3RSC – 2023

Phase 1 Study Report

12/13/2024

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1.0 Executive Summary

The Phase 1 of the 3RSC-2023 Resource Solicitation Cluster (RSC) includes three (3) Generator Interconnection Requests (GIRs):

3RSC-2023-1 is a 200 MW_{ac} net rated Solar Photovoltaic (PV) Generating Facility requesting Network Resource Interconnection Service (NRIS). The requested Point of Interconnection (POI) is at the Mirasol 230 kV switching station, sharing of the common gen-tie with 3RSC-2023-2.

3RSC-2023-2 is a 100 MW_{ac} net rated Battery Energy Storage System (BESS) Generating Facility requesting NRIS. The requested POI is the Mirasol 230 kV switching station, sharing of the common gen-tie with 3RSC-2023-1.

3RSC-2023-3 is a 200 MW_{ac} net rated Wind Generating Facility requesting NRIS. The requested POI is the May Valley 345 kV switching station.

The Interconnection Service determined for GIRs in this report in and of itself does not convey any transmission service.

Based on the study assumptions regarding the transmission upgrades expected to go into service, the study did not identify any System Network Upgrades attributed to the Resource Solicitation Cluster 3RSC-2023.

Any mitigations necessary to alleviate overloads on Affected Systems' facilities are not part of this study.

1.1 3RSC-2023-1 Results

The total estimated cost of the Network Upgrades (Transmission Provider's Interconnection Facilities and Station Network Upgrades) required to interconnect 3RSC-2023-1 at the Mirasol 230 kV switching station for NRIS is **$2.5425 million** (Table 15, 16, 20 and 21). The total estimated cost is split 50/50 between 3RSC-2023-1 and 3RSC-2023-2 due to sharing of the common gen-tie.

1.2 3RSC-2023-2 Results

The total estimated cost of the Network Upgrades (Transmission Provider's Interconnection Facilities and Station Network Upgrades) required to interconnect 3RSC-2023-1 at the Mirasol

230 kV switching station for NRIS is **$2.5425 million** (Table 15, 16, 20 and 21). The total estimated cost is split 50/50 between 3RSC-2023-1 and 3RSC-2023-2 due to sharing of the common gen-tie.

The Grid Charging study for the 100 MW BESS Generating Facility did not identify any impacts. There are no additional costs identified in the Grid Charging study.

1.3 3RSC-2023-3 Results

The total estimated cost of the Network Upgrades (Transmission Provider's Interconnection Facilities and Station Network Upgrades) required to interconnect 3RSC-2023-3 at the May Valley 345 kV switching station for NRIS is **$5.352 million** (Table 17 and Table 21).

2.0 Introduction

Public Service Company of Colorado (PSCo) received three (3) GIRs in the 3RSC-2023 cluster, all of which moved to Phase 1. The total Interconnection Service requested in the 3RSC-2023 Phase 1 is 500 MW.

All three GIRs requested Network Resource Interconnection Service (NRIS)[1]: 3RSC-2023-1, 3RSC-2023-2, and 3RSC-2023-3. A summary and description of the requests is shown in Table 1.

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[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.

Table 1 – Summary of GIRs in 3RSC-2023 Cluster

GI#	Resource Type	Interconnection Service (MW)	COD	POI	Location	Service Type
3RSC-2023-1	PV	200	12/31/2025	Mirasol 230 kV	Pueblo County, CO	NRIS
3RSC-2023-2	BESS	100	12/31/2025	Mirasol 230 kV	Pueblo County, CO	NRIS
3RSC-2023-3	Wind	200	12/31/2025	May Valley 345 kV	Kiowa County, CO	NRIS
Total		500				

The approximate geographical locations of the POIs within the Transmission System are shown in Figure 1. Also, the overlay of Colorado's Power Pathway represented by black lines with purple dots are for illustrative purposes only.

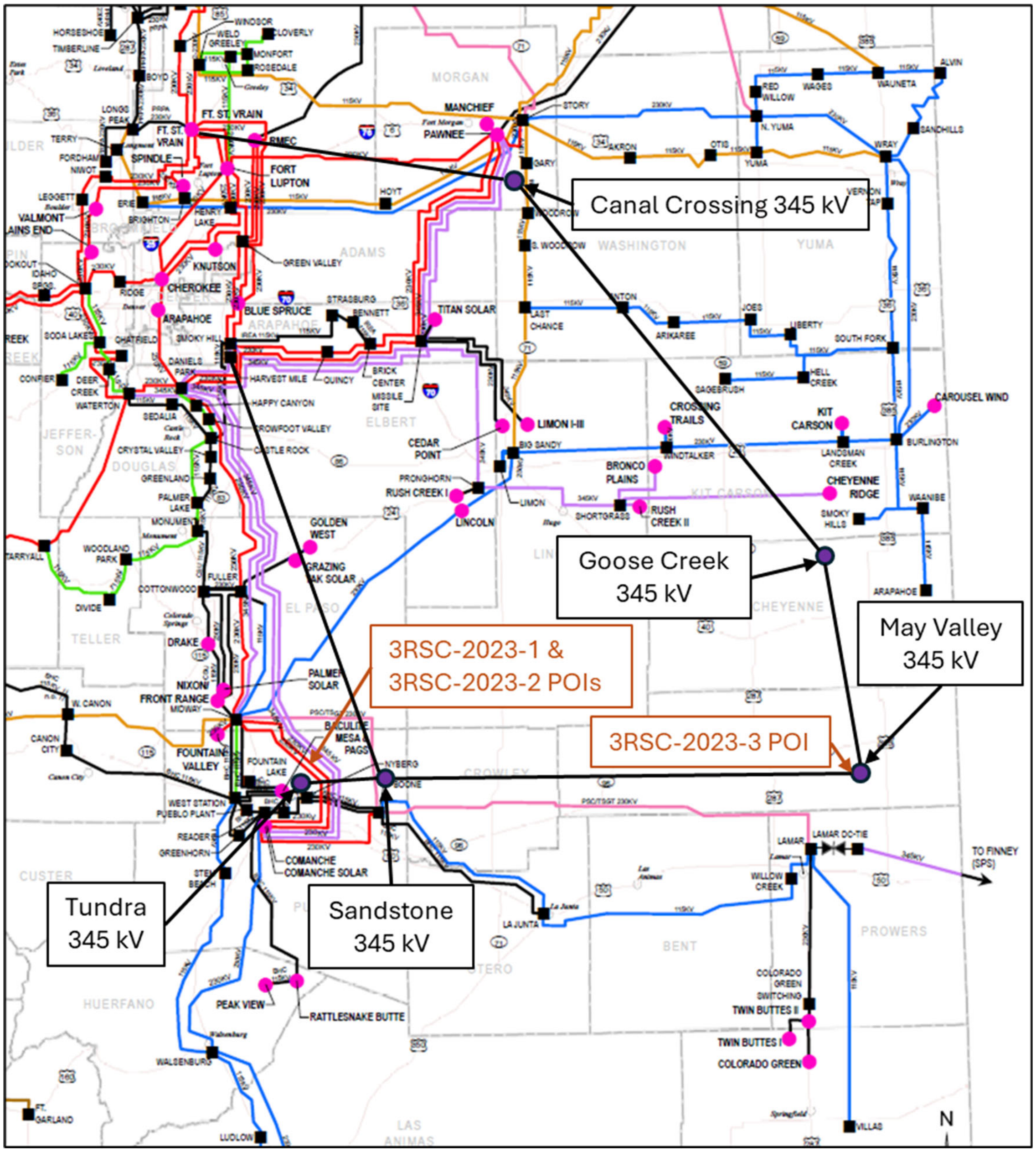

Figure 1 – Approximate Locations of 3RSC-2023 Generator Interconnection POIs

3.0 Description of the GIRs

3.1 3RSC-2023-1

3RSC-2023-1 is a 200 MW_{ac} net rated Solar Photovoltaic Generating Facility located in Pueblo County, Colorado. The project assumes the use of fifty-six (56) Power Electronics FreeSun FS4200M inverters, each rated at 4.2 MVA at 45 degrees C operating at +/-0.87 power factor. Each of the 4.2 MVA inverters is connected to a collector transformer, 0.66/34.5 kV, rated at 4.2 MVA. Two 230/34.5/13.8 kV main GSU transformers rated at 99/132/165 MVA step the voltage up from the collector transformer voltage to the POI voltage. An approximately 1.27-mile generation tie line connecting the project to the Mirasol 230 kV switching station. This is the common generation tie line shared with 3RSC-2023-2.

