INTERCONNECTION FACILITIES STUDY REPORT

GEN-2017-047

Published March 2022

By SPP Generator Interconnections Dept.

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION
03/08/2022	SPP	Initial draft report issued.
03/29/2022	SPP	Final report issued.

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SUMMARY

INTRODUCTION

This Interconnection Facilities Study (IFS) for Interconnection Request GEN-2017-047 is for a 102 MW generating facility located in Beaver County, OK. The Interconnection Request was studied in the DISIS-2017-001 Impact Study and the DISIS-2017-001-1 Impact Restudy for Network Resource Interconnection Service (NRIS).The Interconnection Customer's requested in-service date is December 31st, 2023.

The interconnecting Transmission Owner, Southwestern Public Service (SPS), performed a detailed IFS at the request of SPP. The full report is included in Appendix A. SPP has determined that full Interconnection Service will be available after the assigned Transmission Owner Interconnection Facilities (TOIF), Non-Shared Network Upgrades, Shared Network Upgrades, Contingent Network Upgrades, and Affected System Upgrades that are required for full interconnection service are completed.

The primary objective of the IFS is to identify necessary Transmission Owner Interconnection Facilities, Network Upgrades, other direct assigned upgrades, cost estimates, and associated upgrade lead times needed to grant the requested Interconnection Service.

PHASE(S) OF INTERCONNECTION SERVICE

It is not expected that Interconnection Service will occur in phases. However, full Interconnection Service will not be available until all Interconnection Facilities and Network Upgrade(s) can be placed in service.

COMPENSATION FOR AMOUNTS ADVANCED FOR NETWORK UPGRADE(S)

FERC Order ER20-1687-000 eliminated the use of Attachment Z2 revenue crediting as an option for compensation. The Incremental Long Term Congestion Right (ILTCR) process will be the sole process to compensate upgrade sponsors as of July 1st, 2020.

INTERCONNECTION CUSTOMER INTERCONNECTION FACILITIES

The Generating Facility is proposed to consist of fifty-one (51) 2.0 MW General Electric Wind Turbine Generation Systems for a total generating nameplate capacity of 102 MW.

The Interconnection Customer's Interconnection Facilities to be designed, procured, constructed, installed, maintained, and owned by the Interconnection Customer at its sole expense include:

- 34.5 kV underground cable collection circuits;
- 34.5 kV to 115 kV transformation substation with associated 34.5 kV and 115 kV switchgear;
- One 115/34.5 kV 69/92/115 MVA (ONAN/ONAF/ONAF) step-up transformer to be owned and maintained by the Interconnection Customer at the Interconnection Customer's substation;
- An approximately 4.9 mile overhead mile overhead kV line to connect the Interconnection Customer's substation to the Point of Interconnection ("POI") at the 115 kV bus at existing Transmission Owner substation ("Cole 115kV Substation") that is owned and maintained by Transmission Owner;
- All transmission facilities required to connect the Interconnection Customer's substation to the POI;
- Equipment at the Interconnection Customer's substation necessary to maintain a composite power delivery at continuous rated power output at the high-side of the generator substation at a power factor within the range of 95% lagging and 95% leading in accordance with Federal Energy Regulatory Commission (FERC) Order 827. The Interconnection Customer may use inverter manufacturing options for providing reactive power under no/reduced generation conditions. The Interconnection Customer will be required to provide documentation and design specifications demonstrating how the requirements are met; and,
- All necessary relay, protection, control and communication systems required to protect Interconnection Customer's Interconnection Facilities and Generating Facilities and coordinate with Transmission Owner's relay, protection, control and communication systems.

TRANSMISSION OWNER INTERCONNECTION FACILITIES AND NON-SHARED NETWORK UPGRADE(S)

To facilitate interconnection, the interconnecting Transmission Owner will perform work as shown below necessary for the acceptance of the Interconnection Customer's Interconnection Facilities.

Table 1 and **Table 2** lists the Interconnection Customer's estimated cost responsibility for Transmission Owner Interconnection Facilities (TOIF) and Non-Shared Network Upgrade(s) and provides an estimated lead time for completion of construction. The estimated lead time begins when the Generator Interconnection Agreement has been fully executed.

Table 1: Transmission Owner Interconnection Facilities (TOIF)

Transmission Owner Interconnection Facilities (TOIF)	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)	Estimated Lead Time
Cole 115kV Substation GEN-2017-047 Interconnection (TOIF) (SWPS) (132996): Construct one (1) 345 kV line terminal, line switches, dead end structure, line relaying, communications, revenue metering, line arrestor, and all associated equipment and facilities necessary to accept transmission line from Interconnection Customer's Generating Facility.	$752,869	100%	$752,869	25 Months
Total	**$752,869**		**$752,869**	

Table 2: Non-Shared Network Upgrade(s)

Non-Shared Network Upgrades Description	ILTCR	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)	Estimated Lead Time
Cole 115kV Substation GEN-2017-047 Interconnection (Non-Shared NU) (WSPS) (132997): Construct one (1) greenfield 115kV Bull Creek substation to include rerouting 115kV lines into substation, remote end upgrades and removals, communications equipment, and all other associated work and materials.	Not Eligible	$16,351,746	100%	$16,341,746	25 Months
Total		**$16,351,746**		**$16,351,746**	

SHARED NETWORK UPGRADE(S)

The Interconnection Customer's share of costs for Shared Network Upgrades is estimated in **Table 3** below.

