INTERCONNECTION FACILITIES STUDY REPORT

GEN-2015-075

(IFS-2015-002-30)

Published October 2018

By SPP Generator Interconnections Dept.

REVISION HISTORY

DATE OR VERSION NUMBER	AUTHOR	CHANGE DESCRIPTION	COMMENTS
4/05/2017	SPP	Initial draft report issued.	
4/26/2017	SPP	Initial draft report issued.	Include Carlisle 115/69 Transformer Upgrade Costs
8/8/2018	SPP	Revised draft report issued due to DISIS-2015-002-4.	
10/26/2018	SPP	Final report issued. Updated cost estimates, removed completed Previous Network Upgrade.	

CONTENTS

SUMMARY

INTRODUCTION

This Interconnection Facilities Study (IFS) for Interconnection Request GEN-2015-075/IFS-2015-002-30 is for a 51.50 MW generating facility located in Hockley County, Texas. The Interconnection Request was studied in the DISIS-2015-002 Impact Study for Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS). Prior to an executed IFS agreement, the Interconnection Customer requested to withdraw NRIS per Section 4.4.1 of the Southwest Power Pool (SPP) Generator Interconnection Procedures (GIP), therefore ERIS-only was analyzed for this request in the DISIS-2015-002-1 Impact Restudy, DISIS-2015-002-2 Impact Restudy, and DISIS-2015-002-4 Impact Restudy. The Interconnection Customer's requested in-service date is December 1, 2018.

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, Non-Shared Network Upgrade(s), and Shared Network Upgrade(s) 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, Interconnection Service will not be available until all Interconnection Facilities and Network Upgrade(s) can be placed in service.

CREDITS/COMPENSATION FOR AMOUNTS ADVANCED FOR NETWORK UPGRADE(S)

Interconnection Customer shall be entitled to compensation in accordance with Attachment Z2 of the SPP OATT for the cost of SPP creditable-type Network Upgrades, including any tax gross-up or any other tax-related payments associated with the Network Upgrades, that are not otherwise refunded to the Interconnection Customer. Compensation shall be in the form of either revenue credits or incremental Long Term Congestion Rights (iLTCR).

INTERCONNECTION CUSTOMER INTERCONNECTION FACILITIES

The Generating Facility is proposed to consist of thirteen (13) 3.96 MW General Electric (G.E.) solar inverters for a total generating nameplate capacity of 51.48 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 69 kV transformation substation with associated 34.5 kV and 69 kV switchgear;
- One (1) 69/34.5 kV 39/52/65 MVA (ONAN/ONAF/ONAF) step-up transformer to be owned and maintained by the Interconnection Customer at the Interconnection Customer's substation;
- A fourteen (14) mile overhead 69 kV line to connect the Interconnection Customer's substation to the Point of Interconnection ("POI") at the 69 kV bus at the existing SPS substation ("Carlisle") that is owned and maintained by SPS;
- 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 power factor at the POI between 95% lagging and 95% leading, including approximately 4.0 Mvars[1] of reactors to compensate for injection of reactive power into the transmission system under no/reduced generating conditions. The Interconnection Customer may use wind turbine 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.

The Interconnection Customer shall coordinate relay, protection, control, and communication system configurations and schemes with the Transmission Owner.

[1] This approximate minimum reactor amount is needed for the current configuration of the wind farm as studied in the DISIS-2015-002 study and restudies.

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 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: Interconnection Customer TOIF and Non-Shared Network Upgrade(s)