The proposed Commercial Operation Date (COD) is December 31, 2025. The back-feed date is assumed to be June 30, 2025, approximately six (6) months before the COD.

3.2 3RSC-2023-2

3RSC-2023-2 is a 100 MW_{ac} net rated Battery Energy Storage System Generating Facility located in Pueblo County, Colorado. This project assumes the use of twenty-eight (28) Power Electronics FreeSun FS4200M inverters, each rated at 4.2 MVA at 45 degrees C operating at +/-0.87 power factor. Each of the 4.2 MVA inverters is connected to a collector transformer, 0.66/34.5 kV, rated at 4.2 MVA. A 230/34.5/13.8 kV main GSU transformer rated at 99/132/165 MVA steps the voltage up from the collector transformer voltage to the POI voltage. An approximately 1.27-mile generation tie line connecting the project to Mirasol 230 kV switching station. This is the common generation tie line shared with 3RSC-2023-1.

The BESS facility has a maximum state of charge of 100% and minimum state of charge of 0%.

The proposed COD is December 31, 2025. The back-feed date is assumed to be June 30, 2025, approximately six (6) months before the COD.

3.3 3RSC-2023-3

3RSC-2023-3 is a 200 MW_{ac} net rated Wind Generating Facility located in Kiowa County, Colorado. This project assumes the use of sixty-one (61) GE 3.4-140 wind turbine generators (WTGs), each rated at 3.778 MVA at 45 degrees C operating at +/-0.90 power factor. Each of the WTGs is connected to a collector transformer, 0.69/34.5 kV, rated at 3.811 MVA. Two

345/34.5/13.8 kV main GSU transformers rated at 73.8/98/123 MVA step the voltage up from the collector transformer voltage to the POI voltage. An approximately 8-mile generation tie line connecting the project to the May Valley 345 kV switching station.

The proposed COD of 3RSC-2023-3 is December 31, 2025. The back-feed date is assumed to be June 30, 2025, approximately six (6) months before the COD.

4.0 Study Scope

The purpose of the Phase 1 study is to determine the system impacts of interconnecting three (3) GIRs for the 3RSC-2023 cluster for Network Resource Interconnection Service. Each GIR will be studied for impacts on the specific study pocket to determine the full impact of the proposed generation.

The scope of the study includes steady-state (thermal and voltage) analysis, reactive power evaluation, and cost estimates. The non-binding cost estimates provide total costs and each GIR's cost responsibility for Transmission Provider's Interconnection Facilities (TPIF), Station Network Upgrades, and System Network Upgrades.

Additionally, GIRs that include BESS and specified grid charging were studied at their respective charging rate in a Grid Charging Study Case.

4.1 Study Pockets

Based on the POI location of each GIR, they were all grouped within the Southern Colorado study pocket. The Southern Colorado study area includes WECC designated zone 704. As described in Section 3.11 of the BPM, this pocket is comprised of South-central Colorado and Southeast Colorado transmission system. Below is the current generation in the Southern Colorado study area:

- Comanche: Golden West Wind at Fuller, Fountain Valley Gas at Midway, Comanche Coal and (Solar—replacement generator), Community Solar at Comanche, Mirasol, Tundra.
- Lamar: Colorado Green Wind, Twin Buttes Wind, DC Tie.

4.2 Study Criteria

The following steady-state analysis criteria is used to identify violations on the PSCo system and the Affected Systems:

P0 - System Intact conditions:
Thermal Loading: ≤ 100% of the normal facility rating
Voltage range: 0.95 to 1.05 per unit

P1 & P2-1 – Single Contingencies:
Thermal Loading: ≤ 100% normal facility rating
Voltage range: 0.90 to 1.10 per unit
Voltage deviation: ≤ 8% of pre-contingency voltage

P2 (except P2-1), P4, P5 & P7 – Multiple Contingencies:

Thermal Loading:	≤ 100% emergency facility rating
Voltage range:	0.90 to 1.10 per unit
Voltage deviation:	≤ 8% of pre-contingency voltage

4.3 Study Methodology

The steady-state power flow assessment is performed using the PowerGEM TARA software.

Thermal violations are identified if a facility (i) resulted in a thermal loading >100% in the Study Case after the study pocket GIR cluster addition and (ii) contributed to an incremental loading increase of 1% or more to the benchmark case loading.

Voltage violations are identified if a bus (i) resulted in a bus voltage >1.1 p.u. (or <0.9 p.u.) in the Study Case after the study pocket GIR cluster addition and (ii) contributed to an adverse impact of +0.01 p.u. (or -0.01 p.u.) compared to the Benchmark case voltage.

Distribution factor(s) (DFAX) criteria for identifying contribution to thermal overloads is ≥1%. DFAX criteria for identifying contribution to the voltage violations is 0.01 p.u.

When the study pocket has a mix of NRIS and ERIS requests, it is studied by first modeling the NRIS GIRs at their full requested amount and modeling the ERIS GIRs offline. Network Upgrades required to mitigate the thermal and/or voltage violations are only allocated to NRIS requests because other GIR's output are modeled at zero.

The NRIS GIRs and their associated Network Upgrades are then modeled in the NRIS Study Case, and ERIS GIRs are dispatched at 100% to study the system impact. Violations are identified and the study evaluates if a generation redispatch combination eliminates the violation. If generation redispatch is unable to eliminate the violation, upgrades will be identified.

The resources included in the Optimal Power Flow (OPF) redispatch are:

1. All PSCo and non-PSCo resources connected to the PSCo Transmission System, including the expected resources associated with PSCo's obligation to serve its native load
2. Higher-queued NRIS generation in the PSCo queue
3. Generation connected to an Affected System's Transmission System if that generation is a designated network resource to serve load connected to PSCo

4. All other generation connected to an Affected System's Transmission System and Stressed in the Study Case may be dispatched to the Base Case level

5.0 Base Case Modeling Assumptions

PSCo's OATT department has determined that using a 2030 Heavy Summer case year is the most appropriate model for this analysis. The 2030HS includes a complete build out of Colorado's Power Pathway with forecasted transmission projects, line uprate projects, substation rebuild project, new transformer additions, and the generation assumed to be part of the Native Load Priority to serve PSCo Native Load. The 2029HS2 WECC case released on May 8, 2023, was selected as the Starting Case to build the 2030HS Base Case which includes the following modeling changes:

- Godfrey - Gilcrest - Anadarko 115 kV L9494 uprate to 239 MVA
- Greenwood Bus-Tie uprate to 956 MVA
- Daniels Park-Prairie-Greenwood uprate L5707 to 916 MVA
- Leetsdale-Monroe-Elati- Denver Terminal L5283 & L5625 uprate to 956 MVA
- Cherokee-Federal Heights-Broomfield L9558 uprate to 398MVA
- Daniels Park-Prairie-Greenwood uprate L5111 to 916 MVA
- Arapahoe - Greenwood L5709 uprate to 956 MVA
- Arapahoe - South - Bancroft L9335 uprate to 239 MVA
- Arapahoe - ARLQ - South - Gray L9332 uprate to 159 MVA
- Arapahoe Bus-Tie uprate to 397 MVA
- Greenwood - Monaco Series Reactor L5717
- New Fort Lupton T4 230/115 kV 273/319 MVA
- New Arapahoe T6 230/115 kV 272/319 MVA
- Leetsdale-Harrison L9955 uprate to 378 MVA
- Cherokee - Mapleton L9546 uprate to 318 MVA
- Daniels Park - Santa Fe L5107 uprate to 637 MVA
- New South Substation 230 kV bus and 230/115 kV 560 MVA transformer
- New Smoky Hill T6 & T7 345/230 kV 560 MVA
- Cherokee - Federal Heights - Semper L9055 uprate to 398 MVA
- New Daniels Park T4 345/230 kV 560 MVA
- Gray Street substation rebuild
- Smokey Hill - Buckley - Tollgate - Jewell - Leetsdale Lin 5285 uprate to 796 MVA
- Buckley - Smokey Hill L5167 uprate to 796 MVA
- New double circuit line from Cherokee-Sandown-Chambers-Harvest Mile 230 kV 1195 MVA (each circuit)
- New Sub_A 115 kV substation tying L9542, L9546, & L9549
- Cherokee - Conoco - Sub_A L9546 uprate to 318 MVA
- Daniels Park - Jackson Fuller L5119 uprate to 637 MVA
- Midway - Jackson Fuller L5129 uprate to 637 MVA
- New Fort St. Vrain T9 345/230 kV 560 MVA

