2RSC-2020

Resource Solicitation Cluster

Phase 1 Study Report

1/12/2021

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1.0 Summary

The RSC-2020-2 Resource Solicitation Cluster includes one (1) Generation Interconnection Request: 2RSC-2020-5.

2RSC-2020-5 is a 250MW net rated Solar Photovoltaic and Battery Energy Storage Hybrid Generating Facility requesting Energy Resource Interconnection Service. The requested Point of Interconnection is Mirasol 230kV Substation.

The OPF tool identified generation redispatch for each single contingency overload. All multiple contingency overloads shall be mitigated using system readjustments and/or operator action, as allowed per TPL1-4.

Energy Resource Interconnection Service allotted to 2RSC-2020-5 is: 250MW (after required transmission system improvements in Tables 6 and 7)

The total estimated cost of the transmission system improvements required for 2RSC-2020-5 is $6.95 Million (Tables 6 and 7)

The output of the hybrid Generating Facility will be limited to 250MW at the Point of Interconnection using the power plant controller. Additional monitoring and control requirements will be added to the LGIA to ensure the Interconnection Service amount is not exceeded. The Generating Facility output will also be monitored by PSCo operations.

The Mirasol 230kV Substation is a new substation identified in the DISIS-2020-001. A CPCN is needed for the construction of the Mirasol 230kV Substation. The estimated time frame for regulatory activities and to site, design, procure and construct the interconnection facilities is approximately 36 months after authorization to proceed has been obtained. Any delays in obtaining the CPCN may delay the Commercial Operation Date of 2RSC-2020-5.

2.0 Introduction

Public Service Company of Colorado (PSCo) received one (1) Generation Interconnection Request (GIR) in the RSC-2020-2 Resource Solicitation Cluster (RSC): 2RSC-2020-5. The total Interconnection Service requested in the RSC is 250MW of Energy Resource Interconnection

Service (ERIS)[1]. A summary of the 2RSC-2020-5 request is given in Table 1 and an approximate location of the Point of Interconnection (POI) of 2RSC-2020-5 is shown in Figure 1 below.

Table 1 – Summary of GIRs in the 2RSC-2020

Generation Interconnection Number	Current Cluster	Date of Valid Request	Capacity (MW)	Maximum MW Output-Summer	Maximum MW Output-Winter	Location (County/State)	Station or Transmission Line POI	Projected In-Service Date	Service Type	Generating Facility Type
2RSC-2020-5	2RSC-2020	9/10/2020	250	250	250	Pueblo County, CO	Mirasol Switchyard on the Comanche-Midway 230kV Transmission Line	9/30/2022	ERIS	PV Solar and Battery

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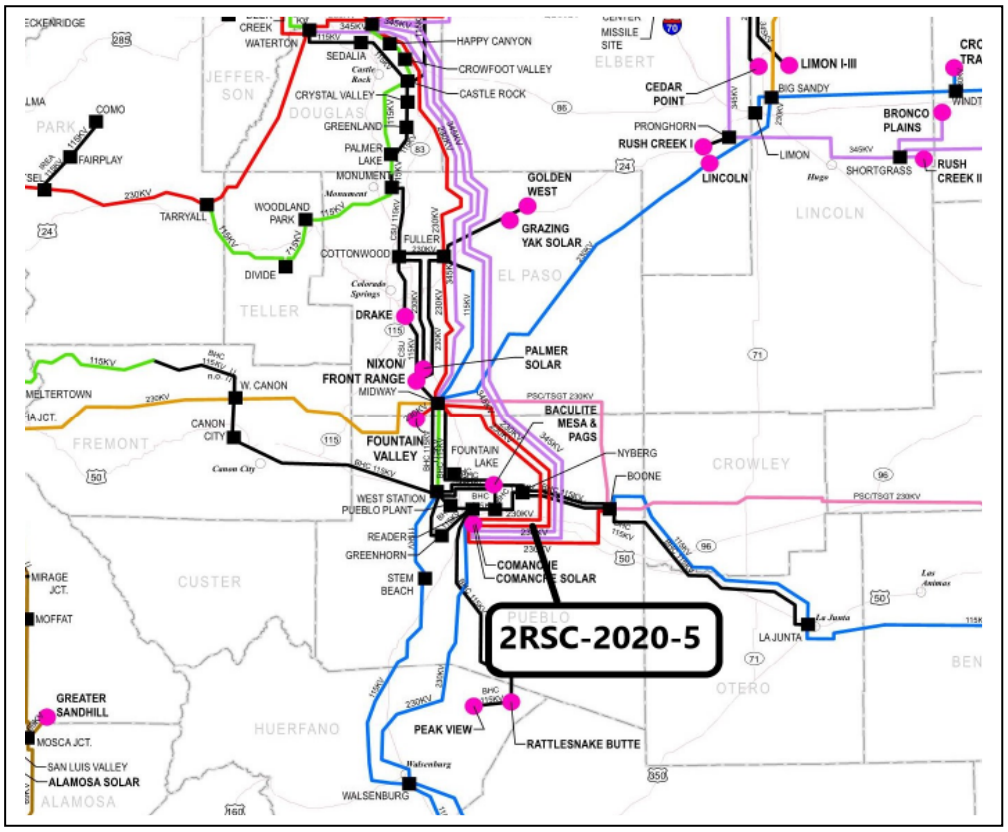
Figure 1 – POI of 2RSC-2020-5 in RSC-2020-2



