Feasibility Study Report
Generation Interconnection Request # GI-2016-28

51.75 MW Solar Photovoltaic Facility
Collbran 138kV Substation
Mesa County, Colorado

Transmission Planning West
Xcel Energy
June 21, 2017

Executive Summary

The "GI-2016-28" project is a 51.75 MW solar photovoltaic generation facility that will be located in Mesa County, in Western Colorado. The Point of Interconnection (POI) requested by the Interconnection Customer is the Collbran Substation 138kV bus. The proposed Commercial Operation Date of the GI-2016-28 facility is December 1, 2019. The affected parties for this study are Western Area Power Administration ("Western"), Tri-State Generation and Transmission Inc. ("Tri-State"), and Grand Valley Power ("Grand Valley"). The GI-2016-28 interconnection request was received by PSCo on November 22, 2016 and a scoping meeting was held on December 9, 2016. Details about the proposed project, power flow study work and conclusions, short circuit study work and conclusions, indicative cost estimates, and a conceptual one-line diagram are provided in this report.

The power flow study examined transmission system reliability for on-peak winter and summer conditions with Nucla generation off-line (as represented in the WECC base cases selected). The Molina Generating Station that connects to the Collbran Substation was dispatched at its maximum output (13.5 MW). Two high TOT2A (500 MW north-to-south) study cases (winter on-peak and summer on-peak) were developed and studied. A high TOT5 (1680 MW west-to-east) winter on-peak study case was also developed and studied. For these stressed system conditions, the power flow study work determined the following:

- There were no observed reliability issues on the PSCo bulk transmission system that do not have a proposed mitigation. A slight post-contingency overload (101.5%) of PSCo's Collbran-Grand Junction 138kV line (for an outage of the Grand Junction-Montrose 345kV line) could occur with the GI-2016-28 project dispatched at its maximum output. The overload is due to a 96 MVA rating limitation of the Collbran-Grand Junction 138kV line because of a current transformer (CT) limitation at the Collbran Substation. The Transmission Provider has determined that the addition of interconnection facilities needed for GI-2016-28 would require a complete rebuild of the Collbran Substation and that this substation rebuild would eliminate the CT limitation at Collbran Substation. Therefore, the potential thermal violation of the Collbran-Grand Junction 138kV line will be mitigated by the interconnection and rebuild of the Collbran Substation.

- A pre-existing post-contingency thermal violation on Tri-State's Grand Junction-Star Nelson 115kV line (for an outage of the Grand Junction-Montrose 345kV line) worsened

with the addition of GI-2016-28 at maximum output. The Interconnection Customer should discuss this with Tri-State. Tri-State may have plans to increase the rating of the Grand Junction-Star Nelson 115kV line.

The short circuit study work included a preliminary breaker duty analysis. All new circuit breakers in the rebuilt Collbran Substation will be adequately rated. The analysis did not identify any circuit breakers in neighboring substations that would become "over-dutied"[1] with the addition of GI-2016-28. The fault current levels and Thevenin impedance values for three phase and single line to ground faults at the POI are provided in the report.

