SPP DISIS-2023-001 AFS STUDY REPORT

INTRODUCTION

Associated Electric Cooperative Inc. (AECI), through coordination with the Southwest Power Pool (SPP), has identified generator interconnection requests (GIRs) within the DISIS-2023 Study Cycle (the "Study Cycle") for an Affected System Study (AFS) evaluation on the AECI transmission system (the "Study"). The full list of Study Cycle requests included in the Study is listed in Table 1.

Table 1: Study Cycle Requests Evaluated

Project #	TO	SP Capacity (MW)	WP Capacity (MW)	Fuel Type	POI
GEN-2023-005	SPS	256	256	Solar	Plant X 230kV Substation
GEN-2023-006	NEET	202	202	Wind	Wolf Creek- Blackberry 345 kV Line Break
GEN-2023-009	WFEC	250	250	Battery/Storage	Hugo 138 kV Substation
GEN-2023-010	SPS	280	280	Wind	Moore Co 230 kV Substation
GEN-2023-011	NPPD	190	190	Wind	Harbine 115 kV Substation
GEN-2023-015	SPS	330	330	Solar	Finney-Carpenter 345 KV line
GEN-2023-022	OGE	250	250	Wind	Canadian River 345 kV Substation
GEN-2023-023	KACY	200	200	Battery/Storage	Center City 161 kV Substation
GEN-2023-027	AEP	150	150	Hybrid	Bird Hollow (Langley) - Pryor Junction 138 kV Line
GEN-2023-028	GRDA	230	230	Hybrid	Dry Gulch - Pensacola 161 kV Line
GEN-2023-032	Evergy	200	200	Solar	Odessa and Lexington 161 kV Line
GEN-2023-033	Evergy	200	200	Battery/Storage	Liberty South 161 kV Substation
GEN-2023-034	Evergy	130	130	Solar	Clear Water - Waco 138 kV line
GEN-2023-035	WFEC	200	200	Solar	Cleveland - Amber Tap 138 kV Line
GEN-2023-036	INDN	165	165	Battery/Storage	Eckles Road 161 kV Substation
GEN-2023-037	KACY	200	200	Battery/Storage	Nearman 161 kV Substation
GEN-2023-038	OGE	200	200	Solar	Lula 138 kV Substation
GEN-2023-049	GRDA	150	150	Hybrid	Dry Gulch - Pensacola 161 kV Line
GEN-2023-050	Evergy	400	400	Hybrid	Neosho 345 kV Substation
GEN-2023-055	GRDA	100	100	Battery/Storage	Kerr Grove 161 kV
GEN-2023-056	SWPA	150	150	Battery/Storage	Van Buren 161 kV
GEN-2023-057	GRDA	150	150	Battery/Storage	Pawnee Switch 138 kV
GEN-2023-059	AEP	200	200	Hybrid	Tap Rockhill to South Shreveport 138 kV line
GEN-2023-060	SPS	256	256	Solar	Plant X 230kV Substation
GEN-2023-061	SWPA	100	100	Battery/Storage	Carthage 161 kV Substation
GEN-2023-063	AEP	135	135	Hybrid	Catoosa - Owasso 88th 138 kV line
GEN-2023-064	SWPA	200	200	Hybrid	RS Kerr-Stigler 161 kV line
GEN-2023-065	Evergy	140	140	Battery/Storage	Halstead 69 kV Substation

Project #	TO	SP Capacity (MW)	WP Capacity (MW)	Fuel Type	POI
GEN-2023-069	WFEC	100	100	Hybrid	Tupelo - Atoka 138 kV Line
GEN-2023-073	Evergy	250	250	Battery/Storage	Rose Hill 345 kV Substation
GEN-2023-075	Evergy	200	200	Wind	Delaware to Neosho 345 kV
GEN-2023-076	Evergy	100	100	Wind	Delaware - Neosho 345 kV
GEN-2023-077	OPPD	255	255	Thermal	Substation 3740 345 kV
GEN-2023-078	OPPD	255	255	Thermal	Substation 3740 345 kV
GEN-2023-079	OPPD	303	303	Thermal	Substation 3740 345 kV
GEN-2023-081	NEET	625	625	Hybrid	Crossroads - Hobbs 345 kV Line
GEN-2023-082	WAPA	175	175	Battery/Storage	White 115 kV Substation
GEN-2023-085	SWPA	150	150	Wind	Mansfield - Logan 161 kV Line
GEN-2023-086	SPS	300	300	Hybrid	Potter - Newhart 230 kV line
GEN-2023-087	Evergy	200	200	Solar	Archie 161 kV Substation
GEN-2023-088	WFEC	117	117	Wind	Pharaoh 138 kV Substation
GEN-2023-092	WFEC	125	125	Hybrid	Unger - Frogville 138 kV line
GEN-2023-097	BEPC	250	250	Battery/Storage	Judson 345 kV Substation
GEN-2023-099	Evergy	300	300	Solar	Jeffery Energy Center 345 kV Substation
GEN-2023-100	OGE	300	300	Hybrid	Degrasse 345 kV Substation
GEN-2023-102	OGE	475	475	Hybrid	Degrasse 345 kV Substation
GEN-2023-105	BEPC	249	249	Wind	Chappelle Creek 345 kV
GEN-2023-110	SPS	250	250	Solar	Tap Border to Tuco 345 kV Line
GEN-2023-116	NPPD	500	500	Wind	Keystone 345 kV Substation
GEN-2023-117	NPPD	300	300	Wind	Keystone 345 kV Substation
GEN-2023-123	SPS	285	285	Wind	Pringle Interchange 230 kV Substation
GEN-2023-132	SWPA	150	150	Solar	Jonesboro - Independence 161 kV
GEN-2023-133	NPPD	250	250	Wind	Sweetwater 345 kV Substation
GEN-2023-134	AEP	252	252	Wind	Fixico Tap to Weleetka 138 kV Line
GEN-2023-138	GRDA	250	250	Wind	GRDA1 - Tonece7 345 kV Line
GEN-2023-142	SPS	275	275	Solar	Plant X 230 kV Substation
GEN-2023-143	SPS	200	200	Battery/Storage	Plant X 230 kV Substation
GEN-2023-149	Evergy	300	300	Battery/Storage	LaCygne - Stilwell 345 kV Line
GEN-2023-150	OGE	150	150	Solar	Gracemont 138 kV Substation
GEN-2023-151	AEP	100	100	Hybrid	South Nashville - South Murfreesboro 138kV
GEN-2023-154	WAPA	175	175	Solar	Fort Thompson - Huron 230 kV Tap
GEN-2023-158	SPS	335	335	Solar	Needmore - Yoakum 230 kV Line
GEN-2023-159	SPS	170	170	Battery/Storage	Needmore - Yoakum 230 kV Line
GEN-2023-164	OGE	210	210	Battery/Storage	Gracemont 345 kV Substation
GEN-2023-165	OGE	210	210	Battery/Storage	Gracemont 345 kV Substation
GEN-2023-166	OGE	150	150	Battery/Storage	84th Street - Tennessee Tap 138 kV Line
GEN-2023-167	OGE	250	250	Battery/Storage	Washington Park 138 kV Substation