[1] 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

3.0 Description of the GIR

The 2RSC-2020-5 is a 250MW net rated Solar Photovoltaic (PV) plus Battery Energy Storage (BES) Hybrid Generating Facility that will be located in Pueblo County, Colorado. This hybrid Generating Facility will consist of two distinct facility groups – 200MW Solar PV facility and 100MW BES facility. The 200MW Solar PV facility will consist of ninety-seven (97) GE LV5 2.3MVA, ±0.90PF inverters, each with its own 600V/34.5kV, 2.3MVA, Z=6.3% and X/R=7.5 pad-mounted step-up transformer. The 100MW BES facility will consist of fifty-seven (57) Parker 890-GTB2200 2.2MVA, ±0.95PF inverters, each with its own 480V/34.5kV, 2.2MVA, Z=5.75% and X/R=7.5 pad-mounted step-up transformer. The 34.5kV collector system of the PV and BES generators will connect to two (2) 34.5/13.8/230kV, 102/138/170MVA, Z=8.5%, X/R=40 wye-gnd/delta/wye-gnd main step-up transformer which in turn will connect to the Mirasol Substation via a 0.1mile generation tie-line. The Mirasol Substation is a new substation identified in the higher-queued DISIS-2020-001. The net output of 2RSC-2020-5 will not exceed 250MW at any time, which will be limited using the Plant Power Controller, and the PV and BES generators will be operated in back-feed voltage control mode. The expected operating modes of 2RSC-2020-5 are:

i. Generation mode - 250MW rated generation output at the POI via combination of PV and BES generators.
ii. Grid Charging mode - 50MW for a maximum of 4 hours when the PV output is 0MW. The BES facility will not charge from the grid during the first five (5) years and three (3) months of the COD, but it may charge from the grid after that period.

The proposed Commercial Operation Date (COD) of 2RSC-2020-5 is September 30, 2022. Accordingly, based on the standard interconnection practices, the back-feed date is assumed to be April 1, 2022, approximately six (6) months before the COD.

4.0 Study Scope

The Purpose of the study is to determine the system impact of interconnecting 2RSC-2020-5 for Interconnection Service. The Interconnection Service requested by the GIR is summarized in Table 1.

The scope of the study includes steady state (thermal and voltage) analysis and cost estimates. Since the RSC has only one GIR, all costs provided in this report are 100% assigned to 2RSC-2020-5.

The steady state analysis identifies thermal and voltage violations in the PSCo system, and the Affected Systems using the study criteria in Section 4.2 and study methodology in Section 4.3.

4.1 Study Pocket Determination

As shown in Figure 1, 2RSC-2020-5 is in "Southern Colorado" and falls under the "Southern Colorado" study pocket.

4.2 Study Criteria

The following steady state analysis criteria is used to identify violations on the PSCo system and 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 & P6 – 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 assessment is performed using PSSE V33 and the ACCC tool. The generation redispatch for ERIS is identified using GE's Optimum Power Flow (OPF) tool.