Table 3: Interconnection Customer Shared Network Upgrade(s)

Shared Network Upgrades Description	ILTCR	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)	Estimated Lead Time
Badger 345kV Substation Reconfiguration (DISIS-2017-001) (144326): Reconfigure the Badger 345kV substation from a Ring Bus to a Breaker-and-a-Half scheme.	Not Eligible	$8,500,000	49.47%	$4,204,950	36 Months
Total		**$8,500,000**		**$4,204,950**	

*UID 144326 replaced UID 143693 from the DISIS due to the "Badger 345kV Substation Reconfiguration" being a cheaper solution than "Beaver County to Woodward 345kV New Line". This new solution invalidates the P42:345:OKGE:SB_BAER7314 non-convergence contingency.

All studies have been conducted assuming that higher-queued Interconnection Request(s) and the associated Network Upgrade(s) will be placed into service. If higher-queued Interconnection Request(s) withdraw from the queue, suspend or terminate service, the Interconnection Customer's share of costs may be revised. Restudies, conducted at the customer's expense, will determine the Interconnection Customer's revised allocation of Shared Network Upgrades.

CONTINGENT NETWORK UPGRADE(S)

Certain Contingent Network Upgrades are **currently not the cost responsibility** of the Interconnection Customer but will be required for full Interconnection Service.

Table 4: Interconnection Customer Contingent Network Upgrade(s)

Contingent Network Upgrade(s) Description	Current Cost Assignment	Estimated In-Service Date
None	$0	N/A

Depending upon the status of higher- or equally-queued customers, the Interconnection Request's in-service date is at risk of being delayed or Interconnection Service is at risk of being reduced until the in-service date of these Contingent Network Upgrades.

AFFECTED SYSTEM UPGRADE(S)

To facilitate interconnection, the Affected System Transmission Owner will be required to perform the facilities study work as shown below necessary for the acceptance of the Interconnection Customer's Interconnection Facilities. **Table 5** displays the current impact study costs provided by either MISO or AECI as part of the Affected System Impact review. The Affected System facilities study could provide revised costs and will provide each Interconnection Customer's allocation responsibilities for the upgrades.

Table 5: Interconnection Customer Affected System Upgrade(s)

Affected System Upgrades Description	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
None	$0	N/A	$0
Total	$0		$0

CONCLUSION

After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 102 MW can be granted. Full Interconnection Service will be delayed until the TOIF, Non-Shared NU, Shared NU, Contingent NU, Affected System Upgrades that are required for full interconnection service are completed. The Interconnection Customer's estimated cost responsibility for full interconnection service is summarized in the table below.

Table 6: Cost Summary

Description	Allocated Cost Estimate
Transmission Owner Interconnection Facilitie Upgrade(s)	$752,869
Non-Shared Network Upgrade(s)	$16,351,746
Shared Network Upgrade(s)	$4,204,950
Affected System Upgrade(s)	$0
Total	**$21,309,565**

Use the following link for Quarterly Updates on upgrades from this report: https://spp.org/spp-documents-filings/?id=18641

A draft Generator Interconnection Agreement will be provided to the Interconnection Customer consistent with the final results of this IFS report. The Transmission Owner and Interconnection Customer will have 60 days to negotiate the terms of the GIA consistent with the SPP Open Access Transmission Tariff (OATT).

APPENDICES

A: TRANSMISSION OWNER'S INTERCONNECTION FACILITIES STUDY REPORT AND NETWORK UPGRADES REPORT(S)

See next page for the Transmission Owner's Interconnection Facilities Study Report and Network Upgrades Report(s).

Facilities Study For Southwest Power Pool (SPP)

GEN-2017-047
Total Output: 102 MW
Beaver Co, Oklahoma

Xcel Energy Services, Inc.
Transmission Planning South
Updated 9/9/2021

Executive Summary

The Southwest Power Pool (SPP or Transmission Provider) evaluated the request GEN-2017-047 to interconnect the generation facility to the SPS transmission system in the Definitive Interconnection System Impact Study (DISIS-2017-001).

