INFO-2020-11

100MW Solar plus BES Hybrid Generating Facility

Uintah – Cameo 230kV Line

12/10/2021

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1.0 Summary

This report is the informational evaluation study of a 100MW DC-coupled Solar PV plus BES Hybrid Generating Facility interconnection on the Uintah – Cameo 230kV line. The expected Commercial Operation Date of the Generating Facility is December 31, 2024 and requested NRIS.

Network Resource Interconnection Service (NRIS) of INFO-2020-11 is 100MW.

The total estimated cost of the transmission system improvements to interconnect INFO-2020-11 for 100MW NRIS is $19.061 Million (Tables 5, 6 and 7). This cost does not include the cost for network upgrades to deliver the generator output from Western Colorado to Eastern Colorado across the TOT5 power transfer path[1].

The interconnection station needed to tap the Uintah – Cameo 230kV line will require a CPCN (Certificate of Public Convenience and Need). The total estimated time frame for completing regulatory activities (CPCN approval) and to site, design, procure and construct the switching station at the POI is approximately 36 months after authorization to proceed has been obtained.

Note – This report is an informational evaluation study and does not grant any Interconnection Service or Transmission Service. The results are based on the modeling assumptions and study scope specified by the Customer, which may or may not reflect the standard modeling assumptions followed for the LGIP studies.

[1] TOT5 Path is jointly owned by Platte River Power Authority (PRPA), Public Service Company of Colorado (PSCo), Tri-State Generation and Transmission Association, Inc. (TSGT), and Western Area Power Administration (WAPA). As such, any network upgrades needed to increase the TOT5 Path capacity/rating would need to be determined through joint studies.

2.0 Introduction

This report is the informational evaluation study for a 100MW DC-Coupled Solar Photovoltaic (PV) plus Battery Energy Storage (BES) Hybrid Generating Facility. The net output at the POI will be limited to 100MW at all times. The Point of Interconnection (POI) is a tap on the Uintah–Cameo 230kV line.

The request is referred to as "INFO-2020-11" which requested Network Resource Interconnection Service (NRIS)[2].

The proposed Commercial Operation Date (COD) of INFO-2020-11 is December 31, 2024. The geographical location of the Transmission System near the POI is shown in Figure 1 below.

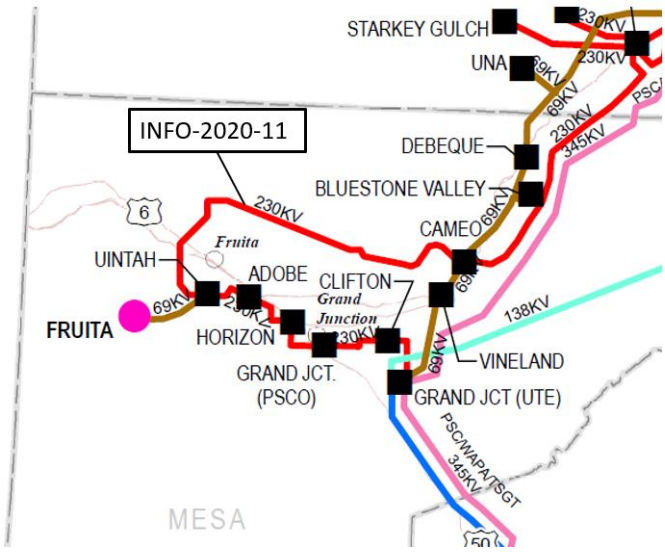


Figure 1 – Approximate location of INFO-2020-11 POI

[2] **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

3.0 Study Scope

The study was performed using the modeling assumptions specified by the Interconnection Customer. The study scope identified by the Customer includes FERC Order 827 reactive power requirements analysis, power flow analysis to evaluate the steady state thermal and voltage limit violations, and stability analysis. This report also provides cost estimates for Interconnection Facilities, Station Upgrades and Network Upgrades.

Per the Study Request, the 100 MW rated output of INFO-2020-11 is assumed to be delivered to PSCo native load, so existing PSCo generation is used to sink the interconnecting generator's output.

3.1 Study Criteria

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

P0 - System Intact conditions:

Thermal Loading: <=100% 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%

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%

The transient voltage stability criteria are as follows:

a. Following fault clearing, voltage shall recover to 80% of the pre-contingency voltage within 20 seconds of the initiating event for all P1 through P7 events for each applicable Bulk Electric System (BES) bus serving load.

b. Following fault clearing and voltage recovery above 80%, voltage at each applicable BES bus serving load shall neither dip below 70% of pre-contingency voltage for more than 30 cycles nor remain below 80% of pre-contingency voltage for more than two seconds, for all P1 through P7 events.

c. For Contingencies without a fault (P2.1 category event), voltage dips at each applicable BES bus serving load shall neither dip below 70% of pre-contingency voltage for more than 30 cycles nor remain below 80% of pre-contingency voltage for more than two seconds.

The transient angular stability criteria are as follows:

a. P1 – No generating unit shall pull out of synchronism. A generator being disconnected from the system by fault clearing action or by a special Protection System is not considered an angular instability.
b. P2-P7 – One or more generators may pull out of synchronism, provided the resulting apparent impedance swings shall not result in the tripping of any other generation facilities.
c. P1-P7 – The relative rotor angle (power) oscillations are characterized by positive damping (i.e., amplitude reduction of successive peaks) > 5% within 30 seconds.