4.3.1 Steady State Assessment methodology

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 voltage has a further variation of 0.1p.u.

Since 2RSC-2020-5 is the only GIR studied in the cluster, all violations are 100% attributed to 2RSC-2020-5.

The 2RSC-2020-5 is dispatched at 100% and violations are identified. All violations are then simulated using OPF and a generation redispatch combination which eliminates the violation is identified. Any violations which are not mitigated using generation redispatch are considered credible violations that need Network Upgrades.

The OPF is run using the following generation dispatch assumptions:

1. All existing resources and external resources on the PSCo system are considered.
2. The Pmin of wind and solar generator's is 0MW.
3. The Pmin of conventional generation is as provided in the Base Case.

4.3.2 Contingency Analysis

The transmission system on which steady state contingency analysis is run includes the WECC designated areas 70 and 73, and WECC designated zone 121.

4.3.3 Study Area

The study area includes the WECC designated zones 121, 700, 703, 704, 710, 712, 752 and 757. The Affected Systems included in the analysis are Tri-State Generation and Transmission Inc. (TSGT), Black Hills Energy (BHE), Colorado Spring Utilities (CSU), Intermountain Rural Electric Association (IREA) and Western Area Power Administration (WAPA) transmission systems in the study area.

5.0 Base Case Modeling Assumptions

The 2023HS case developed for the 2019 Colorado Coordinated Planning Group TPL1-4 studies is selected as the starting case. The Base Case is created from the Starting Case by including the following modeling changes.

The following approved transmission projects in PSCo's 10-year transmission plan, with an in-service before 2023 are modeled: (http://www.oasis.oati.com/woa/docs/PSCO/PSCOdocs/FERC_890_Q1_2020_Transmission_Plan_Presentation.pdf)

- Cloverly 115kV Substation – ISD 2021
- Graham Creek 115kV Substation – ISD 2022
- Husky 230/115kV Substation – ISD 2022
- Ault – Husky 230kV line – ISD 2022

- Husky – Graham Creek – Cloverly 115kV line – ISD 2022
- Monument – Flying Horse 115kV Series Reactor – ISD 2023
- Avery Substation – ISD 2021
- High Point Substation –ISD 2022
- Titan Substation – ISD 2022
- Gilman – Avon 115kV line – ISD 2022
- Upgrade Villa Grove – Poncha 69kV Line to 73MVA – ISD 2021
- Upgrade Poncha - Sargent - San Luis Valley 115kV line to 120MVA – ISD 2021
- Climax – Robinson Rack – Gilman 115kV line – ISD 2022
- Greenwood – Arapahoe - Denver Terminal 230kV line – ISD 2022

Also, the following facility uprate projects are modeled at their planned future ratings:

- Upgrade Allison – SodaLakes 115kV line to 318MVA – ISD 2021
- Upgrade Buckley34 – Smokyhill 230kV line to 506MVA – ISD 2021
- Upgrade Daniels Park – Priarie1 230kV line to 576MVA – ISD 2021
- Upgrade Greenwood – Priarie1 230kV line to 576MVA – ISD 2021
- Upgrade Daniels Park – Priarie3 230kV line to 576MVA – ISD 2021
- Upgrade Greenwood – Priarie3 230kV line to 576MVA – ISD 2021
- Upgrade Midway 230kV bus tie to 576MVA – ISD 2023
- Upgrade Waterton – Martin2 tap 115kV line to 189MVA – ISD 2021
- Upgrade Daniels Park 345/230kV # T4 to 560MVA – ISD 2021
- Upgrade Leetsdale – Monaco 230kV line to 560MVA – ISD 2021
- Upgrade Greenwood – Monaco 230kV line to 560MVA – ISD 2021
- Upgrade Waterton – Martin1 tap 115kV line to 189MVA – ISD 2023

The following additional changes were made to the TSGT model in the Base Case per further review and comment from TSGT:

- Fuller – Vollmer – Black Squirrel 115 kV line modeled at 173 MVA – ISD 2022
- Fuller 230/115kV, 100MVA #2 transformer – ISD 2023