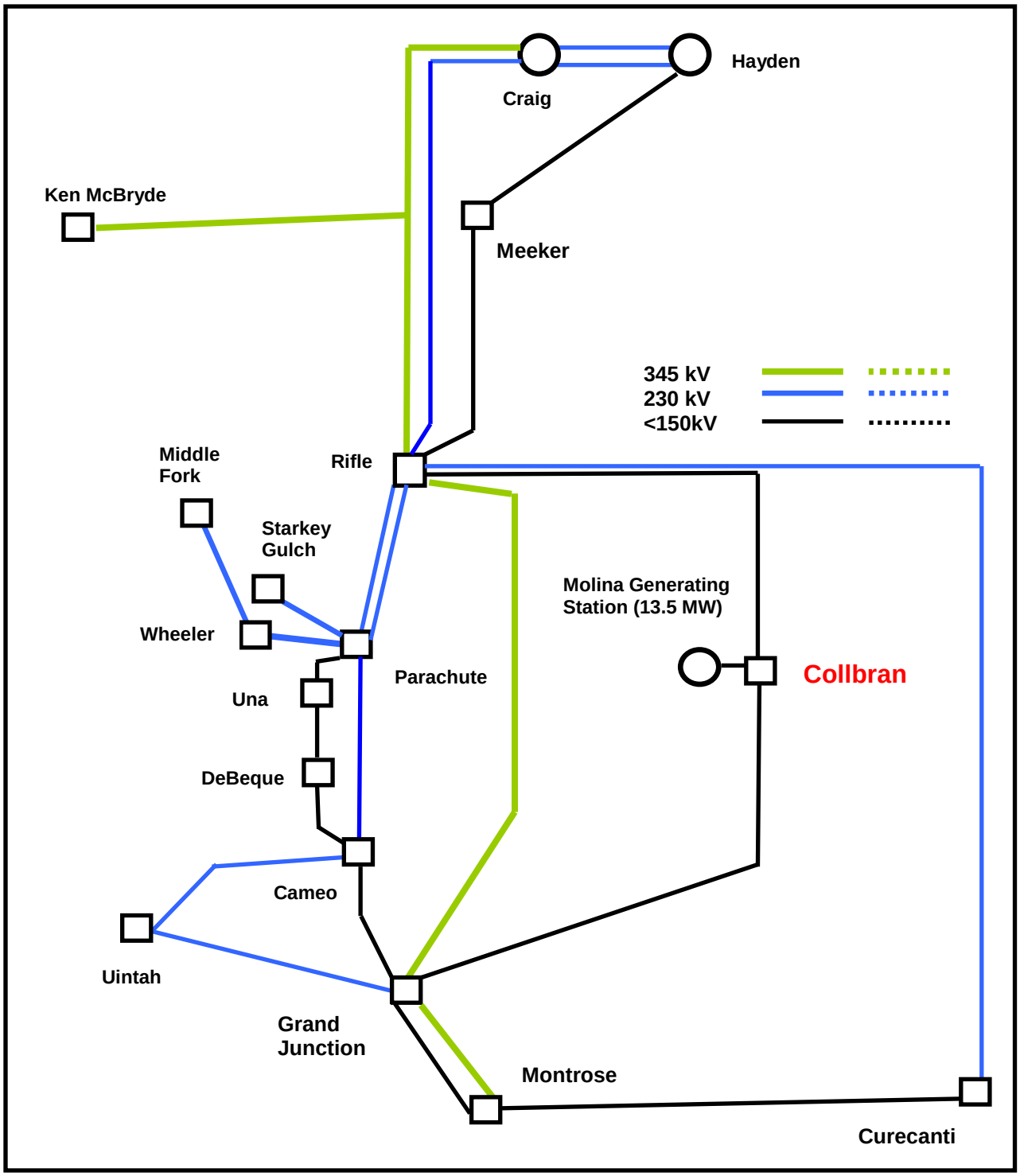
The GI-2016-28 interconnection qualifies for both Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS) at 51.75 MW. This conclusion assumes that the Interconnection Customer is able to address with Tri-State the pre-existing post-contingency thermal violation on the Grand Junction-Star Nelson 115kV line.

The estimated total cost for the required Transmission Provider Interconnection Facilities and Network Upgrades for Interconnection and Delivery is approximately $13.135 million (in 2017 dollars). These costs represent Indicative Estimates (IE) which are based upon typical construction costs for previously performed similar construction projects. They have no specified level of accuracy. This cost estimate does not include the cost for any Interconnection Customer owned equipment and its associated design and engineering. The estimated time to design, procure and construct the Transmission Provider Interconnection Facilities is approximately 18 months after authorization to proceed has been obtained.

Figure 1 below is a simplified one-line diagram of the study area with the Collbran 138kV POI indicated in "red".

[1] "Over-dutied" circuit breaker: A circuit breaker whose short circuit current (SCC) rating is less than the available SCC at the bus.

Figure 1 – Collbran 138kV POI and Study Area



Background

The GI-2016-28 interconnection request was received by PSCo on November 22, 2016 and a scoping meeting was held on December 9, 2016.

The primary POI requested by the Interconnection Customer is the Collbran 138kV bus. The Interconnection Customer did not request a secondary POI. The proposed Commercial Operation Date of the GI-2016-28 facility is December 1, 2019. The back-feed date is assumed to be approximately six months before the Commercial Operation Date.

The Generation Facility will consist of twenty-three (23) SMA2500 2.25 MW inverters for a 51.75 MW aggregate output. The Generation Facility will include a 0.54kV generator bus, a 34.5kV collector bus, and a 138kV transmission bus. Transformation will include a 57.5 MVA 0.54-34.5kV generator step-up transformer and a 60.0 MVA 34.5-138kV main step-up transformer. This transformer has five tap settings - +/- 5.0%, +/- 2.5%, and 0% that can be used to adjust the facility output voltage. The Generation Facility's 138kV transmission bus will interconnect to the POI via a three-mile 138kV tie line (aka "gen-tie").

The feasibility study for the GI-2016-28 interconnection request was performed for both Energy Resource Interconnection Service (ERIS)[2] and Network Resource Interconnection Service (NRIS)[3].