- Gray Street - Lakewood L9000 & 9005 uprate to 128 MVA
- Palmer Lake - Fox Run L9605 uprate to 239 MVA
- Added May Valley Synchronous Condensers
- Added Goose Creek STATCOM

Additionally, the following segments of the Colorado Power Pathway (CPP) were included in the Base Case:

- Segment #1: Fort St. Vrain – Canal Crossing 345 kV Double Circuit.
- Segment #2: Canal Crossing – Goose Creek 345 kV Double Circuit.
- Segment #3: Goose Creek – May Valley 345 kV Double Circuit.
- Segment #4: May Valley – Sandstone – Tundra 345 kV Double Circuit.
- Segment #5: Sandstone – Harvest Mile 345 kV Double Circuit.

The Base Case model includes the existing PSCo generation resources and all Affected Systems' existing resources.

While the higher-queued NRIS requests were dispatched at 100%, the higher-queued ERIS requests were modeled offline.

PSCo used this 2030HS base case to reflect the major system upgrades expected after the latest requested COD (YE 2025) in the RSC Cluster and associated transmission system use by native load (PSCo's firm transmission reservation for Native Load Priority). If any of these changes to the Base Case are withdrawn, restudy of these requests may be required, as the results and conclusions contained within this study could change.

6.0 Voltage and Reactive Power Capability Evaluation

Per Section 4.1.1.1 of the BPM, the following voltage regulation and reactive power capability requirements are applicable to non-synchronous generators:

- Xcel Energy's OATT requires all non-synchronous generator Interconnection 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. Furthermore, 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.
- 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 (on the Interconnection Customer's facility) 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 at the high side of the main step-up transformer.
- It is the responsibility of the Interconnection Customer to compensate their generation tie-line to ensure minimal reactive power flow under no load conditions.

Per Section 4.1.1.2 in the BPM, the following voltage regulation and reactive power capability requirements are applicable to synchronous generators:

- Xcel Energy's OATT requires all synchronous Generator Interconnection Customers to provide dynamic reactive power within the power factor range of 0.95 leading to 0.95 lagging at the POI.
- The reactive power analysis performed in this report is an indicator of the reactive power requirements at the POI and the capability of the generator to meet those requirements. 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 the regulating voltage of the POI.

Per Section 4.4.1 in the BPM, the following steps shall be followed to perform the reactive power capability evaluation for synchronous generators:

a. The reactive power evaluation of the Synchronous generators is done by dispatching the generator at Pmax and changing the POI voltage till Qmax and Qmin are reached.

b. This step is repeated for Pmin.
c. The POI voltage and power factor for the two evaluations are noted. If the POI power factor of 0.95 is reached and the POI voltage stays under the voltage guidance values noted (1-1.04 p.u. for the 230 kV system, 1-1.05 for the 345 kV system and 1-1.03 for 115 kV system), the GIR is considered to meet reactive power requirements. If not, additional dynamic reactive support would be identified.

All proposed reactive devices in customer provided models are switched favorably to provide appropriate reactive compensation in each test, therefore identified deficiencies are in addition to any proposed reactive compensation.

All summary tables representing GIRs' Voltage and Reactive Power Capability tests adhere to the following color formatting representing the different aspects of the tests:

- Values highlighted in red indicate a failed reactive power requirement.
- Voltages outside of 0.95 – 1.05 p.u. are highlighted in yellow to provide additional information.

6.1 3RSC-2023-1

The 3RSC-2023-1 GIR is modeled as follows:

PV Generator 1: Pmax = 102.31 MW, Pmin = 0.0 MW, Qmax = 57.98 Mvar, Qmin = -57.98 Mvar.

PV Generator 2: Pmax = 102.31 MW, Pmin = 0.0 MW, Qmax = 57.98 Mvar, Qmin = -57.98 Mvar.

The summary for the Voltage and Reactive Power Capability Evaluation for 3RSC-2023-1 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the Interconnection Service request.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for 3RSC-2023-1 are summarized in Table 2.

Table 2 – Reactive Capability Evaluation for 3RSC-2023-1

Generator 1 Terminals					Generator 2 Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
101.8	51.0	58.0	-58.0	1.046	101.8	51.0	58.0	-58.0	1.046	200.2	66.2	1.039	0.9494	200.2	65.6	1.037	0.9503
101.7	-15.9	58.0	-58.0	0.997	101.7	-15.9	58.0	-58.0	0.997	200.4	-66.0	1.023	-0.9498	200.2	-66.4	1.024	-0.9493
0.0	0.0	58.0	-58.0	1.033	0.0	0.0	58.0	-58.0	1.033	0.0	2.0	1.032	0.0000	0.0	2.4	1.032	0.0000

6.2 3RSC-2023-2

The 3RSC-2023-2 GIR is modeled as follows:

BESS Generator: Pmax = 102.31 MW, Pmin = -102.31 MW, Qmax = 57.98 Mvar, Qmin = -57.98 Mvar.

The summary for the Voltage and Reactive Power Capability Evaluation for 3RSC-2023-2 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the Interconnection Service request at the POI.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for 3RSC-2023-2 are summarized in Table 3.

Table 3 – Reactive Capability Evaluation for 3RSC-2023-2

Generator Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
101.8	55.4	58.0	-58.0	1.048	100.1	33.0	1.036	0.9497	100.0	33.3	1.035	0.9488
101.7	-12.7	58.0	-58.0	0.999	100.2	-33.0	1.029	-0.9498	100.1	-32.7	1.030	-0.9506
0.0	0.0	58.0	-58.0	1.033	0.0	0.6	1.032	0.0000	0.0	1.0	1.032	0.0000

6.3 3RSC-2023-3

The 3RSC-2023-3 GIR is modeled as follows:

Wind Generator 1: Pmax = 105.4 MW, Pmin = 0.0 MW, Qmax = 51.05 Mvar, Qmin = -51.05 Mvar.

Wind Generator 2: Pmax = 102.0 MW, Pmin = 0.0 MW, Qmax = 49.4 Mvar, Qmin = -49.4 Mvar.

The summary for the Voltage and Reactive Power Capability Evaluation for 3RSC-2023-3 is:

- The GIR is capable of meeting ±0.95 pf at the high side of the main step-up transformer while maintaining a normal operating voltage at the POI.
- The GIR is capable of meeting ±0.95 pf at its terminals while meeting the Interconnection Service request at the POI. Note during the lagging pf test, the terminal voltage of both GIR units exceeded the upper limit of 1.05 p.u.
- The reactive power exchange and voltage change across the gen-tie are acceptable under no load conditions.

The Voltage and Reactive Power Capability tests performed for 3RSC-2023-3 are summarized in Table 4.