TOIF and Non-Shared Network Upgrades Description	Z2 Type[2]	Allocated Cost Estimate ($)	Allocated Percent (%)	Total Cost Estimate ($)	Estimated Lead Time
SPS Carlisle Interconnection Substation - Transmission Owner Interconnection Facilities: Construct one (1) 69 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.	N/A	$459,005	100%	$459,005	18 Months
SPS Carlisle Interconnection Substation - Non-Shared Network Upgrades: Construct one (1) 69 kV 2000 continuous ampacity breakers, control panels, line relaying, disconnect switches, structures, foundations, conductors, insulators, and all other associated work and materials.	Non-Creditable	$49,833	100%	$49,833	
SPS Carlisle 115/69/13kV Transformer Replacement - Non-Shared Network Upgrades: Replace existing and install new 115/69/13kV 84MVA transformer including line relaying, disconnect switches, foundations, conductors, insulators, and all other associated work and materials.	Creditable	$2,244,618	100%	$2,244,618	24 Months
Total		**$2,753,456**	**100%**	**$2,753,456**	

[2] Indicates the method used for calculating credit impacts under Attachment Z2 of the Tariff.

SHARED NETWORK UPGRADE(S)

The Interconnection Customer's share of costs for Shared Network Upgrades is estimated in **Table 2** below.

Table 2: Interconnection Customer Shared Network Upgrades

Shared Network Upgrades Description	Z2 Type	Allocated Cost Estimate ($)	Allocated Percent (%)	Total Cost Estimate ($)
Border – Chisholm 345 kV Circuit #1 and #2: Build twenty-four (24) miles of double 345 kV circuit from Border (OKGE) – Chisholm (AEP), convert Border 345 kV bus to breaker-and-a-half configuration for acceptance of the new line terminal and install seven (7) 345 kV 5000 continuous ampacity breakers, and expand Chisholm 345 kV bus for acceptance of the new line terminal by installing three (3) 345 kV 3000 continuous ampacity breakers. Border and Chisholm substations will require upgrades including: control panels, line relaying, disconnect switches, structures, foundations, conductors, insulators, and all other associated work and materials. **Estimated Lead Time:** 36 Months	Creditable	$4,418,813	6.06	$72,945,000 (AEP: $42,945,000 OKGE: $30,000,000)
Crawfish Draw – Border 345 kV circuit #2: Build one-hundred-ninety-four (194) miles of second 345 kV circuit from Crawfish Draw (SPS) – Border (OKGE), expand Crawfish Draw substation for acceptance of the new line terminal by installing one (1) 345 kV 3000 continuous ampacity breakers, and expand Crawfish Draw substation for acceptance of the new line terminal by installing one (1) 345 kV 5000 continuous ampacity breakers. Crawfish Draw and Border substations will require upgrades including: control panels, line relaying, disconnect switches, structures, foundations, conductors, insulators, and all other associated work and materials. **Estimated Lead Time:** TBD	Creditable	$15,029,517	6.06	$247,951,345 (SPS: $243,551,345 OKGE: $4,400,000)
Crawfish Draw 345/230 kV Substation Upgrade and 345/230 Transformer: Tap Border – TUCO and Tap TUCO – Oklaunion approximately three (3) miles from TUCO, build Crawfish Draw 345 kV substation, add 345/230/13.2 kV transformer, and tie on TUCO – Swisher 230 kV.	Creditable	$4,249,030	17.16	$24,764,205
Total		**$23,697,360**		**$345,660,550**

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.

PREVIOUS NETWORK UPGRADE(S)

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

- None

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 Previous Network Upgrades.

CONCLUSION

After all Interconnection Facilities and Network Upgrades have been placed into service, Interconnection Service for 51.48 MW can be granted. Interconnection Service will be delayed until the Transmission Owner Interconnection Facilities, Non-Shared Network Upgrade(s), and Shared Network Upgrade(s) are completed. The Interconnection Customer's estimated cost responsibility for Transmission Owner Interconnection Facilities, Non-Shared Network Upgrade(s), and Shared Network Upgrade(s) are summarized in the table below.

Table 3: Cost Summary

Description	Allocated Cost Estimate
Transmission Owner Interconnection Facilities	$459,005
Network Upgrades	$25,991,811
Total	**$26,450,816**

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

See next page for the Transmission Owner's Interconnection Facilities Study Report.