3.2 Study Methodology

Thermal violations are identified if a facility (if) resulted in a thermal loading >100% in the Study Case after the study generator 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 0.01p.u.

All existing generators and the study generator should meet the Transient stability criteria.

3.3 Affected Systems

The study identified mitigations to impacts to the PSCo Transmission System and any impacted Affected Systems. The Affected Systems included in the study are Holy Cross Electric Association (HCEA), Tri-State Generation and Transmission, Inc (TSGT), and Western Area Power Administration (WAPA).

As shown in Figure 1, the POI of the request is in Western Colorado. Hence the study analysis is based on the Western Colorado study pocket analysis.

3.4 Study Area

The study area includes the appropriate WECC designated zones. The study area includes the TOT5 power transfer path between Western Colorado and the Denver Metro / Front Range Area The path represents transmission lines that cross the Continental Divide in Colorado.

Table 1. TOT5 Power Transfer Path Definition

Line	Metered End
North Park-Terry Ranch Road 230 kV	Terry Ranch Road
Craig-Ault 345 kV	Craig
Hayden-Gore Pass 230 kV	Gore Pass
Hayden-Gore Pass 138 kV	Gore Pass
N. Gunnison-Salida (Poncha Jct.) 115 kV	Poncha
Curecanti-Poncha 230 kV	Curecanti
Basalt-Malta 230 kV	Basalt
Hopkins-Malta 230 kV	Hopkins

The Total Transfer Capability (TTC) of the TOT5 power transfer path is 1680 MW and is allocated among the following utilities:

- Platte River Power Authority (PRPA)
- Public Service Company of Colorado (PSCo)
- Tri-State Generation and Transmission Association, Inc. (TSGT)
- Western Area Power Administration (WAPA)

4.0 Modeling Assumptions

The study was performed using a 2026HW case. Please note the following assumptions:

(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 2024
- Husky 230/115kV Substation – ISD 2024
- Mirasol 230kV Switching Station – ISD 2022
- Tundra 345kV Switching Station – ISD 2022

- Avery Substation – ISD 2022
- Barker Substation – Bank1 ISD: 2025, Bank 2 ISD: 2026
- High Point Substation – ISD 2022
- Titan Substation – ISD 2023
- Bluestone Valley Phase 2 – ISD 2023
- Monument – Flying Horse 115kV Series Reactor – ISD 2023
- Ault – Husky 230kV line – ISD 2024
- Husky – Graham Creek – Cloverly 115kV line – ISD 2024
- Gilman – Avon 115kV line – ISD 2023
- Climax – Robinson Rack – Gilman 115kV – ISD 2023
- Greenwood – Arapahoe – Denver Terminal 230kV – ISD 2022
- Upgrade Villa Grove – Poncha 69kV Line to 73MVA – ISD 2021
- Upgrade Poncha – Sargent - San Luis Valley 115kV line to 120MVA – ISD 2022
- Upgrade Antonito – Romeo – Old40Tap – Alamosa Terminal – Alamosa Switchyard 69kV line to 143MVA – ISD 2022/2023

All transmission facilities were modeled at their expected ratings for 2023 Summer season. Also, the following facility uprate projects were 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 756MVA – ISD to be determined
- Upgrade Greenwood – Priarie1 230kV line to 576MVA – ISD 2021
- Upgrade Daniels Park – Priarie3 230kV line to 756MVA – ISD to be determined
- 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 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:

- 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 1/31/2022
- 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 South 115/230kV transformer project tapping the Cottonwood – Fuller 230kV line – ISD 2023

The Base Case model includes the existing PSCo generation resources and all Affected System's existing resources. In addition, the following higher-queued generation from PSCo's queue were modeled in the Base Case:

GI-2014-6, GI-2014-9, GI-2014-13, GI-2016-15, Transitional Cluster (GI-2018-24 , GI-2018-25, and GI-2019-6), 1RSC-2020 (1RSC-2020-2), DISIS-2020-001 (GI-2020-1, GI-2020-3, GI-2020-4, GI-2020-5, GI-2020-6, GI-2020-7, and GI-2020-10), 2RSC-2020, DISIS-2020-002 (GI-2020-12, GI-2020-13, GI-2020-14, GI-2020-15 and GI-2020-16) and GI-2020-18.

The following Network Upgrades from higher-queued studies are modeled:

- DISIS-2020-001: tap the Comanche – Midway 230kV line at Mirasol 230kV
- DISIS-2020-002:
    - Tap the Daniels Park – Comanche 345kV line at GI-2020-14/12 POI
    - Upgrade Boone – GI-2020-13 230kV line to 394MVA

The following Network Upgrades from the approved TSR are also modeled:

- Midway 230/115kV, 97MVA transformer replacement with 280MVA

- Uprate Daniels Park – Prairie 1 & 3 230kV lines

The following future generation connected to the Affected Systems are modeled in the Base Case:

CORE Electric Cooperative (formerly IREA):

- 80MW Pioneer Solar PV Generating Facility interconnecting on the Victory – Brick Center 115kV line – COD 12/31/2020
- 45MW Hunter Solar PV Generating Facility interconnecting at Brick Center 115kV Substation – COD 2/1/2022
- 54.5MW Kiowa Solar PV Generating Facility interconnecting at Victory 115kV Substation – COD 4/1/2023

TSGT:

- TI-18-0809, 100MW NRIS/ERIS Solar, Walsenburg-Gladstone 230kV line
- GI-TI-2021-04, 40MW NRIS/ERIS Solar, Walsenburg-Gladstone 230kV line

5.0 Study Analysis

The INFO-2020-11 is studied in the Western Colorado study pocket.

