



**INFO-2022-3**

**Informational Study Report**

**12/23/2022**



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## 1.0 Summary

This report is an informational evaluation of a 300 MW Solar Photovoltaic (PV) plus Battery Energy Storage System (BESS) Hybrid Generating Facility with a Point of Interconnection (POI) at a new 345 kV switching station on the Missile Site – Pawnee 345 kV line. The expected Commercial Operation Date (COD) of the Generating Facility is December 31, 2027. The following studies were performed in this informational study:

1. Generating Facility as a 300 MW of Network Resource Interconnection Service (NRIS)
2. Generating Facility as a 300 MW of Energy Resource Interconnection Service (ERIS)

This report is an informational evaluation 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.

### 1.1 INFO-2022-3 NRIS Results

The total cost of the upgrades required to interconnect INFO-2022-3 on the Missile Site – Pawnee 345 kV line for NRIS is \$140.3 million (Table 11, Table 13, and Table 15)

### 1.2 INFO-2022-3 ERIS Results

The total cost of the upgrades required to interconnect INFO-2022-3 on the Missile Site – Pawnee 345 kV line for ERIS is \$26.1 million (Table 11 and Table 13)

Maximum allowable output of INFO-2022-3 without requiring additional System Network Upgrades is 0 MW.

ERIS of INFO-2022-3 is 300 MW when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis.



## 2.0 Introduction

This report is an informational evaluation of a 300 MW Solar (PV) plus BESS Hybrid Generating Facility connecting on the Missile Site – Pawnee 345 kV line. Since this is an informational study, the study modeled a generic 300 MW Generating Facility that can maintain  $\pm 0.95$  power factor at the POI.

A summary and description of the request for INFO-2022-3 as an NRIS are shown in Table 1.

**Table 1 – Summary of Request for INFO-2022-3 as an NRIS**

INFO#	Resource Type	Service (MW)	Service Type	COD	POI	Location
INFO-2022-3	PV + BESS	300	NRIS	12/31/2027	Missile Site – Pawnee 345 kV line	Weld County, CO

A summary and description of the request for INFO-2022-3 as an ERIS are shown in Table 2.

**Table 2 – Summary of Request for INFO-2022-3 as an ERIS**

INFO#	Resource Type	Service (MW)	Service Type	COD	POI	Location
INFO-2022-3	PV + BESS	300	ERIS	12/31/2027	Missile Site – Pawnee 345 kV line	Weld County, CO



### 3.0 Study Scope

The study was performed using the modeling assumptions specified by the Interconnection Customer (IC).

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

Per the Study Request, INFO-2022-3 was analyzed as both an ERIS and NRIS.

### 3.1 Study Pockets

The POI of INFO-2022-3 is located within the Eastern Colorado study pocket.

### 3.2 Study Areas

The study area for the Eastern Colorado study pocket includes the WECC base case zone 706. The Affected System included in the analysis are Tri-State Generation and Transmission Inc. (TSGT) and Western Area Power Administration (WAPA) transmission systems in the study area.

### 3.3 Study Criteria

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

P0 - System Intact conditions:

Thermal Loading:  $\leq 100\%$  of the 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:  $\leq 8\%$  of pre-contingency voltage

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:  $\leq 8\%$  of pre-contingency voltage



### 3.4 Study Methodology

The steady-state power flow assessment is performed using the PowerGEM TARA software. The generation redispatch for ERIS is identified using TARA's Security Constrained Redispatch (SCRD) tool.

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

Voltage violations are identified if a bus (i) resulted in a bus voltage >1.1 p.u. (or <0.9 p.u.) in the Study Case after the study pocket GIR cluster addition and (ii) contributed to an adverse impact of +0.005 p.u. (or -0.005 p.u.) compared to the Benchmark Case voltage.

DFAX criteria for identifying contribution to thermal overloads is  $\geq 1\%$ . DFAX criteria for identifying contribution to the voltage violations is 0.005 p.u.

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

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

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

- All PSCo and Non-PSCo resources connected to the PSCo Transmission System
- Higher-queued NRIS generation in the PSCo queue
- Generation connected to an Affected System Transmission System if that generation is a designated network resource to serve load connected to PSCo
- All other generation connected to an Affected System Transmission System and Stressed in the Study Case may be dispatched to the Base Case level

Maximum allowable ERIS generation is calculated for each GIR using its distribution factor(s) (DFAX) for overloads identified at full output, such that all identified overloads are eliminated.

## 4.0 Base Case Modeling Assumptions

The 2026HS2a1 WECC case released on July 31, 2020, was selected as the starting case. The Base Case was 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 date before summer 2026 were modeled:

[http://www.oasis.oati.com/woa/docs/PSCO/PSCOdocs/FERC\\_890\\_Q1\\_2020\\_Transmission\\_Plan\\_Presentation.pdf](http://www.oasis.oati.com/woa/docs/PSCO/PSCOdocs/FERC_890_Q1_2020_Transmission_Plan_Presentation.pdf)