Facilities Study For Southwest Power Pool (SPP)
In Hockley County, Texas
GEN-2015-075
Total Output is 51.48 MW
Generation Facilities

November 14, 2016

Xcel Energy Services
Transmission Planning South

Executive Summary

An Interconnection Customer (IC), in 2015, requested the interconnection of a solar energy generating facility to the Southwestern Public Service Company (SPS)[1] transmission network. The IC's solar facility will be located in Hockley County, Texas and interconnecting to a 69kV breaker terminal at the existing SPS Carlisle Interchange, in Lubbock, TX. This facility has a net capacity of 51.48 MW, and the IC's proposed in-service date is 12/01/2018.

The Southwest Power Pool (SPP) has evaluated the request (GEN-2015-075) to interconnect the solar energy generation facility to the SPS transmission system in a Definitive Interconnection System Impact Study (DISIS-2015-002-1), which was completed in August 2016. The interconnection request was studied using GE 3.96 MW inverters for a total of 51.48 MW of solar energy. The IC is required to build, own and maintain any necessary transmission line from the IC solar farm substation to the SPS Carlisle Interchange 69kV breaker terminal. 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 will implement automatic Under Frequency Load Shedding (UFLS) according to the SPP UFLS Plan for SPS, which is found in the Xcel Energy Interconnection Guidelines For Transmission Interconnected Producer-Owned Generation Greater Than 20 MW at the following link:

http://www.transmission.xcelenergy.com/staticfiles/microsites/Transmission/Files/PDF/Interconnection/Interconnections-POL-TransmissionInterconnectionGuidelineGreat20MW.pdf

To fulfill this requirement for the generation, coordination with Xcel Energy is required during the under-frequency relay-setting phase. The Interconnection Customer is required to report their generation off-nominal frequency tripping relay settings to both 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 solar 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 Interconnection Customer 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 Interconnection Customer is responsible for funding of the Interconnection Facilities Network Upgrades and Direct Assigned Transmission Owner Interconnection Facilities; inclusive of all costs required for the IC's generating facility to interconnect to the SPS transmission system. If at a future time Transmission Owner upgrades the Carlisle 69 kV facilities to a higher voltage, the IC will be responsible for all costs to upgrade the Direct Assigned Interconnection Facilities to the higher voltage.

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

It is anticipated that the entire process of building a new 69 kV terminal at Carlisle Interchange for the acceptance of the IC's Solar Farm facility output and the network upgrades allocated to this project will require approximately 18 months to complete after an Interconnection Agreement is signed and an

[1] Southwestern Public Service Company is a subsidiary of Xcel Energy, Inc.

authorization to proceed is received. The cost of these upgrades, inclusive of the IC's cost for the interconnection of this Solar Farm facility, is shown below in Table 1, with the detailed description of the cost shown in Table 3.

Table 1, Cost Summary[2]

Description	Cost
Shared Network Upgrades:	**$ TBD**
Network Upgrades:	**$49,833**
Transmission Owner Interconnection Facilities: Direct Assigned	**$459,005**
Total:	**$508,838**

[2] The cost estimates are 2015 dollars with an accuracy level of ±20%.

General Description of SPS[3] Facilities

1. **Construction on the 69kV at Carlisle Interchange**: See Appendix A, Figure A-1 for a general vicinity map of the Point of Interconnection (POI) substation location in Lubbock, TX.

    1.1. **Location**: Customer will build a new 69kV line from their substation to SPS's 69kV breaker terminal at Carlisle Interchange, which includes one (1) 69kV breaker. Appendix A, Figure A-2, shows a preliminary one-line of Carlisle Interchange.

    1.2. **Bus Design**: The new 69kV terminal will add one (1) 69kV breaker to accommodate the output from the solar energy facility. This is shown in Appendix A, Figure A-2.

    1.3. **Line Terminals**: The 69 kV line and static wire breaker terminal, maximum per phase tension, shall be verified by the IC prior to termination of any IC line to the Point of Interconnection (POI). The SPS substation engineering department can provide guidance on the design tension for this breaker terminal and any specifics required of IC.