The following additional changes were made to the BHE model in the Base Case per further review and comment from BHE:

- Burnt Mill – Greenhorn 115kV Rebuild - ISD 1/21/2021
- Desert Cove – Fountain Valley Rebuild – ISD 1/22/2021
- Nyberg - Airport Memorial Rebuild - ISD 1/22/2021

- Pueblo West substation – ISD 4/13/2021
- Pueblo Reservoir – Burnt Mill 115kV Rebuild – ISD 8/31/2021
- Boone - South Fowler 115kV Project – ISD 10/1/2021
- North Penrose Substation – ISD 1/2022
- West Station – Pueblo Res 115kV Rebuild – ISD 1/31/2022

The following additional changes were made to the CSU model in the Base Case per further review and comment from CSU:

- The Cottonwood – Tesla 34.5kV line is modeled open and Kettle Creek – Tesla 34.5kV line is modeled closed on the CSU system – ISD 2023
- Briargate S 115/230kV transformer with the high end tapping the Cottonwood – Fuller 230kV line – ISD 2023

The Base Case includes all existing PSCo generation resources and all Affected System's existing resources. In addition, the following higher-queued generation from PSCo's queue are modeled in the Base Case: GI-2014-6, GI-2014-7, GI-2014-8, GI-2014-9, GI-2014-12, GI-2014-13, GI-2016-15, Transitional Cluster, 1RSC-2020 and DISIS-2020-001. While the higher-queued NRIS requests are dispatched at 100% nameplate, the higher-queued ERIS requests are modeled offline.

The following Network Upgrades identified in the higher-queued GIR are modeled:

- Uprate Daniels Park – Prairie1 230kV line to 756MVA (identified in DISIS-2020-001)
- Uprate Daniels Park – Prairie3 230kV line to 756MVA (identified in DISIS-2020-001)

The following future generation connection to the Affected System's Transmission System is also modeled:

IREA:

- 80MW Pioneer Solar PV facility interconnecting on the Victory – Brick Center 115kV line – COD 12/31/2020
- 75MW Hunter Solar PV facility interconnecting at Brick Center 115kV Substaiton – COD 2/1/2022
- 54.5MW Kiowa Solar PV facility interconnecting at Victory 115kV Substation – COD 4/1/2023

TSGT:

- TI-18-0809, 100MW NRIS/ERIS Solar, Walsenburg-Gladstone 230kV line
- TI-19-1016, 40MW NRIS/ERIS Solar, Walsenburg-Gladstone 230kV line (schedule to NM)

6.0 Generation Interconnection Service Analysis

The Interconnection Service for 2RSC-2020-5 is determined using the Southern Colorado study pocket analysis.

6.1 Voltage and Reactive Power Capability Evaluation

The following voltage regulation and reactive power capability requirements at the POI are applicable to 2RSC-2020-5:

- 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. Finally, it is the responsibility of the Interconnection Customer to compensate their generation tie-line to ensure minimal reactive power flow under zero output conditions.

The reactive power analysis looks for the capability of the GIR to maintain ±0.95pf at the high side of the main step-up transformer and maintain normal steady state operating voltage range (0.95-1.05 p.u.) at the POI. All GIRs are required to design their interconnection to meet the POI voltage control requirements that will be specified by PSCo's Transmission Operations group.

The 2RSC-2020-5 generator model includes: Pmax = 250MW, Pmin = 0MW, Qmax = 136.4Mvar, Qmin= -136.4Mvar.

Table 2 - Reactive capability evaluation of 2RSC-2020-5

Gen MW / Mvar (PV+BES)	Configuration	Gen Voltage (p.u.) (PV/BES)	Main Step-up Transformer High Side				POI			
			Voltage (p.u.)	MW	Mvar	Power Factor	Voltage (p.u.)	MW	Mvar	Power Factor
253 MW / 136.4 Mvar	PV+BES	1.115 / 1.114	1.038	249.9	96.7	0.933 (lag)	1.038	249.9	96.7	0.933 (lag)
253 MW /- 136.4 Mvar	PV+BES	0.918 / 0.923	1.013	248.4	-195.8	0.785 (lead)	1.013	248.4	-195.9	0.785 (lead)
25.3 MW / 7.2 Mvar	PV+BES	1.036 / 1.037	1.030	25.3	8.5	0.948 (lag)	1.030	25.3	8.5	0.948 (lag)
25.3 MW /- 9.6 Mvar	PV+BES	1.025 / 1.024	1.029	25.3	-8.4	0.949 (lead)	1.029	25.3	-8.3	0.950 (lead)
0 MW /- 136.3 Mvar	PV+BES	0.927 / 0.931	1.017	-1	-147.8	N/A	1.017	-1	-147.7	N/A