5.1 Reactive Power Capability Evaluation

The following voltage regulation and reactive power capability requirements at the POI are applicable to the generator:

- 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 no load conditions.

The reactive power analysis performed in this report is an indicator of the generic reactive power requirements at the POI and the capability of the generator to meet those requirements. All generators are required to design the interconnection to meet the POI voltage control requirements that will be specified by the Transmission Operator. 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.

According to the modeling data provided by the Customer, the generator model is as follows:

PV: Pmax = 101.745 MW, Pmin = 0, Qmax = 33.44MVAR, Qmin = -33.44MVAR. Generator output was adjusted appropriately to achieve 100MW at the POI as seen in Table 2 for each scenario. The main step-up transformer is undersized as customer provided data has the transformer rated for 68MVA.

Additionally, the Generating Facility includes a 1 x 21 MVAR shunt capacitor bank.

The results of the reactive capability analysis are given in Table 2. The INFO-2020-11 is capable of maintaining ±0.95pf at the high side of the main step-up transformer, however, the POI voltage exceeds the normal system intact operating range of 0.95-1.05 p.u.

The modeling data provided does not reflect an accurate model for the 100MW Generating Facility. The high voltage at the POI seems to be an artifact of the incorrect modeling data and could be resolved with accurate Generating Facility model information.

Table 2 – Reactive Capability Evaluation for INFO-2020-11

Gen MW / Mvar	21 MVAR Cap bank status	Gen Voltage (p.u.)	Main Step-up Transformer High Side				POI			
			Voltage (p.u.)	MW	Mvar	Power Factor	Voltage (p.u.)	MW	Mvar	Power Factor
101.5MW/ 33.4Mvar	On	1.13	1.09	100	39.5	0.930 (lag)	1.09	100	39.7	0.930 (lag)
102.3MW/ -33.6Mvar	Off	0.87	1.01	100	-62.5	0.848 (lead)	1.01	100	-62.4	0.848 (lead)
10.1MW/ 3.3Mvar	On	1.06	1.08	10.0	26.0	0.359 (lag)	1.08	10.0	26.3	0.359 (lag)
10.1MW/ -3.3Mvar	Off	1.00	1.05	10.0	-3.4	0.947 (lead)	1.05	10.0	-3.1	0.947 (lead)
0MW/ 0Mvar	Off	0.99	1.04	0.0	-0.2	NA	1.04	0.0	-0.5	NA

5.2 Study Analysis – Generation Interconnection Service

5.2.1 Benchmark Case Modeling

The Benchmark Case for evaluating INFO-2020-11 was developed from the Base Case described in Section 4.0 by changing the generation dispatch in the Western part of Colorado to reflect a West to East flows across TOT5. The study modeled the TOT5 path at a maximum of 1,680MW.

5.2.2 Study Case Modeling

A Study case was created from the Benchmark Case by modeling INFO-2020-11 at the POI tapping the Uintah-Cameo 230kV line. The 100MW NRIS output from the generator was balanced by reducing Pawnee Unit 1.

5.2.3 Steady State Analysis Results

The results of the single contingency analysis are shown in Table 3. The addition of INFO-2020-11 caused an increase in the existing overload for the following facilities:

Xcel Energy

Table 3 – Overloads identified in Single Contingency Analysis

Overloaded Facility	Type	Owner	Facility Normal Rating (MVA)	Facility Loading in Benchmark Case		Facility Loading in Study Case		% Change due to INFO-2020-11	Single Contingency Definition
				MVA Flow	% Line Loading	MVA Flow	% Line Loading		
Cabin Creek - Lookout 230kV	Line	PSCo	478	506.2	105.9%	524.2	109.7%	3.8%	Cabin Creek - Idaho Springs 230kV Line
Cameo 69/230kV T5	Xfmr	PSCo	66.7	95.3	143.0%	107.1	161.0%	18.0%	Uintah - INFO-2020-11 230kV Line
Gorepass 230/138kV T1	Xfmr	PSCo	129.5	148.8	114.9%	152.4	117.7%	2.8%	Blue River - Gorepass 230kV Line
Glenwood - Mitchel Creek 69kV	Line	PSCo	55.9	51.9	92.9%	56.3	100.7%	100.7%	Hopkins - Rifle_PS 230kV Line
Hopkins - Basalt 115kV	Line	PSCo	94	177.3	188.6%	184.5	196.3%	7.7%	Hayden West - Foidelck 230kV Line
Idaho Springs - Lookout 230kV	Line	PSCo	478	488.7	102.2%	506.7	106.0%	3.8%	Cabin Creek - Lookout 230kV Line
Mitchell Creek - New Castle 69kV	Line	PSCo	55.9	58.4	104.5%	62.5	111.7%	7.2%	Hopkins - Rifle_PS 230kV Line
Newcastle - Silt 69kV	Line	PSCo	55.9	64.4	115.3%	68.6	122.7%	7.4%	Hopkins - Rifle_PS 230kV Line
Rifle_CU - Silt 69kV	Line	PSCo	55.9	64.5	115.3%	68.6	122.7%	7.4%	Hopkins - Rifle_PS 230kV Line
Tarryall 115/230kV T1	Xfmr	PSCo	100	99.7	99.7%	103.3	103.3%	3.6%	Tarryall - Waterton 230kV Line
W.Canon 115/230kV T1	Xfmr	PSCo	100	109.2	109.2%	116.8	116.8%	7.6%	MidwayBR - W Canon 230kV Line
East Portal - West Portal 69kV	Line	PSCo	30	42.1	140.3%	44.9	149.7%	9.4%	Ault - Craig 345kV Line