    1.4. **Relay and Protection Scheme**: The new 69kV breaker line terminal primary protection to the interconnection customer 69kV transmission line will use line current differential relaying over optical fiber installed in the static of the customer's 69kV transmission line. Secondary relaying will use mirrored bit, Permissive Overreaching Transfer Trip (POTT) over the optical fiber. An SEL 411L and an SEL 311C will be used as primary and secondary relays, respectively. The SEL 411L will be used for line/bus SCADA closing conditions for the 69kV breakers. Also, a SEL 351S will be used for breaker failure.

        An SEL 411L will display the bus voltage, GCB amps, MW, MVAR, and fault location. A communication relay will be installed and for other functions as required.

    1.5. **Revenue Metering**: An individual billing meter will be installed at Carlisle Interchange on the 69kV 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. There will be one meter per line terminal. Pulses out of the billing meter will be sent via SCADA to the Transmission Owner's Control Center in Amarillo, Texas.

    1.6. **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 DFR equipment shall also be equipped with a GPS time synching clock. This DFR equipment will have communication capability with a dedicated communication circuit. The DFR equipment will have its own dedicated communications circuit.

    1.7. **Remote Terminal Unit (RTU)**: The existing RTU will be utilized with communications for the new switching station. A communication SEL Relay will be installed for relay communications and other functions as required: these costs will be directly assigned to the

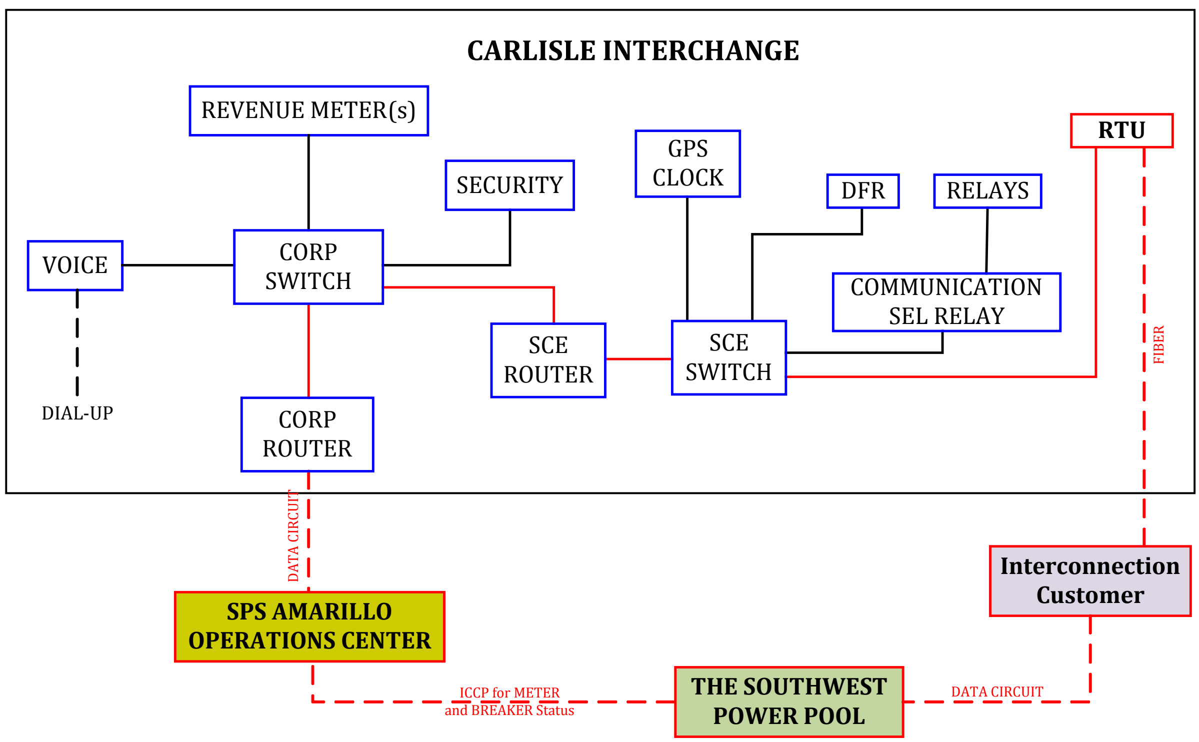
[3] All modifications to SPS facilities will be owned, maintained and operated by SPS.

