INTERCONNECTION FACILITIES STUDY REPORT

GEN-2020-008

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By SPP Generator Interconnections Dept.

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION
May 19, 2025	SPP	Initial draft report issued.

CONTENTS

SUMMARY

INTRODUCTION

This Interconnection Facilities Study (IFS) for Interconnection Request GEN-2020-008 is for a 250 MW generating facility located in Stevens County, KS. The Interconnection Request was studied in the DISIS-2020-001 Impact Study for ERIS. The Interconnection Customer's requested in-service date is 12/31/2026.

The interconnecting Transmission Owner, Southwestern Public Service Company (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 eighty-four TIMEC - PVU - L0840GR solar and storage inverters for a total generating nameplate capacity of 250 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 345 kV transformation substation with associated 34.5 kV and 345 kV switchgear;
- One 345 kV/34.5 kV 160/213/266 MVA (ONAN/ONAF/ONAF) step-up transformer to be owned and maintained by the Interconnection Customer at the Interconnection Customer's substation;
- An Approximately 100 foot overhead 345 kV line to connect the Interconnection Customer's substation to the Point of Interconnection ("POI") at the 345 kV bus at existing Transmission Owner substation ("Corporation Carpenter 345kV 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** list 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 ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
Transmission Owner's Corporation Carpenter 345kV Substation GEN-2020-008 Interconnection (TOIF) (UID156896): Interconnection upgrades and cost estimates needed to interconnect the following Interconnection Customer facility, GEN-2020-008 (250/Hybrid), into the Point of Interconnection (POI) at Corporation Carpenter 345kV Substation. Estimated Lead Time: 36 Months	$3,277,798	100.00%	$3,277,798
Total	**$3,277,798**		**$3,277,798**

Table 2: Non-Shared Network Upgrade(s)

Non-Shared Network Upgrades Description	ILTCR	Total Cost Estimate ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
Transmission Owner's Corporation Carpenter 345kV Substation GEN-2020-008 Interconnection (UID156895): Interconnection upgrades and cost estimates needed to interconnect the following Interconnection Customer facility, GEN-2020-008 (250/Hybrid), into the Point of Interconnection (POI) at Corporation Carpenter 345kV Substation. Estimated Lead Time: 36 Months	Ineligible	$2,521,943	100.00%	$2,521,943
Total		**$2,521,943**		**$2,521,943**

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 ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
NA				
Total		**$0**		**$0**

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
Line - Wolf Creek - Blackberry 345 kV (122598): Build a new 345kV line from Wolf Creek to Blackberry with a summer emergency rating of 1792 MVA.	**$0**	7/15/2025

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 ($)	Allocated Percent (%)	Allocated Cost Estimate ($)
NA			
Total	**$0**		**$0**

CONCLUSION

After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 250 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 Facilities Upgrade(s)	$3,277,798
Non-Shared Network Upgrade(s)	$2,521,943
Shared Network Upgrade(s)	$0
Affected System Upgrade(s)	$0
Total	**$5,799,741**

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)

DISIS 2020-001
Group 5
GEN-2020-008

Xcel Energy Services, Inc.

Southwestern Public Service Co.
Transmission Planning South
Updated 5/5/2025

Executive Summary

The Southwest Power Pool (SPP or Transmission Provider) evaluated the generation facilities requesting to interconnect to the SPS transmission system in the Definitive Interconnection System Impact Study (DISIS-2020-001), which was completed in May 2025. The requests for interconnection were placed with SPP in accordance with the Scope of Interconnection Facilities Study GIP Section 8.10 and the Interconnection Facilities Study Procedures in accordance with GIP Section 8.11.

GEN-2020-008 requested the interconnection of a 250 MW solar/storage energy generation facility, located in Stevens County, Kansas, to the Southwestern Public Service Company (SPS or Transmission Owner) transmission network. To accommodate the Interconnection Customer's (IC) request, SPS will expand the existing Carpenter Substation 345 kV three-breaker ring bus to a four-breaker ring bus, laid out for future breaker and one-half expansion. After the conversion, the IC will connect to the SPS 345 kV bus. The IC is required to build a 345 kV generation tie-line from their collector substation facility to the SPS' Carpenter 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).

The customer will refer to the Xcel Energy Interconnection Guidelines For Transmission Interconnected Producer-Owned Generation Greater Than 20 MW for additional requirements found at the following link:
Salesforce

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 follow 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' Carpenter Substation.