Also, the PV and BES generators are operated in backfeed voltage control mode. As shown in Table 2, the reactive capability analysis indicates that 2RSC-2020-5 is capable of meeting ±0.95pf at the high side of the main step-up transformer while maintaining at least 0.95-1.05p.u. voltage at the POI for 100%, 10% and 0% output levels.

6.2 Southern Colorado Study Pocket Analysis

6.2.1 Benchmark Case Modeling

The Benchmark Case is created from the Base Case and by changing the Study Pocket generation dispatch to reflect a heavy south to north flow on the Comanche – Midway – Jackson Fuller – Daniels Park transmission system. This was accomplished by adopting the generation dispatch in Table 3.

Table 3 – Generation Dispatch Used to Stress the Southern Study Pocket Benchmark Case (MW is Gross Capacity)*

Bus Name	ID	Status	PGen (MW)	PMax (MW)
COMAN_1 24.000	C1	1	360	360
COMAN_2 24.000	C2	1	365	365
COMAN_3 27.000	C3	1	853	853
COMAN_PV 34.500	S1	1	106.25	125
CO_GRN_E 34.500	W1	1	64.8	81
CO_GRN_W 34.500	W2		64.8	81

Bus Name	ID	Status	PGen (MW)	PMax (MW)
FTNVL1&2 13.800	G1	1	36	40
FTNVL1&2 13.800	G2	1	36	40
FTNVL3&4 13.800	G3	1	36	40
FTNVL3&4 13.800	G4	1	36	40
FTNVL5&6 13.800	G5	1	36	40
FTNVL5&6 13.800	G6	1	36	40
JKFULGEN 0.6900	W1	1	200	250
LAMAR_DC 230.00	DC	0	0	210
TWNBUTTE 34.500	W1	1	60	75
SI_GEN 0.6000	1	1	25.5	30
TBII_GEN 0.6900	W	1	60.8	76
TI-18-0809 0.6300	PV	1	85	100
TI-19-1016 0.6300	PV	0	0	40

*This table only shows the generation increases from the Base Case.

6.2.2 Study Case Modeling

The Study case is created from the Benchmark Case by modeling 2RSC-2020-5 at the Mirasol 230kV Substation. The 250 MW ERIS output from the generator is sunk to Pawnee.

6.2.3 Steady State Analysis Results

The results of the single contingency analysis are given in Table 4.

The results of the multiple contingency analysis on the Study Case are given in Table 5.

The multiple contingency analysis shows that addition of 2RSC-2020-5 resulted in one new overload and increased existing overloads on several facilities. Per TPL1-4, multiple contingency overloads can be mitigated using system adjustments, including generation redispatch and/or operator actions. PSCo is in the process of identifying system mitigations which may include automatic generation adjustments schemes for the PSCo multiple contingencies studied in Table 5 above. These future mitigations will address existing and new overloads, and all GIRs in the Southern Colorado study pocket may become part of the mitigations and may be subject to automatic generation adjustments.

Table 4 shows that all single contingency overloads caused by 2RSC-2020-5 for stressed generation dispatch in the Southern Colorado region. Also, the OPF identified redispatch scenarios for each overload. Since all ERIS overloads were mitigated with generation redispatch, the full requested ERIS can be accommodated for 2RSC-2020-5.