Overloaded Facility	Type	Owner	Facility Normal Rating (MVA)	Facility Loading in Benchmark Case		Facility Loading in Study Case		% Change due to INFO-2020-11	Single Contingency Definition
				MVA Flow	% Line Loading	MVA Flow	% Line Loading		
East Portal - MARYLKSB 69kV	Line	PSCo	30	40.1	133.7%	42.6	141.9%	8.3%	Blue River - Ptarmgn 230kV Line
West Portal - McKenzie 69kV	Line	PSCo	36	42.6	118.3%	45.6	126.7%	8.4%	Ault - Craig 345kV Line
Oak Creek TP - Gorepass 138kV	Line	PSCo	140	192.6	137.6%	198.3	141.7%	4.1%	Gorepass - Hayden East 230kV Line
Oak Creek TP - Hayden 138kV	Line	PSCo	140	192.7	137.6%	198.4	141.7%	4.1%	Gorepass - Hayden East 230kV Line
Fraser 138/115kV T#1	Line	PSCo	100	106.2	106.2%	109	109.0%	2.8%	Blue River - Gorepass 230kV Line
Weld LM 115/230kV T# 1	Transformer	PSCo	150	150.2	100.1%	153.5	102.3%	2.2%	Weld LM 115/230kV T# 1
MARYLKSB 115/69kV	Transformer	PSCo	25	40.4	161.4%	42.8	171.2%	9.8%	Blue River - Ptarmgn 230kV Line
Blue Mesa - Skito 115kV	Line	PSCo	137	149.5	109.1%	155.9	113.8%	4.7%	Curecanti - PonchaBr 230kV Line
Craig 230/22kV	Transformer	PSCo	470.4	478.5	101.7%	486	103.3%	1.6%	DAVEJOHN - LAR.RIVR 230kV Line
Craig 230/22kV	Transformer	PSCo	470.4	478.5	101.7%	486	103.3%	1.6%	DAVEJOHN - LAR.RIVR 230kV Line
Craig - Hayden West 230kV	Line	PSCo	319	386.7	121.2%	402.5	126.2%	5.0%	Craig - Hayden East 230kV Line

This table illustrates the potential reliability issues for a 100 MW dispatch from Western to Eastern Colorado to deliver to PSCo native load across the TOT5 power transfer path[3].

[3] TOT5 Path is jointly owned by Platte River Power Authority (PRPA), Public Service Company of Colorado (PSCo), Tri-State Generation and Transmission Association, Inc. (TSGT), and Western Area Power Administration (WAPA). As such, any network upgrades needed to increase the TOT5 Path capacity/rating would need to be determined through joint studies.

5.2.4 Transient Stability Results

Transient stability studies were conducted for this Informational Study. The following results were obtained for the transient stability analysis:

- ✓ No machines lost synchronism within the system
- ✓ No voltage recovery violations were observed
- ✓ Machine rotor angles displayed positive damping

The results of the transient stability analysis are shown in Table 4. The transient stability plots are shown in Section 7 of this report.

Table 4 – Stability Scenarios

Stability Scenarios						
#	**Fault Location**	**Fault Type**	**Facility Tripped**	**Clearing Time (cycles)**	**Post-Fault Voltage Recovery**	**Angular Stability**
1	CRAIG 345 kV	3ph	Craig 345 kV	4	Stable	Stable
2	GRANDJCT 345 kV	3ph	GRANDJCT-RIFLE_CU 345 kV	4	Stable	Stable
3	INFO-2020-11 POI 230kV	3ph	POI – Cameo 230kV POI – Uintah 230 kV	5	Stable	Stable
4	UINTAH 230 kV	3ph	Uintah – Adobe-Grand JCT – Clifton - Grand JCT Ute 230 kV	5	Stable	Stable

6.0 Cost Estimates and Assumptions

PSCo Engineering has developed cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades required for the interconnection of the Interconnection Customer's proposed generation facility. The cost estimates are in 2021 dollars with escalation and contingencies applied. AFUDC is not included. These estimated costs include all applicable labor and overheads associated with the siting, 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.

The estimated total cost for the required upgrades is **$19,061,000.**

Figure 2 below is a conceptual one-line of the proposed interconnection. The Point of Interconnection will be a tap on the new 230kV substation proposed for INFO-2020-11. The proposed substation will tap the Cameo - Uintah 230kV Transmission Line.