The affected parties for this study are Western Area Power Administration ("Western"), Tri-State Generation and Transmission Inc. ("Tri-State"), and Grand Valley Power ("Grand Valley").

Study Scope and Analysis Criteria

The scope of this report includes steady state (power flow) analysis and short circuit analysis. The power flow analysis identifies thermal and voltage violations in the PSCo system and the affected party's system as a result of the generator interconnection project. Several single contingencies are studied. The short circuit analysis determines the maximum fault current levels at the POI. In addition, the breaker duty study determines if breaker replacements are needed at the POI substation and/or in the neighboring substations due to the fault current contribution from the generation interconnection project.

The steady state (power flow) analysis adhered to the NERC Reliability Standard TPL-001-4 (transmission system planning performance requirements). Table 1 below lists the system performance criteria assumed for this study.

[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.

[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.

Table 1: System Performance Criteria for Bus Voltages and Branch/Transformer Flows

System Condition	System Criteria
System Intact (P0 Event)	Bus voltages to be within 0.95 p.u and 1.05 p.u. Branch flows not to exceed 100% of its continuous rating. Transformer flows not to exceed 100% of its highest nameplate rating or appropriate owner's top rating
Single/Multiple Contingency (P1, P2-1, P6 Events)	Bus voltages to be within 0.90 p.u and 1.10 p.u. Branch flows not to exceed 100% of its continuous rating or not to exceed 100% of its emergency rating (if applicable). Transformer flows not to exceed 100% of its highest nameplate rating or appropriate owner's top rating or 100% of its 30 minute emergency rating (if applicable). Post transient voltage deviations should not exceed 8% (WECC).
Multiple Contingency (P2-P5, P7 Events)	Bus voltages to be within 0.90 p.u and 1.10 p.u. Allowable emergency limits will be considered as determined by the affected parties and the available emergency mitigation plan. Curtailment of firm transfers, generation re-dispatch, and load shedding will be considered as necessary.

The TPL-001-4 Standard Category P0 (No Contingency) and Category P1 (Single Contingency) were applicable for this study.

Power Flow Study Models

The power flow studies were performed using two Western Electricity Coordinating Council (WECC) approved cases:

- A 2020-21 heavy winter base case ("21hw1ap.sav") approved on August 10, 2016
- A 2022 heavy summer base case ("22hs1ap.sav") approved on September 1, 2016

The Molina generating station that connects to the Collbran Substation was dispatched at its maximum output (13.5 WM) in the case. The two WECC cases were re-dispatched to address schedule commitments on the TOT2A power transfer path and a high export scenario on the TOT5 power transfer path creating three benchmark study cases namely:

- A 2022 heavy summer high TOT2A[4] flow scenario case (a high north-to-south flow of 500 MW on the TOT2A power transfer path)
- A 2020-21 heavy winter high TOT2A flow scenario case (a high north-to-south flow of 500 MW on the TOT2A power transfer path)
- A 2020-2021 heavy winter high TOT5[5] flow scenario case (a high west-to-east flow of 1680 MW on the TOT5 power transfer path)

[4] TOT2A is a WECC-defined power transfer path that describes the bulk power flows transfers between Colorado and New Mexico/Arizona

[5] TOT5 is a WECC-defined power transfer path that describes the bulk power transfers across the Colorado Continental Divide.

The Waterflow and Shiprock phase-shifting transformers were used to control the TOT2A flow. The three benchmark cases were modified by adding the GI-2016-28 interconnection facility that was dispatched to the full generation output level of 51.75 MW. The facility was modeled using the PSSE modeling data provided by the Interconnection Customer. PSCo's generation in Eastern Colorado was used as the sink for the 51.75 MW generation injection from GI-2016-28. The high TOT5 scenario case (TOT5 = 1680 MW) was re-dispatched after the addition of the GI-2016-28 interconnection facility (generation output at 51.75 MW and scheduled to Eastern Colorado) to reduce the TOT5 west-to-east flow to 1680 MW (the TOT5 west-to-east power transfer limit). The Nucla generating station is out-of-service in the WECC base cases. Under high TOT2A north-to-south conditions, this generation station outage creates high branch flows in the study area.

Voltage Regulation and Reactive Power Capability

The Customer is required to interconnect the Large Generating Facility with Public Service of Colorado's (PSCo) Transmission System in accordance with the "*Xcel Energy Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW"* available at:

http://www.transmission.xcelenergy.com/staticfiles/microsites/Transmission/Files/PDF/Interconnection/Interconnections-POL-TransmissionInterconnectionGuidelineGreat20MW.pdf.