GEN-2017-047 requested the interconnection of a 102 MW wind energy generation facility, located in Beaver County, Oklahoma, to the Southwestern Public Service Company (SPS or Transmission Owner) transmission network. To accommodate the Interconnection Customer's (IC) request, SPS will construct a new breaker and one-half substation named Bull Creek, adjacent to the existing SPS Cole substation. After the conversion, the IC will connect to the SPS 115 kV bus. The IC is required to build a 115 kV transmission line from their substation facility to SPS's new Bull Creek Substation. The IC will be required to maintain a Power Factor between 0.95 lagging and 0.95 leading at the Point of Interconnection (POI).

SPP requires that each generator shall implement automatic Under Frequency Load Shedding (UFLS) according to the SPP UFLS Plan for SPS found in the Xcel Energy interconnection document for "Large Generation Interconnection Guidelines (>20MW)" found at the following link: https://www.transmission.xcelenergy.com/Interconnections

To fulfill this requirement, coordination with Xcel Energy is required during the under-frequency relay-setting phase for the generation. The IC is required to report their generation off-nominal frequency tripping relay settings to SPP and SPS. SPS specifies that generators shall not trip at frequencies above 58.5 Hz unless exceptions in the Transmission Provider Criteria are met. The IC agrees that the energy generating units installed at this interconnection will not be tripped for under-frequency conditions above 58.5 Hz in compliance with Transmission Provider criteria. This means that the generation subject to this Interconnection Agreement may not trip for under-frequency conditions on the transmission system until all under-frequency load shedding relays have operated. SPS will also require that the IC be in compliance with all applicable criteria, guidelines, standards, requirements, regulations, and procedures issued by the North American Electric Reliability Corporation (NERC), SPP, and the Federal Energy Regulatory Commission (FERC) or their successor organizations.

The IC is responsible for all the cost of the Interconnection Facilities, installation of the direct assigned Transmission Owner Interconnection Facilities (TOIF) which are facilities paid for by the IC but are owned, operated and maintained by SPS; inclusive of all construction required for the IC to interconnect at SPS's new Bull Creek Substation.

The shared network upgrades will be determined at a later date by SPP and may impact the total overall costs for interconnection of the IC.

It is anticipated that the entire process of building the Bull Creek Substation for the acceptance of the IC facility output and the network upgrades allocated to this project will require approximately 25 months to complete after an Interconnection Agreement is signed and an authorization to proceed is received. The IC's cost for the interconnection of this generation facility is shown below in Table 1, with the detailed description of the cost shown in Table 3.

Table 1: Cost Summary[1]

Shared Network Upgrades Total:	**$ See DISIS Report**
Network Upgrades:	**$ 16,351,746**
Transmission Owner Interconnection Facilities:	**$ 752,869**
Total:	**$ 17,104,615**

[1] The cost estimates are 2021 dollars with an accuracy level of ±20%.

General Description of SPS[2] Facilities

1. **Construction at the SPS Bull Creek Substation**: See Appendix A, Figure A-1 for general vicinity location map of the SPS facility.

    a. **Location**: IC will build a new 115 kV line from their substation to SPS's new 115 kV Bull Creek Substation, in Beaver County, Oklahoma.

    b. **Bus Design**: The 115 kV Bull Creek substation will be a new substation in close proximity to the existing SPS Cole substation. It will be laid out in a breaker and one-half configuration to accommodate the output from the wind energy facility. Appendix A, Figure A-2, shows a preliminary one-line of the new 115 kV at Bull Creek, while Figure A-3 shows a typical elevation view of the normal Point of Interconnection (POI).

    c. **Revenue Metering**: An individual billing meter will be installed at the SPS substation on the line terminal from the IC's substation, which meets the standards: ANSI C12.1 accuracy class 0.2 (3-PT's IEEE C57.13 accuracy class 0.3 and 3-CT's IEEE C57.13 accuracy class 0.15) for full 3-phase 4-wire metering. Pulses out of the billing meter will be sent via SCADA to the Transmission Owner's Control Center in Amarillo, Texas.
        i. Wind Interconnections: two meters per line terminal will be installed
            1. One will be primary and the other will be a back up
        ii. Solar Interconnections: a single meter per line terminal will be installed
        iii. Coal, Natural Gas, hydro, other:

    d. **Disturbance Monitoring Device**: A Disturbance Fault Recorder (DFR), capable of recording faults, swings, and long term trending, will be installed to monitor and record conditions in the substation and on the transmission lines. The disturbance equipment shall also be equipped with a GPS time synching clock. This equipment will have communication capability with a dedicated communication circuit. The disturbance equipment will have its own dedicated communications circuit.

    e. **Remote Terminal Unit (RTU)**: A RTU will be utilized for communications with the new IC facilities. A Communication SEL Relay will be utilized for relay communications and other functions as required; these costs will be directly assigned to the IC. The IC will provide and install a RTU for metering and telemetry at the IC's facility as required by the latest Xcel Energy Interconnection Guidelines.