Project #	TO	SP Capacity (MW)	WP Capacity (MW)	Fuel Type	POI
GEN-2023-168	OGE	175	175	Battery/Storage	Classen 138 kV Substation
GEN-2023-169	Evergy	125	125	Battery/Storage	Missouri City - Liberty South 161 kV Line
GEN-2023-170	Evergy	150	150	Battery/Storage	Salisbury 161 kV Substation
GEN-2023-171	INDN	150	150	Battery/Storage	Sub M 161 kV Substation
GEN-2023-174	WFEC	150	150	Battery/Storage	Paoli West 138 kV Substation
GEN-2023-176	SPS	300	300	Wind	Plant X 230 kV Substation
GEN-2023-177	OGE	200	200	Solar	Paoli - Seminole 138 kV line tap
GEN-2023-178	SPS	200	200	Solar	Roosevelt 230kV Substation
GEN-2023-180	AEP	150	150	Solar	Hackett - N Huntington 161 kV Line Tap
GEN-2023-182	BEPC	300	300	Wind	Groton - Leland Olds 345 kV Line
GEN-2023-183	SPS	217	217	Thermal	Tuco 345kV
GEN-2023-188	AEP	160	160	Hybrid	Oklaunion - Lawton 345 kV Line
GEN-2023-189	LES	200	200	Battery/Storage	NW 68th - Holdrege 345 kV Substation
GEN-2023-191[1]	EDE	74	74	Battery/Storage	Hockersville 138 kV Substation
GEN-2023-193	AEP	175	175	Hybrid	Pirkey - Whitney 138 kV Line
GEN-2023-194	EDE	225	225	Solar	Riverton - Neosho 161 kV Line Tap
GEN-2023-195	SPS	250	250	Solar	Roosevelt - Tolk 230 kV line tap
GEN-2023-199	NPPD	250	250	Hybrid	Twin Church 230 kV Substation
GEN-2023-201	NEET	300	300	Hybrid	Crossroads - Hobbs 345 kV Line
GEN-2023-203	SPS	300	300	Hybrid	Hobbs - Ink Basin 230 kV Transmission Line
GEN-2023-204	AEP	953	953	Thermal	Welsh-Lydia 345kV Line
GEN-2023-205	AEP	180	180	Solar	McAlester City - Weleetka 138 kV line
GEN-2023-206	OGE	50	50	Battery/Storage	Battlefield BESS 161 kV Substation
GEN-2023-208	SPS	200	200	Battery/Storage	Rolling Hills 115 kV
GEN-2023-210	WFEC	191	191	Solar	Prague - Chernicky 138 kV Line
GEN-2023-211	OGE	250	250	Hybrid	Ranch Road 345 kV Substation
GEN-2023-212	AEP	400	400	Hybrid	Northwest Texarkana - Valliant 345 kV Line
GEN-2023-213	AEP	100	100	Battery/Storage	Chamber Springs 161 kV Substation
GEN-2023-214[1]	OGE	100	100	Battery/Storage	Brown 138 kV Substation
GEN-2023-216	NPPD	200	200	Wind	Turtle Creek 345 kV Substation
GEN-2023-217	NPPD	200	200	Wind	Turtle Creek 345 kV Substation
GEN-2023-218	NPPD	200	200	Wind	Turtle Creek 345 kV Substation
GEN-2023-220	Evergy	250	250	Solar	Emporia Energy Center - Swissvale 345 kV Line
GEN-2023-221	Evergy	250	250	Solar	Emporia Energy Center - Swissvale 345 kV Line
GEN-2023-222	NPPD	478	478	Thermal	New Beatrice Power Station 345 kV
GEN-2023-223	NPPD	239	239	Thermal	New Beatrice Power Station 345 kV
GEN-2023-224	NPPD	478	478	Thermal	Olive Creek 345 kV Substation

[1] Withdrawn after study start. Impact of withdrawn request will be captured in future restudy.

Project #	TO	SP Capacity (MW)	WP Capacity (MW)	Fuel Type	POI
GEN-2023-225	NPPD	217	217	Thermal	Olive Creek 345 kV Substation
GEN-2023-227	AEP	200	200	Battery/Storage	Petty to Chapel 138 kV Line
GEN-2023-228	SPS	250	250	Battery/Storage	Tuco-Okalunion 345 kV line
GEN-2023-229	AEP	230	230	Wind	Southwestern Power Station 138 kV Substation (SWS4)
GEN-2023-231	Evergy	310	310	Hybrid	Neosho - LaCynge 345 kV Line
GEN-2023-236	SPS	400	400	Solar	Hobbs - Yoakum 345 kV
GEN-2023-237	SPS	500	500	Wind	Crawfish Draw 345 kV Substation
GEN-2023-241	AEP	93	93	Solar	Winnsboro 138 kV Substation

Network upgrades from the following studies were added to models prior to the addition of the Study Cycle requests.

- Network Upgrades from AECI Expansion Plan
- MISO Tranche 1 System Upgrades
- Network Upgrades from AECI GI-083 request
- Network Upgrades from AECI GI-099/100 requests[2]
- Network Upgrades from AECI GI-101/102 requests
- Network Upgrades from AECI GI-103 request
- Network Upgrades from AECI GI-104 request
- Network Upgrades from AECI GI-105 request[2]
- Network Upgrades from AECI's AFS of MISO DPP-2019-Cycle requests
- Network Upgrades from AECI's AFS of SPP DISIS-2017-002 requests

The Network Upgrades included from these requests are detailed in Table 6. Should these upgrades no longer be tagged to the higher queued studies, AECI may restudy the Study Cycle.

[2] GI-099/100/105 withdrew during the Study, the withdraw of this request and removal of associated network upgrades will be captured in a restudy.

INPUTS AND ASSUMPTIONS

Each of the SERC member transmission planners is responsible for submitting system modeling data to SERC for development of the power flow models. Power flow analysis utilized Long-Term Working Group (LTWG) models as developed by SERC Reliability Corporation (SERC). Each of the power flow models for the steady state analysis was modified to include appropriate higher-queued generation interconnection requests. Modeling parameters from the SPP DISIS 2023-001 steady state models were referenced for each of the Study Cycle requests.

Full details of the inputs and assumptions are provided in Appendix A.

METHODOLOGY

Steady state analysis was performed to confirm the reliability impacts on the AECI system under a variety of system conditions and outages. AECI's transmission system must be capable of operating within the applicable normal ratings, emergency ratings, and voltage limits of AECI planning criteria. AECI is a member of SERC, one of eight Electric Reliability Organizations under the North American Electric Reliability Corporation (NERC). As a member of SERC, AECI develops its planning criteria consistent with NERC Reliability Planning Standards and the SERC planning criteria. The NERC TPL-001-5 Planning Standard Table 1 requires that, for normal and contingency conditions, line and equipment loading shall be within applicable thermal limits, voltage levels shall be maintained within applicable limits, all customer demands shall be supplied (except as noted), and stability of the network shall be maintained.

In evaluating the impacts of the Study Cycle requests, the following thermal and voltage limits were applied to the analysis for P0 or normal system conditions:

- Thermal Limits within Applicable Rating – Applicable Rating shall be defined as the Normal Rating. The thermal limit shall be 100% of Rating A.
- Voltage Limits within Applicable Rating – Applicable Rating shall have the meaning of Nominal Voltage. Voltage limits shall be set at plus or minus five percent (+/- 5%), 0.95 p.u. - 1.05 p.u. for systems operating at 60 kV or above on load serving buses.

The following thermal and voltage limits were applied to the analysis for contingency conditions under P1 and P2EHV planning events:

- Thermal Limits within Applicable Rating – Applicable Rating shall be defined as the Emergency Rating. The thermal limit shall be 100% of Rating B.
- Voltage Limits within Applicable Rating – Applicable Rating shall have the meaning of Nominal Voltage. Voltage limits shall be set at plus five percent to minus ten percent (+5%/-10%), 0.90 p.u. – 1.05 p.u. for systems operating at 60 kV or above on load serving buses.

In order for the Study Cycle requests to have a negative impact (i.e. criteria violation) on the system, the Study Cycle must cause a three percent (3%) or greater increase in flow on an overloaded facility based upon the rating of the facility. In order for the Project to have a negative voltage impact on the system, the Project must cause a voltage violation and have a two percent (2%) or greater change in the voltage.

System upgrades are required for constraints resulting from the addition of the Study Cycle requests under P0, P1, P2.1, P2.2 (EHV only), and P2.3 (EHV only) system conditions. For the purpose of this study, P2.1

events are included as part of the P1 contingency file. As such, these events will be denoted as a P1 event in the results. All improvements were developed and studied in coordination with AECI.

AECI will perform an annual limited operations study which will indicate seasonal operating limits for SPP/MISO/AECI generation interconnection requests that will reach commercial operation in the 12 month horizon but whose AECI network upgrades have not yet been energized.

STEADY STATE ANALYSIS RESULTS

Steady state analysis results showed eight (8) constraints reported on the AECI transmission system, as shown in Table 2, which are attributed to the Study Cycle requests. Transmission upgrades were evaluated to mitigate the impacts reported from the analysis as a result of the Study Cycle requests. Simulations were performed on each of the scenarios with the identified network upgrades and contingent network upgrades included.

The upgrades shown in Table 8 were evaluated in order to mitigate the reported steady state constraints for the Study Cycle requests; results from the simulations found that the network upgrades were able to mitigate the reported overload conditions as shown in Table 2.