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 are expected to adhere to the *Rocky Mountain Area Voltage Coordination Guidelines (RMAVCG)*. Since the POI for this interconnection request is located within Northwest Colorado (Region 1), the applicable ideal transmission system voltage profile range is 1.01-1.03 per unit at regulated buses and 1.00-1.03 per unit at non-regulated buses. Wider voltage ranges are allowed during abnormal/emergency system operating conditions.

    - Xcel Energy's OATT (Attachment N effective October 14, 2016) requires all non-synchronous Generator Interconnection (GI) Customers to provide dynamic reactive power within the power factor range of 0.95 leading to 0.95 lagging at the high side of the generator substation.
    - Xcel Energy requires every Generating Facility to have dynamic voltage control capability to assist in maintaining the POI voltage schedule specified by the Transmission Operator as long as the Generating Facility does not have to operate outside its 0.95 lagging to 0.95 leading dynamic power factor range capability.
    - 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 (34.5kV or 138kV bus) of any additional static reactive power compensation needed within the generating plant in order to have adequate reactive capability to meet the +/- 0.95 power factor and the 1.01 per unit to 1.03 per unit voltage range standards at the POI. Further, for wind generating plants to meet the LVRT (Low Voltage Ride Through) performance requirements specified in FERC Order 661-A, an appropriately sized and located dynamic reactive power device

(DVAR, SVC, etc.) may also need to be installed within the generating plant. Finally, it is the responsibility of the Interconnection Customer to compensate their generation tie-line to ensure minimal reactive power flow under no load conditions.

- 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).
- 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-024-2.

Power Flow Study Process

Study Assumptions:

The following are the study assumptions for "GI-2016-28":

- The "GI-2016-28" (GI) is a 51.75 MW solar photovoltaic generation facility that will be located in Mesa County in Western Colorado.
- The Point of Interconnection (POI) is PSCo's Collbran Substation138kV bus in Mesa County in Western Colorado.
- The proposed Commercial Operation Date (COD) is December 1, 2019. The back-feed date is assumed to be approximately six months before the COD.
- The Generation Facility will consist of twenty-three (23) SMA2500 2.25 MW inverters for a 51.75 MW aggregate output. The Generation Facility will include a 0.54kV generator bus, a 34.5kV collector bus, and a 138kV transmission bus. Transformation will include a 57.5 MVA 0.54-34.5kV generator step-up transformer and a 60.0 MVA 34.5-138kV main step-up transformer.
- The Generation Facility 138kV transmission bus will interconnect to the POI via a three-mile 138kV transmission tie line.
- The generator interconnection feasibility study request was submitted for both Network Resource Interconnection Service (NRIS) and Energy Resource Interconnection Service (ERIS) analysis.
- The GI-2016-28 interconnection request was studied as a "stand alone" generation project. Other (higher or lower) queued proposed generation projects (i.e. those not comprising Transmission Provider's electric resource plan) were disregarded. The study did not include any other Generator Interconnection (GI) requests existing in PSCo's or any affected party's GI request queue, other than the interconnection requests that are considered to be planned resources for which Power Purchase Agreements have been signed.

- The affected parties for this study are Western Area Power Administration ("Western"), Tri-State Generation and Transmission Inc. ("Tri-State"), and Grand Valley Power ("Grand Valley").

- The scope of this report included steady state (power flow) analysis and short circuit analysis.

Study Software:

The steady state analysis was performed using PTI's PSSE Ver. 33.6.0 program and the MUST 11.0.1 contingency analysis tool.

Transmission Planning Performance Requirements:

Contingencies were performed in accordance with the NERC Standard TPL-001-4. These are described below. The analysis was performed for categories P0 and P1. The transmission planning performance requirements used for this study are described in the following table:

Table 2: TPL-001-4 Transmission Planning Performance Requirements Simulated

Category	Description	Initial Condition	Event	Interruption of Firm Transmission Service Allowed?	Non-consequential Load Loss Allowed?
P0	No Contingency	Normal System	None	No	No
P1	Single Contingency	Normal System	Loss of generator, branch, transformer, shunt device	No	No

Customer Cost Responsibility Guidelines:

Thermal violations are attributed to the Generator Interconnection (GI) request if the study results identify the following:

1) All PSCo transmission facilities without a pre-existing thermal violation that experience a thermal loading greater than100% after the addition of the GI request, and contribute a 2% increase or greater in the facility loading compared to the benchmark case loading.
2) Pre-existing thermal violations on PSCo facilities in the benchmark case are attributable to the GI request if the planned PSCo transmission upgrade is insufficient to mitigate the (increased) thermal violation in the study case. In such scenarios, only the additional facility rating needed beyond the PSCo planned rating increase would qualify as the network upgrade required for NRIS, and is thus attributed to the GI request.
3) Affected party's transmission facilities without a pre-existing thermal violation that experience a thermal loading >100% of applicable facility rating after the addition of the GI request are attributable to the GI request. For pre-existing thermal violations on an affected party's transmission facilities, only the mitigation of the incremental facility loading would qualify as the network upgrade required for NRIS, and is thus attributed to the GI request.