- Cloverly 115 kV Substation – ISD 2021
- Graham Creek 115 kV Substation – ISD 2022
- Husky 230/115 kV Substation – ISD 2022
- Mirasol 230 kV Substation – ISD 2022
- Avery Substation – ISD 2021
- Barker Substation – Bank1 ISD: 2021, Bank 2 ISD: 2022
- High Point Substation – ISD 2022
- Titan Substation – ISD 2022
- Dove Valley Substation – ISD 2023
- Stock Show – ISD 2026
- Monument – Flying Horse 115 kV Series Reactor – ISD 2024
- Ault – Husky 230 kV line – ISD 2022
- Husky – Graham Creek – Cloverly 115 kV line – ISD 2022
- Gilman – Avon 115 kV line – ISD 2022
- Climax – Robinson Rack – Gilman 115 kV – ISD 2022
- Greenwood – Arapahoe – Denver Terminal 230 kV – ISD 2022
- Upgrade Villa Grove – Poncha 69 kV Line to 73 MVA – ISD 2021
- Upgrade Poncha – Sargent - San Luis Valley 115 kV line to 120 MVA – ISD 2021
- Upgrade Antonito – Romeo – Old40 Tap – Alamosa Terminal – Alamosa Switchyard 69 kV line to 143 MVA – ISD 2023
- Tundra Switching Station 345 kV – ISD 2022
- Upgrade Allison – Soda Lakes 115 kV line to 318 MVA – ISD 2022

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

- Fuller – Vollmer 115 kV line modeled at 173 MVA – ISD 2022
- Black Squirrel – Vollmer 115 kV line modeled at 144 MVA – ISD 2022
- Black Squirrel – Black Forest Tap 115 kV line modeled at 144 MVA – ISD 2022
- Beaver Creek – Adena 115 kV line modeled at 114 MVA
- Fuller 230/115 kV, 150 MVA #2 transformer – ISD 2023
- Paddock – Shaw Ranch – Calhan Tap – Santa Fe Springs 115 kV Loop modeled open

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

- Cottonwood – Tesla 34.5 kV line modeled open and Kettle Creek – Tesla 34.5 kV line modeled closed on the CSU system – ISD 2023
- Briargate South 115/230 kV transformer project tapping the Cottonwood – Fuller 230 kV line – ISD 2023

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

In addition, the following higher-queued generation from PSCo's queue were modeled offline in the Base Case along with any System Network Upgrades identified in their corresponding studies.

- Individual GIRs (GI-2014-5, GI-2014-6, GI-2014-7, GI-2014-9, GI-2014-13, GI-2014-14, GI-2016-4, and GI-2016-15)
- Transitional Cluster (GI-2018-24, and GI-2019-6)
- DISIS-2020-001 Cluster
- 2RSC-2020-05 Cluster
- DISIS-2020-002 Cluster
- DISIS-2021-003 Cluster
- DISIS-2021-004 Cluster
- DISIS-2022-005 Cluster

While the higher-queued NRIS requests in the study pocket were dispatched at 100% while performing each study pocket's analysis, the higher-queued ERIS requests were modeled offline.

## 5.0 Eastern Colorado Study Pocket Analysis

### 5.1 Benchmark Cases Modeling

The Benchmark Case was created from the Base Case by adopting the generation dispatch in Table 3 to reflect heavy generation in the Eastern Colorado pocket.

**Table 3 – Generation Dispatch Used to Create the Eastern Colorado Benchmark Case  
(MW is Gross Capacity)**

Bus Number	Bus Name	ID	Status	Pgen (MW)	Pmax (MW)
70314	MANCHEF1	G1	1	136.10	150.80
70315	MANCHEF2	G2	1	136.10	150.80
70562	SPRUCE1	G1	1	163.40	181.50
70563	SPRUCE2	G2	1	128.30	142.50
70310	PAWNEE	C1	1	536.20	536.20
70593	SPNDLE1	G1	1	141.30	157.00
70594	SPNDLE2	G2	1	141.30	157.00
70710	PTZLOGN1	W1	1	161.44	201.80
70712	PTZLOGN2	W2	1	96.44	120.80
70713	PTZLOGN3	W3	1	64.24	80.30
70714	PTZLOGN4	W4	1	140.00	175.00
70635	LIMON1_W	W1	1	161.90	202.40
70636	LIMON2_W	W2	1	161.90	202.40
70637	LIMON3_W	W3	1	161.90	202.40
70670	CEDARPT_W1	W1	1	100.80	126.00
70671	CEDARPT_W2	W2	1	100.80	126.00
70733	CHEYRGE_W1	W1	1	99.60	125.00
70736	CHEYRGE_W2	W2	1	100.40	126.00
70739	CHEYRGW_W1	W1	1	99.60	125.00
70742	CHEYRGW_W2	W2	1	100.40	126.00
70753	BRONCO_W1	W1	1	240.00	300.00
70616	TITAN_S1	S1	1	44.60	50.00
70767	RUSHCK1_W1	W1	1	168.00	202.00
70770	RUSHCK1_W2	W2	1	148.00	178.00
70771	RUSHCK2_W3	W3	1	168.00	202.00
88884	GI-2021-6	G1	1	199.00	199.00
990175	GI-21-14 G1	1	1	199.00	209.00
990204	GI-21-27 G1	1	1	180.00	183.30
990092	GI-21-29 G	1	1	199.50	218.30
990104	GI-21-30 G	1	1	500.00	507.20

Bus Number	Bus Name	ID	Status	Pgen (MW)	Pmax (MW)
990115	GI-21-31 G	1	1	250.00	254.30
999001	GI-2016-4	G1	1	240.00	300.00
201	GI-2022-6G	G1	1	199.00	199.00
202	GI-2022-7G	G1	1	199.00	199.00
Total				5866.22	6647.00

## 5.2 INFO-2022-3 – NRIS

### 5.2.1 Study Cases Modeling

An NRIS Study Case was developed from the Benchmark Case by modeling INFO-2022-3 with a POI at a new 345 kV switching station on the Missile Site – Pawnee 345 kV line. The 300 MW NRIS output of INFO-2022-3 is balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

### 5.2.2 Steady-State Analysis

Contingency analysis was performed on the East pocket NRIS Study Case.