Table 2: Steady State Constraints for the Study Cycle Requests with Upgrades

Constraint ID	Event	Monitored Facility	Contingency	Season	Base Loading	Project Loading	Upgrade Loading
NU01[3]	P1	300071 5CLINTN 161.00 300124 5HOLDENB2 161.00 1	OPEN LINE FROM BUS 300110 [5PITTSV 161.00] TO BUS 301561 [5HOLDENB1 161.00] CKT 1	28S	95.9	100.6	80.6
NU02	P0	300095 5MANSFDMN 161.00 773680 G23-085-TAP 161.00 1	BASE CASE	28L	53.7	107.1	78.5
	P1		OPEN LINE FROM BUS 300092 [5LEBANN 161.00] TO BUS 301070 [5ORLA 161.00] CKT 1	28L	74.4	120.7	88.4
	P2EHV		OPEN BRANCH FROM BUS 300042 [7HUBEN 345.00] TO BUS 300051 [7FRANKSRCTP 345.00] CKT 1 OPEN BRANCH FROM BUS 300041 [7FRANKS 345.00] TO BUS 300051 [7FRANKSRCTP 345.00] CKT 1 OPEN BRANCH FROM BUS 300042 [7HUBEN 345.00] TO BUS 300045 [7MORGAN 345.00] CKT 1	28L	66.0	115.3	84.5
NU03	P1	300131 4FISHERTP 138.00 300140 4SILVCTY 138.00 1	OPEN LINE FROM BUS 509757 [WEKIWA-4 138.00] TO BUS 512726 [SILVCTYGR4 138.00] CKT 1	28S	80.2	101.7	68.1
				33S	80.2	101.6	68.0
NU04[4]	P1	300794 5LAMAR 161.00 300950 5JASPER 161.00 1	OPEN LINE FROM BUS 300045 [7MORGAN 345.00] TO BUS 709500 [GI-95_POI 345.00] CKT 1	33S	79.5	100.4	86.0
	P2EHV		OPEN BRANCH FROM BUS 300045 [7MORGAN 345.00] TO BUS 709500 [GI-95_POI 345.00] CKT 1	28S	79.7	100.5	86.3

[3] Clinton to Holden was previously assigned as an impact of higher queued projects. The Project had a loading increase of 3% or more on this facility. The previously identified system reinforcement for this facility is no longer sufficient for the loadings seen as a result of the Project. As a result, this facility is assigned as an impact of the Project.

[4] Adverse impact with the inclusion of network upgrades applied for the Projects, Project Loading reported with Network Upgrades included.

Constraint ID	Event	Monitored Facility	Contingency	Season	Base Loading	Project Loading	Upgrade Loading
			OPEN BRANCH FROM BUS 300042 [7HUBEN 345.00] TO BUS 300045 [7MORGAN 345.00] CKT 1	33S	80.8	101.8	87.3
NU05	P1	301451 2GRAY TP 69.000 512628 PENSA 2 69.000 1	OPEN LINE FROM BUS 512750 [TONECE7 345.00] TO BUS 774740 [G23-138-TAP 345.00] CKT 1	28S	82.8	100.9	58.7
				33S	85.8	103.1	60.0
NU06	P1	301563 5MOCITYB1 161.00 548808 ECKLES-161 161.00 1	OPEN LINE FROM BUS 541248 [LBRTYST5 161.00] TO BUS 543020 [BRMGHAM5 161.00] CKT 1	28H	56.0	104.9	70.4
NU07	P1	300123 5WPLAINW 161.00 301123 2WSTPL3 69.000 1	OPEN LINE FROM BUS 301123 [2WSTPL3 69.000] TO BUS 301549 [5WPLAINE 161.00] CKT 2	28H	93.4	105.1	74.8[5]
NU08	P1	301201 2DONIPH 69.000 505440 DONIPHN5 161.00 1	OPEN LINE FROM BUS 301201 [2DONIPH 69.000] TO BUS 505440 [DONIPHN5 161.00] CKT 2	28S	112.1	117.4	80.4[5]

[5] Loading with transformer tap adjustment.

CONTINGENT FACILITY RESULTS

Nine (9) facilities were reported as Contingent Facilities with the addition of the Study Cycle requests, as shown in Table 3. Contingent Facilities are those facilities identified that are the responsibility of higher-queued generators or are included in the Transmission Provider's transmission expansion plan and that if not included in the Study may otherwise be the responsibility of the Study Cycle requests as necessary to interconnect to the transmission system.

The transmission upgrades for the Contingent Facilities were evaluated in order to confirm that the planned system adjustments were sufficient to mitigate the overloads seen for the addition of the Study Cycle requests. Simulations were performed on each of the scenarios with the identified network upgrades and contingent network upgrades included. The upgrades shown in Table 6 were evaluated in order to mitigate the reported constraints as listed in Table 3 below.

Table 3: Steady State Contingent Constraints for the Study Cycle Requests with Upgrades

Constraint ID	Event	Monitored Facility	Season	Base Loading	Project Loading	Upgrade Loading	Contingent Generator(s)
CF01	P1	300069 5CHOTEAU1 161.00 512648 MAID 5 161.00 1	28H	103.3	106.5	106.4	Prior Queued Studies[6]
			28L	115.4	122.2	122.1	
CF02	P2EHV	300101 5MORGAN 161.00 505498 STOCKTN5 161.00 1	33W	89.9	101.3	65.1	AECI
CF03	P1	300651 2LAMR 69.000 300794 5LAMAR 161.00 1	28H	100.4	112.0	74.4	SPP DISIS-2017-002
			28S	123.7	136.9	86.9	
			28W	122.1	135.6	88.6	
			33S	126.4	139.2	88.2	
			33W	120.5	137.1	90.5	
	P2EHV		28H	101.5	113.9	75.4	
			28S	125.6	138.9	87.7	
			28W	123.0	136.4	88.8	
			33S	128.4	141.5	89.6	
			33W	121.6	138.0	91.1	
CF04	P1	300045 7MORGAN 345.00 301622 5MORGANXF1 161.00 1	28S	81.3	106.1	76.6	SPP DISIS-2018-001
			33S	82.8	106.8	77.1	
	P2EHV		28H	100.3	118.8	85.5	
			28S	104.4	133.1	95.8	
			28W	109.2	133.0	95.4	
			33S	105.8	133.9	96.4	
			33W	109.5	135.2	96.9	

[6] Ongoing studies show this element will be the responsibility of a higher queue request. Final scope of the upgrades tagged to higher queue request are still being developed.

Constraint ID	Event	Monitored Facility	Season	Base Loading	Project Loading	Upgrade Loading	Contingent Generator(s)
CF05	P2EHV	300101 5MORGAN 161.00 549969 BROOKLINE 5161.00 1	28W	98.0	104.8	67.0	SPP DISIS-2021-001
			33W	97.2	106.0	67.8	
CF06	P1	300084 5GRNFRT 161.00 301207 2GRNFOR 69.000 1	28W	111.6	116.7	69.9	SPP DISIS-2022-001
			33W	108.9	113.6	68.0	
CF07[4]	P1	301207 2GRNFOR 69.000 301210 2HILLRD 69.000 1	28S	87.7	106.0	73.0	SPP DISIS-2022-001
			28W	92.5	109.8	74.9	
			33S	85.7	104.3	71.8	
			33W	88.1	104.8	71.6	
CF08	P1	301553 4WELEETKA 138.00 521026 PHAROAH4 138.00 1	28L	107.1	118.0	57.8	SPP DISIS-2022-001
CF09	P1	300053 5OLDMARS 161.00 301476 4OLDMARS 138.00 1	28W	107.6	112.4	48.2	MISO DPP-2021 (West)
			33W	112.2	116.5	49.9	
	P2EHV		28W	102.8	107.3	46.7	
			33W	106.4	110.2	47.9	

NEIGHBORING SYSTEM RESULTS

The Study has identified impacts from the Study Cycle requests on the AECI ties with neighboring systems. The most limiting component of the AECI owned portion of the facility was evaluated and if found inadequate, a network upgrade for the AECI equipment was determined. Network upgrades for transmission facilities limited by non-AECI equipment are not captured and may need to be coordinated with the appropriate transmission owner.