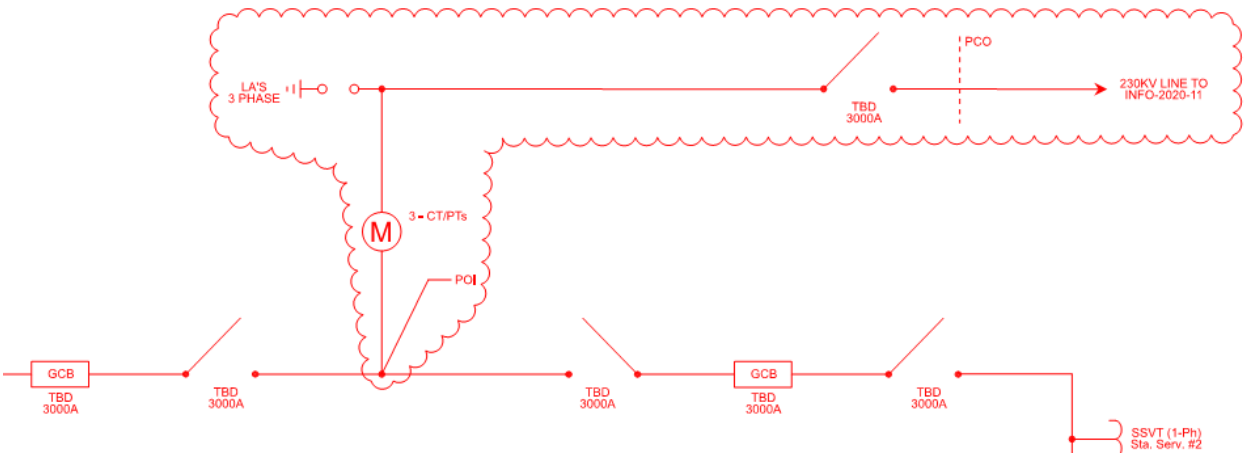


Figure 2. INFO-2020-11 Project One-line Diagram

Tables 5-7 below list the transmission improvements required to interconnect the Customer's 100 MW solar generation facility output for NRIS. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines.

Table 5: Transmission Provider Interconnection Facilities (TPIF)

Element	Description	Cost Est. (Millions)
INFO-2020-11 230kV Substation	Interconnect Customer at the INFO-2020-11 Substation 230kV bus. The new equipment includes: •Three (3) 230kV arresters • One (1) 230kV Switch • One set (of three) high side metering units • Fiber communication equipment • Station controls • Associated electrical equipment, bus, wiring and grounding • Associated foundations and structures •Associated transmission line communications, fiber, relaying and testing.	$1.226
	Transmission Line tap into substation.	$0.050
	Siting and Land Rights support for permitting and construction.	$0.020
	Total Cost Estimate for Transmission Providers Interconnection Facilities	**$1.296**
Time Frame	**Site, design, procure and construct**	**36 Months**

Table 6: Substation Network Upgrades for Interconnection

Element	Description	Cost Est. (Millions)
INFO-2020-11 230kV Substation	INFO-2020-11 230kV Substation. The new equipment includes: •Nine (9) 230kV gang switches •Three (3) 230kV circuit breakers •Two (2) Line Traps •Two (2) SSVTs •One (1) 27' x 55' EEE •Associated bus, wiring and equipment •Associated foundations and structures •Associated transmission line communications, relaying and testing	$14.711
L5607 230kV Transmission Line	Transmission Line tap into substation.	$1.234
	Siting and Land Rights support for substation site acquisition, permitting and construction	$0.080
	Total Cost Estimate for Network Upgrades for Interconnection	**$16.025**
Time Frame	**Site, design, procure and construct**	**36 Months**

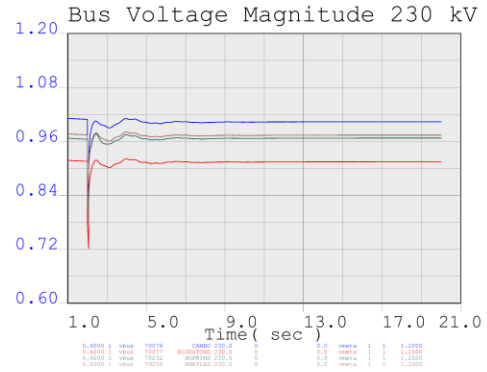
Table 7: Transmission Network Upgrades

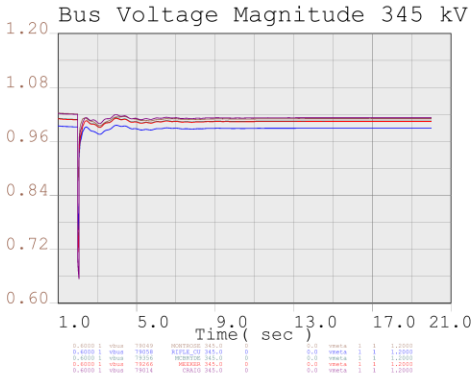
Element	Description	Cost Est. (Millions)
Cameo 230kV Substation	•Three (3) CCVTs •Three (3) Line Arresters •One (1) Line Trap •SEL-411L •Two (2) new UPLC-IIs •All required foundations, structures, and fittings for the new equipment	$0.870
Uintah 230kV Substation	•Three (3) CCVTs •Three (3) Line Arresters •One (1) Line Trap •SEL-411L •Two (2) new UPLC-IIs •All required foundations, structures, and fittings for the new equipment	$0.870
	Total Cost Estimate for Network Upgrades for Interconnection	**$1.740**
Time Frame	**Site, design, procure and construct**	**36 Months**