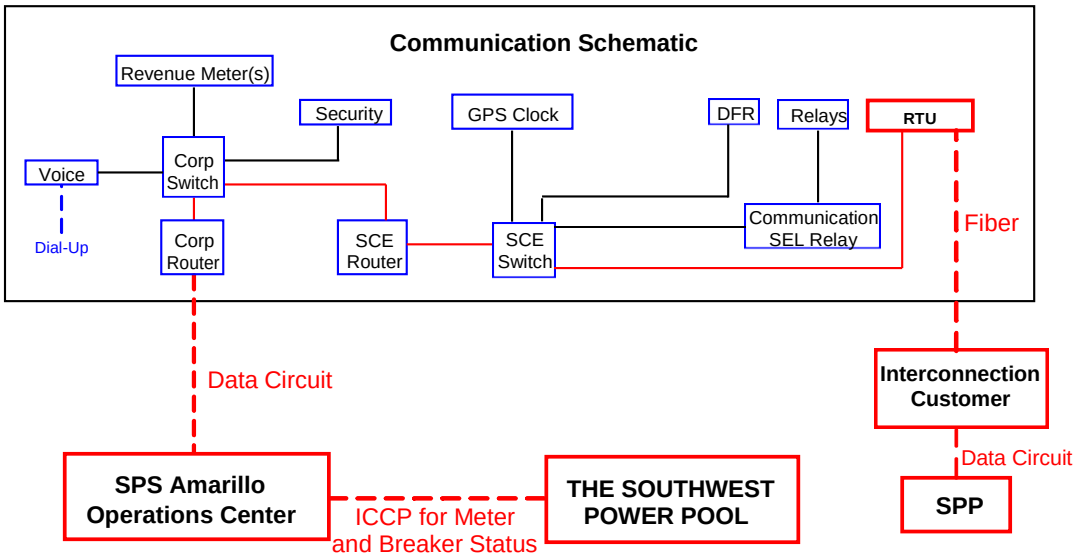
    f. **Communications**: To meet its Communications obligations, the IC shall be responsible for making arrangements with the local phone company to provide a communication circuit as required by the Transmission Owner. Transmission Owner equipment may include, but is not limited to the following: relay communication equipment, RTU, and disturbance monitoring equipment. Prior to any construction, the IC is required to contact the Transmission Owner substation-engineering department for all communication details and provide detail of the method to be used in communication.

        The following communications schematic diagram, which includes communication equipment information for the IC, Transmission Provider (Southwest Power Pool) and Transmission Owner

[2] All modifications to SPS facilities will be owned, maintained and operated by SPS

(Southwestern Public Service), is provided to assist the Parties as a template.

A schematic outlining the proposed communications is provided below:



IC shall be responsible for providing the fiber optic communication circuit installed in the overhead transmission line static wire from the customer substation to the SPS substation for protective relaying and for transmitting metering and status data to SPS. Utilizing this fiber optic connection, SPS will establish a direct connection to the IC's RTU.

SPS will not serve as a proxy for communication from the IC to SPP.

2. Transmission Work – Engineering and Construction

a. **Coordination**: The Xcel Energy Transmission Engineering and Design groups require an engineering review of the customer's design prior to any construction by the IC or its contractor on any customer transmission lines, the proposed termination to the SPS substation, or doing work in close proximity to any SPS transmission line. It is the IC's responsibility to initiate the design review in a timely manner before construction of any transmission line begins. If the review has not been made or the design at any of the aforementioned locations is deemed inadequate, the crossing(s) and or termination into the interchange will be delayed until the matters are resolved. SPS will not be held responsible for these delays

b. **Fault or Short Circuit Study**: The IC will coordinate with the System Protection Engineering department at SPS on the available fault current at the interconnection location following the acceptance of the Generator Interconnection Agreement (GIA) and prior to final design on the IC's facilities. The table below shows the approximate available fault current at the interconnection location. The fault data does not contain fault current contribution from the IC's facility.

Table 1: Available fault current at interconnection location

Short Circuit Information without contribution from new Generator Facilities				
Fault Location	Fault Current (Amps)		Impedance (Ω)	
	Line-to-Ground	3–Phase	Z^+	Z^0
115 kV Bus	1,069	3,949	3.49328 + j16.4466	5.08945 + j28.0340

3. Right-Of-Way

a. **Permitting**: The IC will be responsible for any permitting and right of way of their substation and their transmission line from their substation to the Point of Interconnection (POI).

4. Construction Power and Retail Service

a. **Responsibility**: It is the sole responsibility of the IC to make arrangements for both construction and station power. The IC needs to make arrangements for retail service from the local retail provider. Retail provider and Customer will be responsible for making any necessary transmission service arrangements as required under the SPP OATT.