4) The voltage violations attributed to the GI request include any new voltage limits and voltage deviation violations.

WECC Power Transfer Path Definitions:

Three WECC-defined power transfer paths define the Western Colorado area as pertaining to power transfers out of Western Colorado. They are as follows:

TOT1A – A WECC-defined power transfer path that represents the power transfers from northwest Colorado to northeast Utah.

Line/Transformer	Metered End
-Craig-Bonanza 345 kV	Craig
-Hayden-Artesia 138 kV	Hayden
-Calamity Ridge-Rangely 138 kV	Rangely

TOT2A – A WECC-defined power transfer path that represents the power transfers from southwest Colorado to New Mexico/Arizona. Phase shifting transformers at Waterflow and Shiprock may be used to reduce unscheduled flows on the path.

Line/Transformer	Metered End
-Hesperus-Waterflow 345 kV	Waterflow
-Lost Canyon-Shiprock 230 kV	Shiprock
-El Paso Tap-Glade Tap 115 kV	El Paso Tap

TOT5 – A WECC-defined power transfer path represents the power transfers from Western Colorado to Eastern Colorado.

Line/Transformer	Metered End
-North Park-Terry Ranch kV	Terry Ranch
-Craig-Ault 345 kV	Craig
-Hayden-Gore Pass 230kV	Hayden
-Hayden-Gore Pass 138kV	Gore Pass
-Hopkins-Malta 230kV	Hopkins
-Basalt-Malta 230kV	Basalt
-N. Gunnison-Poncha 115kV	Poncha
-Curecanti-PonchaBR 230kV	Curecanti

Study Results

Steady State Contingency Analysis:

- No system intact (P0) thermal or voltage violations attributable to GI-2016-28 were observed.

- A potential thermal violation (transmission facility overload) on PSCo's system with GI-2016-28 dispatched at its maximum output was observed. The post-contingency flow on PSCo's Collbran-Grand Junction 138kV line increased from 96.9% to 101.5% of its 96.0 MVA normal rating for a forced outage (single contingency) of the Grand Junction-Montrose 345kV line due to the GI-2016-28 Project. The 96 MVA rating of the Collbran-Grand Junction 138kV line is due to a current transformer (CT) limitation at the Collbran Substation. PSCo Substation Engineering determined that the addition of interconnection facilities needed for GI-2016-28 would require a complete rebuild of the Collbran Substation and that this substation rebuild would eliminate the CT limitation at Collbran Substation. Therefore, the potential thermal violation of the Collbran-Grand Junction 138kV line will be mitigated by the interconnection and rebuild of the Collbran Substation.

- A pre-existing post-contingency thermal violation on Tri-State's system worsened with the addition of GI-2016-28 at maximum output. The Grand Junction-Star Nelson 115kV line post-contingency overload increased from 130.6% of its 80 MVA rating (before the addition of GI-2016-28) to 146.9% of its 80 MVA rating (after the addition of GI-2016-28) for an outage of the Grand Junction-Montrose 345kV line. The study case that was used to demonstrate this condition has Tri-State's Nucla generation station out-of-service and TOT2A at a very high level (500 MW north-to-south). The status of the Nucla generating station impacts the post-contingency flow[6] on the Grand Junction-Star Nelson 115kV line. Placing the Nucla generation station at maximum output (110 MW) significantly reduces the post-contingency overload of the Grand Junction-Star Nelson 115kV line. After placing the Nucla generating station on-line, the Grand Junction-Star Nelson 115kV line post-contingency overload increased from 110.6% of its 80 MVA rating (before the addition of GI-2016-28) to 126.8% of its 80 MVA rating (after the addition of GI-2016-28) for an outage of the Grand Junction-Montrose 345kV line. The results of this study are shown in Table 3 below.

[6] Power flowing from Northwest Colorado (and areas north) to New Mexico and Arizona passes north to south through the study area to serve Southwest Colorado loads (located north of TOT2A) and loads in New Mexico and Arizona (located south of TOT2A). The Nucla generating station offsets load demand in Southwest Colorado and this means lower power transfers across the study area are needed to serve load demand in Southwest Colorado (along with load demand in New Mexico and Arizona). The Nucla generating station is scheduled to be retired in December 2022.