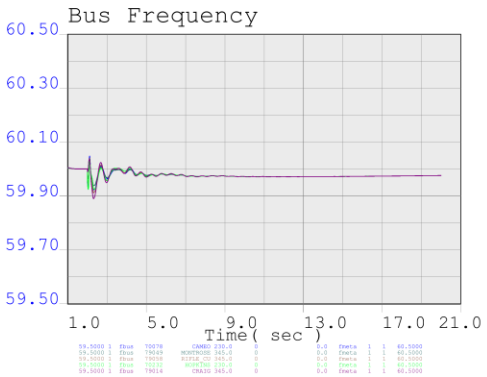
Cost Estimate Assumptions

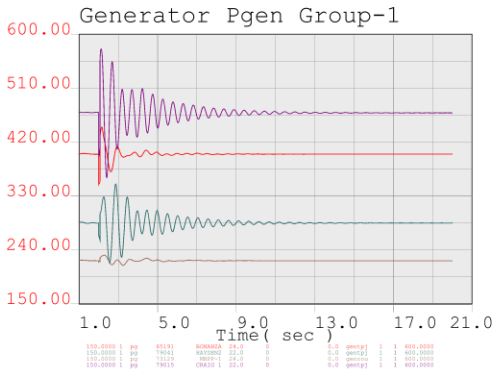
- Estimates are based on 2021 dollars (appropriate contingency and escalation applied).
- "Allowance for Funds Used During Construction" (AFUDC) has been excluded.
- Labor is estimated for straight time only – no overtime included.
- Lead times for materials were considered for the schedule.
- The Solar Generation Facility is not 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.
- PSCO anticipates that a CPCN will be required for the interconnection facilities construction. CPCN processing is included in the estimated project Time Frame.
- Customer will install two (2) redundant fiber optics circuits into the Transmission provider's substation
- Power Quality Metering (PQM) will be required on the Customer's 345kV line terminating into the PSCo / Xcel Substation.
- 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.