Four (4) facilities were reported on the AECI ties with the addition of the Study Cycle requests. The most severe constraints are shown in Table 4.

Table 4: Steady State Neighboring System Constraints for the Study Cycle Requests

Constraint ID	Event	Monitored Facility	Area	Season	Base Loading	Project Loading
AFS01	P1	300098 5MOCITYB2 161.00 775360 G23-169-TAP 161.00 1	KCPL/AECI	28L	93.3	114.3
AFS02	P1	300131 4FISHERTP 138.00 505610 KEYSTON4 138.00 1	SWPA/AECI	28W	84.1	101.8
AFS03	P1	300927 2CLEVLND 69.000 512876 OSAGEK2 69.000 1	GRDA/AECI	28S	97.1	103.4
				33S	98.3	104.6
AFS04	P1	301563 5MOCITYB1 161.00 548808 ECKLES-161 161.00 1	INDN/AECI	28H	56.0	104.9

NETWORK UPGRADES

Transmission upgrades were evaluated to mitigate the impacts reported from the analyses as a result of the Study Cycle projects. The upgrades shown in Table 5 were evaluated in order to mitigate the reported steady state constraints for the Study Cycle as listed in Table 2.

Table 5: Network Upgrades for the Study Cycle Constraints

ID	Monitored Facility	Option/Description
NU00A	Blackberry 345 kV Station Modifications	Modification to Blackberry 345 kV station required for GEN-2023-006 to interconnect on Blackberry-Wolf Creek 345 kV line.
NU00B	Stigler 161 kV Station Modifications	Modification to Stigler 161 kV station required for GEN-2023-064 to interconnect on RS Kerr-Stigler 161 kV line.
NU00C	Mansfield-Logan 161 kV Station Modifications	Modification to Mansfield and Logan 161 kV stations required for GEN-2023-085 to interconnect on Mansfield-Logan 161 kV line.
NU00D	Missouri City 161 kV Station Modifications	Modification to Missouri City 161 kV station required for GEN-2023-169 to interconnect on Missouri City-Liberty South 161 kV line.
NU01	300071 5CLINTN 161.00 300124 5HOLDENB2 161.00 1	Rebuild 30.2 mile long segment of Clinton-Holden 161 kV line to 795 ACSR at 100C.
NU02	300095 5MANSFDMN 161.00 773680 G23-085-TAP 161.00 1	Upgrade Disconnect Switches at Mansfield on Mansfield-Logan 161 kV line to 2000 amp switches.
NU03	300131 4FISHERTP 138.00 300140 4SILVCTY 138.00 1	Rebuild 14.7 mile long Fisher Tap-Silver City 138 kV line to 1192 ACSR at 100C. Upgrade jumpers on both sides of line to 1192 ACSR. Upgrade Wave Trap on the Fisher Tap-Silver City 138 kV line at the Silver City station to 2000 amps.
NU04	300794 5LAMAR 161.00 300950 5JASPER 161.00 1	Rebuild 12.8 mile long Jasper-Lamar 161 kV line to 1192 ACSR at 100C. Upgrade jumpers on both sides of line to 1192 ACSR.
NU05	301451 2GRAY TP 69.000 512628 PENSA 2 69.000 1	Rebuild 4.4 mile long Gray Tap-Pensacola 69 kV line to 795 ACSR at 100C.
NU06	301563 5MOCITYB1 161.00 548808 ECKLES-161 161.00 1	Rebuild 6.1 mile long Missouri City-Eckles 161 kV line to 1192 ACSS at 200C. Upgrade jumpers at Missouri City to 1192 ACSS at 200C.
NU07	300123 5WPLAINW 161.00 301123 2WSTPL3 69.000 1	Overload reported able to be mitigated with the adjustments of transformer taps; no upgrade required.
NU08	301201 2DONIPH 69.000 505440 DONIPHN5 161.00 1	Overload reported able to be mitigated with the adjustments of transformer taps; no upgrade required.

The upgrades shown in Table 6 were evaluated in order to mitigate the reported steady state contingent constraints for the Study Cycle as listed in Table 3.

Table 6: Contingent Facilities for the Study Cycle Constraints

Constraint ID	Monitored Facility	Contingent Facilities
-	300889 2BRIISTOW 69.000 300898 2GYPSY 69.000 1	**Contingent on AECI** Rebuild and convert 0.09-mile-long section of Gypsy to Stroud 69 kV line to 138 kV 1192.5 ACSR at 100C: - Build additional 138kV bay at Stroud. - Convert Gypsy substation to 138 kV. - Install a GOAB near Gypsy station to create a 3 terminal 138 kV line between Stroud, Gypsy, and Bristow. - Re-terminate Gypsy-Stroud line to land on 138 kV bay at Stroud. Rebuild and convert 9.50-mile-long section of Bristow to Gypsy 69 kV line to 138 kV 1192.5 ACSR at 100C: - Build additional 138kV bay at Bristow. - Re-terminate Gypsy – Bristow 138 kV line land on a 138 kV bay at Bristow.
-	300906 2NUYAKA 69.000 513092 BEGGS 2 69.000 1	
-	300847 2STROUD 69.000 513106 STROUDTAP 2 69.000 1	
-	300135 4LUTHER 138.00 300856 2LUTHER 69.000 1	
-	300107 5OSBORN 161.00 301564 5FAIRPTB1 161.00 1	

Constraint ID	Monitored Facility	Contingent Facilities
-	300091 5LATHRP 161.00 300302 2LATHRP 69.000 1	**Contingent on AECI** Rebuild 17.8 mile long Fairport-Osborn 161 kV line to 1192 ACSS High Temp at 200C. - Upgrade jumpers at Osborn and Fairport line to 1192 ACSS. - Upgrade disconnect switches at Osborn on line to 2,000 amp switches. Build a new 161 kV line from Fairport-Shoal Creek to 1192 ACSS at 200C. Overbuild existing 69 kV lines from Fairport-Kidder-Mabel Tap and Turney-Cameron Junction. Overbuilt 69 kV lines will be built to 336 ACSR at 100C.
-	300191 2CROSRDS 69.000 301628 2OSBORNTPN 69.000 1	
-	300302 2LATHRP 69.000 301627 2LATHRPLD 69.000 1	
-	300293 2CAMRNJ 69.000 300312 2TURNEY 69.000 1	
-	300097 5MARYVB2 161.00 652560 CRESTON5 161.00 1	
-	300517 2KINGDM 69.000 301497 5KINGDMB2 161.00 2	**Contingent on GI-083:** - Upgrade Kingdom City 161/69 kV transformer #3 to 84/96 MVA unit. - Remove Kingdom City 161/69 kV transformer #2 from service. - Salt River area upgrades: - Add two new terminal positions to the Salt River 161 kV substation. - Add Salt River 161/69 kV transformer rated for 84/96 MVA. - Convert Auxvasse 69 kV substation to 161 kV operation. - Rebuild Auxvasse - Salt River 69 kV line, 10.00 miles, to 161 kV service, utilize 795 ACSR conductor to be designed for 100ºC and re-terminate line at the Salt River 161 kV bus. - Add one new terminal position to the Montgomery City 161 kV substation. Construct a ~17 mile double circuit 161/69 kV line from Salt River-Vandiver-Scotts Corner - 161 kV line will be 795 ACSR at 100C. Terminated at Salt River and will continue to Montgomery City. - 69 kV line will be 336 ACSR at 100C. Terminated at Salt River, Vandiver, Lindell, and Scotts Corner. - Upgrade Jumpers at Lindell, Vandiver, Scotts Corner to 336 ACSR. - Build a new 161 kV line from Scotts Corner - Montgomery City, 16.30 miles, utilize 795 ACSR conductor to be designed for 100ºC. Line section will be used as 161 kV path between Salt River and Montgomery City. Line will not terminate at Scotts Corner. - Add two new breakers to Vandalia 69 kV substation. - Build a new 69 kV line from Scotts Corner - Vandalia, 12.00 miles, utilize 336 ACSR conductor to be designed for 100ºC - Upgrade Thomas Hill 345/161 k V transformer #4 to 625/712 MVA unit. - Thomas Hill - Bevier Area Upgrades - Add Thomas Hill - Bus 1 - Bevier 161 kV line. - Add Bevier 161/69 kV transformer, 112/127 MVA unit. - Remove Thomas Hill - Bevier 69 kV line.
-	300517 2KINGDM 69.000 301497 5KINGDMB2 161.00 3	
-	300172 2TMHILLB1 69.000 300387 2BEVIER 69.000 1	
-	301530 7NEWMADXF12 345.00 301531 5NEWMADXF12 161.00 1	**Contingent on GI-099/100:**[7] Convert Gobbler Knob 345 kV station to a breaker and half configuration. Upgrade 161 kV disconnect switches on Gobbler 345/161 kV transformer #1 with 2,000 amp disconnect switches. Switches 161, 1611, 1613, 1621, 1622 - Add a second 345/161 kV transformer at Gobbler Knob with ratings 500 MVA Summer/570 MVA Winter. Rebuild existing 69 kV line from Gobbler-PB South-Harviell-Poplar Bluff-Township-Green Forest to double circuit 161 and 69 kV. The 69 kV circuit will be constructed to 795 ACSR and terminate at stations as it currently does. The 161 kV circuit will be constructed to 795 ACSS High Temp at 200C and terminate only at Gobbler Knob and Green Forest. Add terminals and associated equipment as needed at Gobbler and Green Forest stations. The individual line segments are: - Rebuild 4.4-mile-long Gobbler Knob to Poplar Bluff South 69 kV Line with 795 ACSR at 100C. - Rebuild 2.5-mile-long Green Forest to Township 69kV Line with 795 ACSR at 100C. - Rebuild 4.5-mile-long Harviell to Poplar Bluff South 69 kV Line with 795 ACSR at 100C.
-	300168 5GOBKNOB 161.00 300173 2GOBKNOB 69.000 3	