Table 4 – Reactive Capability Evaluation of 3RSC-2023-3

Generator 1 Terminals					Generator 2 Terminals					High Side of Main Transformer				POI			
Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	Pgen (MW)	Qgen (Mvar)	Qmax (Mvar)	Qmin (Mvar)	V (p.u.)	P (MW)	Q (Mvar)	V (p.u.)	PF	P (MW)	Q (Mvar)	V (p.u.)	PF
104.5	50.6	51.1	-51.1	1.056	101.0	49.3	49.4	-49.4	1.055	200.2	66.0	1.035	0.9497	200.0	69.7	1.030	0.9443
104.3	-16.7	51.1	-51.1	1.005	101.1	-16.7	49.4	-49.4	1.005	200.4	-65.9	1.028	0.9500	200.1	-62.3	1.030	-0.9548
0.0	0.0	51.1	-51.1	1.037	0.0	0.0	49.4	-49.4	1.037	0.0	9.7	1.031	0.0000	0.0	15.4	1.030	0.0000

7.0 Southern Colorado Study Pocket Analysis

7.1 Benchmark Case Modeling

The Benchmark Case was created from the Base Case (2030HS) by modifying the study pocket generation dispatch to create stressed transmission flow conditions from southern Colorado into the load center of Denver Metro Area, as described in section 3.4.2 of the BPM. This was accomplished by adopting the generation dispatch in Table 5. Additionally, 4,050 MW of Native Load Priority (NLP) was modeled on Colorado Power Pathway (CPP), as shown in Table 6. This represents the amount of firm transmission capacity set aside to reasonably meet PSCo's native load obligations using the assumptions about necessary transmission upgrades and generation resources that will be used to serve forecasted native load.

Table 5 – Generation Dispatch Used to Create the Southern Colorado Benchmark Case (MW is Gross Capacity)

Bus Number	Bus Name	Voltage (kV)	ID	Status	Pgen (MW)	Pmax (MW)
70878	BIGHORN_S	0.63	S1	1	210.4	247.5
70708	CO_GRN_E	0.58	W1	1	64.8	81.0
70256	CO_GRN_W	0.58	W2	1	64.8	81.0
70120	COMAN_2	24.00	C2	1	365.0	365.0
70777	COMAN_3	27.00	C3	1	804.9	804.9
70934	COMAN_S1	0.42	S1	1	102.0	120.0
70013	REPL_2021_1	230	N/A	1	314.4	325
70577	FTNVL1&2	13.8	G1	1	35.4	40.0
70577	FTNVL1&2	13.8	G2	1	35.4	40.0
70578	FTNVL3&4	13.8	G4	1	35.4	40.0
70578	FTNVL3&4	13.8	G3	1	35.4	40.0
70579	FTNVL5&6	13.8	G5	1	35.4	40.0
70579	FTNVL5&6	13.8	G6	1	35.4	40.0
70663	GLDNWST_W1	0.69	W1	1	199.5	249.4
70756	NEPTUNE_B1	0.48	B1	1	106.3	125.0
70758	NEPTUNE_S1	0.66	S1	1	212.9	250.5
70859	SUN_MTN_S1	0.66	S1	1	172.3	202.7
70704	TBI_GEN	0.58	W1	1	60.0	75.0
70010	TBII_GEN	0.69	W	1	62.4	78.0
70761	THNDWLF_B1	0.48	B1	1	85.0	100.0
70763	THNDWLF_S1	0.66	S1	1	170.0	200.0

Bus Number	Bus Name	Voltage (kV)	ID	Status	Pgen (MW)	Pmax (MW)
Total (MW)					**2892.7**	**3220.0**

Table 6 – NLP Generation Included

Generator Bus Number	Name	ID	Status	Pgen (MW)
700043	24_14_B	B	1	192.3
700057	24_13_W2	W2	1	143.3
700060	24_13_W3	W3	1	143.3
700063	24_13_W4	W4	1	122.9
700067	24_13_W1	W1	1	143.3
700076	24_12_W1	W1	1	109.2
700077	24_12_W2	W2	1	122.9
700078	24_12_W3	W3	1	109.2
700079	24_9_W1	W1	1	116.0
700082	24_9_W2	W2	1	122.9
700085	24_9_W3	W3	1	102.4
700088	24_9_W4	W4	1	116.0
700095	24_18_W	W	1	235.8
700182	24_28_W	W	1	389.2
700196	24_19_W1	W1	1	419.8
700226	24_6_S	S	1	336.4
700232	24_22_S	S	1	384.9
700235	24_26_S1	S1	1	116.0
700237	24_26_B1	B1	1	76.6
700239	24_26_S2	S2	1	116.0
700241	24_26_B2	B2	1	76.6
700244	24_27_B1	B1	1	82.9
700245	24_27_B2	B2	1	79.3
700246	24_27_S1	S1	1	96.8
700247	24_27_S2	S2	1	96.8
Total (MW)				**4050.8**

7.2 Grid Charging Benchmark Case Modeling

The Grid Charging Benchmark Case was created from the Benchmark Case from the previous section by changing the study pocket generation dispatch to reflect a Grid Charging scenario, as outlined in Section 3.16 of the BPM. This was accomplished by adopting the stressed generation dispatch in Table 7.

Table 7 – Generation Dispatch to Create the Southern Colorado Grid Charging Benchmark Case (MW is Gross Capacity)

Bus Number	Bus Name	Voltage (kV)	ID	Status	Pgen (MW)	Pmax (MW)
70878	BIGHORN_S	0.63	S1	1	0.0	247.5
70708	CO_GRN_E	0.58	W1	1	17.0	81.0
70256	CO_GRN_W	0.58	W2	1	17.0	81.0
70120	COMAN_2	24.00	C2	1	365.0	365.0
70777	COMAN_3	27.00	C3	1	804.9	804.9
70934	COMAN_S1	0.42	S1	1	0.0	120.0
70013	REPL_2021_1	230	N/A	1	314.4	325
70577	FTNVL1&2	13.8	G1	1	35.4	40.0
70577	FTNVL1&2	13.8	G2	1	35.4	40.0
70578	FTNVL3&4	13.8	G4	1	35.4	40.0
70578	FTNVL3&4	13.8	G3	1	35.4	40.0
70579	FTNVL5&6	13.8	G5	1	35.4	40.0
70579	FTNVL5&6	13.8	G6	1	35.4	40.0
70663	GLDNWST_W1	0.69	W1	1	52.4	249.4
70756	NEPTUNE_B1	0.48	B1	1	-112.9	125.0
70758	NEPTUNE_S1	0.66	S1	1	0.0	250.5
70859	SUN_MTN_S1	0.66	S1	1	0.0	202.7
70704	TBI_GEN	0.58	W1	1	15.8	75.0
70010	TBII_GEN	0.69	W	1	16.4	78.0
70761	THNDWLF_B1	0.48	B1	1	-50.0	100.0
70763	THNDWLF_S1	0.66	S1	1	0.0	200.0
Total					1338.0	3220.0

7.3 Study Case Modeling

The Southern Colorado pocket NRIS Study Case was developed from the Benchmark case by modeling 3RSC-2023-1, 3RSC-2023-2, and 3RSC-2023-3 at their respective POIs. The total 500 MW generation from GIRs was balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

The Southern Colorado pocket Grid Charging Study Case was developed from the Benchmark Case by modeling 3RSC-2023-2 as a load at its respective POI. The -100 MW load from the GIR was balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

7.4 Steady-State Analysis – NRIS Study Case

Contingency analysis was performed on the Southern Colorado pocket NRIS Study Case. The results are summarized below:

- System-Intact analysis: No voltage violations attributable to 3RSC-2023-01, 3RSC-2023-02 and 3RSC-2023-03 were identified. Table 8 lists the overloads attributed to 3RSC-2023-01 and 3RSC-2023-02 GIRs. No thermal overload is attributed to 3RSC-2023-03 GIR. Thermal overloads occur on Affected Systems' facilities and, therefore, they will not be mitigated as part of this analysis.
- Single Contingency analysis: No voltage violations attributable to 3RSC-2023-01, 3RSC-2023-02 and 3RSC-2023-03 were identified. Table 9 lists the overloads attributed to 3RSC-2023 GIRs. Thermal overloads Ref. Nos. 1, 7, 8, 9, 10, 14, 16, 17, 19, and 21 are not attributed to 3RSC-2023-03 GIR. Note thermal overloads occur on non-PSCo-owned facilities and, therefore, they will not be mitigated as part of this analysis. Three P1 contingencies, shown in Table 10, were divergent in both Benchmark and NRIS Study Cases. The divergence, in all occurrences, is not attributed to the 3RSC-2023 GIRs and may be due to WECC base case issues that will need to be investigated further.

