SPP DISIS-2022-001 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-2022 Study Cycle (the "Study Cycle") for an Affected System Study (AFS) evaluation on the AECI transmission system (the "Study"). The report has been revised to reflect the change in impacts due to the withdrawal of fifty-six (56) Study Cycle requests as listed in Table 1 below.

Table 1: Withdrawn Study Cycle Requests

Project	TO	SP Capacity (MW)	WP Capacity (MW)	Fuel Type	POI
GEN-2022-001	AEP	100.0	100.0	Battery/Storage	Catoosa 138 kV Substation
GEN-2022-005	WERE	200.0	200.0	Solar	Northeast Parsons 138kV Substation
GEN-2022-011	AEP	374.0	374.0	Solar	Tap of Oklaunion to Lawton Eastside 345 kV line
GEN-2022-041	WERE	100.0	100.0	Solar	Tie Substation 69 kV
GEN-2022-042	OGE	174.0	174.0	Solar	Sunnyside to Pooleville 138 kV line
GEN-2022-048	WFEC	250.0	250.0	Wind	Mooreland 138 kV
GEN-2022-058	EDE	180.0	180.0	Solar	Noel Southwest to Decatur 161 kV line tap
GEN-2022-062	NEET	200.0	200.0	Solar	Wolf Creek to Blackberry 345 kV
GEN-2022-068	BEPC	250.0	250.0	Wind	Chappelle Creek 345 kV
GEN-2022-072	GRDA	181.0	181.0	Solar	Grand River Dam to Claremore 161 kV Line
GEN-2022-074	WFEC	220.9	220.9	Wind	Hanna 138kV Substation
GEN-2022-076	SPS	500.0	500.0	Solar	Carpenter 345 kV Substation
GEN-2022-077	NPPD	255.0	255.0	Solar	Enders 115 kV Substation
GEN-2022-079	EDE	192.0	192.0	Solar	Dadeville East to Bolivar South 161kV
GEN-2022-080	EDE	96.0	96.0	Battery/Storage	Dadeville East to Bolivar South 161kV
GEN-2022-081	SUNC	218.0	218.0	Solar	Clifton 115kV Substation
GEN-2022-082	SPS	180.0	180.0	Solar	Tuco to Carlisle 230 kV line
GEN-2022-085	OGE	241.4	241.4	Wind	Seminole to Muskogee 345kV Substation
GEN-2022-090	AEP	150.0	150.0	Solar	Valiant Substation 138kV
GEN-2022-091	AEP	150.0	150.0	Battery/Storage	Valiant Substation 138kV
GEN-2022-092	AEP	299.2	299.2	Wind	Neosho to Delaware 345 kV
GEN-2022-094	ITCGP	250.0	250.0	Wind	Postrock to Axtell 345 kV line
GEN-2022-103	EDE	75.0	75.0	Battery/Storage	Ozark South 161kV
GEN-2022-105	AEP	300.0	300.0	Solar	Tap of Oklaunion to Lawton Eastside 345 kV Transmission Line
GEN-2022-106	AEP	300.0	300.0	Solar	Tap of Oklaunion to Lawton Eastside 345 kV Transmission Line
GEN-2022-107	AEP	400.0	400.0	Solar	Tap of Oklaunion to Lawton Eastside 345 kV Transmission Line
GEN-2022-110	AEP	150.0	150.0	Battery/Storage	Lehigh 138kV Station