[7] GI-099/100/105 withdrew during the Study, the withdraw of this request and removal of associated network upgrades will be captured in a restudy.

Constraint ID	Monitored Facility	Contingent Facilities
-	300168 5GOBKNOB 161.00 300173 2GOBKNOB 69.000 4	- Rebuild 6.3-mile-long Harviell to Poplar Bluff 69 kV Line with 795 ACSR at 100C. - Rebuild 2.7-mile-long Poplar Bluff to Township 69 kV Line with 795 ACSR at 100C. - Construct a new 161 kV circuit from Gobbler Knob to Green Forest along the existing 69 kV path between these stations. Use 795 ACSS High Temp at 200C.
-	500 SHOALCR 161.00 300036 5ELATHRP 161.00 1	**Contingent on GI-101/102:** Construct a new 161 kV switchyard called Shoal Creek. Cut existing REX-Osborn 161 kV line in/out of new switchyard. Cut existing REX-Lathrop 161 kV line in/out of new switchyard. Build a new 27.8 mile long 161 kV circuit between Shoal Creek and Missouri City utilizing 1192 ACSS at 200C. - Line will be overbuilt on the 69 kV line from Turney - Lathrop Load - Lathrop - Holt - Summerset - Kearney - Missouri City. The 69 kV lines will be replaced with 336 ACSR at 100C. Add a new 161 kV terminal and reconfigure Missouri City 161 kV bus to accommodate the new 161 kV line between Missouri City and Shoal Creek. Add second 161/69 kV transformer to Lathrop rated for 56 MVA Summer, 63 MVA Winter. Leave existing transformer in service. Rebuild 2.2 mile long Lathrop-Lathrop East 161 kV line to 1192 ACSS at 200C. - Upgrade jumpers at Lathrop East and Lathrop on line to 1192 ACSS. - Replace disconnect switches at Lathrop on line to 2,000 amp switches. Rebuild 23.2 mile long Missouri City-Lathrop 161 kV line to 1192 ACSS at 200C. - Upgrade jumpers at Lathrop and Missouri City on line to 1192 ACSS at 200C. - Upgrade relay limits at Missouri City to 477 MVA Summer, 595 MVA Winter minimum. Rebuild 12.2 mile long Osborn-Shoal Creek 161 kV line to 1192 ACSS at 200C. - Upgrade jumpers at Osborn on line to 1192 ACSS at 200C. - Replace disconnect switches at Osborn to 2,000-amp switches. - Replace bushing CTs at Osborn on line to 2,000 base amps. Rebuild 5.2 mile long Shoal Creek-Lathrop East 161 kV line to 1192 ACSS at 200C. - Upgrade jumpers at Lathrop East on line to 1192 ACSS at 200C.
-	300036 5ELATHRP 161.00 300091 5LATHRP 161.00 1	
-	300091 5LATHRP 161.00 301563 5MOCITYB1 161.00 1	
-	300297 2HOLT 69.000 300302 2LATHRP 69.000 1	
-	300297 2HOLT 69.000 300311 2SMRSET 69.000 1	
-	500 SHOALCR 161.00 300107 5OSBORN 161.00 1	
-	300191 2CROSRDS 69.000 300206 2MABEL 69.000 1	
-	300192 2RCKWOLT 69.000 300292 2CAMERN 69.000 1	
-	300192 2RCKWOLT 69.000 300293 2CAMRNJ 69.000 1	
-	300203 2KIDDER 69.000 300215 2MABELTP 69.000 1	
-	300206 2MABEL 69.000 300215 2MABELTP 69.000 1	
-	300290 2OSBORN 69.000 301629 2OSBORNTPS 69.000 1	
-	300292 2CAMERN 69.000 301629 2OSBORNTPS 69.000 1	
-	300296 2GRNBRI 69.000 300310 2SMITHV 69.000 1	
-	300301 2KEARNY 69.000 300311 2SMRSET 69.000 1	
-	300302 2LATHRP 69.000 300313 2WESTBR 69.000 1	
-	300312 2TURNEY 69.000 300316 2LATHRPEMG 69.000 1	
-	300316 2LATHRPEMG 69.000 301627 2LATHRPLD 69.000 1	
-	300107 5OSBORN 161.00 300290 2OSBORN 69.000 1	
-	300306 2PARADS 69.000 300310 2SMITHV 69.000 1	
-	300306 2PARADS 69.000 300313 2WESTBR 69.000 1	
-	300137 4BRISTOW 138.00 300140 4SILVCTY 138.00 1	**Contingent on GI-103:** Upgrade existing Bristow 138/69 kV transformer to a 112 MVA Summer/127 MVA Winter rated unit. Add a second 138/69 kV transformer at Bristow with rating of 112 MVA Summer/127 MVA Winter. Rebuild 21.6 mile Bristow - Silver City 138 kV line to 1192 ACSR at 100C. - At Bristow 138 kV substation: - Upgrade wave trap to 2000 A. - Upgrade jumpers to 1192 ACSR. - Upgrade disconnect switches to 2000 A.

