen: Comanche = 102 MW (dispatched @ 85% of Installed Capacity)

Table A.2 – GI-2016-5 with Palmer Lake – Monument 115 kV line open (as per Palmer Lake operating procedure)

				Facility Contingency Loading Without GI-2016-5		Facility Contingency Loading With GI-2016-5			
Monitored Facility (Line or Transformer)	Type	Facility Owner	Branch Rating MVA (Norm/Emer)	Flow in MVA (Current Equiv)	Flow in % Current Equiv of Normal/Emer Rating	Flow in MVA (Current Equiv)	Flow in % Current Equiv of Normal/Emer Rating	% Change	Contingency Outage
Midway 115/230 kV	Txfm	PSCo	97 / 120	32.9	33.1 / 27.4	126.6	131 / 106	97.9 / 78.6	None – System Intact
Briar Gate S – Cottonwood S 115 kV	Line	CSU	150 / 192	131.5	86 / 68.5	135.3	90.2 / 70.5	4.2 / 2.0	Cottonwood N – Kettle Creek S 115 kV
Cottonwood N – Kettle Creek S 115 kV	Line	CSU	162 / 180	137.2	83.1 / 76.2	141.4	87.3 / 78.6	4.2 / 2.4	Briar Gate S – Cottonwood S 115 kV
Boone – La Junta Tap 115 kV	Line	TSGT	79 / 79	128.7	160 / 160	129	160 / 160	0 / 0	Boone – Lamar 230 kV
Midway (PSCo) – West Station 115 kV	Line	BHCE	80 / 80	19.4	24.2 / 24.2	142.2	173 / 173	149 / 149	Midway 115/230 kV
Midway 115/230 kV	Txfm	PSCo	97 / 120	30.1	30.3 / 25.1	167.7	169 / 140	135 / 113	Midway – West Station 115 kV
Midway 115/230 kV	Txfm	PSCo	97 / 120	84.9	87.1 / 70.8	190.7	197 / 159	110 / 88.2	2x Comanche – Daniels Park 345 kV Lines

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

Appendix B - Generation Dispatch

Case Description: 2020 HS, Colorado South to North Generation Flow Bias, based on CCPG 2020 HS case.

Benchmark Case – Before GI-2016-5
PSCo:

Bus	ID	MW
Comanche PV	S1	102
Comanche	C1	360
Comanche	C2	364
Comanche	C3	780
Lamar DC Tie	DC	0
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	0
Colorado Green	2	0
Twin Butte	1	15.8
Jackson Fuller	W1	50
Jackson Fuller	W2	50
RMEC 1	G1	145
RMEC 2	G2	145
RMEC 3	G3	290
Alamosa CT	G1	17
Alamosa CT	G2	14
GE Solar	S1	25.5
Greater Sandhill	S1	16.1
SLV Solar	S1	44.2

BHCE:

Bus	ID	MW
BUSCHWRTG1	G1	4
BUSCHWRTG2	G2	4
BUSCHWRTG3	G3	4
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	24
Baculite 4	G1	40.0
Baculite 4	G2	40.0
Baculite 4	S1	24
Baculite 5	G1	40

CSU:

Bus	ID	MW
Birdsale1	1	0.0
Birdsale 2	1	0.0
Birdsale 3	1	0.0
RD Nixon	1	221.39
Tesla	1	13.2
Drake 5	1	49.65
Drake 6	1	81.19
Drake 7	1	138.03
Nixon CT 1	1	0.0
Nixon CT 2	1	0.0
Front Range CC 1	1	138.4
Front Range CC 2	1	138.8
Front Range CC 3	1	136.0

Study Case – With GI-2016-5

Bus	ID	MW
GI-2016-5	S1	200 (+200)
Alamosa CT1	G1	0 (-17)
Alamosa CT2	G2	0 (-14)
Comanche 2	C2	358.9 (-4.6)
Ft. Lupton	G1	15 (-5)
Ft. Lupton	G2	15 (-5)

Manchief	G1	115 (-25)
Manchief	G2	115 (-25)
RMEC 1	G1	130 (-15)
RMEC 2	G2	130 (-15)
RMEC 3	G3	275 (-15)
St. Vrain 2	G2	122 (-5)
St. Vrain 3	G3	125 (-7)
St. Vrain 4	G4	125 (-7)
St. Vrain 5	G5	140 (-8)
St. Vrain 6	G6	140 (-7)
Valmont 6	G6	0 (-53)

Appendix C – Engineering Drawings

Figure 2: One-Line of Proposed GI-2016-5 Interconnection at Midway 115kV Station