Project	TO	SP Capacity (MW)	WP Capacity (MW)	Fuel Type	POI
GEN-2022-113	EDE	200.0	200.0	Solar	Tipton Station 161 kV Substation
GEN-2022-114	AEP	250.0	250.0	Wind	Lawton to Oklaunion 345kV Line
GEN-2022-129	AEP	200.0	200.0	Battery/Storage	Webb City Tap to Shidler 138 kV line
GEN-2022-131	KCPL	200.0	200.0	Battery/Storage	Warrensburg East to Odessa161kV Substation
GEN-2022-132	WFEC	315.8	315.8	Battery/Storage	Anadarko 138kV Substation
GEN-2022-137	WFEC	210.4	210.4	Battery/Storage	Canadian Switchyard 138kV
GEN-2022-138	AEP	316.6	316.6	Battery/Storage	Tulsa North to Northeast Station 345 kV Substation
GEN-2022-152	NPPD	80.0	80.0	Battery/Storage	Humboldt 161 kV Substation
GEN-2022-159	NEET	280.0	280.0	Wind	Crossroads to Hobbs 345 kV Line
GEN-2022-160	NEET	280.0	280.0	Wind	Crossroads to Hobbs 345 kV Line
GEN-2022-162	NPPD	118.0	118.0	Wind	Friend 115 kV Substation
GEN-2022-163	OGE	200.0	200.0	Battery/Storage	Cimarron 345kV Substation
GEN-2022-167	AEP	250.0	250.0	Solar	Tulsa North to Northeastern 345 kV Line
GEN-2022-168	KCPL	380.0	380.0	Solar	Silwell to Clinton 161 kV Line
GEN-2022-171	SPS	200.0	200.0	Wind	Pleasant Hill 230 kV Substation
GEN-2022-186	WERE	684.0	684.0	Solar	Wolf Creek to Benton 345 kV Substation
GEN-2022-196	AEP	215.0	215.0	Wind	Pittsburg 345kV Substation
GEN-2022-204	ITCGP	250.0	250.0	Wind	Post Rock to Spearville 345 kV
GEN-2022-205	ITCGP	250.0	250.0	Wind	Post Rock to Spearville 345 kV
GEN-2022-206	ITCGP	250.0	250.0	Wind	Post Rock to Spearville 345 kV
GEN-2022-208	KCPL	400.0	400.0	Wind	Tap on the Mullen Creek to Ketchum 345 kV Line
GEN-2022-209	KCPL	600.0	600.0	Hybrid	Tap on the Mullen Creek to Ketchum 345 kV Line
GEN-2022-219	WAPA	350.0	350.0	Solar	Belfield 230 kV Substation
GEN-2022-231	OGE	166.0	166.0	Solar	Crescent to Cottonwood Creek 138 kV Line
GEN-2022-234	AEP	200.0	200.0	Solar	Alluwe Tap - Chelsea 138 kV line
GEN-2022-237	OGE	150.0	150.0	Solar	Maud 138 kV substation
GEN-2022-239	AEP	350.0	350.0	Solar	John W Turk Jr Power Plant 345 kV sub
GEN-2022-240	AEP	200.0	200.0	Battery/Storage	John W Turk Jr Power Plant 345 kV sub
GEN-2022-241	AEP	200.0	200.0	Battery/Storage	John W Turk Jr Power Plant 345 kV sub

The full list of active Study Cycle requests included in the Study is listed in Table 2 below.

Table 2: Study Cycle Requests Evaluated

Project	TO	SP Capacity (MW)	WP Capacity (MW)	Fuel Type	POI
GEN-2022-006	WERE	200.0	200.0	Solar	Neosho to N345 161 kV Substation
GEN-2022-007	WERE	135.0	135.0	Solar	Lang to Reading 115 kV Transmission Line
GEN-2022-010	BEPC	250.0	250.0	Thermal	Judson Substation 345 kV
GEN-2022-013	WERE	300.0	300.0	Solar	Tap of Neosho to LaCygne 345 kV Line