Multiple Contingency analysis: Table 11 lists the voltage violations identified in this analysis.

- Table 12 lists the thermal overloads identified in this analysis. Note one P4 and three P7 contingencies were divergent in this analysis, as shown in Table 13. Per TPL-001-5, multiple contingency issues are mitigated using system adjustments, including generation redispatch (includes GIRs under study) and/or operator actions. Therefore, the violations presented in Multiple Contingency analysis are not attributable to 3RSC-2023 GIRs.

Table 8 – System Intact Thermal Overloads for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	kV	Areas	Owner	Normal Rating (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
1	Foxrun (73414) - Flyhorse N2 (73738) 115 kV CKT 1	Base Case	115	73	CSU	142	100.73	111.59	10.86
2	Flyhorse S (73576) - Kettleck N (73711) 115 kV CKT 1	Base Case	115	73	CSU	162	100.74	110.28	9.54
3	Cttnwd N (73391) - Kettleck S (73410) 115 kV CKT 1	Base Case	115	73	CSU	162	100.53	107.64	7.11

Table 9 – Single Contingency Thermal Overloads for Discharging Scenario

Ref. No.	Monitored Facility	Contingency Name	kV	Areas	Owner	Normal Rating (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
1	Cttnwd N (73391) - Kettleck S (73410) 115 kV CKT 1	Briargate S (73389) - Briargate N (73710) 115 kV CKT 1	115	73	CSU	162	165.66	175.98	10.32
2	Foxrun (73414) - Flyhorse N2 (73738) 115 kV CKT 1	Vollmert (72413) - Fuller (73481) 115 kV CKT 1	115	73	CSU	142	154.33	168.20	13.87
3	W. Canon (70550) - Hogback115 (71025) 115 kV CKT 1	Midway BR (73413) - Hambone Tap (73638) 230 kV CKT 1	115	70	Black Hills	120	152.78	164.49	11.71
4	Smelter (70394) - W.Canon (70550) 115 kV CKT 1	W Canon (73551) - Poncha BR (79054) 230 kV CKT 1	115	70	Black Hills	73	148.87	161.82	12.95
5	Flyhorse S (73576) - Kettleck N (73711) 115 kV CKT 1	Vollmert (72413) - Fuller (73481) 115 kV CKT 1	115	73	CSU	162	147.72	159.95	12.23

Ref. No.	Monitored Facility	Contingency Name	kV	Areas	Owner	Normal Rating (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
6	Ftn Vly (70193) - Midway BR (73412) 115 kV CKT 1	Midway PS (70286) - Midway BR (73413) 230 kV CKT 1	115	70/73	Black Hills	179	119.12	131.47	12.35
7	Briargate N (73710) - Kettleck N (73711) 115 kV CKT 1	Cttnwd N (73391) - Kettleck S (73410) 115 kV CKT 1	115	73	CSU	186	116.07	123.94	7.87
8	Kelker E (73408) - Templton (73422) 115 kV CKT 1	Kelker E (73408) - Rockisld (73420) 115 kV CKT 1	115	73	CSU	131	113.96	118.77	4.81
9	Kelker E (73408) - Rockisld (73420) 115 kV CKT 1	Kelker E (73408) - Templton (73422) 115 kV CKT 1	115	73	CSU	162	109.50	113.60	4.10
10	Vollmert (72413) - Fuller (73481) 115 kV CKT 1	Flyhorse S (73576) - Kettleck N (73711) 115 kV CKT 1	115	73	Tri-State G&T	173	106.63	114.18	7.55
11	Portland (70330) - Skala (70390) 115 kV CKT 1	N Penrose (71024) - Trk Crk Poi (71032) 115 kV CKT 1	115	70	Black Hills	110	104.75	110.95	6.20
12	Desrtcov (70449) - W.Staton (70456) 115 kV CKT 1	Midway PS (70286) - Midway BR (73413) 230 kV CKT 1	115	70	Black Hills	221	104.56	114.63	10.07
13	Puebplnt (70339) - Reader (70352) 115 kV CKT 1	Greenhrn (70004) - Reader (70352) 115 kV CKT 1	115	70	Black Hills	160	104.02	111.11	7.09
14	Vollmert (72413) - Blk Sqmv (73460) 115 kV CKT 1	Flyhorse S (73576) - Kettleck N (73711) 115 kV CKT 1	115	73	Tri-State G&T	173	101.48	108.92	7.44
15	Midway PS (70286) - Midway BR (73413) 230 kV CKT 1	Midway PS (70286) - Fuller (73477) 230 kV CKT 1	230	70/73	WAPA	637	99.88	112.44	12.56
16	Briargate S (73389) - Cttnwd S (73393) 115 kV CKT 1	Cttnwd N (73391) - Kettleck S (73410) 115 kV CKT 1	115	73	CSU	150	99.02	108.13	9.11
17	Midway BR (73412) - Rancho (73416) 115 kV CKT 1	LoTC_28: Midway PS - Fuller 230 kV CKT 1	115	73	Tri-State G&T	119	97.26	103.04	5.78
18	Ftn Vly (70193) - Desrtcov (70449) 115 kV CKT 1	Midway PS (70286) - Midway BR (73413) 230 kV CKT 1	115	70	Black Hills	221	97.06	107.07	10.01
19	Drake E (73575) - Fontero E (73706) 115 kV CKT 1	LoTC_28: Midway PS - Fuller 230 kV CKT 1	115	73	CSU	167	96.88	102.13	5.25
20	W.Canon (70550/73551) 115/230 kV transformer T1	Midway BR (73413) - Hambone Tap (73638) 230 kV CKT 1	115/230	70/73	Black Hills	100	96.13	104.42	8.29

Ref. No.	Monitored Facility	Contingency Name	kV	Areas	Owner	Normal Rating (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
21	Kettleck S (73410) - Kettleck N (73711) 115 kV CKT 1	Briargate S (73389) - Briargate N (73710) 115 kV CKT 1	115	73	CSU	239	95.73	102.51	6.78

Table 10 – Diverged P1 Contingencies for NRIS Study Case

Contingency	BM Case	NRIS Study Case
Loss of 79016 CRAIG 2 22.0 kV	Diverged	Diverged
Loss of 700182 24_28_W 0.69 kV	Diverged	Diverged
Loss of GLDSTNPS (12181) - VALENT (70990) 230 kV ckt 1	Diverged	Diverged

Table 11 – Multiple Contingency Voltage Violations for NRIS Study Case

Bus Name	Bus Number	Base kV	Area	Contingency Name	Benchmark Case Bus Voltage (p.u.)	Study Case Bus Voltage (p.u.)	Voltage Difference (p.u.)
Boulder Tm1	70059	115	70	BF_148g: Valmont 115 bus tie	0.8715	0.8574	-0.0141
Boulder Tm2	70033	115	70	BF_148g: Valmont 115 bus tie	0.8715	0.8574	-0.0141
Boulder Tm3	70034	115	70	BF_148g: Valmont 115 bus tie	0.8716	0.8575	-0.0141
Sunshine	70424	115	70	BF_148g: Valmont 115 bus tie	0.8845	0.8710	-0.0135
Boulder Cn2	70058	115	70	BF_148g: Valmont 115 bus tie	0.8935	0.8803	-0.0132
Boulder Hyd	70492	115	70	BF_148g: Valmont 115 bus tie	0.8936	0.8804	-0.0132
Boulder Cn1	70423	115	70	BF_148g: Valmont 115 bus tie	0.8936	0.8804	-0.0132