5. Project and Operating Concerns:

a. **Collaboration**: Close work between the Transmission group, the IC's personnel and local operating groups will be imperative in order to meet any in-service date that has been established.

b. **Reactive Power Requirements**: The IC will be required to maintain a power factor between 0.95 lagging and a 0.95 leading at the Point of Interconnection (POI). All capacitors required will be installed on the lower voltage bus at IC's substation. This is required to maintain acceptable dynamic voltage rise as per latest revision of the Xcel Energy Interconnection Guidelines for Transmission Interconnection Producer-Owned Generation Greater than 20 MW. If switched reactive devices are used on the IC's system, they need to be switched in stages where the voltage rise is less than 3%.

6. Estimated Construction Costs and Schedule

a. The projects required for the interconnection of GEN-2017-047 consist of the projects summarized in the table below:

Table 3: Required Interconnection Projects[3]

Project	Description	Estimated Cost
	Shared Network Upgrades:	
1	The current estimated shared network upgrades to be determined (TBD)	**See DISIS Report**
2	**Network Upgrades (at the IC's expense)**	
	New Bull Creek Substation	12,122,157
	Rerouting 115 kV Transmission lines into new substation	1,804,284
	Remote End Upgrades and removals	1,779,748
	Communications	645,557
	Subtotal:	**$16,351,746**
	Transmission Owner Interconnection Facilities (at the IC's expense)	
3	Communications [4]	*$ See footnote*
4	TOIF	$752,869
	Subtotal:	**$752,869**
	Total Cost	**$17,104,615**

b. **Schedule**: An engineering and construction schedule for this project is estimated at approximately 25 months. Other factors associated with clearances, equipment delays and work schedules could cause additional delays. This is applicable after all required agreements are signed and internal approvals are granted

c. All additional cost for work not identified in this study is the sole responsibility of the IC unless other arrangements are made.

[3] The cost estimates are 2021 dollars with an accuracy level of ±20%.

[4] It is the Requester's responsibility to provide both the data circuit and communication circuits, see Section 1.f