Table 3: Impact of Nucla on the Grand Junction-Star Nelson 115kV Line Flow Case: 2021 Heavy Winter, High TOT2A Flow (500 MW North-to-South)

Monitored Facility	Rating	Nucla Gen	Facility Loading Without GI-2016-28	Facility Loading With GI-2016-28	Single Contingency
Grand Junction-Star Nelson 115kV	80.0	0 (Off)	130.6%	146.9%	Grand Junction-Montrose 345kV
Grand Junction-Star Nelson 115kV	80.0	110 (Max)	110.6%	126.8%	Grand Junction-Montrose 345kV

- Placing the Nucla generation station at maximum output (110 MW) significantly reduces the post-contingency overload of the Grand Junction-Star Nelson 115kV line; however, it does not eliminate the post-contingency flow for high TOT2A (500 MW north-to-south) flow conditions. The TOT2A north-to-south flows would need to be reduced to eliminate the post-contingency overload. The addition of GI-2016-28 increases the post-contingency flow on Tri-State's Grand Junction-Star Nelson 115kV line. The Interconnection Customer should discuss this with Tri-State. Tri-State may have plans to increase the rating of the Grand Junction-Star Nelson 115kV line.

- No single contingency voltage violations attributable to GI-2016-28 were observed. Pre-existing voltage issues in the Transmission Provider's transmission system were not worsened with the addition of GI-2016-28.

ERIS and NRIS Evaluation:

The proposed GI-2016-28 interconnection qualifies for 51.75 MW Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS). This conclusion assumes that the Interconnection Customer is able to address with Tri-State the pre-existing post-contingency thermal violation on the Grand Junction-Star Nelson 115kV line.

Short Circuit Study Results

The calculated short circuit levels and Thevenin system equivalent impedances at the GI-2016-28 POI (assuming the rebuild of the Collbran Substation) are tabulated below.

Table 4: Short Circuit Levels at the GI-2016-28 POI

	Without Proposed Generation	With Proposed Generation
Three Phase Current	2811A	3183A
Single Line to Ground Current	2567A	3817A
Positive Sequence Impedance	4.452+j27.990 ohms	4.452+j27.990 ohms
Negative Sequence Impedance	4.476+j27.984 ohms	4.476+j27.984 ohms
Zero Sequence Impedance	6.376+j35.860 ohms	2.333+j17.686 ohms

- The impedance of the main power transformer was assumed to be 9% at 60MVA.
- The impedance of the generator tie line was estimated based on the 3 mile stated length.

The short circuit study work included a preliminary breaker duty analysis. The analysis did not identify any circuit breakers in neighboring substations that would become "over-dutied"[7] with the addition of this generation; therefore, no circuit breaker replacements are needed. All new circuit breakers at the rebuilt Collbran Substation will be adequately rated.

Costs Estimates and Assumptions

PSCo Engineering has developed indicative level cost estimates (IE) for Transmission Provider Interconnection Facilities and Network Upgrades required for the interconnection of the Interconnection Customer's proposed generation facility. Indicative Estimates are based upon typical construction costs for previously performed similar construction projects; however they have no specified level of accuracy. The cost estimates are in 2017 dollars with escalation and contingencies applied. AFUDC is not included. 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 Customer owned equipment and associated design and engineering.

Cost Estimates (in 2017 dollars):

The estimated total cost of the transmission improvements required to interconnect the project is approximately $13.135 million and includes:

- $ 0.850 million for PSCo-Owned, Customer-Funded Transmission Provider Interconnection Facilities
- $ 12.285 million for PSCo-Owned, PSCo-Funded Network Upgrades for Interconnection
- $ 0.000 million for PSCo-Owned, PSCo-Funded Network Upgrades for Delivery

[7] Over-dutied" circuit breaker: A circuit breaker whose short circuit current (SCC) rating is less than the available SCC at the bus.

The estimated time to design, procure and construct the interconnection facilities is approximately 18 months after authorization to proceed has been obtained.

Tables 5, 6 and 7 below list the transmission improvements required for the interconnection of the customer's solar generation facility and for the delivery of its 51.75 MW rated output. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to revision as a more detailed and refined design is produced.