The shared network upgrades were determined by SPP and may impact the total overall costs for interconnection of the IC.

It is anticipated that the entire process of expanding the Carpenter Substation for the acceptance of the IC facility output and the network upgrades allocated to this project will require approximately 36 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.

Table 1: Cost Summary[1]

Shared Network Upgrades Total:	**$ See DISIS Report**
Unshared Network Upgrades:	**$ 2,521,943**
Transmission Owner Interconnection Facilities:	**$ 3,277,798**
Total:	**$ 5,799,741**

[1] The cost estimates are 2025 dollars with an accuracy level of ±20%.

General Description of SPS[2] Facilities

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

   Location: The IC will build a new 345 kV generation tie-line from their collector substation to SPS' 345 kV Carpenter Substation, in Stevens County, Kansas. SPS requires the IC to run dual OPGW conductors on their generation tie-line to provide redundant communication. The customer will terminate their generation tie-line to a transmission terminal structure installed and owned by SPS. The transmission terminal structure will be located outside of the Carpenter Substation. SPS will install transmission jumpers at the transmission terminal structure and phase conductors along with fiber optics cable to the Point-Of-Interconnection terminal inside the Carpenter Substation. The transmission terminal structure will provide a clear change-of-ownership point for the IC.

   Bus Design: The new 345 kV four position ring bus configuration at Carpenter will be built to accommodate the output from the solar/storage energy facility. The four-position ring bus will be laid out for future breaker and one-half configuration.

   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.

   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.

   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.

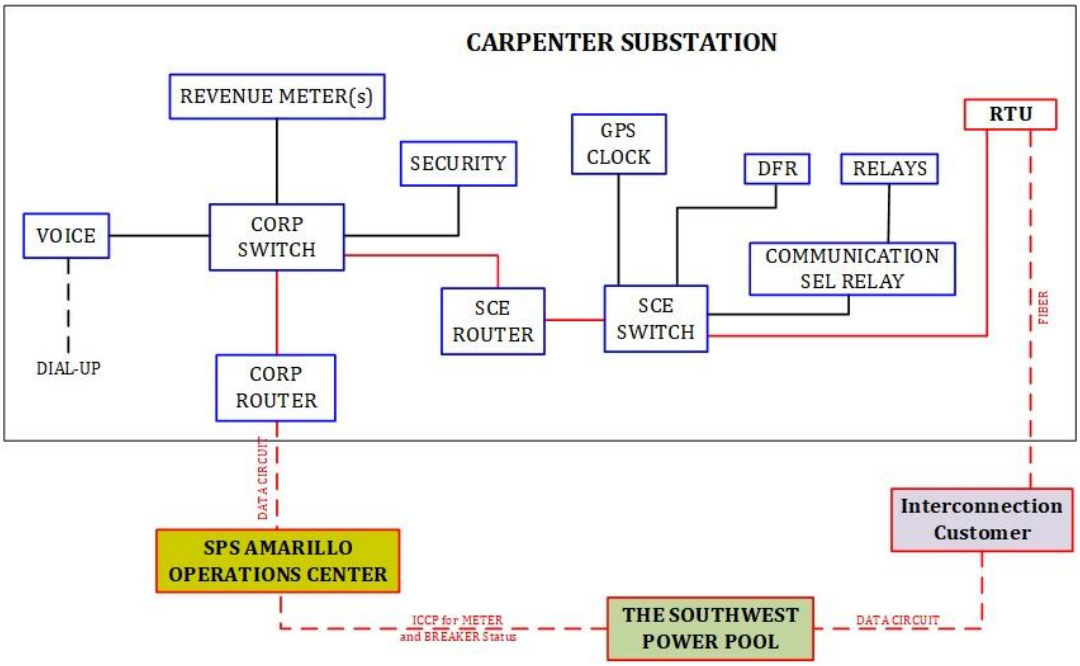
   Communications: To meet its Communications obligations, the IC shall be responsible for planning with the local phone company to provide a communication circuit as required by the Transmission Owner. Transmission Owner equipment may include but is not limited to the following: relay communication equipment, RTU, and disturbance monitoring equipment. Prior to any construction, the IC is required to

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

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 (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 dual 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 (GEN 2020-008)				
Fault Location	Fault Current (Amps)		Impedance (Ω)	
	Line-to-Ground	3–Phase	Z^+	Z^0
Carpenter 345 kV Bus	2319.79	7860.71	2.43647+j25.4513	5.66265+j34.5422