ERIS of 2RSC-2020-5 is 250MW

Table 4 Southern Colorado Study Pocket ERIS study results – Overloads identified in Single Contingency Analysis

Overloaded Facility	Type	Owner	Facility Normal Rating (MVA)	Facility Loading in Benchmark Case		Facility Loading in ERIS Study Case		% Change due to 2RSC-2020-5	Single Contingency Definition	Type of Overload	OPF Identified
				MVA Flow	% Line Loading	MVA Flow	% Line Loading				
MidwayPS 230/115kV # T1	Xfmr	PSCo	150	143.9	95.9%	152.0	101.3%	5.4%	Boone – MidwayPS 230kV #1	Beyond POI Sub	Yes

Table 5 Southern Colorado Study Pocket ERIS study results – Overloads identified in Multiple Contingency Analysis

Overloaded Facility	Type	Owner	Facility Emergency Rating (MVA)	Facility Loading in Benchmark Case		Facility Loading in Study Case		% Change due to 2RSC-2020-5	Multiple Contingency Definition
				MVA Flow	% Line Loading	MVA Flow	% Line Loading		
Black Forest Tap – Black Squirrel MV 115kV # 1	Line	TSGT	143	155.4	108.7%	171.3	119.8%	11.1%	Midway - Waterton 345kV #1 and Daniels Park – Fuller 230 KV #1
Boone – MidwayPS 230kV # 1	Line	TSGT/PSCo	319	455.9	142.9%	526.4	165.0%	22.1%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2
Daniels Park – Fuller 230kV # 1	Line	PSCo	478	711.7	148.9%	837.9	175.3%	26.4%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2
Fountain S – RD_Nixon 115kV # 1	Line	CSU	212	255.9	120.7%	261.0	123.1%	2.4%	Kelker N 230kV Bus and Kelker S 230kV Bus
Fountain valley – MidwayBR 115kV # 1	Line	BHE	171	179.2	104.8%	210.0	122.8%	18.0%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2
HydePark – Pueblo Plant 115kV # 1	Line	BHE	160	171.7	107.3%	198.4	124.0%	16.7%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2

Overloaded Facility	Type	Owner	Facility Emergency Rating (MVA)	Facility Loading in Benchmark Case		Facility Loading in Study Case		% Change due to 2RSC-2020-5	Multiple Contingency Definition
				MVA Flow	% Line Loading	MVA Flow	% Line Loading		
MidwayPS 230/115kV # T1	Xfmr	PSCo	150	199.1	132.7%	218.0	145.3%	12.6%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2
MidwayPS – Fuller 230kV # 1	Line	PSCo	478	469.4	98.2%	541.1	113.2%	15.0%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2
MidwayPS – GI-2014-9 230kV # 2	Line	PSCo	478	514.3	107.6%	594.6	124.4%	16.8%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2
MidwayPS – MidwayBR 230kV # 1	Line	WAPA	576	640.5	111.2%	760.3	132.0%	20.8%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2
MidwayPS – Mirasol 230kV # 1	Line	PSCo	544	554.9	102.0%	677.8	124.6%	22.6%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2
Monument – Gresham 115kV # 1	Line	TSGT	145	146.0	100.7%	167.8	115.7%	15.0%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2
Palmer – Monument 115kV #1	Line	PSCo	108	143.4	132.8%	168.0	155.6%	22.8%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2
Pueblo Plant – Reader 115kV # 1	Line	BHE	160	189.9	118.7%	217.3	135.8%	17.1%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2
Vollmer – Black Squirrel 115kV # 1	Line	TSGT	173	185.8	107.4%	209.8	121.3%	13.9%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2
Vollmer – Fuller 115kV #1	Line	TSGT	173	185.8	107.4%	209.8	121.3%	13.9%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2
West Canyon – Hogback 115kV # 1	Line	BHE	120	104.2	86.8%	123.8	103.2%	16.4%	Comanche - Daniels Park 345kV #1 and Daniels Park – Tundra 345 KV #2

6.2.4 Affected Systems

The study did not identify any impacts to the Affected Systems.

The multiple contingency overloads are mitigated using system adjustments, including generation redispatch and/or operator actions.

7.0 Cost Estimates and Assumptions

Since 2RSC-2020-5 is the only GIR in the Cluster, all costs below are 100% allotted to 2RSC-2020-5.