Table 5: PSCo Owned; Customer Funded Transmission Provider Interconnection Facilities

Element	Description	Cost Estimate (Millions)
PSCo's Collbran 138kV Transmission Sub Station	Interconnect Customer to the Collbran Sub 138kV bus. The new equipment includes; • One (1) motor operated 138kV disconnect switch • Three (3) 138kV combination CT/PT metering units • Power Quality Metering (138kV line from Customer) • Three (3) surge arresters • Two (2) relay panels • Associated bus, wiring and equipment • Associated foundations and structures • Associated transmission line communications, relaying and testing	**$0.800**
	Transmission line tap into substation. Conductor, hardware, and installation labor.	**$0.050**
	Total Cost Estimate for PSCo-Owned, Customer-Funded Interconnection Facilities	**$0.850**
Time Frame	**Design, procure and construct**	**18 Months**

Table 6: PSCo Owned; PSCo Funded Network Upgrades for Interconnection

Element	Description	Cost Estimate (Millions)
PSCo's Collbran 138kV Transmission Sub Station	Interconnect Customer to the Collbran Sub 138kV bus. The new equipment includes; • Eight (8) 138kV circuit breaker • Seventeen (17) 138kV gang switches • Two (2) 138kV CCVT • 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	**$12.200**
	Siting and Land Rights support for substation land acquisition and construction.	**$0.085**
	Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities	**$12.285**
Time Frame	**Site, design, procure and construct**	**18 Months**

Table 7: PSCo Owned; PSCo Funded Network Upgrades for Delivery

Element	Description	Cost Estimate (Millions)
NA	None identified	**NA**
	Total Cost Estimate for PSCo Network Upgrades for Delivery	**$0**
Duration	**Design, procure, permit and construct**	**NA**
	Total Project Estimate	**$13.135**

A. Power Flow Contingency Analysis Results

Notes for Table 8:

1. For Single Contingency Analysis, thermal overloads on PSCo facilities are calculated using the applicable Normal Rating.
2. The Nucla Generating Station is out-of-service in the cases[8]. The station will be retired in December 2022.
3. The Molina Generating Station are hydroelectric units owned by the U.S. Bureau of Reclamation. The facility is modeled at a maximum generation level of 13.5 MW in the cases. This generation connects to the Collbran 138kV bus through the Collbran 115-138kV transformer.

Table 8: Differential Impact of GI-2016-28 on Facility Loadings
Summary of Single Contingency Power Flow Analysis
2020-21 Heavy Winter with High TOT2A Flow (500 MW north to south)

				Facility Loading Without GI-2016-28		Facility Loading With GI-2016-28			
Monitored Facility (Line or Transformer)	Type	Owner	Branch Rating MVA (Norm/Emer)	N-1 Flow MVA	N-1 Flow % of Rating (Norm/Emer)	N-1 Flow MVA	N-1 Flow % of Rating (Norm/Emer)	% Change	NERC Single Contingency
Colllbran-Grand Junction 138kV	Line	PSCo	96/96	78.4	81.7%/81.7%	97.4	101.5%/101.5%	24.2%	Grand Junction-Montrose 345kV
Colllbran-Grand Junction 138kV	Line	PSCo	96/96	76.7	79.9%/79.9%	96.3	100.3%/100.3%	25.6%	Rifle-Grand Junction 345kV
Collbran-Rifle 138kV	Line	PSCo	72/72	69.7	96.9%/96.9%	36.3	50.4%/50.4%	-47.9%	Grand Junction-Montrose 345kV
Grand Junction 138-115kV	Xfmr	PSCo	100/100	72.4	72.4%/72.4%	90.6	90.6%/90.6%	25.1%	Grand Junction-Montrose 345kV
Grand Junction-Star Nelsen 115kV	Line	TSGT	80/80	104.5	130.6%/130.6%	117.5	146.9%/146.9%	12.4%	Grand Junction-Montrose 345kV
Meeker—Rifle 138kV	Line	TSGT	125/125	146.8	117.4%/117.4%	136.4	109.1%/109.1%	-7.1%	Craig-Meeker 345kV

[8] The retirement of the Nucla generating station will increase the contingency flow on the RifleWA-RifleUte 230kV line for high TOT2A north-to-south transfers. PSCo is examining ways to mitigate contingency flows on this jointly-owned transmission path. The GI-2016-28 project helps reduce the contingency flow on the RifleWA-RifleUte 230kV line (for an outage of the Craig-Meeker 345kV line).

Notes for Table 9:

1. For Single Contingency Analysis, thermal overloads on PSCo facilities are calculated using the applicable Normal Rating.
2. The Nucla Generating Station is out-of-service in the cases[9]. The station will be retired in December 2022.
3. The Molina Generating Station are hydroelectric units owned by the U.S. Bureau of Reclamation. The facility is modeled at a maximum generation level of 13.5 MW in the cases. This generation connects to the Collbran 138kV bus through the Collbran 115-138kV transformer.