Project	TO	SP Capacity (MW)	WP Capacity (MW)	Fuel Type	POI
GEN-2022-015	SUNC	270.0	270.0	Solar	Tap of Mingo to Red Willow 345 kV Line
GEN-2022-016	OGE	288.0	288.0	Solar	Woodward 345kV Substation
GEN-2022-024	WERE	200.0	200.0	Battery/Storage	Tap of Neosho to LaCygne 345 kV Line
GEN-2022-038	AEP	180.0	180.0	Solar	Longwood to Scottville 138 kV line
GEN-2022-054	NEET	200.0	200.0	Solar	Wolf Creek to Blackberry 345 kV Tap
GEN-2022-055	WFEC	200.0	200.0	Solar	Sunshine North to Anadarko 138 kV
GEN-2022-071	AEP	90.8	90.8	Solar	Talawanda to Canadian River 138 kV Line Tap
GEN-2022-073	KCPL	300.0	300.0	Battery/Storage	Nashua to Smithville 161kV
GEN-2022-098	OGE	200.0	200.0	Solar	Bison 345kV Substation
GEN-2022-100	KCPL	80.0	80.0	Hybrid	Overton to Sedalia East 161 kV Substation
GEN-2022-102	KCPL	100.0	100.0	Battery/Storage	Liberty West 161 kV
GEN-2022-104	WFEC	113.1	113.1	Solar	Brown to South Coleman Junction 138kV line
GEN-2022-111	AEP	150.0	150.0	Hybrid	Wilkes 345 kV Substation
GEN-2022-130	OGE	200.0	200.0	Battery/Storage	Battlefield BESS 161kV
GEN-2022-136	WFEC	180.0	180.0	Battery/Storage	Colbert 138 kV Substation
GEN-2022-139	AEP	300.0	300.0	Battery/Storage	Pirkey 345kV Substation
GEN-2022-142	KCPL	210.4	210.4	Battery/Storage	Shoal Creek 161 kV Substation
GEN-2022-143	OGE	210.4	210.4	Battery/Storage	Caney Creek 138 kV Substation
GEN-2022-144	KCPL	210.4	210.4	Battery/Storage	Blue Mills BESS 161kV Substation
GEN-2022-145	AEP	180.0	180.0	Battery/Storage	Weatherford Jct. to Hinton 138 kV line
GEN-2022-147	SPS	196.0	203.0	Thermal	Tuco 345kV
GEN-2022-154	WFEC	100.0	100.0	Battery/Storage	Canadian Switch 138 kV Substation
GEN-2022-155	OGE	200.0	200.0	Battery/Storage	Horseshoe Lake 138 kV Substation
GEN-2022-156	GRDA	100.0	100.0	Battery/Storage	Silver City 138 kV Substation
GEN-2022-161	WERE	360.0	360.0	Wind	Burns 345kV Substation
GEN-2022-176	AEP	215.0	215.0	Wind	Northeastern to Delaware 345 kV transmission line
GEN-2022-214	WERE	239.0	239.0	Solar	Gill to Viola 138 kV Line Break
GEN-2022-235	WFEC	150.0	150.0	Battery/Storage	El Reno SW 138 kV
GEN-2022-238	OGE	150.0	150.0	Battery/Storage	Maud 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 SPP ITP requests
- MISO Tranche 1 System Upgrades

- Network Upgrades from MISO DPP-2019 requests[1]

The Network Upgrades included from these requests are detailed in Table 4. Should these upgrades no longer be tagged to the higher queued studies, AECI may restudy the Study Cycle.

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 the latest 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 2022-001 steady state models were referenced for each of the Study Cycle requests.

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

[1] Full details for the Network Upgrades 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 showed no new thermal violations on the AECI system due to the addition of the Study Cycle projects.

CONTINGENT FACILITY RESULTS

Three (3) 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 4 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	300541 2SEDALI 69.000 300545 2SYLVAN 69.000 1	28W	103.0	107.2	59.3	AECI GI-091
			33W	106.5	110.7	61.3	
CF02	P2EHV	300045 7MORGAN 345.00 301622 5MORGANXF1 161.00 1	28S	92.1	106.8	63.8	SPP DISIS-2021-001
			28W	97.6	110.1	65.9	
			33S	93.2	107.9	64.4	
			33W	97.0	110.0	65.8	
CF03	P2EHV	300651 2LAMR 69.000 300794 5LAMAR 161.00 1	28S	109.3	121.2	76.8	MISO Tranche 1
			28W	108.4	119.2	78.5	
			33S	111.9	123.8	77.3	
			33W	105.2	116.7	76.8	

NEIGHBORING SYSTEM RESULTS

The Study has identified no impacts from the Study Cycle requests on the AECI ties with neighboring systems.