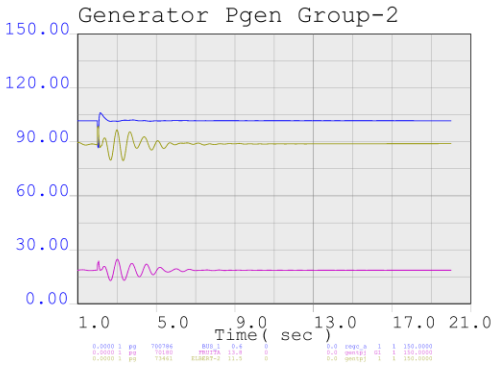
7.0 Transient Stability Plots

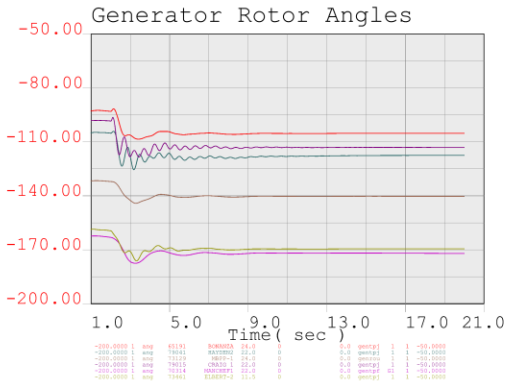




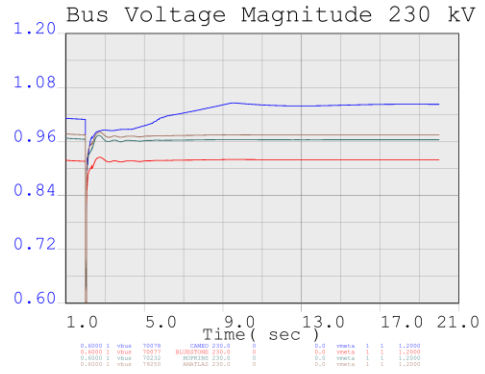


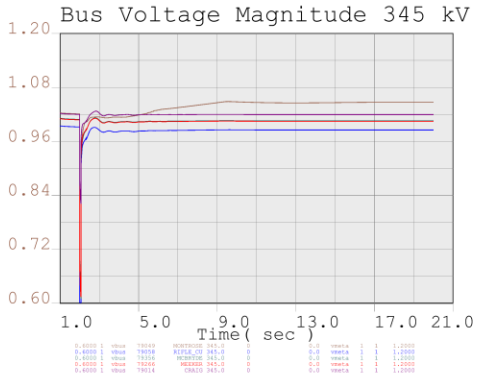


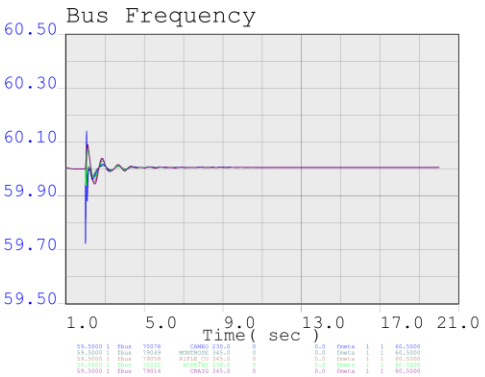


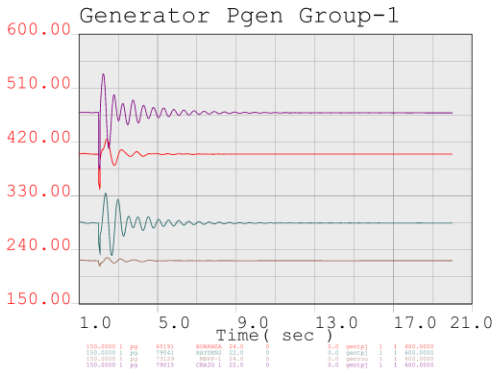


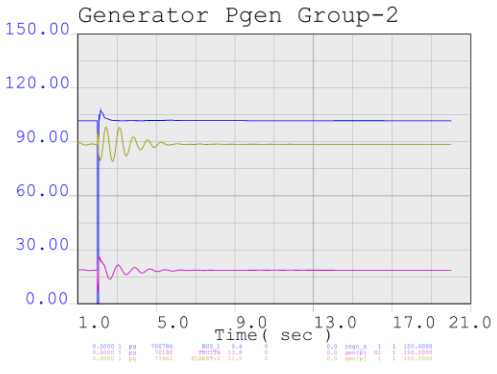
C1:
Fault: 3ph bus fault on CRAIG 345 kV for 4 cycles.
Outage: Trip CRAIG 3.