Appendix A

Figure A-1: General vicinity location map of the SPS facility

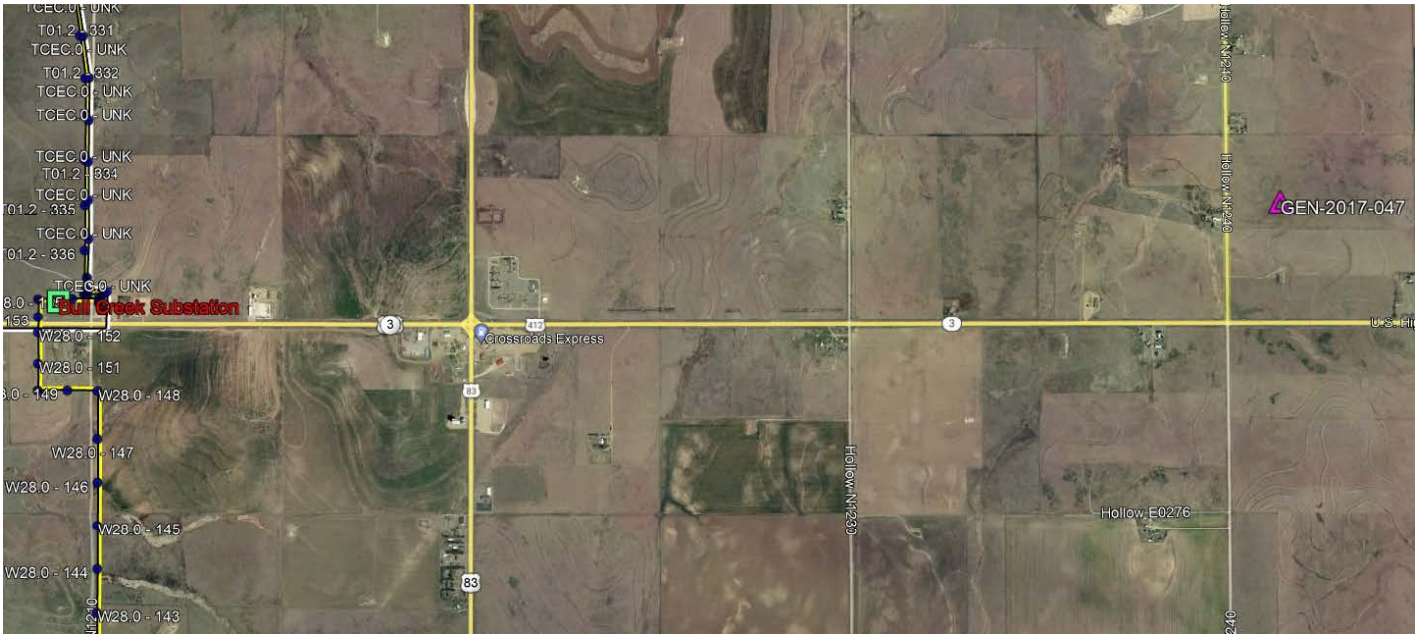


Figure A-2: One-line Diagram at Bull Creek Substation

DIAGRAMS ARE NOT FOR CONSTRUCTION PURPOSES

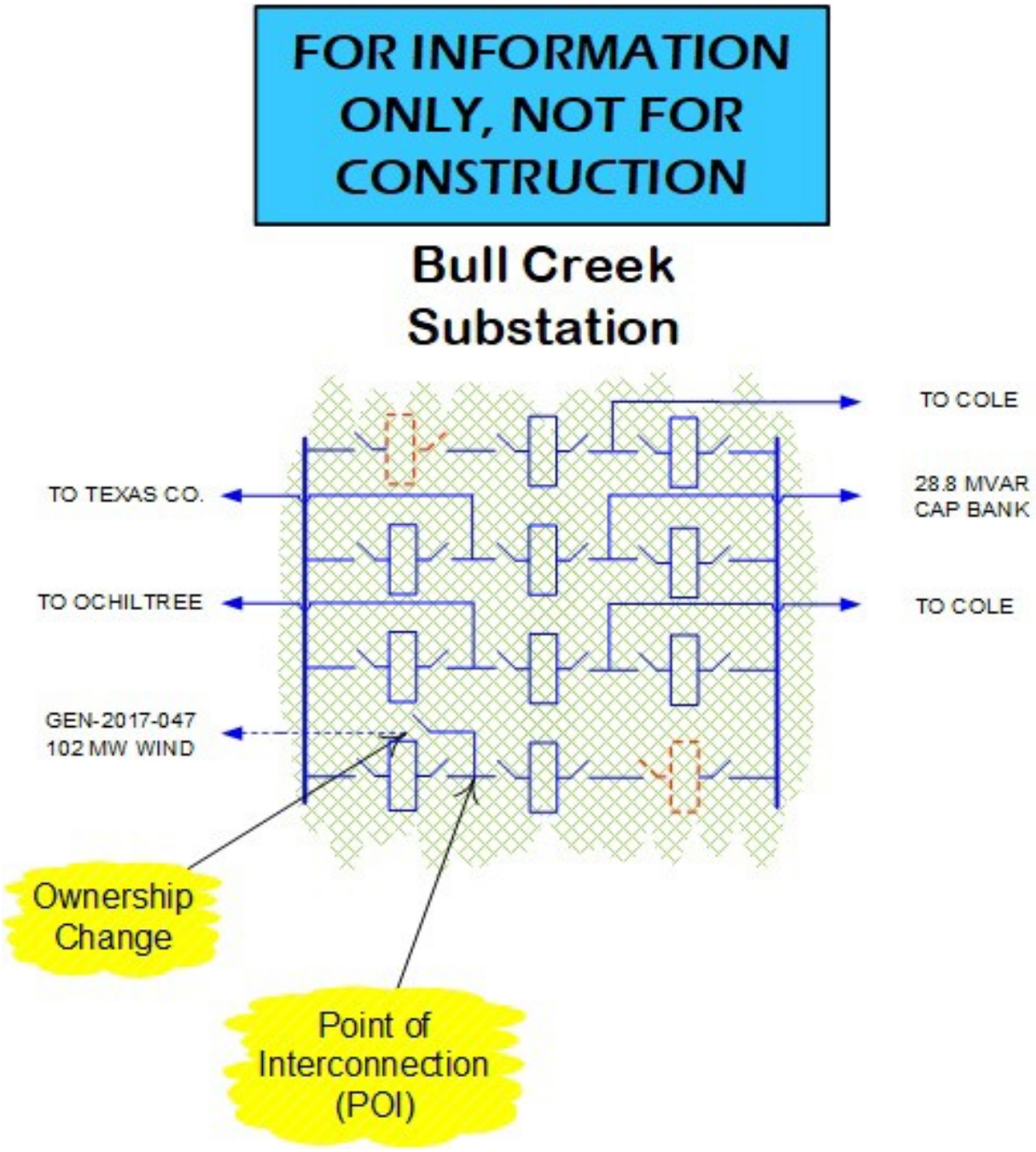
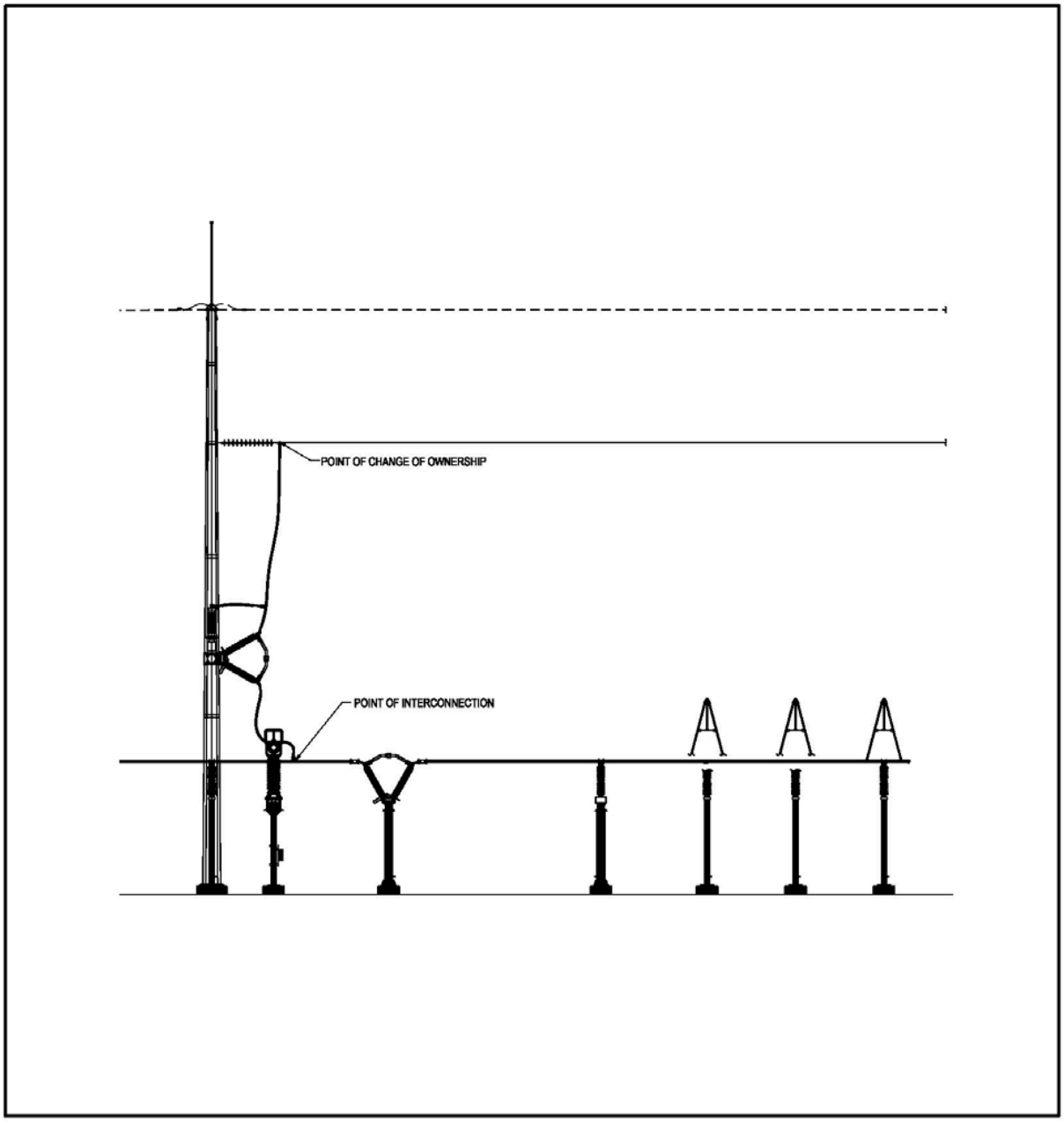


