INFO-2020-14

Informational Study Report

11/17/2021

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1.0 Summary

This report is an informational evaluation of a 120MW Solar PV Generating Facility interconnection on the Pawnee – Missile Site 230kV line. The expected Commercial Operation Date of the Generating Facility is December 31, 2023 and requested was studied for ERIS.

The study did not identify any thermal or voltage violations attributed to INFO-2020-14. The study did identify Tri-State Generation & Transmission as an Affected System.

Energy Resource Interconnection Service of INFO-2020-14 is 120MW.

The total estimated cost of the transmission system improvements to interconnect INFO-2020-14 for 120MW ERIS is $17.646 Million (Tables 7, 8, and 9).

The COD of INFO-2020-14 is dependent of the construction of a new switching station interconnected to the Pawnee – Missile Site 230 kV line, which is expected to require a CPCN. The total estimated time frame for regulatory activities (CPCN) 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 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.

2.0 Introduction

This report is the informational study for a 120MW solar Generating Facility. The facility is composed of a 120MW PV Solar Photovoltaic (PV) Generating Facility. The Point of Interconnection (POI) is the Pawnee – Missile Site 230kV line.

The proposed Commercial Operation Date (COD) of INFO-2020-14 is December 31, 2023. The geographical location of the Transmission System near the POI is shown in Figure 1 below.

The request is referred to as “INFO-2020-14” and requested Energy Resource Interconnection Service (ERIS)[1].

