

INFO-2020-2
Informational Study Report
5/4/2021



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1.0 Summary

Customer has requested an informational evaluation of the interconnection of a 150MW Solar PV Generating Facility interconnection at the Boone 115kV Substation. The expected Commercial Operation Date of the Generating Facility is December 31, 2024 and requested evaluation for Energy Resource Interconnection Service.

Energy Resource Interconnection Service of INFO-2020-2 before Network Upgrades is 150MW.

Energy Resource Interconnection Service of INFO-2020-2 is 150MW.

The total estimated cost of the transmission system improvements to interconnect INFO-2020-2 is \$1.724 Million (Tables 4 and 5).

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

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 150MW Solar Photovoltaic (PV) Generating Facility with a Point of Interconnection (POI) at the Boone 115kV Substation. The request is referred to as “INFO-2020-2” and studied for Energy Resource Interconnection Service (ERIS)¹.

The proposed Commercial Operation Date (COD) of INFO-2020-2 is December 31, 2024. The geographical location of the Transmission System near the POI is shown in Figure 1.

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

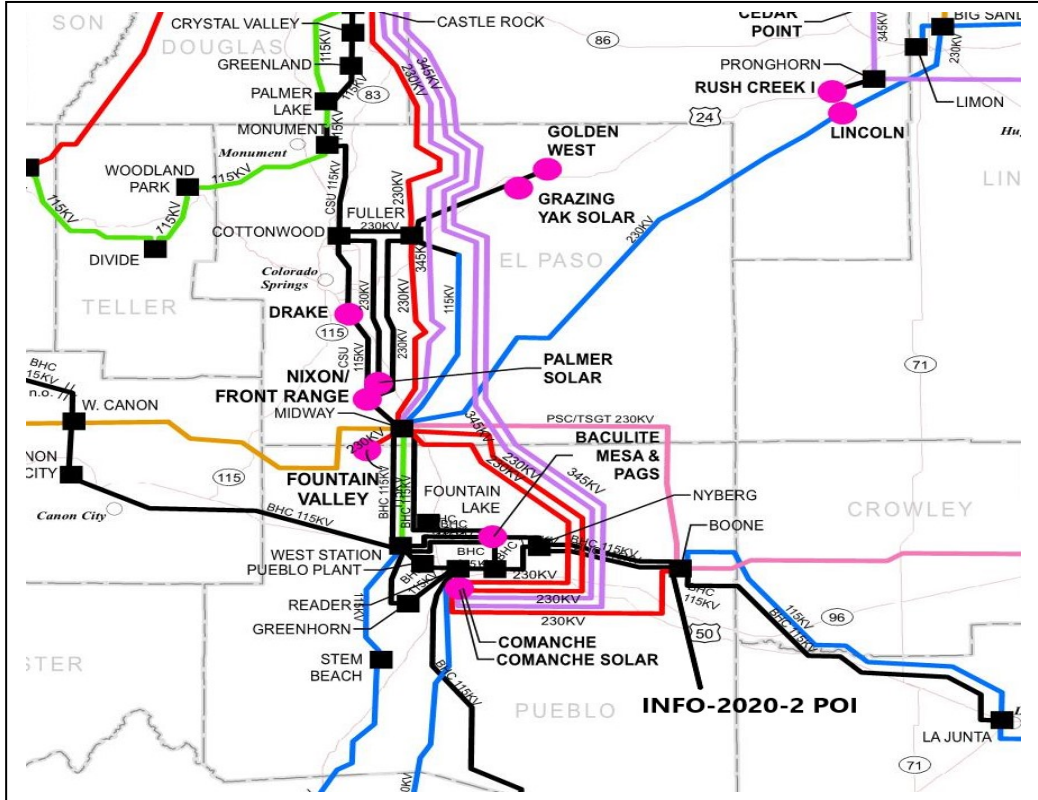


Figure 1 – INFO-2020-2 Point of Interconnection

3.0 Study Scope

The study was performed using the modeling assumptions specified by the Interconnection Customer. The scope of the study only includes power flow analysis to evaluate the steady-state thermal and voltage limit violations in the PSCo Transmission System and Affected Systems resulting from the addition of INFO-2020-2 for ERIS at the Boone 115kV Substation. The study identified the maximum allowable ERIS before upgrades, and upgrades required to allow full ERIS. The scope of this report also includes cost estimates for Interconnection Facilities, Station Upgrades and Network Upgrades.

3.1 Study Pocket Determination

As shown in Figure 1, the POI of the request is located in southern Colorado. Hence the study analysis is based on the southern 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: $\leq 100\%$ Normal facility rating

Voltage range: 0.95 to 1.05 per unit

P1 & P2-1 – Single Contingencies:

Thermal Loading: $\leq 100\%$ Normal facility rating

Voltage range: 0.90 to 1.10 per unit

Voltage deviation: $\leq 8\%$

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

Thermal Loading: $\leq 100\%$ Emergency facility rating

Voltage range: 0.90 to 1.10 per unit

Voltage deviation: $\leq 8\%$

3.3 Study Methodology

The steady state assessment is performed using PSSE V33 and the TARA AC tool.