Figure A-3: Point of Interconnection & Change of Ownership Elevation (Typical)

DIAGRAMS ARE NOT FOR CONSTRUCTION PURPOSES



– END OF REPORT –

FACILITY STUDY

for

Facility Request DISIS-2017-001

Shared Network Upgrade
345kV Breakers at Badger Substation
In Beaver County, Oklahoma

March 4, 2022

Steve M. Hardebeck, PE
Manager
Transmission Planning
OG&E Electric Services

Summary

Pursuant to the tariff and at the request of the Southwest Power Pool (SPP), Oklahoma Gas and Electric (OG&E) performed the following Facility Study to satisfy the request by the SPP for Facility Study for DISIS-2017-001. The SPP request consists of adding four new 345kV 5000A breakers, bus work associated switches and relays OG&E Badger Substation. The total cost for OKGE to add four new 345kV breakers and associated equipment in the Badger Substation is estimated to be $8,500,000.

Table of Contents

Introduction

The Southwest Power Pool has requested a Facility Study for the purpose of adding four new 345kV 5000A breakers within the service territory of OG&E Electric Services (OKGE) in Beaver County Oklahoma and building out two new rungs of the six breaker ring bus at Badger substation to a breaker and a half configuration.

Interconnection Facilities

The primary objective of this study is to identify the necessary facilities. The requirements for this facility study request consist of adding four 345kV breakers and associated equipment in the OG&E Badger Substation. This 345kV addition shall be constructed and maintained by OKGE.

The total cost for OKGE to add four 345kV breakers in the Badger Substation, is estimated at $8,500,000. The costs of building out the Badger substation to a breaker and a half configuration are listed in Table 1.