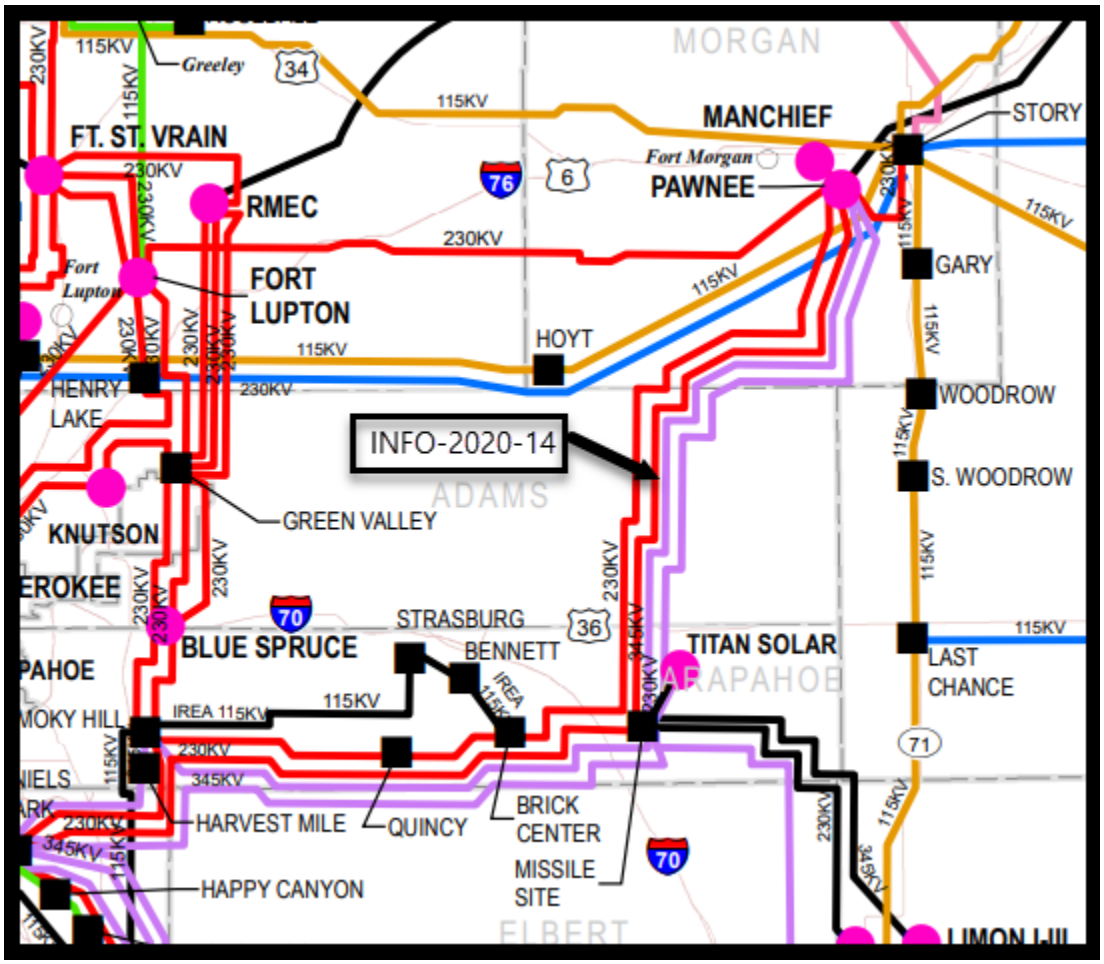

Figure 1 – INFO-2020-14 Point of Interconnection

[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 Study Scope

The study was performed using the modeling assumptions specified by the Interconnection Customer. The study scope identified by the Customer includes power flow analysis to evaluate the steady state thermal and voltage limit violations. Per the Study Request, the 120MW rated output of INFO-2020-14 is assumed to be delivered to PSCo native load, so existing PSCo generation is used to sink the generator output.

This report also provides cost estimates for Transmission Provider's Interconnection Facilities, Substation Network Upgrades for Interconnection, and Transmission Network Upgrades.

The study analyzed impacts to the PSCo Transmission System and the Affected Systems, while mitigations to PSCo system impacts are identified and costs are included in this report, Affected System impacts are identified but mitigations are not identified.

3.1 Study Pocket Determination

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

3.2 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%

3.3 Study Methodology

The steady state assessment is performed using PSSE V34.

3.3.1 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 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.

3.4 Study Area

The Study Area includes WECC designated zones 700, 704, and 706. The Affected System included in the analysis is the Tri-State Generation and Transmission Inc. (TSGT) system in the study area.

4.0 Modeling Assumptions

The study was performed using the 2026HS case.

4.1 Base Case Modeling

The Base Case was created from the 2026HS case by making the following modifications. The following approved transmission projects in the PSCo's 10-year transmission plan which are expected to be in-service before August 2026 are modeled:

- Cloverly 115kV Substation – ISD 2021
- Mirasol switching station 230kV – ISD 2022
- Tundra 345kV Switching Station – ISD 2022
- Bluestone Valley Phase 2 – ISD 2023
- Avery Substation – ISD 2022
- High Point Substation – ISD 2022
- Titan Substation – ISD 2023
- Dove Valley Substation – ISD 2023
- Greenwood – Arapahoe - Denver Terminal 230kV line – ISD 2022

- Monument – Flying Horse 115kV Series Reactor – ISD 2023
- Gilman – Avon 115kV line – ISD 2023
- Climax – Robinson Rack – Gilman 115kV – ISD 2023
- Rebuild Villa Grove – Poncha 69kV Line to 73MVA – ISD 2021
- Upgrade Poncha – Sargent – San Luis Valley 115kV line to 120MVA – ISD 2022
- Rebuild San Luis Valley – Mosca 69kV line to 143MVA – ISD 2022

All transmission facilities are modeled at their expected ratings for 2026 Summer season. 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 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 115kV line modeled at 173MVA – ISD 2022
- Fuller 230/115kV, 100MVA #2 transformer – ISD 2023

The following additional changes were made to the Black Hills Energy (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 Colorado Springs Utilities (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 project tapping the Cottonwood – Fuller 230kV line – ISD 2023

The Base Case model includes existing PSCo generation resources and existing Affected System generation. In addition, the following generation with approved Transmission Service and higher-queued generation are modeled:

- GI-2014-7, GI-2018-24, 1RSC-2020-1, 1RSC-2020-2, 2RSC-2020-5, T-2021-2 and GI-2020-06 (DISIS-2020-001) in the PSCo queue
- TI-18-0809 and TI-19-1016 in the TSGT queue
- BHCT-G29 in the BHE queue
- Victory Solar, Pioneer Solar, Hunter Solar and Kiowa Solar in the IREA system

5.0 Study Analysis

The INFO-2020-14 is studied in the Eastern Colorado study pocket.