The results of the system-intact analysis on the NRIS Study Case are shown in Table 4.

The results of the single contingency analysis on the NRIS Study Case are shown in Table 5.

Xcel PSCo identified system-intact overloads and single contingency overloads tabulated in Table 4 and Table 5 are mitigated by the System Network Upgrades tabulated in Table 7.

Table 6 shows the multiple contingency analysis on the NRIS Study Case. Per TPL-001-4, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (includes GIRs under study) and/or system operator actions. None of the listed multiple contingency overloads are attributed to INFO-2022-3.

Single contingency and multiple contingency analysis showed no voltage violations attributed to INFO-2022-3 as NRIS.



**Table 4 – Eastern Colorado Study Pocket NRIS Results – System Intact Analysis**

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIR	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
CLARK (70112) TO JORDAN (70241) 230 kV CKT #1	Line	PSCo	331.0	376.6	113.8	393.8	119.0	5.2	System Intact Condition
MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	564.0	552.3	97.9	570.3	101.1	3.2	System Intact Condition

**Table 5 – Eastern Colorado Study Pocket NRIS Results – Single Contingency Analysis**

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIR	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
CLARK (70112) TO JORDAN (70241) 230 kV CKT #1	Line	PSCo	331.0	502.6	151.8	522.3	157.8	5.9	BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1
B.CK TRI (73015) TO B.CK TRI (73016) 115/230 kV CKT #1	Xfmr	TSGT	224.0	269.2	120.2	279.1	124.6	4.4	BEAVER_CK2 (70397) TO BEAVERCK (73020) 115 kV CKT #1
MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	564.0	681.0	120.7	701.3	124.3	3.6	BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1
STORY (73192) TO PAWNEE (70311) 230 kV CKT #1	Line	PSCo	581.0	643.7	110.8	689.2	118.6	7.8	STORY (73192) TO PAWNEE (70311) 230 kV CKT #2
STORY (73192) TO PAWNEE (70311) 230 kV CKT #2	Line	PSCo	581.0	643.7	110.8	689.2	118.6	7.8	STORY (73192) TO PAWNEE (70311) 230 kV CKT #1
B.CK TRI (73015) TO BEAVERCK (73020) 115 kV CKT #1	Line	TSGT	239.0	268.0	112.1	278.4	116.5	4.4	BEAVER_CK2 (70397) TO BEAVERCK (73020) 115 kV CKT #1
MEADOWHL (70283) TO ORCHARD (70313) 230 kV CKT #1	Line	PSCo	546.0	604.4	110.7	624.5	114.4	3.7	BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1



**Table 6 (Cont.) – Eastern Colorado Study Pocket NRIS Results – Single Contingency Analysis**

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIR	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
CLARK (70112) TO GREENWD (70212) 230 kV CKT #1	Line	PSCo	367.0	396.3	108.0	415.6	113.3	5.3	BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1
BEAVERCK (73020) TO ADENA (73464) 115 kV CKT #1	Line	WAPA	114.0	126.3	110.8	129.0	113.1	2.3	BEAVERCK (73020) TO BRUSHTAP (73031) 115 kV CKT #1
WL_CHILD (72818) TO ARCHER (73009) 230 kV CKT #1	Line	WAPA	394.0	429.9	109.1	439.9	111.6	2.5	AULT (73012) TO LAR.RIVR (73108) 345 kV CKT #1
MIS_SITE (70624) TO HARVEST_MI (70597) 345 kV CKT #1	Line	PSCo	1449.0	1486.8	102.6	1594.5	110.0	7.4	SMOKYHIL (70599) TO MIS_SITE (70624) 345 kV CKT #1
HAVANA1 (70216) TO CHMBERS (70538) 115 kV CKT #1	Line	PSCo	159.0	173.0	108.8	174.8	109.9	1.1	HAVANA2 (70217) TO CHMBERS (70538) 115 kV CKT #2
KIOWA_IR (70571) TO ELIZABTH_IR (70583) 115 kV CKT #1	Line	PSCo	120.0	124.3	103.6	129.3	107.8	4.1	QUINCY (70343) TO SMOKYHIL (70396) 230 kV CKT #1
BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	559.7	581.5	103.9	593.3	106.0	2.1	MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1
HAVANA2 (70217) TO CHMBERS (70538) 115 kV CKT #2	Line	PSCo	159.0	165.4	104.0	167.1	105.1	1.1	HAVANA1 (70216) TO CHMBERS (70538) 115 kV CKT #1
JORDAN (70241) TO ORCHARD (70313) 230 kV CKT #1	Line	PSCo	546.0	552.1	101.1	572.0	104.8	3.6	BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1
BUCKLEY2 (70046) TO TOLGATE (70491) 230 kV CKT #1	Line	PSCo	566.7	581.5	102.6	593.3	104.7	2.1	MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1
JEWELL2 (70239) TO TOLGATE (70491) 230 kV CKT #1	Line	PSCo	484.0	481.6	99.5	493.3	101.9	2.4	MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1
HPCYN (70115) TO DANIELPK (70138) 115 kV CKT #1	Line	PSCo	132.0	128.4	97.2	134.2	101.7	4.4	CASTLRCK (70091) TO BAYOU_IR (70518) 115 kV CKT #1