Short Circuit Fault Duty Evaluation

It is standard practice for OG&E to recommend replacing a circuit breaker when the current through the breaker for a fault exceeds 100% of its interrupting rating with recloser de-rating applied, as determined by the ANSI/IEEE C37.5-1979, C37.010-1979 & C37.04-1979 breaker rating methods.

For this facility study, no breakers were found to exceed their interrupting capability after the addition of the related facilities. OG&E found no breakers that exceeded their interrupting capabilities on their system. Therefore, there is no short circuit upgrade costs associated with this DISIS-2017-001 upgrade.

Table 1: Required Network Upgrade Facilities

Facility	ESTIMATED COST (2022 DOLLARS)
OKGE – **Network Upgrades** at Badger sub, 4-345kV 5000A breakers, relays, bus work, disconnect switches, and associated equipment	**$8,500,000**
Total	**$ 8,500,000**

Prepared by Steve M. Hardebeck, PE
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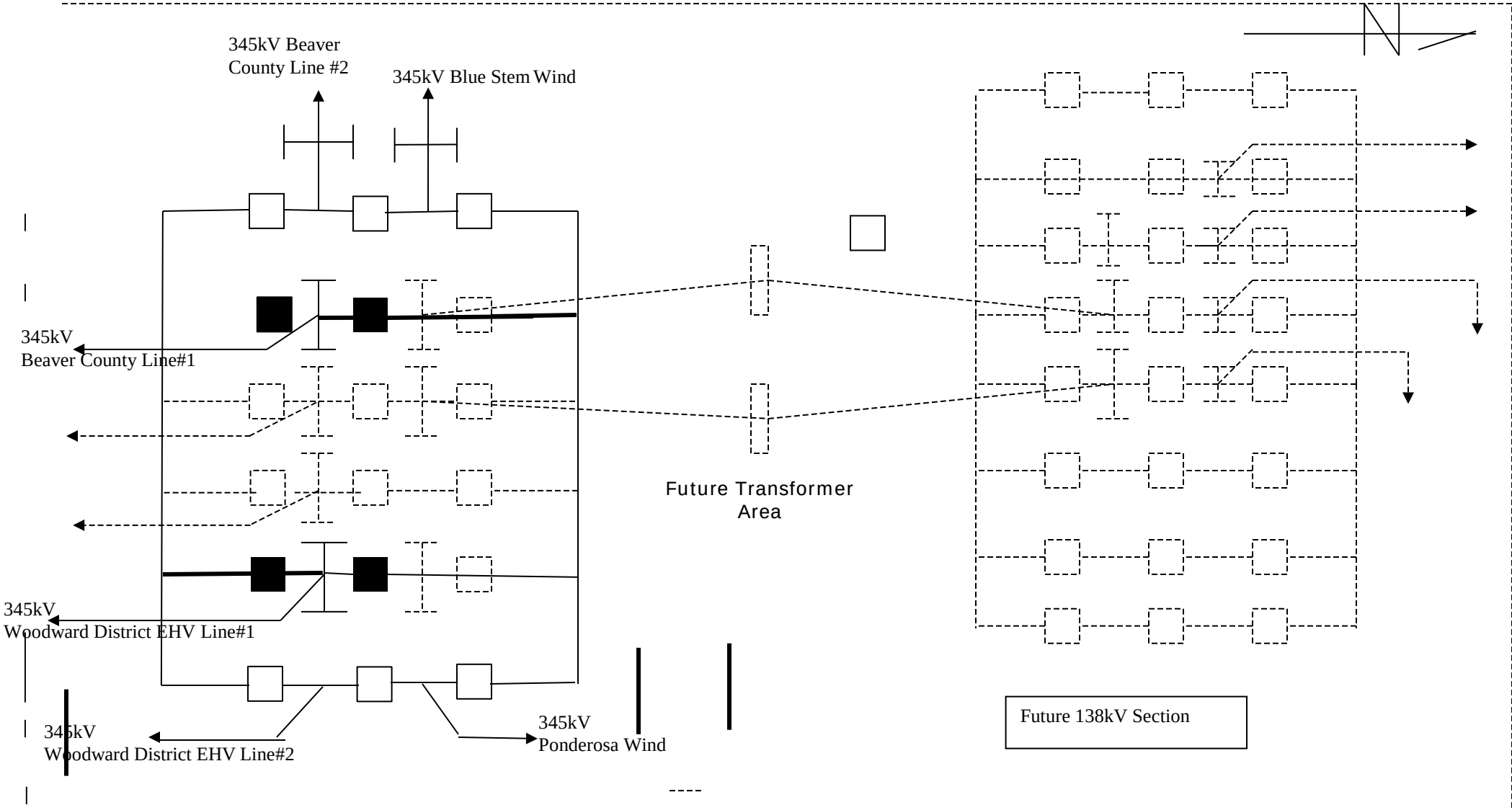
OG&E Electric Services

March 4, 2022

Badger Substation



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