5.1 Study Analysis – Generation Interconnection Service

Benchmark Case Modeling

The Benchmark Case was created from the Base Case by changing the study pocket generation dispatch as shown in Table 2 below.

Table 2 – Generation Dispatch Used to Create the Benchmark Case (MW is Gross Capacity)

Bus Name	ID	Status	PGen (MW)
SPRUCE1 18.000	G1	1	130.6
SPRUCE2 18.000	G2	1	126.5
MANCHEF1 16.000	G1	1	126.0
MANCHEF2 16.000	G2	1	126.0
PAWNEE 22.000	C1	1	536
PTZLOGN1 34.500	W1	1	160.8

Bus Name	ID	Status	PGen (MW)
PTZLOGN2 34.500	W2	1	96
PTZLOGN3 34.500	W3	1	63.6
PTZLOGN4 34.500	W4	1	140
CEDARPOINT 34.500	W1	1	200
TITAN-PV 34.500	S1	1	45.5
CHEYRGE_W1 0.6900	W1	1	99.2
CHEYRGE_W2 0.6900	W2	1	100.8
CHEYRGW_W1 0.6900	W1	1	99.2
CHEYRGW_W2 0.6900	W2	1	26.5
LIMON1_W 34.500	W1	1	160.8
LIMON2_W 34.500	W2	1	160.8
LIMON3_W 34.500	W3	1	160.8
BRONCO_W1 0.6900	W1	1	240
RUSHCK_W1 34.500	W1	1	304
RUSHCK_W2 34.500	W2	1	176
KNUTSON1 13.800	G1	1	40.3
KNUTSON2 13.800	G2	1	40.3
CEDAR2_W1 0.6600	W1	1	26.3
CEDAR2_W2 0.6900	W2	1	21.2
CEDAR2_W3 0.6600	W3	1	5.3
CEDARCK_1A 34.500	W1	1	46.2
CEDARCK_1B 34.500	W2	1	16.8
GI-2020-6	S1	1	204.8

5.1.1 Study Case Modeling

A Study case was created from the Benchmark Case by modeling INFO-2020-14 at a station interconnected to the Pawnee – Missile Site 230kV line. The 120MW ERIS output from the generator was balanced by reducing Comanche Unit 3.

5.1.2 Steady State Analysis Results

The results of the single contingency analysis are shown in Table 3.

The addition of INFO-2020-14 caused an increase in the existing overload on the Pawnee – Story 230kV line from 102.7% to 106.8% in the system intact condition and 135.8% to 140.9% in a contingency condition. The addition of INFO-2020-14 also caused an increase in the existing overload on the Clark – Jordan 230 kV line from 100.6% to 103.1%. The benchmark overloads will be mitigated by PSCo and it is expected that the benchmark mitigations will eliminate the Study Case overloads, so these overloads are not attributed to INFO-2020-14.

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-2020-14	Single Contingency Definition
				MVA Flow	% Line Loading	MVA Flow	% Line Loading		
Pawnee - Story 230kV	Line	PSCo	581	598	102.7%	622	106.8%	4.1%	None
Clark - Jordan 230kV	Line	PSCo	331	324	100.6%	332	103.1%	2.5%	Smoky Hill - Buckley 230 kV
Pawnee - Story 230kV	Line	PSCo	581	782	135.8%	141	140.9%	5.1%	Missile Site - Smoky Hill 230 kV

The results of the multiple contingency analysis are given in Table 4. Per TPL1-4, multiple contingency overloads on the PSCo facilities and Affected System facilities can be mitigated using system adjustments, including generation redispatch (including GI under study) and/or operator actions.