Constraint ID	Monitored Facility	Contingent Facilities
-	300137 4BRISTOW 138.00 300889 2BRIISTOW 69.000 2	- Upgrade breaker switchers to 2000 A. - At Silver City 138 KV substation: - Upgrade jumpers to 1192 ACSR. Rebuild 21.7 mile Bristow - Woody 138 kV line to 1192 ACSR at 100C. - At Bristow 138 kV substation: - Upgrade wave trap to 2000 A. - Upgrade jumpers to 1192 ACSR. - Upgrade disconnect switches to 2000 A. - Upgrade breaker switchers to 2000 A. - Upgrade bushing CTs to 2000 A. - At Woody 138 KV substation: - Upgrade jumpers to 1192 ACSR. Rebuild 13.40 mile Woody-Pharoah 138 kV line to 1192 ACSR at 100C. - At Woody 138 kV substation: - Upgrade jumpers to 1192 ACSR. - At Pharoah 138 kV substation: - Upgrade jumpers to 1192 ACSR. Uprate 0.90 mile Bristow-Bristow Tap 69 kV to 336 ACSR line at 100C. Uprate 0.90 mile KAMO owned line section of Bristow-Beggs 69 kV line to 336 ACSR at 100C. Rebuild 9.90 mile Kellyville-Bristow Tap 69 kV 1192 ACSR at 100C. 1192 ACSR will be 161 kV built, operated at 69 kV.
-	300889 2BRIISTOW 69.000 300977 2BRISTOWTP 69.000 1	
-	300901 2KELYVIL 69.000 300977 2BRISTOWTP 69.000 1	
-	300139 4FAIRFAX 138.00 300929 2FAIRFAX 69.000 1	**Contingent on GI-104** Add a second 138/69 kV transformer at Fairfax with a rating of 56 MVA Summer/63 MVA Winter.
-	300141 4STILWTR 138.00 300844 4RAMSEY 138.00 1	**Contingent on GI-104** Uprate 13.00 mile Stillwater-Ramsey 138 kV 795 ACSR line from 75C to 100C.
-	301369 4REMNGTON 138.00 510403 SHIDLER4 138.00 1	**Contingent on GI-105**[7] Uprate 3.40 mile Remington - Shidler 138 kV 795 ACSR line from 75C to 100C.
-	300196 2WOODY 69.000 300906 2NUYAKA 69.000 1	**Contingent on GI-105**[7] Rebuild 9.40 mile Woody - Nuyaka 69 kV line to 336 ACSR at 100C.
-	300388 2AXTELL 69.000 300401 2MACNTP 69.000 1	**Contingent on MISO DPP-2019-Cycle** Add a second 161/69 kV transformer at Holden with rating of 84 MVA Summer, 95 MVA Winter. Rebuild 2.9-mile-long Vanduser-Morley 69 kV line to 336 ACSR at 100C. Rebuild 12.2 mile-long Love Lake to Macon Tap 69 kV line to 795 ACSR at 100C. - Upgrade Bushing CTs on CB 33 at Love Lake to 600 amp minimum base rating. Rebuild 3.1 mile 336 ACSR segment of Elm-Holden (existing double circuit). Utilize 556 ACSR at 100C for 69 kV circuit. Rebuild 9.9 mile-long St. Francis to Jim Hill 161 kV line to 1192 ACSS at 250C. - Replace jumpers at St. Francis with 1192 ACSS at 250C. - Replace disconnect switches at St. Francis 161 kV bus on Jim hill line with 4000A switches.
-	300387 2BEVIER 69.000 301623 2BEVIERTP 69.000 1	
-	300400 2MACNLK 69.000 301623 2BEVIERTP 69.000 1	
-	301251 2VANDSR 69.000 301255 2MORLEY 69.000 1	
-	300388 2AXTELL 69.000 300400 2MACNLK 69.000 1	
-	300694 5PALMYR_AI 161.00 347516 5MARBLE N 161.00 1	**Contingent on MISO Tranche 1 Projects** Build new 345 kV line from Orient 345 kV substation (Ameren) to Fairport 345 kV substation (Ameren/AECI). Build new 345 kV line from Fairport 345 kV substation to Zachary 345 kV substation (Ameren). Build new 345 kV line from Thomas Hill 345 kV substation (AECI) to Zachary 345 kV substation. Build new 345 kV line from Zachary 345 kV substation to Maywood 345 kV substation (Ameren). Build new 345 kV line from Meredosia 345 kV substation (Ameren) to Maywood 345 kV substation. Tap the existing 161 kV line from Adair 161 kV substation to Appanoose 161 kV substation with the Zachary 161 kV substation.
-	300050 7PALMYR_AI 345.00 300694 5PALMYR_AI 161.00 1	
-	300133 5THMHLB3 161.00 344004 5ADAIR1 161.00 1	
-	300525 5WRIGHTB2 161.00 300600 5NEWMELB1 161.00 1	
-	300172 2TMHILLB1 69.000 301318 2THMINTP 69.000 1	
-	300390 2CAIRO 69.000 300394 2HUNTSV 69.000 1	

Constraint ID	Monitored Facility	Contingent Facilities
-	300394 2HUNTSV 69.000 301318 2THMINTP 69.000 1	
-	300104 5NODWAY 161.00 301592 5MARYVLB1 161.00 1	
-	300505 2STURGN 69.000 300508 5STURGN 161.00 3	
-	300505 2STURGN 69.000 300508 5STURGN 161.00 4	
-	300071 5CLINTN 161.00 300124 5HOLDENB2 161.00 1	**Contingent on SPP DISIS-2017-002 Network Upgrades** Build new 161 kV line from Archie to G17-108-Tap and place in service. The *upgrade as described above was not sufficient, additional upgrade required to mitigate overloads seen for Project (NU01).*
CF01	300069 5CHOTEAU1 161.00 512648 MAID 5 161.00 1	**Contingent on Prior Queued Studies** Overload will be mitigated by upgrades tagged to higher queue request. Final scope of the upgrades tagged to higher queue request are still being developed.
CF02	300101 5MORGAN 161.00 505498 STOCKTN5 161.00 1	**Contingent on AECI** Rebuild 17.3 mile long Morgan-Stockton 161 kV line to 1192 ACSR at 100C.
CF03	300651 2LAMR 69.000 300794 5LAMAR 161.00 1	**Contingent on SPP DISIS-2017-002** Install a second Lamar 161/69 kV transformer rated at 84 MVA Summer, 95 MVA Winter unit.
CF04	300045 7MORGAN 345.00 301622 5MORGANXF1 161.00 1	**Contingent on SPP DISIS-2018-001** Replace the Morgan 345/161 kV transformer with a unit rated 712 MVA Summer and 811 MVA Winter. Upgrade 161 kV breaker switchers (Switch 2022) and relay limits to 3,000 amps.
CF05	300101 5MORGAN 161.00 549969 BROOKLINE 5161.00 1	**Contingent on DPP DISIS-2021-001** Rebuild 26.49 mile long Morgan-Brookline 161 kV line to 1192 ACSR rated at 100C.
CF06	300084 5GRNFRT 161.00 301207 2GRNFOR 69.000 1	**Contingent on DISIS-2022-001** Replace Green Forest 161/69 kV transformer with 84 MVA Summer, 95 MVA Winter rated unit.
CF07	301207 2GRNFOR 69.000 301210 2HILLRD 69.000 1	**Contingent on DISIS-2022-001** Rebuild 4/0 section (0.35 miles) of Green Forest-Hilliard 69 kV line to 336 ACSR at 100C.
CF08	301553 4WELEETKA 138.00 521026 PHAROAH4 138.00 1	**Contingent on DISIS-2022-001** Reconductor 0.4 mile long 138 kV line from Weleetka-Pharoah to 1192 ACSS at 200C and upgrade jumpers at Weleetka to 1192 ACSS. Replace Breaker Switchers, Disconnect Switches, Bushing CTs, CTs on line at Weleetka with 2000 amp equipment.
CF09	300053 5OLDMARS 161.00 301476 4OLDMARS 138.00 1	**Contingent on MISO DPP-2021 (West)** Replace Old Maries 161/138 transformer with a unit rated 250 MVA Summer and 285 MVA Winter.

No upgrades were evaluated for the neighboring system constraints listed in Table 4. For the facilities listed in Table 7, AFS01-AFS03 may require resolution through coordination with MISO/SPP. For AFS04, while alternative coordination with MISO/SPP may still be needed, it is partially owned by AECI, and an upgrade for this facility has been assigned under NU06, as noted in Table 7.

Table 7: Neighboring System Constraints

Constraint ID	Monitored Facility	Network Upgrade
AFS01	300098 5MOCITYB2 161.00 775360 G23-169-TAP 161.00 1	KCPL Owned; no upgrade evaluated. Elements owned by AECI on this line are not overloaded.
AFS02	300131 4FISHERTP 138.00 505610 KEYSTON4 138.00 1	SWPA Owned; no upgrade evaluated. Elements owned by AECI on this line are not overloaded.
AFS03	300927 2CLEVLND 69.000 512876 OSAGEK2 69.000 1	GRDA Owned; no upgrade evaluated. Elements owned by AECI on this line are not overloaded.
AFS04	301563 5MOCITYB1 161.00 548808 ECKLES-161 161.00 1	INDN Owned; upgrade for INDN limiting element not evaluated. *Upgrade for AECI limiting element evaluated in NU06.*

AECI developed non-binding, good faith estimates of the timing and cost estimates for upgrades needed as a result of the addition of the Study Cycle requests as shown in Table 8.