IC. The IC will provide and install an RTU for metering and telemetry at the IC's facility as required by the latest Xcel Energy Interconnection Guidelines.

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

A schematic outlining the proposed communications is provided below:



Interconnection Customer shall be responsible for providing fiber optic communication circuit installed in the overhead transmission line static wire from the customer substation to Carlisle Interchange 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**:

   2.1. The Interconnection Customer will construct, own, operate, and maintain any customer owned 69kV transmission line from the Interconnection Customer's substation to the Point of Interconnection at SPS's Carlisle Interchange on the 69kV. The POI (Carlisle Interchange) is shown in Appendix A, Figure A-1, the POI where customer's proposed 14 mile is interconnect. **The SPS transmission design group prior to any construction by the Interconnection Customer or its contractor on any customer 69kV transmission lines, or doing work in close proximity to any SPS transmission line, will require an engineering review of the customer's design. It is the Interconnection Customer'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.**

3. **Right-Of-Way**:

   3.1. **Permitting**: The IC will be responsible for any permitting and right of way of their substation and their 69kV transmission line from their substation to the Interconnection Point at Carlisle Interchange on the 69kV.

4. **Construction Power and Retail Service**:

   4.1. **Responsibilities**: It is the sole responsibility of the Interconnection Customer to make arrangements for both construction and station power, which may be required for the Interconnection Customer's solar farm facility. **Additionally, if the Interconnection Customer's substation(s) and/or construction site(s) are located outside of the SPS service area, SPS cannot provide station power (retail service) and the Interconnection Customer 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**:

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

   5.2. **Reactive Power Requirements**: The Interconnection customer 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 34.5 kV at customer'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. The capacitor banks need to be switched in stages where the voltage rise is less than 3%.

6. Fault Current Study:

The available fault current at the POI location was calculated using the 2016 SPP MDWG[4] Series 2021 Summer Peak[5] Short Circuit Model. The fault data is shown below in Table 2 and does not contains fault current contribution from the IC's facility.

Table 2, Available fault current at interconnection location

SHORT CIRCUIT INFORMATION WITHOUT CONTRIBUTION FROM IC'S FACILITIES (GEN 2015-075)					
Fault Location	Fault Current (Amps)			Impedance (Ω)	
	3–Phase	Single-Line-Gnd	Line-Line-Gnd	Z^+	Z^0
Carlisle 69 kV Bus	4855.9	4827.0	4783.2	1.712+j8.023	0.595+j8.393

7. Estimated Construction Costs

The projects required for the interconnection of 51.48 MW Solar Generation facilities consist of the projects summarized in Table 3 below.

Table 3, Required Interconnection Projects[6]

Project	Description	Estimated Cost
	Shared Network Upgrades:	
1	Shared Network Upgrades	$ TBD
	Subtotal:	**$ TBD**
	Network Upgrades (funded by the IC)	
2	69 kV breaker terminal at Carlisle	$ 49,833
	Subtotal:	**$49,833**

	Transmission Owner Interconnection Facilities (direct assigned to the IC)	
3	Communications [7]	*$ See footnote*
4	Line Arrestors, Metering and Related Items	$ 459,005
	Subtotal:	**$459,005**

	Total Cost	**$508,838**

[4] Model Development Working Group
[5] 2016MDWGSC_Classical_MAX_FAULT_FINAL-21S-U01+W77.sav
[6] The cost estimates are 2015 dollars with an accuracy level of ±20%.
[7] It is the Requester's responsibility to provide both the data circuit and communication circuits, see Section 1.8.

8. Engineering and Construction:

An engineering and construction schedule for this project is estimated at approximately 18 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.