**Table 7 – Eastern Colorado Study Pocket NRIS Results – Multiple Contingency Analysis**

Overloaded Facility	Type	Owner	Emergency Rating (MVA)	Benchmark Case		NRIS Study Case		Loading % Change Due to Study GIR	Contingency Name <sup>1</sup>
				MVA Flow	% Loading	MVA Flow	% Loading		
CLARK (70112) TO JORDAN (70241) 230 kV CKT #1	Line	PSCo	364.0	614.1	168.7	637.7	175.2	6.5	P7_049
CLARK (70112) TO GREENWD (70212) 230 kV CKT #1	Line	PSCo	403.0	508.0	126.1	531.2	131.8	5.8	BF_313
MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	621.0	791.2	127.4	815.4	131.3	3.9	P7_049
BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	559.7	677.6	121.1	686.6	122.7	1.6	BF_155
BUCKLEY2 (70046) TO TOLGATE (70491) 230 kV CKT #1	Line	PSCo	566.7	677.6	119.6	686.7	121.2	1.6	BF_155
B.CK TRI (73015) TO B.CK TRI (73016) 115/230 kV CKT #1	Xfmr	TSGT	224.0	259.7	116.0	269.7	120.4	4.4	BF_028
MEADOWHL (70283) TO ORCHARD (70313) 230 kV CKT #1	Line	PSCo	621.0	715.3	115.2	739.3	119.1	3.9	BF_313
STORY (73192) TO PAWNEE (70311) 230 kV CKT #2	Line	PSCo	589.0	652.9	110.9	698.8	118.6	7.8	BF_253
DENVTM (70148) TO GRAY_ST. (70208) 115 kV CKT #1	Line	PSCo	239.0	272.5	114.0	275.1	115.1	1.1	BF_361
B.CK TRI (73015) TO BEAVERCK (73020) 115 kV CKT #1	Line	TSGT	239.0	257.9	107.9	268.3	112.2	4.3	BF_028
KIOWA_IR (70571) TO ELIZABTH_IR (70583) 115 kV CKT #1	Line	PSCo	120.0	128.2	106.9	133.5	111.3	4.4	P7_083
JORDAN (70241) TO ORCHARD (70313) 230 kV CKT #1	Line	PSCo	622.0	663.3	106.6	687.1	110.5	3.8	P7_049
JEWELL2 (70239) TO LEETSDAL (70260) 230 kV CKT #1	Line	PSCo	478.0	518.3	108.4	527.7	110.4	2.0	BF_155
MIS_SITE (70624) TO HARVEST_MI (70597) 345 kV CKT #1	Line	PSCo	1696.0	1721.4	101.5	1848.0	109.0	7.5	P7_068
JEWELL2 (70239) TO TOLGATE (70491) 230 kV CKT #1	Line	PSCo	555.0	577.0	104.0	586.1	105.6	1.6	BF_155

<sup>1</sup> Contingency Definitions corresponding to Contingency Names are given in Appendix A.





**Table 8 – Eastern Colorado Study Pocket NRIS – System Network Upgrades**

Network Upgrade	Type
UPGRADE CLARK (70112) TO JORDAN (70241) 230 kV CKT #1	Line
UPGRADE B.CK TRI (73015) TO B.CK TRI (73016) 115/230 kV CKT #1	Xfmr
UPGRADE MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1	Line
UPGRADE STORY (73192) TO PAWNEE (70311) 230 kV CKT #1	Line
UPGRADE STORY (73192) TO PAWNEE (70311) 230 kV CKT #2	Line
UPGRADE B.CK TRI (73015) TO BEAVERCK (73020) 115 kV CKT #1	Line
UPGRADE MEADOWHL (70283) TO ORCHARD (70313) 230 kV CKT #1	Line
UPGRADE CLARK (70112) TO GREENWD (70212) 230 kV CKT #1	Line
UPGRADE BEAVERCK (73020) TO ADENA (73464) 115 kV CKT #1	Line
UPGRADE WL_CHILD (72818) TO ARCHER (73009) 230 kV CKT #1	Line
UPGRADE MIS_SITE (70624) TO HARVEST_MI (70597) 345 kV CKT #1	Line
UPGRADE HAVANA1 (70216) TO CHMBERS (70538) 115 kV CKT #1	Line
UPGRADE KIOWA_IR (70571) TO ELIZABTH_IR (70583) 115 kV CKT #1	Line
UPGRADE BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1	Line
UPGRADE HAVANA2 (70217) TO CHMBERS (70538) 115 kV CKT #2	Line
UPGRADE JORDAN (70241) TO ORCHARD (70313) 230 kV CKT #1	Line
UPGRADE BUCKLEY2 (70046) TO TOLGATE (70491) 230 kV CKT #1	Line
UPGRADE JEWELL2 (70239) TO TOLGATE (70491) 230 kV CKT #1	Line
UPGRADE HPCYN (70115) TO DANIELPK (70138) 115 kV CKT #1	Line

### 5.2.3 Affected Systems

TSGT and WAPA were identified as impacted Affected Systems as result of NRIS study overloads on their facilities as listed in Table 5 and Table 6.