Table 8: Network Upgrade Costs

ID	Option/Description	Estimated Cost	Estimated Lead Time (Months)[8]
NU00A[9]	Modification to Blackberry 345 kV station required for GEN-2023-006 to interconnect on Blackberry-Wolf Creek 345 kV line.	$ 350,000	30
NU00B[9]	Modification to Stigler 161 kV station required for GEN-2023-064 to interconnect on RS Kerr-Stigler 161 kV line.	$ 250,000	30
NU00C[9]	Modification to Mansfield and Logan 161 kV stations required for GEN-2023-085 to interconnect on Mansfield-Logan 161 kV line.	$ 500,000	30
NU00D[9]	Modification to Missouri City 161 kV station required for GEN-2023-169 to interconnect on Missouri City-Liberty South 161 kV line.	$ 250,000	30
NU01	Rebuild 30.2 mile long segment of Clinton-Holden 161 kV line to 795 ACSR at 100C.	$ 19,630,000	40
NU02	Upgrade Disconnect Switches at Mansfield on Mansfield-Logan 161 kV line to 2000 amp switches.	$ 350,000	24
NU03	Rebuild 14.7 mile long Fisher Tap-Silver City 138 kV line to 1192 ACSR at 100C. Upgrade jumpers on both sides of line to 1192 ACSR. Upgrade Wave Trap on the Fisher Tap-Silver City 138 kV line at the Silver City station to 2000 amps.	$ 14,455,000	40
NU04	Rebuild 12.8 mile long Jasper-Lamar 161 kV line to 1192 ACSR at 100C. Upgrade jumpers on both sides of line to 1192 ACSR.	$ 11,770,000	36
NU05	Rebuild 4.4 mile long Gray Tap-Pensacola 69 kV line to 795 ACSR at 100C.	$ 2,860,000	36
NU06	Rebuild 6.1 mile long Missouri City-Eckles 161 kV line to 1192 ACSS at 200C. Upgrade jumpers at Missouri City to 1192 ACSS at 200C.	$ 4,021,000	36
NU07	Overload reported able to be mitigated with the adjustments of transformer taps; no upgrade required.	-	-
NU08	Overload reported able to be mitigated with the adjustments of transformer taps; no upgrade required.	-	-
	Total Cost:	$ 54,436,000	

Cost allocations for each of the impacted facilities are discussed in the Cost Allocation section below.

[8] Estimated Lead Time is the estimated time to place a network upgrade in service once AECI has received Provision of Security equal to the total Estimated Cost of the Network Upgrade.

[9] The Study Cycle request connects on a transmission line that terminates at an AECI owned station. This request is responsible for all costs associated with the work required to ready the AECI station for the newly interconnected Study Cycle request.

COST ALLOCATION

Network upgrade costs are allocated to each of the Study Cycle projects based on the worst MW impact[10] each project had on the constraint and as described in the steps below:

1. Determine the MW impact each Study Cycle project had on each constraint using the size of each request in the season it was reported:

$$Project\ X\ MW\ Impact\ on\ Constraint\ 1 = DFAX\ (X) * MW\ (X) = X1$$

$$Project\ Y\ MW\ Impact\ on\ Constraint\ 1 = DFAX\ (Y) * MW\ (Y) = Y1$$

$$Project\ Z\ MW\ Impact\ on\ Constraint\ 1 = DFAX\ (Z) * MW\ (Z) = Z1$$

2. Determine the maximum MW% impact each generator has as a percentage of the total Study Cycle impact on a given constraint.

$$X2\ =\ Project\ X\ MW\ impact\ \%\ = \frac{X1}{Total\ MW\ Impact\ of\ Study\ Cycle\ on\ Constraint}$$

$$Y2\ =\ Project\ Y\ MW\ impact\ \%\ = \frac{Y1}{Total\ MW\ Impact\ of\ Study\ Cycle\ on\ Constraint}$$

$$Z2\ =\ Project\ Z\ MW\ impact\ \%\ = \frac{Z1}{Total\ MW\ Impact\ of\ Study\ Cycle\ on\ Constraint}$$

3. Apply three percent (3%) MW impact De Minimis Threshold: If a Study Cycle project MW% impact is less than 3% for a particular constraint then the project MW% impact is adjusted to 0 for that constraint and the Study Cycle project will not be allocated cost for that particular constraint.

4. Determine the cost allocated to each remaining Study Cycle project for each upgrade using the total cost of a given upgrade:

$$Project\ X\ Upgrade\ 1\ Cost\ Allocation\ (\$) = \frac{Network\ Upgrade\ 1\ Cost\ (\$) * X2}{X2 + Y2 + Z2}$$

The associated cost allocation of the network upgrades to each of the Study Cycle projects is shown below in Table 9. Further breakdown of costs is provided in Appendix B.

[10] All negative MW impacts (helpers) were set to 0 MW impact.

Table 9: Network Upgrade Cost Allocation

Project	Cluster Group	POI	MW	Total
GEN-2023-005	05 SOUTHWEST	Plant X 230kV Substation	256	$ -
GEN-2023-006	03 CENTRAL	Wolf Creek- Blackberry 345 kV Line Break	202	$ 3,695,227
GEN-2023-009	04 SOUTHEAST	Hugo 138 kV Substation	250	$ -
GEN-2023-010	05 SOUTHWEST	Moore Co 230 kV Substation	280	$ -
GEN-2023-011	02 NEBRASKA	Harbine 115 kV Substation	190	$ -
GEN-2023-015	03 CENTRAL	Finney-Carpenter 345 KV line	330	$ -
GEN-2023-022	04 SOUTHEAST	Canadian River 345 kV Substation	250	$ -
GEN-2023-023	03 CENTRAL	Center City 161 kV Substation	200	$ 1,355,005
GEN-2023-027	04 SOUTHEAST	Bird Hollow (Langley) - Pryor Junction 138 kV Line	150	$ -
GEN-2023-028	04 SOUTHEAST	Dry Gulch - Pensacola 161 kV Line	230	$ 1,239,251
GEN-2023-032	03 CENTRAL	Odessa and Lexington 161 kV Line	200	$ 1,194,344
GEN-2023-033	03 CENTRAL	Liberty South 161 kV Substation	200	$ 4,662,142
GEN-2023-034	03 CENTRAL	Clear Water - Waco 138 kV line	130	$ -
GEN-2023-035	04 SOUTHEAST	Cleveland - Amber Tap 138 kV Line	200	$ -
GEN-2023-036	03 CENTRAL	Eckles Road 161 kV Substation	165	$ 4,056,374
GEN-2023-037	03 CENTRAL	Nearman 161 kV Substation	200	$ 1,333,785
GEN-2023-038	04 SOUTHEAST	Lula 138 kV Substation	200	$ -
GEN-2023-049	04 SOUTHEAST	Dry Gulch - Pensacola 161 kV Line	150	$ 1,013,903
GEN-2023-050	03 CENTRAL	Neosho 345 kV Substation	400	$ 3,567,957
GEN-2023-055	04 SOUTHEAST	Kerr Grove 161 kV	100	$ 157,627
GEN-2023-056	04 SOUTHEAST	Van Buren 161 kV	150	$ -
GEN-2023-057	04 SOUTHEAST	Pawnee Switch 138 kV	150	$ 5,297,881
GEN-2023-059	04 SOUTHEAST	Tap Rockhill to South Shreveport 138 kV line	200	$ -
GEN-2023-060	05 SOUTHWEST	Plant X 230kV Substation	256	$ -
GEN-2023-061	03 CENTRAL	Carthage 161 kV Substation	100	$ -
GEN-2023-063	04 SOUTHEAST	Catoosa - Owasso 88th 138 kV line	135	$ -
GEN-2023-064	04 SOUTHEAST	RS Kerr-Stigler 161 kV line	200	$ 250,000
GEN-2023-065	03 CENTRAL	Halstead 69 kV Substation	140	$ -
GEN-2023-069	04 SOUTHEAST	Tupelo - Atoka 138 kV Line	100	$ -
GEN-2023-073	03 CENTRAL	Rose Hill 345 kV Substation	250	$ -
GEN-2023-075	04 SOUTHEAST	Delaware to Neosho 345 kV	200	$ 1,461,311
GEN-2023-076	04 SOUTHEAST	Delaware - Neosho 345 kV	100	$ -
GEN-2023-077	02 NEBRASKA	Substation 3740 345 kV	255	$ -
GEN-2023-078	02 NEBRASKA	Substation 3740 345 kV	255	$ -
GEN-2023-079	02 NEBRASKA	Substation 3740 345 kV	303	$ -
GEN-2023-081	05 SOUTHWEST	Crossroads - Hobbs 345 kV Line	625	$ 2,621,304
GEN-2023-082	01 NORTH	White 115 kV Substation	175	$ -
GEN-2023-085	03 CENTRAL	Mansfield - Logan 161 kV Line	150	$ 835,706
GEN-2023-086	05 SOUTHWEST	Potter - Newhart 230 kV line	300	$ -