The total cost of the required Upgrades for 2RSC-2020-5 to interconnect the 250MW hybrid Generating Facility for ERIS is **$6.95 Million.**

- **The cost of Transmission Provider's Interconnection Facilities is $1.95 Million (Table 6).**
- **The cost of Station Network Upgrades is $5.0 Million (Table 7).**

Figure 2 is a conceptual one-line of the 2RSC-2020-5 interconnection at the Mirasol 230kV Substation.

Table 6 – 2RSC-2020-5 Transmission Provider's Interconnection Facilities

Element	Description	Cost Est. (Millions)
Mirasol 230kV Substation	Interconnect Customer to tap at the 230kV bus at the Mirasol 230kV Substation. The new equipment includes: The new equipment includes: - Install one 230kV line position - Three 230 kV line arresters - Station Controls - Switch Gang 230kV - Equipment Foundations - Site Grounding system - Structure Substation Equipment and Bus 230kV - Tower Substation Deadend 230kV - Transformer Instrument Current Potential Voltage C	$1.600
	Transmission line tap into substation.	$0.150
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction	$0.200
	Total Cost Estimate for Transmission Provider's Interconnection Facilities	**$1.950**

Time Frame	**Site, design, procure and construct**	**18 Months**

Table 7 –Station Network Upgrades – Expansion of Mirasol Substation

Element	Description	Cost Est. (Millions)
PSCo's Mirasol 230kV Transmission Substation	Interconnect Customer to the 230 kV bus at the Mirasol 230kV Substation. The new equipment includes: • Four 230kV disconnect Switches • Two 230kV circuit breakers • One power quality panel • Associated communications, supervisory and SCADA equipment • Associated bus, wiring and equipment • Associated foundations and structures	$5.0
	Siting and Land Rights support for substation construction	$0.020
	Total Cost Estimate for Network Upgrades for ERIS	**$5.0**
Time Frame	**Site, design, procure and construct**	**18 Months**

8.0 Summary of Generation Interconnection Service Results:

Energy Resource Interconnection Service allotted to 2RSC-2020-5 is: 250MW (after required transmission system improvements in Tables 6 and 7).

The total estimated cost of the transmission system improvements required for 2RSC-2020-5 is $6.95 Million (Tables 6 and 7).

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, a restudy of the power flow analysis may be performed as needed during Phase 2, and study results and costs will be updated.

The Customer is required to design and build the Generating Facility to mitigate for any potential inverter interactions with the neighboring inverter based Generating Facility(ies) and/or the inverters of the hybrid Generating Facility.

The output of 2RSC-2020-5 will be limited to 250MW at the Point of Interconnection using the power plant controller. Additional monitoring and control requirements will be added to the LGIA

to ensure the Interconnection Service amount is not exceeded. The Generating Facility output will also be monitored by PSCo operations.

The Mirasol 230kV Substation is a new substation identified in the DISIS-2020-001. A CPCN is needed for the construction of the Mirasol 230kV Substation. The estimated time frame for regulatory activities and to site, design, procure and construct the interconnection facilities is approximately 36 months after authorization to proceed has been obtained. Any delays in obtaining the CPCN may delay the Commercial Operation Date of 2RSC-2020-5.

This report only evaluated Interconnection Service of 2RSC-2020-5, and Interconnection Service in and itself does not convey transmission service.

8.1 Cost Estimate Assumptions

The cost estimates are in 2020 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 the new PSCo facilities. The estimates do not include the cost for any Customer owned equipment and associated design and engineering.

A level of accuracy is not specified for the estimates.

- Labor is estimated for straight time only – no overtime included.
- Lead times for materials are considered for the schedule.
- A CPCN is required for the construction of Mirasol Substation. The estimated time frame for regulatory activities (CPCN) and to site, design, procure and construct the interconnection facilities (entire Project) is approximately 36 months after authorization to proceed has been obtained. While the expansion of the Mirasol Substation to interconnect 2RSC-2020-5 is not expected to require a CPCN, the COD of 2RSC-2020-5 is dependent on the construction of Mirasol Substation.
- The Customer Generating Facilities are not located in PSCo's retail service territory. Therefore, no costs for retail load metering are included in these estimates.
- PSCo (or it's Contractor) crews will perform all construction, wiring, testing and commissioning for PSCo owned and maintained facilities.
- Customer will install two (2) redundant fiber optics circuits into the Transmission provider's substation as part of its interconnection facilities construction scope.