### 5.2.4 Summary

NRIS identified for INFO-2022-3 is 300 MW.

The NRIS study identified the overloads caused by the INFO-2022-3 as a NRIS GIR and identified suitable System Network Upgrades for the identified overloads.

## **5.3 INFO-2022-3 – ERIS**

### **5.3.1 Study Cases Modeling**

An ERIS Study Case was developed from the Benchmark Case by modeling INFO-2022-3 with a POI at a new 345 kV switching station on the Missile Site – Pawnee 345 kV line. The 300 MW ERIS output of INFO-2022-3 is balanced against all PSCo generation connected to the PSCo Transmission System outside the study pocket on a pro-rata basis.

### **5.3.2 Steady-State Analysis**

Contingency analysis was performed on the East pocket ERIS Study Case.

The results of the system-intact analysis on the ERIS Study Case are shown in Table 8.

The single-contingency overloads for the ERIS Study Case are shown in Table 9.

All the identified system-intact overloads and single overloads can be alleviated/mitigated using OPF redispatch as explained in Section 3.4, therefore there are no System Network Upgrades required for the ERIS GIRs. The analysis also showed no voltage violations attributed to the ERIS GIRs.

The multiple-contingency overloads for the ERIS Study Case are shown in Table 10. Per TPL-001-4, multiple contingency overloads are mitigated using system adjustments, including generation redispatch (includes GIRs under study) and/or system operator actions. None of the listed multiple contingency overloads are attributed to INFO-2022-3.

The maximum allowable ERIS generation is calculated using each GIR's distribution factor (DFAX) for each of the overloads, such that all the identified overloads in Table 8 and Table 9 are eliminated. The system-intact overloads and single contingency overloads identified in Table 8 and Table 9 show that ERIS GIR contribute to existing overloads in the Benchmark Case. Therefore, the maximum allowable ERIS generation for GIR INFO-2022-3 is 0 MW.



**Table 9 – Eastern Colorado Study Pocket ERIS Results – System Intact Analysis**

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		ERIS Study Case		Loading % Change Due to Study GIR	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
CLARK (70112) TO JORDAN (70241) 230 kV CKT #1	Line	PSCo	331.0	376.6	113.8	393.8	119.0	5.2	System Intact Condition
MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	564.0	552.3	97.9	570.3	101.1	3.2	System Intact Condition

**Table 10 – Eastern Colorado Study Pocket ERIS Results – Single Contingency Analysis**

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		ERIS Study Case		Loading % Change Due to Study GIR	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
CLARK (70112) TO JORDAN (70241) 230 kV CKT #1	Line	PSCo	331.0	502.6	151.8	522.3	157.8	5.9	BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1
B.CK TRI (73015) TO B.CK TRI (73016) 115/230 kV CKT #1	Xfmr	TSGT	224.0	269.2	120.2	279.1	124.6	4.4	BEAVER_CK2 (70397) TO BEAVERCK (73020) 115 kV CKT #1
MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	564.0	681.0	120.7	701.3	124.3	3.6	BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1
STORY (73192) TO PAWNEE (70311) 230 kV CKT #1	Line	PSCo	581.0	643.7	110.8	689.2	118.6	7.8	STORY (73192) TO PAWNEE (70311) 230 kV CKT #2
STORY (73192) TO PAWNEE (70311) 230 kV CKT #2	Line	PSCo	581.0	643.7	110.8	689.2	118.6	7.8	STORY (73192) TO PAWNEE (70311) 230 kV CKT #1
B.CK TRI (73015) TO BEAVERCK (73020) 115 kV CKT #1	Line	TSGT	239.0	268.0	112.1	278.4	116.5	4.4	BEAVER_CK2 (70397) TO BEAVERCK (73020) 115 kV CKT #1
MEADOWHL (70283) TO ORCHARD (70313) 230 kV CKT #1	Line	PSCo	546.0	604.4	110.7	624.5	114.4	3.7	BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1