Xcel Energy

Table 12 – Multiple Contingency Thermal Overloads for NRIS Study Case

Ref. No.	Monitored Facility	Contingency Name	kV	Areas	Owner	Normal Rating (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
1	Foxrun (73414) - Flyhorse N2 (73738) 115 kV CKT 1	P7_129: Lines 5119, 7051	115	73	CSU	157	168.1	186.78	18.68
2	Ftn Vly (70193) - Midwaybr (73412) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70/73	Black Hills	179	162.15	179.88	17.73
3	Flyhorse S (73576) - Kettleck N (73711) 115 kV CKT 1	P7_129: Lines 5119, 7051	115	73	CSU	180	157.61	173.96	16.35
4	W.Canon (70550) - Hogback115 (71025) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70	Black Hills	120	155.04	167.72	12.68
5	Desrtcov (70449) - W.Staton (70456) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70	Black Hills	221	139.59	154.05	14.46
6	Midway PS (70286) - Midway BR (73413) 230 kV CKT 1	P7_130: Lines 5129, 7051	230	70/73	WAPA L.M.	637	137.8	154.4	16.6
7	Cttnwd N (73391) - Kettleck S (73410) 115 kV CKT 1	P7_129: Lines 5119, 7051	115	73	CSU	180	132.99	144.19	11.2
8	Ftn Vly (70193) - Desrtcov (70449) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70	Black Hills	221	131.92	146.29	14.37
9	Puebplnt (70339) - Reader (70352) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70	Black Hills	160	114.93	124.54	9.61
10	Midway BR (73412) - Rancho (73416) 115 kV CKT 1	P7_130: Lines 5129, 7051	115	73	Tri-State G&T	119	107.64	114.61	6.97
11	Clark (70112) - Jordan (70241) 230 kV CKT 1	P7_58: Lines 5707, 5111	230	70	PSCo	364	103.02	108.01	4.99
12	Story (73192) - Pawnee (70311) 230 kV CKT 1	P7_160: Lines 7329, 7297	230	73/70	PSCo	589	102.99	111.34	8.35
13	Smoky Hl (70396) - Harvest Mi (70596) 230 kV CKT 1	P7_137: Lines 5129, 7051	230	70	PSCo	956	102.87	110.57	7.7

Ref. No.	Monitored Facility	Contingency Name	kV	Areas	Owner	Normal Rating (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
14	Midway PS (70285) - W.Staton (70456) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70	Black Hills	87	102.18	109.76	7.58
15	Hydepark (70236) - PuebpInt (70339) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70	Black Hills	159	99.67	109.24	9.57
16	Smelter (70394) - W.Canon (70550) 115 kV CKT 1	BF_133a: Spruce 5180 Stuck	115	70	Black Hills	73	99	106.24	7.24
17	Portland (70330) - Skala (70390) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	70	Black Hills	110	97.17	105.43	8.26
18	Palmer Lk (70308) - Foxrun (73414) 115 kV CKT 1	P7_129: Lines 5119, 7051	115	70/73	PSCo	162	97.07	108.91	11.84
19	Daniel Pk (70139) - Marcy (70278) 230 kV CKT 1	P7_65: Lines 5109, 7051	230	70	PSCo	478	96.87	101.64	4.77
20	Kelker E (73408) - Rockisld (73420) 115 kV CKT 1	P7_130: Lines 5129, 7051	115	73	CSU	180	96.72	101.34	4.62
21	Lamar Swyd (70254) - Lamar C2 (70255) 230 kV CKT 1	BF_094d: Midway 5120 Stuck	230	70	PSCo	239	95.92	102.64	6.72
22	W.Canon (70550/73551) 115/230 kV transformer T1	BF_094d: Midway 5120 Stuck	115/230	70/73	Black Hills	100	95.6	104.27	8.67
23	Tundra (70653) - Comanche (70654) 345 kV CKT 2	BF_140a: Tundra 7015	345	70	PSCo	1183	95.24	107.2	11.96
24	Vollmert (72413) - Fuller (73481) 115 kV CKT 1	P7_129: Lines 5119, 7051	115	73	Tri-State G&T	173	94.45	101.07	6.62
25	Midway BR (73413) - Rd Nixon (73419) 230 kV CKT 1	P7_130: Lines 5129, 7051	230	73	CSU	531	90.68	101.84	11.16
26	Castl Rk T1 (70020) - Palmer Lk (70308) 115 kV CKT 1	P7_129: Lines 5119, 7051	115	70	PSCo	140	90.5	101.74	11.24
27	Castl Rk Cr (70091) - Castl Rk T1 (70020) 115 kV CKT 1	P7_129: Lines 5119, 7051	115	70	PSCo	142	89.01	100.11	11.1
28	Midway PS (70286) - Mirasol (70652) 230 kV CKT 2	BF_094c: Midway PS – Mirasol, Ftn Vly Units	230	70	PSCo	478	88.58	104.12	15.54

Ref. No.	Monitored Facility	Contingency Name	kV	Areas	Owner	Normal Rating (MVA)	Benchmark Case Loading (%)	Study Case Loading (%)	Loading Difference (%)
29	Midway BR (73412) - Rd Nixon (73417) 115 kV CKT 1	BF_094d: Midway 5120 Stuck	115	73	CSU	195	88.54	100.69	12.15

Table 13 – Diverged Multiple Contingencies for NRIS Study Case

Contingency	BM Case	NRIS Study Case
BF_155b: Goose Creek 7254	Converged	Diverged
P7_51: Lines 7017, 7235	Converged	Diverged
P7_55: Lines 7015, 7017	Converged	Diverged
P7_159: Lines 7251, 7295	Converged	Diverged

7.5 Steady-State Analysis – Grid Charging Study Case

Contingency analysis was performed on the Southern Colorado pocket Grid Charging Study Case. The results are summarized below:

- System-Intact analysis: No thermal overload or voltage violations attributable to 3RSC-2023-02 were identified.
- Single Contingency analysis: No thermal overload or voltage violations attributable to 3RSC-2023-02 were identified. Note three P1 contingencies, shown in Table 14, were divergent in both Grid Charging Benchmark (GCBM) and Grid Charging (GC) Study Cases. The divergence, in all occurrences, is not attributed to the 3RSC-2023 GIRs and may be due to WECC base case issues that will need to be investigated further.
- Multiple Contingency analysis: No thermal overload or voltage violations attributable to 3RSC-2023-01, 3RSC-2023-02 and 3RSC-2023-03 were identified. Per TPL-001-5, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (includes GIRs under study) and/or operator actions.

Table 14 – Diverged P1 Contingency for Grid Charging Study Case

Contingency	GCBM Case	GC Study Case
Loss of 79016 CRAIG 2 22.0 kV	Diverged	Diverged
Loss of 700182 24_28_W 0.69 kV	Diverged	Diverged
Loss of GLDSTNPS (12181) – VALENT (70990) 230 kV ckt 1	Diverged	Diverged

7.6 Affected Systems

The study identified Colorado Springs Utilities (CSU), Black Hills, Tri-State G&T and WAPA as Affected Systems as a result of the overloads on their facilities as listed in Table 8, Table 9, and Table 12.

7.7 Summary of Southern Study Pocket Analysis

The study did not identify any System Network Upgrades attributed to the 3RSC-2023 GIRs under single contingency as prescribed in the Study Criteria, Section 4.2. Any mitigations necessary to alleviate overloads on Affected Systems' facilities are not part of this study. The study concludes the following:

- NRIS identified for 3RSC-2023-1 is 200 MW.
- NRIS identified for 3RSC-2023-2 is 100 MW.
- NRIS identified for 3RSC-2023-3 is 200 MW.

Additionally, a Grid Charging study was performed for 3RSC-2023-2. The study did not identify any voltage or thermal overloads attributed to these GIRs. Hence, the study identified the following:

- Grid Charging capabilities without any additional System Network Upgrades for 3RSC-2023-2 is 100 MW.