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 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.

3.4 Study Area

The Study Area for Southern Colorado study pocket includes WECC designated zones 704, 710, and 712. The neighboring utilities included in the analysis include 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) systems in the study area.

4.0 Modeling Assumptions

The study is performed using the WECC 2026HS2 case released on July 31, 2020.

4.1 Base Case Modeling

The Base Case is created from the 2026HS2 case by making the following modifications. The following approved transmission projects in PSCo's 10-year transmission plan which are expected to be in-service before August 2026 are modeled:

- 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 2022
- Avery Substation – ISD 2021
- Barker Substation (Bank 1: 2021, Bank 2: 2022) – ISD 2021/2022
- 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 – ISD 2023
- Greenwood – Arapahoe - Denver Terminal 230kV line – ISD 2022
- Bluestone Valley Phase 2 – ISD 2023

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 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 the existing PSCo generation resources and future resources with approved Transmission Service, and, Affected System's existing resources and future resources with approved Transmission Service. In addition, the following additional generation were modeled per the modeling requirements specified by the Customer:

- GI-2014-13, GI-2014-6, GI-2014-7, GI-2014-9, GI-2016-15, GI-2017-12, Transitional Cluster, 1RSC-2020, DISIS-2020-001, 2RSC-2020 and DISIS-2020-002 in the PSCo queue.

- TI-18-0809, 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

The following upgrades identified in the PSCo Generation interconnection queue studies are also modeled:

- Upgrade Daniels Park – Prairie 230kV # 1 line to 756MVA (DISIS-2020-001)
- Upgrade Daniels Park – Prairie 230kV # 3 line to 756MVA (DISIS-2020-001)
- Install a second Waterton 345/230kV, 560MVA xfmr (DISIS-2020-002)
- Loop Comanche – Daniels Park 345kV line into GI-2020-12/GI-2020-14 345kV Switching Station (DISIS-2020-002)
- Uprate Boone – GI-2020-13 Switching Station segment to 394MVA (DISIS-2020-002)

5.0 Study Analysis

The INFO-2020-2 is studied in the southern colorado study pocket.

5.1.1 Benchmark Case Modeling

The Benchmark Case was created from the Base Case 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 1.

Table 1 – Generation Dispatch Used to Create the Benchmark Case (MW is Gross Capacity)

Bus Name	ID	Benchmark PGen (MW)	PMax (MW)
COMAN_1 24.000	C1	360	360
COMAN_2 24.000	C2	365	365
COMAN_3 27.000	C3	869	869
COMAN_PV 34.500	S1	104	122.5
CO_GRN_E 34.500	W1	64.8	81
CO_GRN_W 34.500	W2	64.8	81
FTNVL1&2 13.800	G1	36	40
FTNVL1&2 13.800	G2	36	40
FTNVL3&4 13.800	G3	36	40

Bus Name	ID	Benchmark PGen (MW)	PMax (MW)
FTNVL3&4 13.800	G4	36	40
FTNVL5&6 13.800	G5	36	40
FTNVL5&6 13.800	G6	36	40
JKFULGEN 0.6900	W1	199.5	250
LAMAR_DC 230.00	DC	0	210
TWNBUTTE 34.500	W1	15.8	41.8
SI_GEN 0.6000	1	25.5	30
TBII_GEN 0.6900	W	60.8	76
TI-18-0809 0.6300	PV	85	100
TI-19-1016 0.6300	PV	0	40
GI-2018-24 34.500	S1	200	250
PI-2020-2	S1	160	200
APT_DSLS 4.1600	G1	0	10
BAC_MSA GEN113.800	G1	90	90
BAC_MSA GEN213.800	G1	90	90
BAC_MSA GEN413.800	G1	35	40
BAC_MSA GEN413.800	G2	35	40
BAC_MSA GEN413.800	S1	20	24.8
BAC_MSA GEN513.800	G1	20	40
BAC_MSA GEN513.800	G2	30	40
BAC_MSA GEN513.800	S1	14	24.8
BAC_MSA GEN613.800	G1	0	40
BUSCHRCH_LO0.7000	W1	30	59.4
BUSCHRWTG1 0.7000	G1	14	28.8
PEAKVIEWLO 0.7000	G1	22	60
PUB_DSLS 4.1600	G1	0	8
R.F.DSLS 4.1600	G1	10	10

5.1.2 Study Case Modeling

A Study case was created from the Benchmark Case by modeling INFO-2020-2 at the Boone 115kV Substation. The 150MW output from the generator was sunk to Pawnee

5.1.3 Steady State Analysis Results

The results of the single contingency analysis are given in Table 2. The MidwayPS – West Station 115kV line overloads in the study case, but OPF identified a generation redispatch to mitigate the overload, so no network upgrades are identified to mitigate this overload.