**Table 11 (Cont.) – Eastern Colorado Study Pocket ERIS Results – Single Contingency Analysis**

Overloaded Facility	Type	Owner	Normal Rating (MVA)	Benchmark Case		ERIS Study Case		Loading % Change Due to Study GIR	Contingency Definition
				MVA Flow	% Loading	MVA Flow	% Loading		
CLARK (70112) TO GREENWD (70212) 230 kV CKT #1	Line	PSCo	367.0	396.3	108.0	415.6	113.3	5.3	BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1
BEAVERCK (73020) TO ADENA (73464) 115 kV CKT #1	Line	WAPA	114.0	126.3	110.8	129.0	113.1	2.3	BEAVERCK (73020) TO BRUSHTAP (73031) 115 kV CKT #1
WL_CHILD (72818) TO ARCHER (73009) 230 kV CKT #1	Line	WAPA	394.0	429.9	109.1	439.9	111.6	2.5	AULT (73012) TO LAR.RIVR (73108) 345 kV CKT #1
MIS_SITE (70624) TO HARVEST_MI (70597) 345 kV CKT #1	Line	PSCo	1449.0	1486.8	102.6	1594.5	110.0	7.4	SMOKYHIL (70599) TO MIS_SITE (70624) 345 kV CKT #1
HAVANA1 (70216) TO CHMBERS (70538) 115 kV CKT #1	Line	PSCo	159.0	173.0	108.8	174.8	109.9	1.1	HAVANA2 (70217) TO CHMBERS (70538) 115 kV CKT #2
KIOWA_IR (70571) TO ELIZABTH_IR (70583) 115 kV CKT #1	Line	PSCo	120.0	124.3	103.6	129.3	107.8	4.1	QUINCY (70343) TO SMOKYHIL (70396) 230 kV CKT #1
BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	559.7	581.5	103.9	593.3	106.0	2.1	MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1
HAVANA2 (70217) TO CHMBERS (70538) 115 kV CKT #2	Line	PSCo	159.0	165.4	104.0	167.1	105.1	1.1	HAVANA1 (70216) TO CHMBERS (70538) 115 kV CKT #1
JORDAN (70241) TO ORCHARD (70313) 230 kV CKT #1	Line	PSCo	546.0	552.1	101.1	572.0	104.8	3.6	BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1
BUCKLEY2 (70046) TO TOLGATE (70491) 230 kV CKT #1	Line	PSCo	566.7	581.5	102.6	593.3	104.7	2.1	MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1
JEWELL2 (70239) TO TOLGATE (70491) 230 kV CKT #1	Line	PSCo	484.0	481.6	99.5	493.3	101.9	2.4	MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1
HPCYN (70115) TO DANIELPK (70138) 115 kV CKT #1	Line	PSCo	132.0	128.4	97.2	134.2	101.7	4.4	CASTLRCK (70091) TO BAYOU_IR (70518) 115 kV CKT #1



**Table 12 – Eastern Colorado Study Pocket ERIS Results – Multiple Contingency Analysis**

Overloaded Facility	Type	Owner	Emergency Rating (MVA)	Benchmark Case		ERIS Study Case		Loading % Change Due to Study GIR	Contingency Name <sup>2</sup>
				MVA Flow	% Loading	MVA Flow	% Loading		
CLARK (70112) TO JORDAN (70241) 230 kV CKT #1	Line	PSCo	364.0	614.1	168.7	637.7	175.2	6.5	P7_049
CLARK (70112) TO GREENWD (70212) 230 kV CKT #1	Line	PSCo	403.0	508.0	126.1	531.2	131.8	5.8	BF_313
MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	621.0	791.2	127.4	815.4	131.3	3.9	P7_049
BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1	Line	PSCo	559.7	677.6	121.1	686.6	122.7	1.6	BF_155
BUCKLEY2 (70046) TO TOLGATE (70491) 230 kV CKT #1	Line	PSCo	566.7	677.6	119.6	686.7	121.2	1.6	BF_155
B.CK TRI (73015) TO B.CK TRI (73016) 115/230 kV CKT #1	Xfmr	TSGT	224.0	259.7	116.0	269.7	120.4	4.4	BF_028
MEADOWHL (70283) TO ORCHARD (70313) 230 kV CKT #1	Line	PSCo	621.0	715.3	115.2	739.3	119.1	3.9	BF_313
STORY (73192) TO PAWNEE (70311) 230 kV CKT #2	Line	PSCo	589.0	652.9	110.9	698.8	118.6	7.8	BF_253
DENVTM (70148) TO GRAY_ST. (70208) 115 kV CKT #1	Line	PSCo	239.0	272.5	114.0	275.1	115.1	1.1	BF_361
B.CK TRI (73015) TO BEAVERCK (73020) 115 kV CKT #1	Line	TSGT	239.0	257.9	107.9	268.3	112.2	4.3	BF_028
KIOWA_IR (70571) TO ELIZABTH_IR (70583) 115 kV CKT #1	Line	PSCo	120.0	128.2	106.9	133.5	111.3	4.4	P7_083
JORDAN (70241) TO ORCHARD (70313) 230 kV CKT #1	Line	PSCo	622.0	663.3	106.6	687.1	110.5	3.8	P7_049
JEWELL2 (70239) TO LEETSDAL (70260) 230 kV CKT #1	Line	PSCo	478.0	518.3	108.4	527.7	110.4	2.0	BF_155
MIS_SITE (70624) TO HARVEST_MI (70597) 345 kV CKT #1	Line	PSCo	1696.0	1721.4	101.5	1848.0	109.0	7.5	P7_068
JEWELL2 (70239) TO TOLGATE (70491) 230 kV CKT #1	Line	PSCo	555.0	577.0	104.0	586.1	105.6	1.6	BF_155

<sup>2</sup> Contingency Definitions corresponding to Contingency Names are given in Appendix A.

### **5.3.3 Affected Systems**

TSGT and WAPA were identified as impacted Affected Systems as result of ERIS study overloads on their facilities as listed in Table 9 and Table 10.