8.0 Cost Estimates and Assumptions

There are three types of costs identified in the study:

- Transmission Provider's Interconnection Facilities (TPIF) which are directly assigned to each GIR.
- Station equipment Network Upgrades, which are allocated each GIR connecting to that station on a per-capita basis per Section 4.2.4(a) of the LGIP.
- All System Network Upgrades which are allocated by the proportional impact per Section 4.2.4(b) of the LGIP.

PSCo notes that these cost estimates assume the changes to the Base Case identified in section 5.0. If any of those changes are withdrawn, restudy of these requests may be required, as the results and conclusions contained within this study could change. Such a re-study could result in the identification of additional or different TPIF, station equipment Network Upgrades, and/or System Network Upgrades, which would in turn likely result in different costs for the Interconnection Customer to receive the requested service.

8.1 Transmission Provider's Interconnection Facilities

8.1.1 3RSC-2023-1 and 3RSC-2023-2

Table 15 – 3RSC-2023-1 and 3RSC-2023-2 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's Mirasol 230 kV switching station	Interconnection of 3RSC-2023-1 and 3RSC-2023-2 at the Mirasol 230 kV switching station sharing an interconnection position. The new equipment includes: • (1) 230 kV dead end bay • (1) 230 kV 3-phase arrester • (1) 230 kV 3000 A line disconnect switch • (1) 230 kV 3-phase CT for metering • (1) 230 kV 3-phase 3-winding CCVT • Dual fiber communication equipment • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing	$2.380

PSCo's Mirasol 230 kV switching station	Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Single span, dead end structure, 3 conductors, insulators, hardware, jumpers and labor.	$0.200
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$2.580**

The total cost of Transmission Provider's Interconnection Facilities for each GIR is given in Table 16.

Table 16 – Allocation of Transmission Provider's Interconnection Facilities Costs by GIR at Mirasol 230 kV Switching Station

GIR	% Share	Total Cost (million)
3RSC-2023-1	50.0%	$1.290
3RSC-2023-2	50.0%	$1.290

8.1.2 3RSC-2023-3

Table 17 – 3RSC-2023-3 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (million)
PSCo's May Valley 345 kV switching station	Interconnection of 3RSC-2023-3 at the May Valley 345 kV switching station. The new equipment includes: • (1) 345 kV dead end structure • (1) 345 kV 3-phase arrester • (1) 345 kV 3000 A line disconnect switch • (1) 345 kV 3-phase CT for metering • (1) 345 kV 3-phase 3-winding CCVT • Dual fiber communication equipment • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures • Associated transmission line communications, fiber, relaying and testing	$3.395
PSCo's May Valley 345 kV switching station	Transmission Provider's dead-end structure at the Point of Change of Ownership (PCO) outside the switching station fence line and transmission line into new switching station from the PCO. Single span, dead end structure, 3 conductors, insulators, hardware, jumpers and labor.	$0.250
	Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities	**$3.645**

8.2 Station Network Upgrades

The total estimated cost of Station Network Upgrades for each GIR is given in Table 18.

Table 18 – Total Cost of Station Network Upgrades by GIR

GIR	POI	Total Cost (million)
3RSC-2023-1	Mirasol 230 kV switching station	**$2.505**
3RSC-2023-2		
3RSC-2023-3	May Valley 345 kV switching station	**$1.707**

8.2.1 Mirasol 230 kV switching station

The details of the Station Network Upgrades required at the Mirasol 230 kV switching station are shown in Table 19. These Station Network Upgrade costs are shared according to Table 20.

Table 19 – Station Network Upgrades – Mirasol 230 kV switching station

Element	Description	Cost Est. (million)
PSCo's Mirasol 230 kV switching substation	Interconnection of 3RSC-2023-1 and 3RSC-2023-2 at Mirasol 230 kV switching station on the existing ring bus. The new equipment includes: • (1) 230 kV dead end structure • (1) 230 kV 3000 A SF6 circuit breaker • (3) 230 kV 3000 A double end break disconnect switches • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures	$2.422
PSCo's Mirasol 230 kV switching substation	Install communication equipment in the Mirasol 230 kV EEE to accommodate 3RSC-2023-1 and 3RSC-2023-2	$0.083
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$2.505**

Table 20 – Allocation of Mirasol 230 kV Switching Station Upgrade Cost by GIR

GIR	% Share per Section 4.2.4(a) of Attachment N	Costs Allocated to GIR (million)
3RSC-2023-1	50.0%	$1.2525
3RSC-2023-2	50.0%	$1.2525

8.2.2 May Valley 345 kV switching station

The details of the Station Network Upgrades required at the May Valley 345 kV switching station are shown in Table 21. These Station Network Upgrade costs are 100% assigned to 3RSC-2023-3.

Table 21 – Station Network Upgrades – May Valley 345 kV switching station

Element	Description	Cost Est. (million)
PSCo's May Valley 345 kV Switching Station	Interconnection of 3RSC-2023-3 at May Valley 345 kV Switching Station on an existing breaker-and-a-half bay. The new equipment includes: • (1) 345 kV dead end structure • (1) 345 kV 3000 A SF6 circuit breaker • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures	$1.707
	Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities	**$1.707**

8.3 Summary of Costs per Generator Interconnection Request

8.3.1 3RSC-2023-1

The total estimated cost of the required upgrades for 3RSC-2023-1 to interconnect at the Mirasol 230 kV switching station is $2.5425 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.290 million (**Table 15 and Table 16**)**
- **The cost of Station Network Upgrades is $1.2525 million (**Table 19 and Table 20**)**
- **The cost of System Network Upgrades is $0 million**

Figure 2 is a conceptual one-line of the Mirasol 230 kV switching station required for the interconnection for 3RSC-2023-1.

The list of improvements required to accommodate the interconnection of 3RSC-2023-1 is given in Table 15 and Table 19. System improvements are subject to revision as a more detailed and refined design is produced.

8.3.2 3RSC-2023-2

The total estimated cost of the required upgrades to allow 3RSC-2023-2 to interconnect at Mirasol 230 kV switching station is $2.5425 million.

- **The cost of Transmission Provider's Interconnection Facilities is $1.290 million (**Table 15 and Table 16**)**
- **The cost of Station Network Upgrades is $1.2525 million (**Table 19 and Table 20**)**
- **The cost of System Network Upgrades is $0 million**

Figure 2 is a conceptual one-line of the Mirasol 230 kV switching station for the interconnection of 3RSC-2023-2.

The list of improvements required to accommodate the interconnection of 3RSC-2023-2 is given in Table 15 and Table 19. System improvements are subject to revision as a more detailed and refined design is produced.

8.3.3 3RSC-2023-3

The total estimated cost of the required upgrades to allow 3RSC-2023-3 to interconnect at May Valley 345 kV switching station is $5.352 million.

- **The cost of Transmission Provider's Interconnection Facilities is $3.645 million (**Table 17**)**
- **The cost of Station Network Upgrades is $1.707 million (**Table 21**)**
- **The cost of System Network Upgrades is $0 million**

Figure 3 is a conceptual one-line of the May Valley 345 kV switching station for the interconnection of 3RSC-2023-3.

The list of improvements required to accommodate the interconnection of 3RSC-2023-3 at the May Valley 345 kV switching station is given in Table 17 and Table 21. System improvements are subject to revision as a more detailed and refined design is produced.

8.4 Cost Estimate Assumptions

PSCo has developed cost estimates for Transmission Provider's Interconnection Facilities and Network/Infrastructure Upgrades required for the interconnection of the GIRs in the 3RSC-2023 cluster for Network Resource Interconnection Service. The estimated costs provided in this report are based upon the following assumptions:

- The estimated costs are in 2024 dollars with escalation and contingencies applied.
- Allowances for Funds Used During Construction (AFUDC) is not included.
- The estimated costs include all applicable labor and overheads associated with the siting, engineering, design, and construction of these new PSCo facilities.
- The estimated costs do not include the cost for any Customer owned equipment and associated design and engineering.
- Labor is estimated for straight time only—no overtime included.
- PSCo (or its Contractor) will perform all construction, wiring, testing, and commissioning for PSCo owned and maintained facilities.