- Line outages will be necessary during the construction period. Outage availability could potentially be problematic and extend requested backfeed date.
- 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 / Xcel will need indications, readings and data from the LFAGC RTU.

9.0 Grid Charging Capacity Evaluation

2RSC-2020-5 requested evaluation of the Grid Charging capacity to charge the 100MW BES facility at a rate of 50MW for 4hrs. The GIR shall not start operating in the grid charging mode until after five (5) years and three (3) months from the COD of the Generating Facility. Since the COD of 2RSC-2020-5 is September 30, 2022, the grid charging mode is not expected to start until December 30, 2027.

9.1 Study Methodology

The study used the same Criteria shown in Section 4.2 of this report. As previously stated, 2RSC-2020-5 is the only GIR in the RSC and is studied in the Southern Colorado study pocket.

The scope of the studies includes steady state assessment and cost estimates. Since the Interconnection Facility costs are identified as part of the Generation Interconnection service, the cost estimates identified for Grid Charging operation only include any additional Interconnection Facilities and Network Upgrade costs required to accommodate charging from the grid (in addition to costs identified in Tables 6 and 7).

9.2 Power Flow Modeling Assumptions

The Benchmark Case is created from the Base Case described in Section 5.1 by adopting the generation dispatch given in Table 8 below. The PSCo loads in the Southern Colorado study area are modeled at their expected 2027 values.

Table 8 – Generation dispatch used to Stress the Benchmark Case for Grid Charging Capacity evaluation (MW is Gross Capacity)*

Bus Name	ID	Status	PGen (MW)	PMax (MW)
COMAN_1 24.000	C1	0	0	360
COMAN_2 24.000	C2	0	0	365
COMAN_3 27.000	C3	1	853	853
COMAN_PV 34.500	S1	0	0	125
CO_GRN_E 34.500	W1	1	17	81
CO_GRN_W 34.500	W2	1	17	81
FTNVL1&2 13.800	G1	0	0	40
FTNVL1&2 13.800	G2	0	0	40
FTNVL3&4 13.800	G3	0	0	40
FTNVL3&4 13.800	G4	0	0	40
FTNVL5&6 13.800	G5	0	0	40
FTNVL5&6 13.800	G6	0	0	40
JKFULGEN 0.6900	W1	1	52.5	250
LAMAR_DC 230.00	DC	0	0	210
TWNBUTTE 34.500	W1	1	15.8	75
SI_GEN 0.6000	1	0	0	30
TBII_GEN 0.6900	W	1	16	76
TI-18-0809 0.6300	PV	0	0	100
TI-19-1016 0.6300	PV	0	0	40

*This table only shows the generation increases from the Base Case.

A Study Case was created from the Benchmark Case by modeling 2RSC-2020-5 in charging mode (negative generator), with the same Mvar limits as the generating mode.

9.3 Grid Charging Analysis

The steady state assessment is performed as described in Section 4.3.1 of this report.

The contingency and monitoring criteria as described in 4.3.2 and 4.3.3 respectively are used. The single contingency analysis (P1 and P2-1) and multiple contingency analysis (P4, P5 and P7) did not identify any overloads.

9.3.1 Summary

Since the steady state analysis did not identify any violations, the maximum allowable Grid Charging Capacity of 2RSC-2020-5 is 50MW.

The Grid Charging Capacity of 2RSC-2020-5 is 50MW at any time of the day

The Generating Facility should be capable of voltage control and frequency control in the Grid Charging mode, similar to the generation mode. The Generating Facility shall not ride through during faults during grid charging mode. The interconnection Guidelines for BES facilities in charging mode are under development and may change between now and 2027. The 2RSC-2020-5 Hybrid Generating Facility shall be capable of meeting these future interconnection requirements for charging mode of operation from the transmission system.

Grid Charging capacity in and of itself does not grant any transmission service for this mode of operation.

Figure 2 – Preliminary One-line of the 2RSC-2020-5 POI at the Mirasol 230kVSubstation