### **5.3.4 Summary**

The ERIS study showed system intact overloads and single contingency overloads which were alleviated by performing OPF redispatch. Therefore, the study did not identify any required System Network Upgrades for INFO-2022-3 as an ERIS.

A DFAX analysis, with respect to thermal overloads, was performed to compute the maximum allowable output for INFO-2022-3 as an ERIS. The maximum allowable output of INFO-2022-3 as an ERIS is:

- ERIS of INFO-2022-3 is 0 MW

ERIS, when using the existing firm or non-firm capacity of the Transmission System on an “as available” basis is:

- INFO-2022-3: 300 MW

## 6.0 Cost Estimates and Assumptions

There are three types of costs identified in the study:

1. Transmission Provider’s Interconnection Facilities (TPIF) which are directly assigned to each GIR
2. Station equipment Network Upgrades, which are allocated each GIR connecting to that station on a per-capita basis per Section 4.2.4(a) of the LGIP
3. All System Network Upgrades which are allocated by the proportional impact per Section 4.2.4(b) of the LGIP
  - o System Network Upgrades allocated to INFO-2022-3 as an NRIS
  - o System Network Upgrades allocated to INFO-2022-3 as an ERIS

### 6.1 Total Cost of Transmission Provider’s Interconnecting Facilities

The total cost of Transmission Provider’s Interconnection Facilities for each POI and INFO-2022-3’s cost assignment is given in Table 11.

**Table 13 – Total Cost of Transmission Provider's Interconnection Facilities**

GIR	POI	Total Cost (million)
INFO-2022-3	Missile Site – Pawnee 345 kV line	\$1.7

Table 12 specifies the INFO-2022-3 project’s Transmission Provider’s Interconnection Facilities and the corresponding costs.

**Table 14 – INFO-2022-3 Transmission Provider’s Interconnection Facilities**

Element	Description	Cost Est. (Million)
New 345 kV Switching Station	Transmission Provider Interconnection Facilities for INFO-2022-3 generation at a new switching station on the Pawnee - Missile 345 kV line 7091.	\$1.70
<b>Total Cost Estimate for Interconnection Customer-Funded, PSCo-Owned Interconnection Facilities</b>		<b>\$1.70</b>

## 6.2 Total Cost of Station Network Upgrades

The total cost of Station Network Upgrades for INFO-2022-3 is given in Table 13.

**Table 15 – Total Cost of Station Network Upgrades by GIR**

GIR	POI	Total Cost (million)
INFO-2022-3	Missile Site – Pawnee 345 kV line	\$24.4

The details of the Station Network Upgrades required at the Missile Site – Pawnee 345 kV line new POI Switching Station are shown in Table 14 .

**Table 16 – Station Network Upgrades – INFO-2022-3 345 kV Switching Station**

Element	Description	Cost Est. (Million)
New 345 kV Switching Station	Install new Switching Station tapping the Pawnee - Missile 345 kV line 7091.	\$17.50
New 345 kV Switching Station	Install required communication in the EEE at the new 345 kV Switching Station	\$1.00
Pawnee - Missile 345 kV Line (7091)	Line tap North side of new 345 kV Switching Station	\$1.80
Pawnee - Missile 345 kV Line (7091)	Line tap South side of new 345 kV Switching Station	\$2.00
Pawnee - Missile 345 kV Line (7111)	Relocate Line 7111 to accommodate Line tap of 7091 into new 345 kV Switching Station	\$0.60
PSCo's GI-2021-6 230kV Switching Station	Siting and Land Rights land acquisition	\$1.50
<b>Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities</b>		<b>\$24.40</b>

## 6.3 Total Cost of System Network Upgrades

### 6.3.1 INFO-2022-3 – NRIS

Steady-state analysis for INFO-2022-3 as an NRIS discovered System Network Upgrades in the Eastern Colorado study Pocket. The System Network Upgrade costs associated with INFO-2022-3 studied as an NRIS request are described in Table 15.

**Table 17 – System Network Upgrades –Eastern Colorado Study Pocket for NRIS**

Description	Transmission Line Cost Est. (Million)	Station Remote End Cost Est. (Million)	Total Cost Est. (Million)
CLARK (70112) TO JORDAN (70241) 230 kV CKT #1 Line 5435 (Contingent Facility)	\$0.0	\$0.0	\$0.0