The customer requirements include:

- Customer will install two (2) redundant fiber optic circuits (one primary circuit with a redundant backup) into the Transmission Provider's substation as part of its interconnection facilities construction scope.
- Power Quality Metering (PQM) will be required on the Customer's generation tie-line terminating into the POI.
- The Customer will be required to design, procure, install, own, operate and maintain a Load Frequency/Automated Generation Control (LF/AGC) RTU at their Customer substation. PSCo will be provided with indications, readings, and data from the LF/AGC RTU.
- The Interconnection Customer will comply with the Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW, as amended from time to time, and available at: XEL-POL-Transmission Interconnection Guideline Greater 20MW (https://corporate.my.xcelenergy.com/s/transmission/interconnection)

9.0 Summary of Generation Interconnection Service

This report is the Phase 1 study results and does not include short circuit or stability analysis. If there is a change in status of one or more higher-queued Interconnection Requests due to withdrawal from the queue, a restudy of the power flow analysis will be performed as needed during Phase 2 and the study results and costs will be updated.

The Customer is required to design and build the Generating Facility to mitigate any potential inverter interactions with the neighboring inverter based Generating Facility(ies) and/or the inverters of the hybrid Generating Facility. This report only evaluated Network Resource Interconnection Service of GIRs in 3RSC-2023 and Network Resource Interconnection Service in and itself does not convey transmission service.

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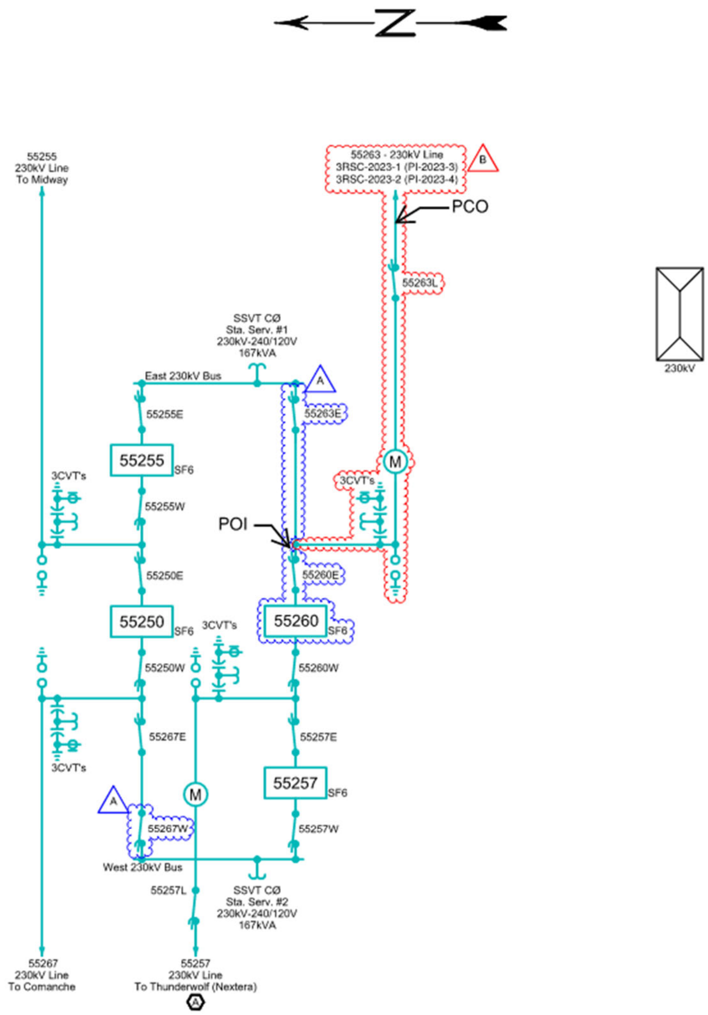
10.0 Single-Line Diagrams at the Point of Interconnection



Notes:

A Station Network Upgrades for 3RSC-2023-1 (PI-2023-3) and 3RSC-2023-2 (PI-2023-4)

B TPIF for 3RSC-2023-1 (PI-2023-3) and 3RSC-2023-2 (PI-2023-4)

Figure 2 – Preliminary One-line of the 3RSC-2023-1 and 3RSC-2023-2 POI at Mirasol 230 kV switching station

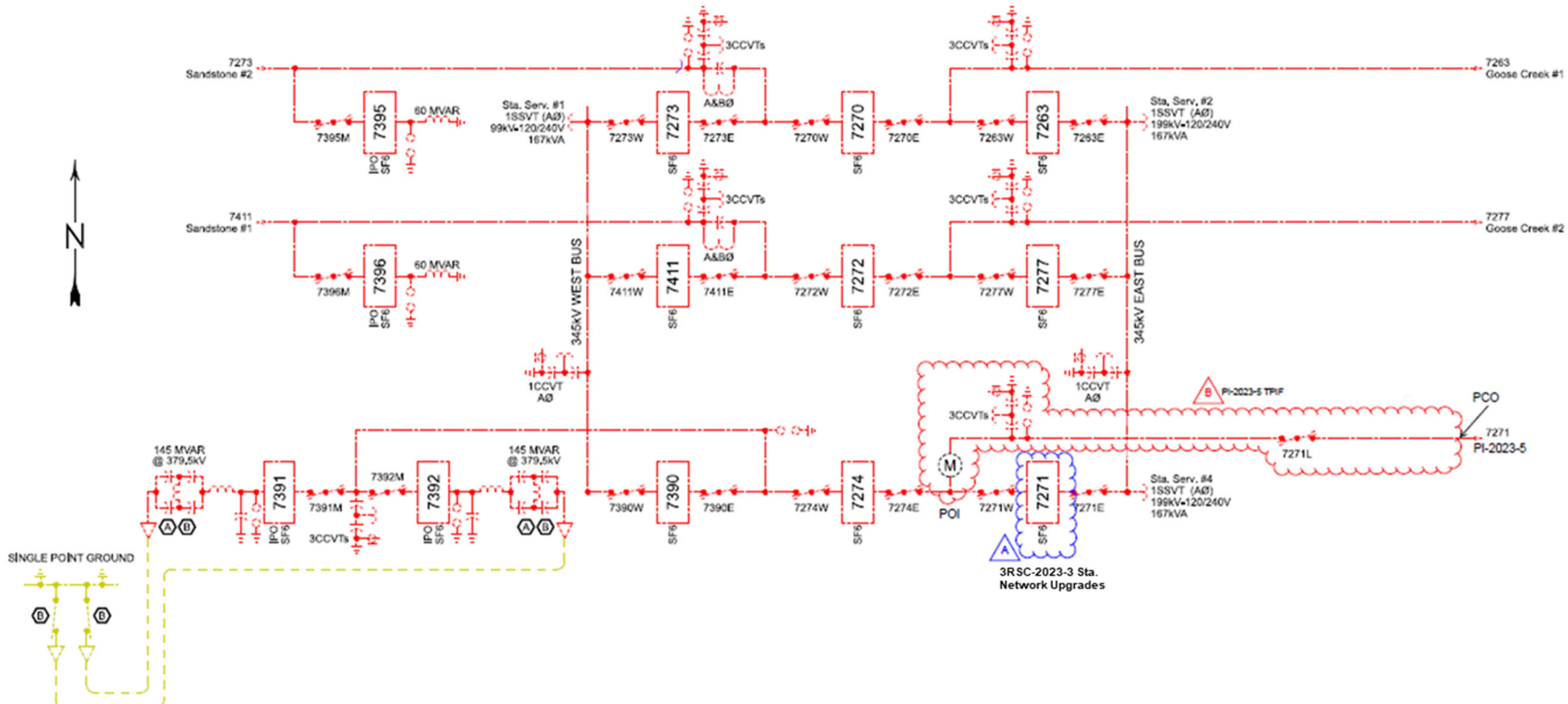


Figure 3 – Preliminary One-line of the 3RSC-2023-3 (PI-2023-5) POI at May Valley 345 kV switching station