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

Table 4: Contingent Facilities for the Study Cycle Constraints

Constraint ID	Monitored Facility	Option/Description
-	300101 5MORGAN 161.00 549969 BROOKLINE 5 161.00 1	**Contingent on SPP Project from 2024 ITP:** - Tap the 345 kV line between Brookline and Flint Creek with a new Monett 345 kV station. - Build a new 345 kV line between Monett 345 kV and Delaware 345 kV. - Build a new 345 kV line between Delaware 345 kV and Buffalo 345 kV. - Install a new 345/161 kV transformer at the Monett 345 kV station. - Cut the Compton-Roark 161 kV in and out of the Monett 161 kV station. - Cut the Branson-Reeds Spring 161 kV line in and out of the Monett 161 kV station. - Cut the Cape Fair-Nixa 161 kV line in and out of the Monett 161 kV station. - Install a reactor at the new 345 kV Monett bus.
-	300101 5MORGAN 161.00 505498 STOCKTN5 161.00 1	
-	300045 7MORGAN 345.00 301622 5MORGANXF1 161.00 1	
-	300133 5THMHLB3 161.00 344004 5ADAIR1 161.00 1	**Contingent on MISO Tranche 1 Upgrades** Build new 345 kV line from Orient 345 kV substation to Denny 345 kV substation (Ameren). Build new 345 kV line from Denny 345 kV substation to Zachary 345 kV substation (Ameren). Build new 345 kV line from Denny 345 kV substation to Fairport 345 kV substation. 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.
-	300097 5MARYVB2 161.00 652560 CRESTON5 161.00 1	
-	300355 2SPALDNG 69.000 300373 2CENTER 69.000 1	
-	300373 2CENTER 69.000 300374 2CNTRSW 69.000 1	
-	300388 2AXTELL 69.000 300401 2MACNTP 69.000 1	**Contingent MISO DPP-2019** Rebuild 12.2 mile-long Love Lake-Macon Tap line to 336 ACSR at 100C Upgrade bushing CTs on CB 33 at Love Lake to 600 amp minimum base rating
-	300069 5CHOTEAU1 161.00 512648 MAID 5 161.00 1	**Contingent SPP DISIS-2017-002:** - Construct a new 161 kV switch yard (Patrol Road) on the Maid-Gerald 161 kV line ~1 mile from Maid. (GRDA SCOPE) - Replace (4) 69 kV switches and associated jumpers/hardware at Afton Substation. (GRDA Scope) - Construct a new 0.8 mile long 161 kV line from Chouteau-Patrol Road switch yard. Construct as double bundle 1590 ACSR at 100C. Assume series reactor installed on line to match impedance of reactor on existing Chouteau-Maid line. (5 ohm, 12.263 mH via MANTIS). All terminal equipment/reactors rated for 4,000 amps. - Add 4,000 amp breaker and associated equipment to the existing Chouteau-Maid line at Chouteau. - Add a 161 kV terminal and associated equipment at Chouteau for the new 161 kV line to Patrol Road. - Upgrade Chouteau West Yard E-W bus from 5" to 6" bus.
CF01	300541 2SEDALI 69.000 300545 2SYLVAN 69.000 1	**Contingent on AECI GI-091** Upgrade bushing CTs (via breaker upgrade), breaker switchers on Sylvan-Sedalia 69 kV line (at Sedalia) to 1200 amp rating.
CF02	300045 7MORGAN 345.00 301622 5MORGANXF1 161.00 1	**Contingent on SPP DISIS-2021-001** 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.
CF03	300651 2LAMR 69.000 300794 5LAMAR 161.00 1	**Contingent on MISO Tranche 1** Install a second Lamar 161/69 kV Xfmer rated at 84 MVA Summer, 95 MVA Winter unit

COST ALLOCATION

The Study Cycle request shown in Table 6 is connecting to 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.

Table 5: Interconnection Facility Projects

ID	Description	Estimated Cost	Estimated Lead Time (months)
NU00	Modification to Blackberry 345 kV station required for GEN-2022-054 to interconnect on Blackberry-Wolf Creek 345 kV line.	$ 350,000	36

Table 6: Interconnection Facility Cost Allocation

Project	POI	Location of Interconnection Facility Work	Allocated Cost
GEN-2022-054	Wolf Creek- Blackberry 345 kV	Blackberry	$ 350,000

VERSION HISTORY

Version	Change Description
V0 – 08/29/2024	Initial release
V1 – 05/29/2026	Withdrawal of fifty-six (56) SPP requests from Study Cycle Withdrawal of MISO, SPP, and AECI higher queued requests