MEADOWHL (70283) TO SMOKYHIL (70396) 230 kV CKT #1 Line 5169 (Contingent Facility)	\$0.0	\$0.0	<b>\$0.0</b>
STORY (73192) TO PAWNEE (70311) 230 kV CKT #1 Line 5455	\$14.0	\$4.0	<b>\$18.0</b>
STORY (73192) TO PAWNEE (70311) 230 kV CKT #2 (Contingent Facility, incremental upgrade cost)	\$2.4	\$4.0	<b>\$6.4</b>
MEADOWHL (70283) TO ORCHARD (70313) 230 kV CKT #1 Line 5169	\$0.0	\$4.0	<b>\$4.0</b>
CLARK (70112) TO GREENWD (70212) 230 kV CKT #1 Line 5435 (Contingent Facility)	\$0.0	\$0.0	<b>\$0.0</b>
MIS_SITE (70624) TO HARVEST_MI (70597) 345 kV CKT #1 Line 7081	\$0.0	\$4.0	<b>\$4.0</b>
HAVANA1 (70216) TO CHMBERS (70538) 115 kV CKT #1 Line 9543 (Contingent Facility, incremental upgrade cost)	\$17.1	\$3.0	<b>\$20.1</b>
BUCKLEY2 (70046) TO SMOKYHIL (70396) 230 kV CKT #1 Line 5285	\$5.9	\$4.0	<b>\$9.9</b>
HAVANA2 (70217) TO CHMBERS (70538) 115 kV CKT #2 Line 9544	\$39.6	\$3.0	<b>\$42.6</b>
JORDAN (70241) TO ORCHARD (70313) 230 kV CKT #1 Line 5169 (Contingent Facility)	\$0.0	\$0.0	<b>\$0.0</b>
BUCKLEY2 (70046) TO TOLGATE (70491) 230 kV CKT #1 Line 5285 (Contingent Facility, incremental upgrade cost)	\$2.2	\$4.0	<b>\$6.2</b>
JEWELL2 (70239) TO TOLGATE (70491) 230 kV CKT #1 Line 5285	\$0.0	\$3.0	<b>\$3.0</b>
HPCYN (70115) TO DANIELPK (70138) 115 kV CKT #1 Line 9674 (Contingent Facility)	\$0.0	\$0.0	<b>\$0.0</b>
<b>Total Cost Estimate for PSCo-Funded, PSCo-Owned Interconnection Facilities</b>			<b>\$114.2</b>

Cost estimates for Network Upgrades are contingent upon the following Network Upgrades for higher-queued studies:

- Upgrade CLARK – JORDAN 230kV Ckt #1 to minimum 536.5 MVA
- Upgrade MEADOWHIL – SMOKYHIL 230 kV ckt #1 to minimum 717.4 MVA
- Upgrade for STORY – PAWNEE 230 kV ckt #2 to minimum 581 MVA, listed cost for incremental upgrade to minimum 689.2 MVA
- Upgrade CLARK – GREENWOOD 230 kV ckt #1 to minimum 428.4 MVA



- Upgrade for HAVANA1 – CHMBERS 115 kV ckt #1 to minimum 559.7 MVA, listed cost for incremental upgrade to minimum 593.3 MVA
- Upgrade JORDAN – ORCHARD 230 kV ckt #1 to minimum 586.7 MVA
- Upgrade BUCKLEY2 – TOLGATE 230 kV ckt #1 to minimum 566.7 MVA, listed cost for incremental upgrade to minimum 593.3 MVA
- Upgrade HPCYN – DANIELPK 115 kV ckt #1 to minimum 139.7 MVA

### **6.3.2 INFO-2022-3 – ERIS**

Steady-state analysis for INFO-2022-3 as an ERIS did not discover any System Network Upgrades in the Eastern Colorado study pocket. There are no System Network Upgrade costs associated with INFO-2022-3 studied as an ERIS.

## 6.4 Summary of Costs assigned to INFO-2022-3 as NRIS

The total cost of the required upgrades for INFO-2022-3 to interconnect at a new INFO-2022-3 345 kV Switching Station on the Missile Site – Pawnee 345 kV line as NRIS is \$140.3 million.

- **Cost of Transmission Provider’s Interconnection Facilities is \$1.7 million (Table 11)**
- **Cost of Station Network Upgrades is \$24.4 million (Table 14)**
- **Cost of System Network Upgrades is \$114.2 million (Table 15)**

The list of improvements required to accommodate the interconnection of INFO-2022-3 are given in Tables 12, 14, and 15. System improvements are subject to revision as a more detailed and refined design is produced.

## 6.5 Summary of Costs assigned to INFO-2022-3 as ERIS

The total cost of the required upgrades for INFO-2022-3 to interconnect at a new INFO-2022-3 345 kV Switching Station on the Missile Site – Pawnee 345 kV line as ERIS is \$26.1 million.

- **Cost of Transmission Provider’s Interconnection Facilities is \$1.7 million (Table 11)**
- **Cost of Station Network Upgrades is \$24.4 million (Table 14)**
- **Cost of System Network Upgrades is \$0**

The list of improvements required to accommodate the interconnection of INFO-2022-3 are given in Table 12 and Table 14. System improvements are subject to revision as a more detailed and refined design is produced.

## 6.6 Cost Estimate Assumptions

The cost estimates are in 2021 dollars with escalation and contingencies applied. Allowances for Funds Used During Construction (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 Interconnection Customer owned equipment and associated design and engineering. A level of accuracy is not specified for the estimates.

1. Labor is estimated for straight time only – no overtime included
2. Lead times for materials were considered for the schedule
3. The GIRs are not located in PSCo's retail service territory. Therefore, no costs for retail load metering are included in these estimates
4. PSCo (or it's Contractor) crews will perform all construction, wiring, testing, and commissioning for PSCo owned and maintained facilities
5. Customer will install two (2) redundant fiber optics circuits into the Transmission provider's substation as part of its interconnection facilities construction scope
6. Breaker duty study determined that no breaker replacements are needed in neighboring substations
7. Line outages will be necessary during the construction period. Outage availability could potentially be problematic and extend requested back-feed date
8. Power Quality Metering (PQM) will be required on the Customer's generation tie-line terminating into the POI
9. 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 Appendices

Appendix A: Multiple Contingency Definitions	 Appendix A - Multiple Contingen
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