Table 9: Differential Impact of GI-2016-28 on Facility Loadings
Summary of Power Flows from Single Contingency Analysis
2022 Heavy Summer with High TOT2A Flow (500 MW north to south)

				Facility Loading Without GI-2016-28		Facility Loading With GI-2016-28			
Monitored Facility (Line or Transformer)	Type	Owner	Branch Rating MVA (Norm/Emer)	N-1 Flow MVA	N-1 Flow % of Rating (Norm/Emer)	N-1 Flow MVA	N-1 Flow % of Rating (Norm/Emer)	% Change	NERC Single Contingency
Colllbran-Grand Junction 138kV	Line	PSCo	111/111	72.2	75.2%/75.2%	91.8	95.6%/95.6%	23.0%	Grand Junction-Montrose 345kV
Colllbran-Grand Junction 138kV	Line	PSCo	478/478	70.8	73.8%/73.8%	91.9	95.7%/95.7%	29.8%	Rifle-Grand Junction 345kV
Grand Junction 115-69kV	Xfmr	PSCo	42/42	40.4	96.1%/96.1%	40.3	96.0%/96.0%	-0.2%	Cameo-Vineland 69
Grd Junction-Star Nelsn 115kV	Line	TSGT	80/80	86.8	108.5%/108.5%	101.0	126.2%/126.2%	16.4%	Grand Junction-Montrose 345kV
Grand Junction 138-115kV	Xfmr	PSCo	100/100	72.2	72.2%/72.2%	85.8	85.8%/85.8%	18.8%	Grand Junction-Montrose 345kV
Meeker-RifleUte 138kV	Line	PSCo	125/125	132.7	106.2%/106.2%	125.2	100.2%/100.2%	-5.7%	Craig-Meeker 345kV
Collbran-RifleUte 138kV	Line	PSCo	72/72	61.5	85.4%/85.4%	61.0	84.7%/84.7%	-0.8%	Grand Junction-Montrose 345kV
RifleUte 345-230kV	Xfmr	PSCo	478/478	476.0	99.6%/99.6%	467.9	97.9%/97.9%	-1.7%	Craig-Meeker 345kV

[9] The retirement of the Nucla generating station will increase the contingency flow on the RifleWA-RifleUte 230kV line for high TOT2A north-to-south transfers. PSCo is examining ways to mitigate contingency flows on this jointly-owned transmission path. The GI-2016-28 project helps reduce the contingency flow on the RifleWA-RifleUte 230kV line (for an outage of the Craig-Meeker 345kV line).

Notes for Table 10:

1. For Single Contingency Analysis, thermal overloads on PSCo facilities are calculated using the applicable Normal Rating.
2. The Nucla Generating Station is out-of-service in the cases. The station will be retired in December 2022.
3. The Molina Generating Station are hydroelectric units owned by the Bureau of Reclamation. The facility is modeled at a maximum generation level of 13.5 MW in the cases. This generation connects to the Collbran 138kV bus through the Collbran 115-138kV transformer.

Table 10: Differential Impact of GI-2016-28 on Facility Loadings
Summary of Power Flows from Single Contingency Analysis
2020-21 Heavy Winter with High TOT5 Flow (1680 MW west to east)

				Facility Loading Without GI-2016-28		Facility Loading With GI-2016-28			
Monitored Facility (Line or Transformer)	Type	Owner	Branch Rating MVA (Norm/Emer)	Flow MVA	Flow % of Rating (Norm/Emer)	Flow MVA	Flow % of Rating (Norm/Emer)	% Change	NERC Single Contingency
Grand Junction 115-69kV	Xfmr	PSCo	42/42	35.1	83.5%/83.5%	40.1	95.5.8%/95.5%	14.3%	Clifton-Grand Junction 230kV
RiflePS-RifleWA 230kV	Line	Joint	500/500	488.1	97.6%/97.6%	499.9	100.0%/100.0%	2.4%	Hayden West-Foidel Creek 230kV #2
Rifle 138-69 kV	Xfmr	PSCo	75.0/75.0	76.2	101.6%/101.6%	79.1	105.5%/105.5%	3.8%	Hopkins-RiflePS 230kV
Grand Junction 138-115kV	Xfmr	PSCo	100.0/100.0	8.4	8.4%/8.4%	58.8	58.8%/58.8%	600.0%	Collbran-Rifle(Ute) 138kV
Meeker-W.RV.City 138kV	Line	TSGT	114.0/114.0	123.8	108.6%/108.6%	119.8	105.1%/105.1%	-3.2%	Craig-Meeker 345kV

B. One Line Diagram

Figure 2 below is a conceptual one-line of the proposed interconnection. The Point of Interconnection (POI) will be at the Collbran 138kV Substation.

Figure 2 –Conceptual One-Line Diagram of the GI-2016-28 POI 138kV Station – Tap of the Collbran 138kV Substation