The study did not identify any single contingency impacts to the Affected Systems. However, the study did identify a multiple contingency impact on Tri State Generation & Transmission's Archer – Wayne Child 230 kV line. Therefore, Tri-State Generation & Transmission is an Affected System.

Table 4 – Overloads identified in Multiple Contingency Analysis

Overloaded Facility	Type	Owner	Facility Normal Rating (MVA)	Facility Loading in Benchmark Case		Facility Loading in Study Case		% Change due to INFO-2020-14	Multiple Contingency Definition
				MVA Flow	% Line Loading	MVA Flow	% Line Loading		
Clark - Jordan 230kV	Line	PSCo	331	358	112.0%	416	128.8%	16.8%	Daniels Park - Greenwood #1 & #2 230 kV

Pawnee - Story 230kV	Line	PSCo	581	921	161.6%	957	168.2%	6.6%	Missile Site - Smoky Hill 230 kV
Archer - Wayne Child 230 kV	Line	TSGT	327	457	136.8%	465	139.4%	2.6%	Missile Site - Smoky Hill 345 kV & Missile Site - Daniels Park 230 kV

6.0 Cost Estimates and Assumptions

The cost estimates are based on 2021 dollars with escalation and contingencies applied. Allowance 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. 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 **$17.646 Million.**

Figure 2 below is a conceptual one-line of the POI.

The estimated total cost of the Transmission Provider's Interconnection Facilities, Substation Network Upgrades for Interconnection, and Transmission Network Upgrades are shown in Tables 7, 8, and 9 respectively. System improvements are subject to revision as a more detailed and refined design is produced. The cost estimate assumptions include:

- 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.
- 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.

Figure 2 – Preliminary One-line of INFO-2020-14 Interconnecting at a new switching station tapping the Pawnee – Missile 230kV line