The results of the multiple contingency analysis are given in Table 3. Per TPL1-4, the multiple contingency overloads can be mitigated using system adjustments, including generation redispatch and/or operator actions, so no network upgrades are identified to mitigate the multiple contingency overloads.

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

Table 2 – 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-2020-2	Single Contingency Definition
				MVA Flow	% Line Loading	MVA Flow	% Line Loading		
Midway – West Station 115kV line	Line	BHE	80	78	97.5%	82.2	102.8%	5.24%	Midway 230/115kV xfmr # 1

Table 3 – Overloads identified in Multiple Contingency Analysis

Overloaded Facility	Type	Owner	Facility Emergency Rating (MVA)	Facility Loading in Benchmark Case		Facility Loading in NRIS Study Case		% Change due to INFO-2020-2	Multiple Contingency Definition
				MVA Flow	% Line Loading	MVA Flow	% Line Loading		
Fountain Valley – MidwayBR 115kV	Line	BHE	115	202.1	175.7%	228	198.3%	22.6%	Midway 230kV bus tie
Midway 230/115kV #1	Xfmr	PSCo	120	146.4	122.0%	164.3	136.9%	14.9%	Midway 230kV bus tie
MidwayPS – MidwayBR 230kV	Line	BHE/WAPA	478	574.3	103.6%	533.6	112.3%	8.7%	Midway 345/230kV xfmr & Midway – Boone 230kV
Midway – Fuller 230kV line	Line	PSCo	478	503.4	105.3%	533.6	111.6%	6.3%	Midway 230kV bus tie
Desert Cove – West Station 115kV	Line	BHE	222	230.2	103.4%	256.3	115.5%	12.1%	Midway 230kV bus tie

6.0 Cost Estimates and Assumptions

The PSCo Engineering has developed cost estimates (with no accuracy) for Interconnection Facilities and Network/Infrastructure Upgrades required for the interconnection of INFO-2020-2 at the Boone 115kV Substation. 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.

- Labor is estimated for straight time only – no overtime included

- Lead times for materials were considered for the schedule
- INFO-2020-2 Generating Facility is not in PSCo’s retail service territory. Therefore, no costs for retail load metering are included in these estimates
- Line and substation outages will be necessary during the construction period. Outage availability could potentially be problematic and extend requested back feed date
- Customer will install two (2) separate fiber optics circuits 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 Boone 115kV 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
- PSCo (or it’s Contractor) crews will perform all construction, wiring, testing and commissioning for PSCo owned and maintained facilities
- PSCo does not anticipate that a CPCN will be required for the interconnection facilities construction
- The estimated time to permit, design, procure and construct the interconnection facilities is approximately 18 months after authorization to proceed has been obtained

Figure 2 is a conceptual one-line of INFO-2020-2 POI at the Boone 115kV Substation.

The estimated total cost of the Transmission Provider’s Interconnection Facilities and Station Network Upgrades are shown in Table 4 and Table 5 respectively. System improvements are subject to revision as a more detailed and refined design is produced.

Table 4 – Transmission Provider’s Interconnection Facilities

Element	Description	Cost Est. (Millions)
PSCo's Boone Substation 115kV bus	Interconnect Customer to tap at the Boone Substation 115kV bus. The new equipment includes: <ul style="list-style-type: none"> • One (1) 115kV deadend structures • Three (3) 115kV arresters • Three (3) 115kV 3000A 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 	\$1.472

	• Associated transmission line communications, fiber, relaying and testing	
	Transmission line tap into substation.	\$0.055
	Siting and Land Rights support for permitting and construction.	\$0.020
	Total Cost Estimate for Transmission Providers Interconnection Facilities	\$1.547
Time Frame	Site, design, procure and construct	18 Months

Table 5 – Station Network Upgrades

Element	Description	Cost Est. (Millions)
PSCO's Boone Substation 115kV bus	Boone Substation Expansion to accommodate INFO-2020-2. The new equipment includes: •One (1) 115 kV gang switches •Associated bus, wiring and equipment •Associated foundations and structures •Associated transmission line communications, relaying and testing	\$0.157
	Siting and Land Rights support for substation site acquisition, permitting, and construction	\$0.020
	Total Cost Estimate for Network Upgrades for Interconnection	\$0.177
Time Frame	Site, design, procure and construct	18 Months

7.0 Summary of Informational Interconnection Study Results:

Energy Resource Interconnection of INFO-2020-2 before Network Upgrades is 150MW.

Energy Resource Interconnection Service of INFO-2020-2 is 150MW.

The total estimated cost of the transmission system improvements to interconnect INFO-2020-2 is \$1.724 (Tables 4 and 5)

Note – This report is only 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.

Figure 2 – Preliminary One-line of INFO-2020-2 Interconnecting at the Boone 115kV Substation