3. **Right-Of-Way**

   a. **Permitting**: The IC will be responsible for any permitting and right of way of their substation and their generation tie-line from their collector substation to Carpenter Substation. The customer will refer to the Xcel Energy *Right-of-Way, Easements, and Encroachments* web page for information concerning crossing of SPS transmission lines with customer generation tie-lines: *Right of Way | Transmission | Corporate | Xcel Energy*

4. **Construction Power and Retail Service**

   a. **Responsibility**: It is the sole responsibility of the IC to arrange for both construction and station power. The IC needs to plan for retail service from the local retail provider. The retail provider and the 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. **Schedule**: An engineering and construction schedule for this project is estimated at approximately 36 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.

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

Appendix A

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

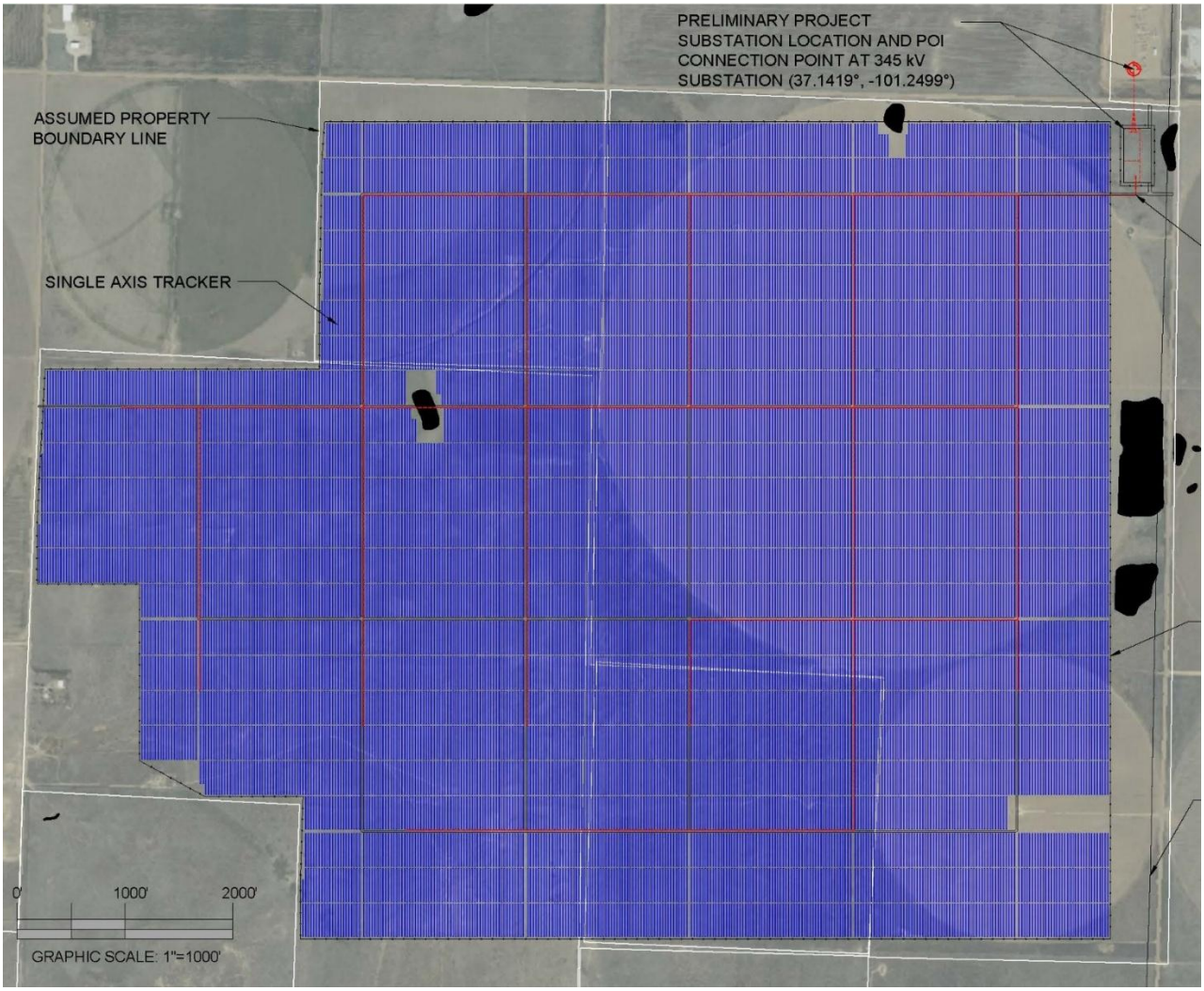
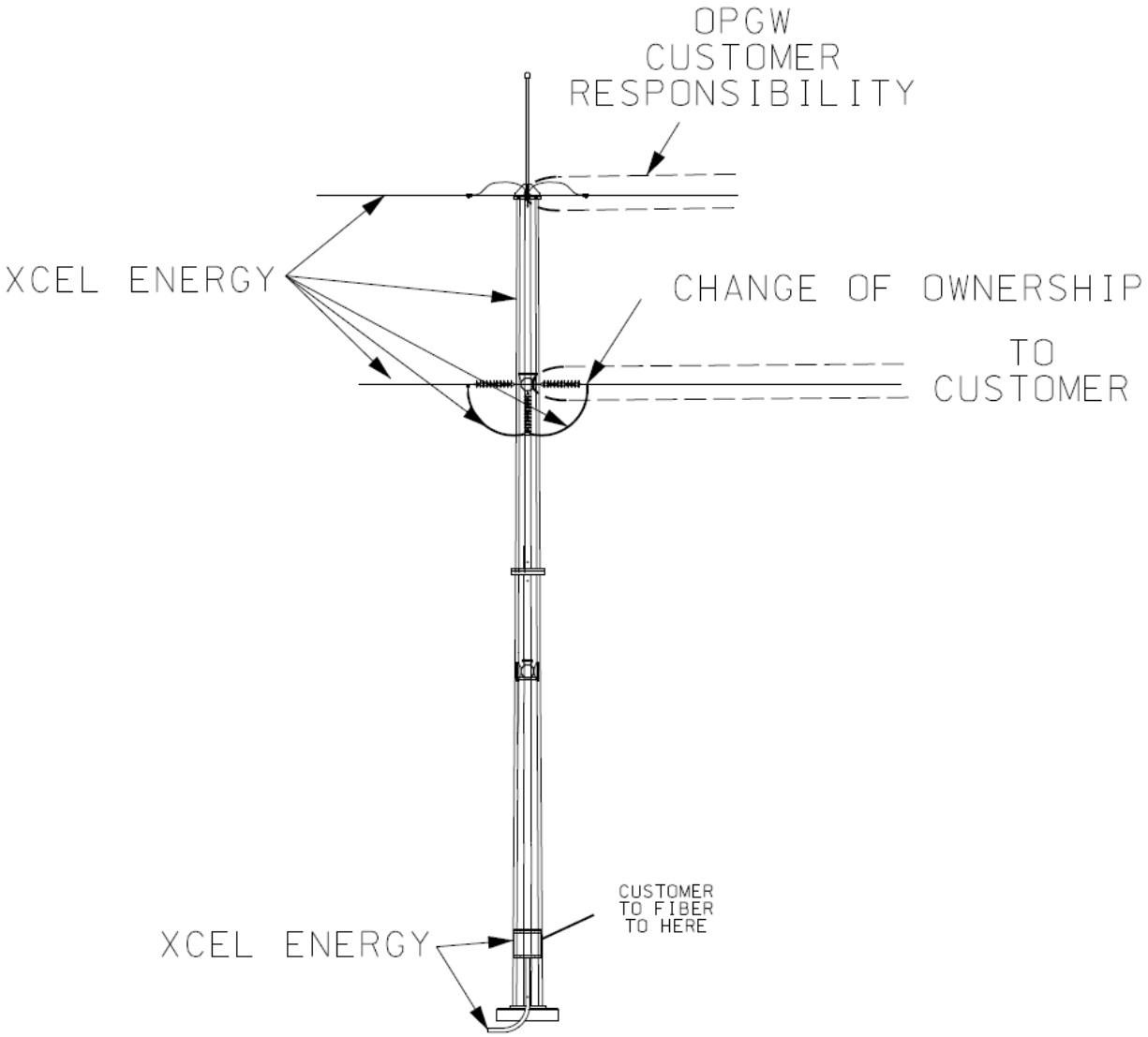


Figure A-2: Satellite Imagery of Carpenter Substation

Figure A-3: Transmission Terminal Structure & Change of Ownership

DIAGRAMS ARE NOT FOR CONSTRUCTION PURPOSES



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