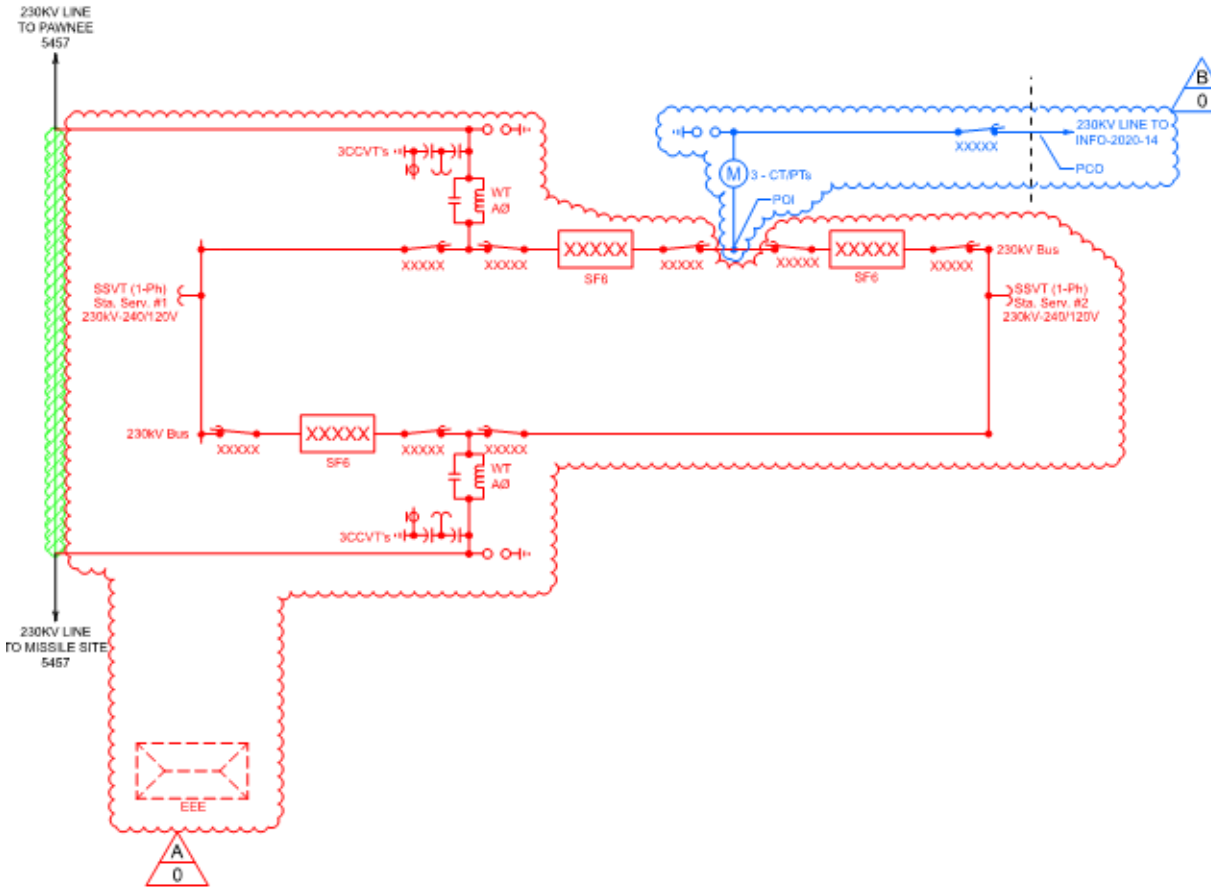

Table 7: Transmission Providers Interconnection Facilities

Element	Description	Cost Est. (Millions)
PSCO's proposed INFO-2020-14 230kV Substation	Interconnection Customer to interconnect at the Proposed Substation 230kV bus. The new equipment includes: • Three (3) 230kV deadend structures • 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.	$1.074
	Transmission line tap into substation.	$0.075
	Siting and Land Rights support for permitting and construction.	$0.020
	Total Cost Estimate for Transmission Providers Interconnection Facilities	**$1.169**
Time Frame	**Site, design, procure and construct**	**36 Months**

Table 8: Substation Network Upgrades for Interconnection

Element	Description	Cost Est. (Millions)
PSCO's proposed INFO-2020-14 230kV Substation	Construct new 230kV Substation to accommodate 120MW, 230kV Interconnection. The new equipment includes: •Eight (8) 230kV gang switches •Three (3) 230kV circuit breakers • Two (2) Wave traps •Associated bus, wiring and equipment •Associated foundations and structures •Associated transmission line communications, relaying and testing	$14.136

PSCO's Pawnee-Missile Site 230kV Line 5457	Construct 0.07 mile double circuit 230kV tap to proposed substation for solar interconnect.	$1.359
	Siting and Land Rights support for substation siting, permitting, and construction	$0.200
	Total Cost Estimate for Network Upgrades for Interconnection	**$15.695**
Time Frame	**Site, design, procure and construct**	**36 Months**

Table 9: Transmission Network Upgrades

Element	**Description**	**Cost Est. (Millions)**
PSCO's Pawnee-Missile Site 230kV Line 5457	Remote line terminal upgrades at Pawnee substation for new INFO-2020-14 switchyard.	$0.391
	Remote line terminal upgrades at Missile Site substation for new INFO-2020-14 switchyard.	$0.391
	Total Cost Estimate for Network Upgrades for Interconnection	**$0.782**
Time Frame	**Site, design, procure and construct**	**36 Months**

Summary of Informational Interconnection Study Results:

Energy Resource Interconnection Service of INFO-2020-14 is 120MW.

The total estimated cost of the transmission system improvements to interconnect INFO-2020-14 for 120MW ERIS is $17.646 Million (Tables 7, 8, and 9).

The COD of INFO-2020-14 is dependent of the construction of a new switching station, which is expected to require a CPCN. The total estimated time frame for regulatory activities (CPCN) and to site, design, procure and construct the switching station at the POI is approximately 36 months after authorization to proceed has been obtained.

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