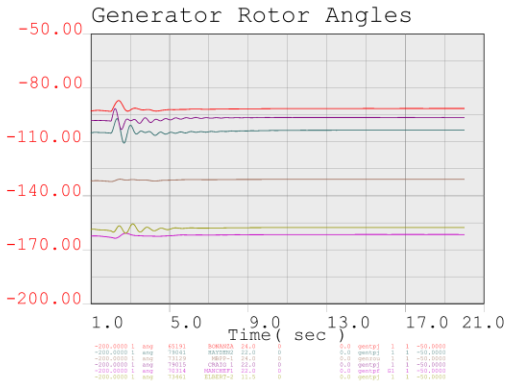




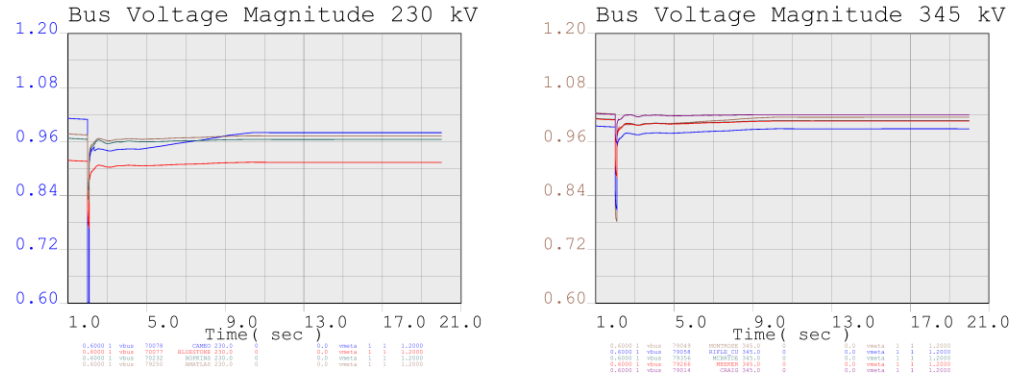


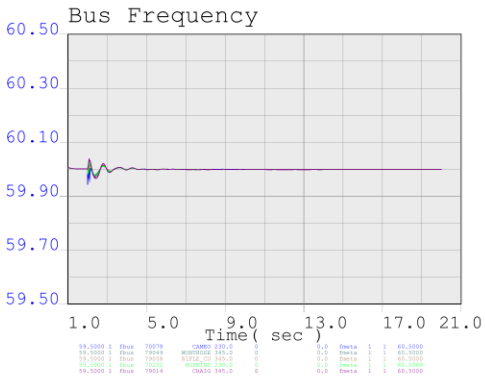


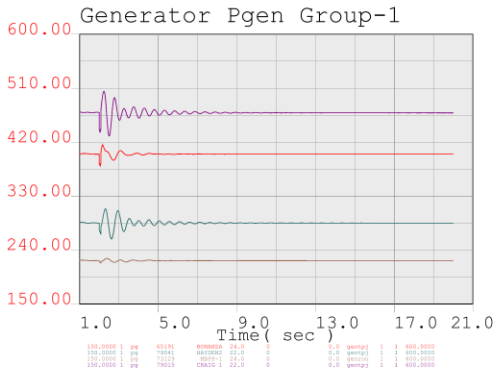


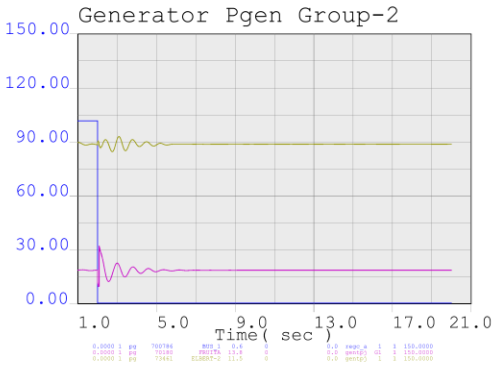


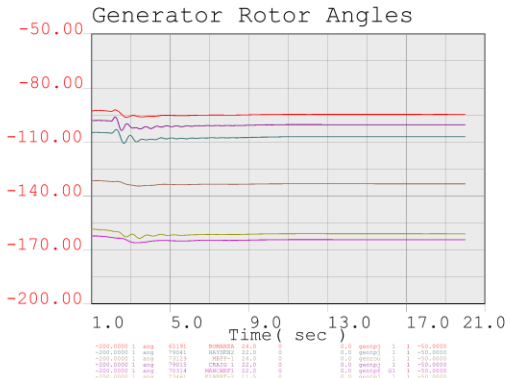
C2:
Fault: 3ph fault at GRANDJCT 345 kV for 4 cycles.
Outage: Lose GRANDJCT to RIFLE_CU 345 kV.



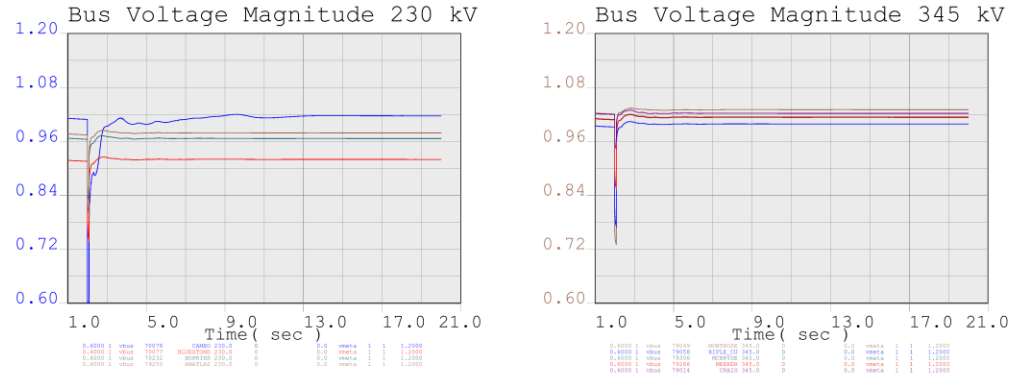


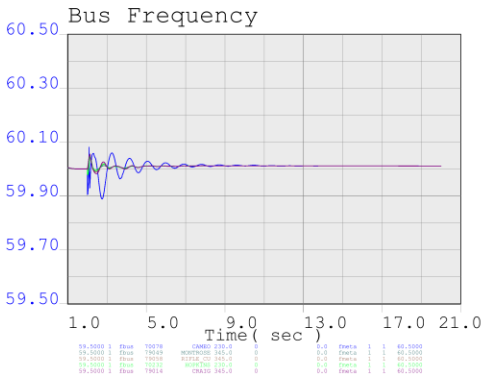


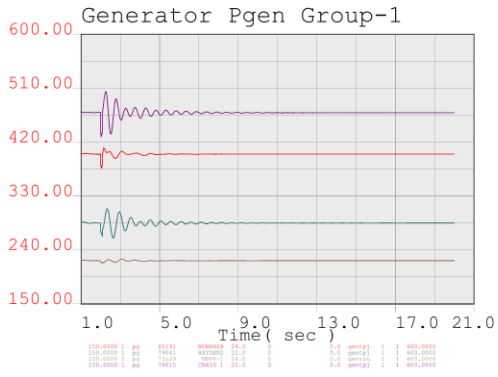


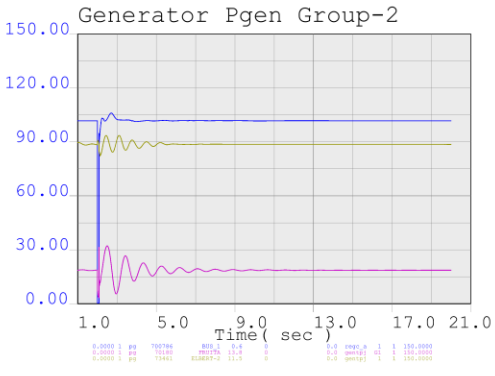


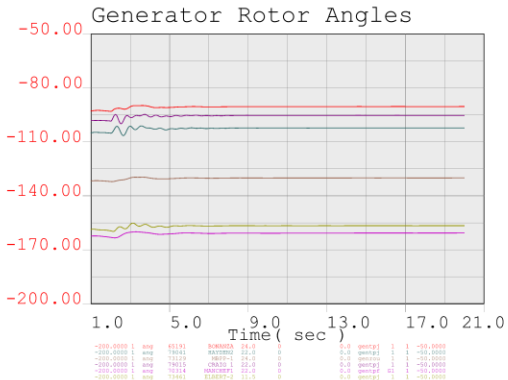
C3:
Fault: 3ph fault at study POI INFO-2020-11 230 kV for 5 cycles.
Outage: Lose POI - CAMEO 230kV and POI - Uintah 230 kV.











C4:
Fault: 3ph fault at Uintah 230kV for 5 cycles.
Outage: Uintah-Adobe-Horizon-Grand Junction-Clifton-Grand Junction Ute