Project	Cluster Group	POI	MW	Total
GEN-2023-087	03 CENTRAL	Archie 161 kV Substation	200	$ -
GEN-2023-088	04 SOUTHEAST	Pharaoh 138 kV Substation	117	$ 1,435,667
GEN-2023-092	04 SOUTHEAST	Unger - Frogville 138 kV line	125	$ -
GEN-2023-097	01 NORTH	Judson 345 kV Substation	250	$ -
GEN-2023-099	03 CENTRAL	Jeffery Energy Center 345 kV Substation	300	$ 995,792
GEN-2023-100	04 SOUTHEAST	Degrasse 345 kV Substation	300	$ -
GEN-2023-102	04 SOUTHEAST	Degrasse 345 kV Substation	475	$ -
GEN-2023-105	01 NORTH	Chappelle Creek 345 kV	249	$ -
GEN-2023-110	05 SOUTHWEST	Tap Border to Tuco 345 kV Line	250	$ -
GEN-2023-116	02 NEBRASKA	Keystone 345 kV Substation	500	$ 1,068,544
GEN-2023-117	02 NEBRASKA	Keystone 345 kV Substation	300	$ -
GEN-2023-123	05 SOUTHWEST	Pringle Interchange 230 kV Substation	285	$ -
GEN-2023-132	04 SOUTHEAST	Jonesboro - Independence 161 kV	150	$ -
GEN-2023-133	02 NEBRASKA	Sweetwater 345 kV Substation	250	$ -
GEN-2023-134	04 SOUTHEAST	Fixico Tap to Weleetka 138 kV Line	252	$ 1,958,432
GEN-2023-138	04 SOUTHEAST	GRDA1 - Tonece7 345 kV Line	250	$ 312,718
GEN-2023-142	05 SOUTHWEST	Plant X 230 kV Substation	275	$ -
GEN-2023-143	05 SOUTHWEST	Plant X 230 kV Substation	200	$ -
GEN-2023-149	03 CENTRAL	LaCygne - Stilwell 345 kV Line	300	$ -
GEN-2023-150	04 SOUTHEAST	Gracemont 138 kV Substation	150	$ -
GEN-2023-151	04 SOUTHEAST	South Nashville - South Murfreesboro 138kV	100	$ -
GEN-2023-154	01 NORTH	Fort Thompson - Huron 230 kV Tap	175	$ -
GEN-2023-158	05 SOUTHWEST	Needmore - Yoakum 230 kV Line	335	$ -
GEN-2023-159	05 SOUTHWEST	Needmore - Yoakum 230 kV Line	170	$ -
GEN-2023-164	04 SOUTHEAST	Gracemont 345 kV Substation	210	$ -
GEN-2023-165	04 SOUTHEAST	Gracemont 345 kV Substation	210	$ -
GEN-2023-166	04 SOUTHEAST	84th Street - Tennessee Tap 138 kV Line	150	$ -
GEN-2023-167	04 SOUTHEAST	Washington Park 138 kV Substation	250	$ -
GEN-2023-168	04 SOUTHEAST	Classen 138 kV Substation	175	$ -
GEN-2023-169	03 CENTRAL	Missouri City - Liberty South 161 kV Line	125	$ 3,828,062
GEN-2023-170	03 CENTRAL	Salisbury 161 kV Substation	150	$ 234,750
GEN-2023-171	03 CENTRAL	Sub M 161 kV Substation	150	$ 1,993,857
GEN-2023-174	04 SOUTHEAST	Paoli West 138 kV Substation	150	$ -
GEN-2023-176	05 SOUTHWEST	Plant X 230 kV Substation	300	$ -
GEN-2023-177	04 SOUTHEAST	Paoli - Seminole 138 kV line tap	200	$ -
GEN-2023-178	05 SOUTHWEST	Roosevelt 230kV Substation	200	$ -
GEN-2023-180	04 SOUTHEAST	Hackett - N Huntington 161 kV Line Tap	150	$ -
GEN-2023-182	01 NORTH	Groton - Leland Olds 345 kV Line	300	$ -
GEN-2023-183	05 SOUTHWEST	Tuco 345kV	217	$ -
GEN-2023-188	05 SOUTHWEST	Oklaunion - Lawton 345 kV Line	160	$ -

Project	Cluster Group	POI	MW	Total
GEN-2023-189	02 NEBRASKA	NW 68th - Holdrege 345 kV Substation	200	$ -
GEN-2023-191[1]	03 CENTRAL	Hockersville 138 kV Substation	74	$ 136,501
GEN-2023-193	04 SOUTHEAST	Pirkey - Whitney 138 kV Line	175	$ -
GEN-2023-194	03 CENTRAL	Riverton - Neosho 161 kV Line Tap	225	$ -
GEN-2023-195	05 SOUTHWEST	Roosevelt - Tolk 230 kV line tap	250	$ -
GEN-2023-199	02 NEBRASKA	Twin Church 230 kV Substation	250	$ -
GEN-2023-201	05 SOUTHWEST	Crossroads - Hobbs 345 kV Line	300	$ -
GEN-2023-203	05 SOUTHWEST	Hobbs - Ink Basin 230 kV Transmission Line	300	$ -
GEN-2023-204	04 SOUTHEAST	Welsh-Lydia 345kV Line	953	$ -
GEN-2023-205	04 SOUTHEAST	McAlester City - Weleetka 138 kV line	180	$ 1,538,843
GEN-2023-206	04 SOUTHEAST	Battlefield BESS 161 kV Substation	50	$ -
GEN-2023-208	05 SOUTHWEST	Rolling Hills 115 kV	200	$ -
GEN-2023-210	04 SOUTHEAST	Prague - Chernicky 138 kV Line	191	$ 1,442,274
GEN-2023-211	04 SOUTHEAST	Ranch Road 345 kV Substation	250	$ -
GEN-2023-212	04 SOUTHEAST	Northwest Texarkana - Valliant 345 kV Line	400	$ -
GEN-2023-213	04 SOUTHEAST	Chamber Springs 161 kV Substation	100	$ -
GEN-2023-214[1]	04 SOUTHEAST	Brown 138 kV Substation	100	$ -
GEN-2023-216	02 NEBRASKA	Turtle Creek 345 kV Substation	200	$ -
GEN-2023-217	02 NEBRASKA	Turtle Creek 345 kV Substation	200	$ -
GEN-2023-218	02 NEBRASKA	Turtle Creek 345 kV Substation	200	$ -
GEN-2023-220	03 CENTRAL	Emporia Energy Center - Swissvale 345 kV Line	250	$ -
GEN-2023-221	03 CENTRAL	Emporia Energy Center - Swissvale 345 kV Line	250	$ -
GEN-2023-222	02 NEBRASKA	New Beatrice Power Station 345 kV	478	$ 1,492,445
GEN-2023-223	02 NEBRASKA	New Beatrice Power Station 345 kV	239	$ -
GEN-2023-224	02 NEBRASKA	Olive Creek 345 kV Substation	478	$ 1,685,899
GEN-2023-225	02 NEBRASKA	Olive Creek 345 kV Substation	217	$ -
GEN-2023-227	04 SOUTHEAST	Petty to Chapel 138 kV Line	200	$ -
GEN-2023-228	05 SOUTHWEST	Tuco-Okalunion 345 kV line	250	$ -
GEN-2023-229	04 SOUTHEAST	Southwestern Power Station 138 kV Substation (SWS4)	230	$ -
GEN-2023-231	03 CENTRAL	Neosho - LaCynge 345 kV Line	310	$ 2,316,721
GEN-2023-236	05 SOUTHWEST	Hobbs - Yoakum 345 kV	400	$ -
GEN-2023-237	05 SOUTHWEST	Crawfish Draw 345 kV Substation	500	$ 1,253,678
GEN-2023-241	04 SOUTHEAST	Winnsboro 138 kV Substation	93	$ -
			Total Cost	$ 54,436,000

VERSION HISTORY

Version	Change Description
V0	Initial release