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

Appendix A

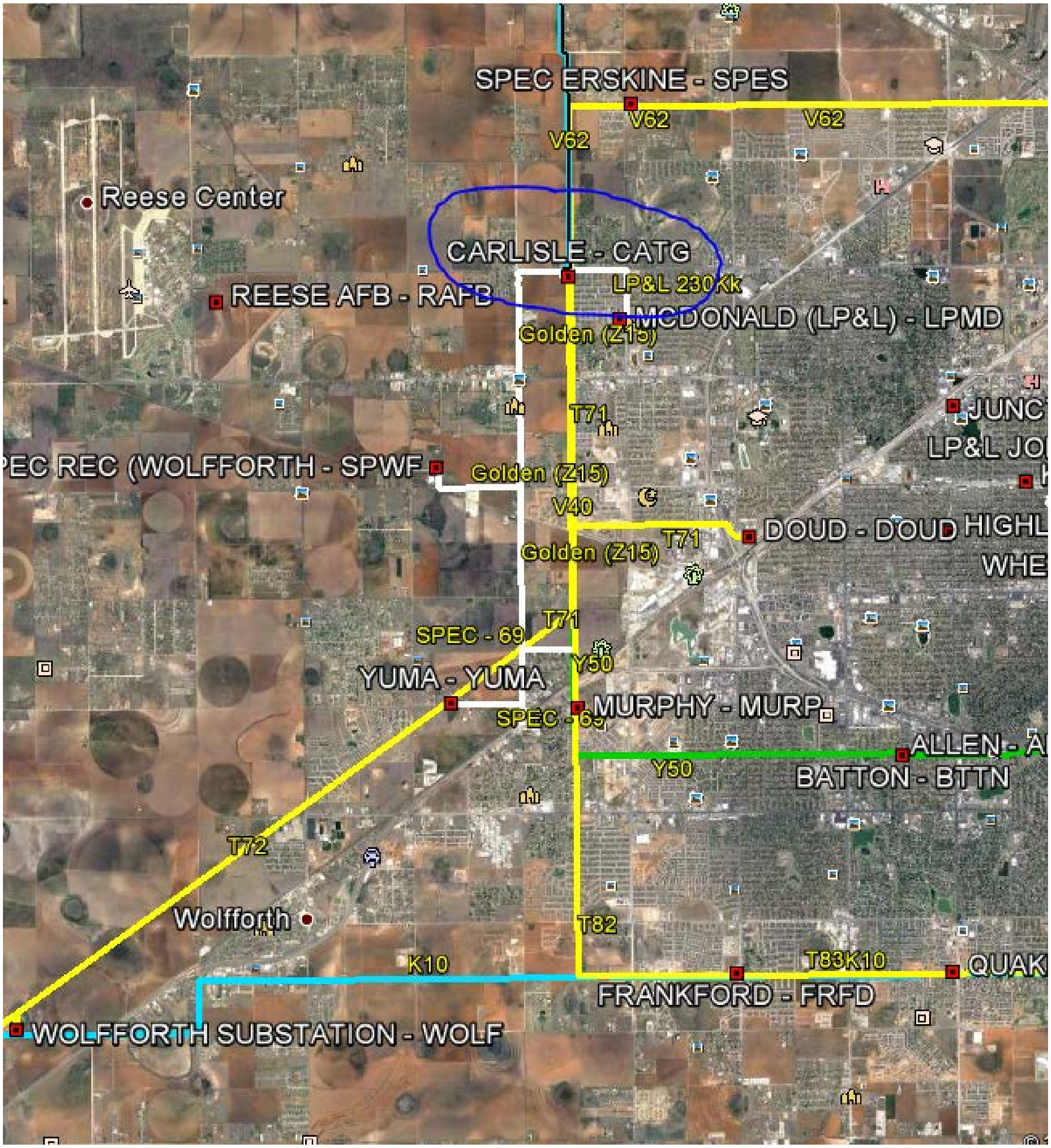


Figure A-1 Location of the SPS Carlisle Interchange

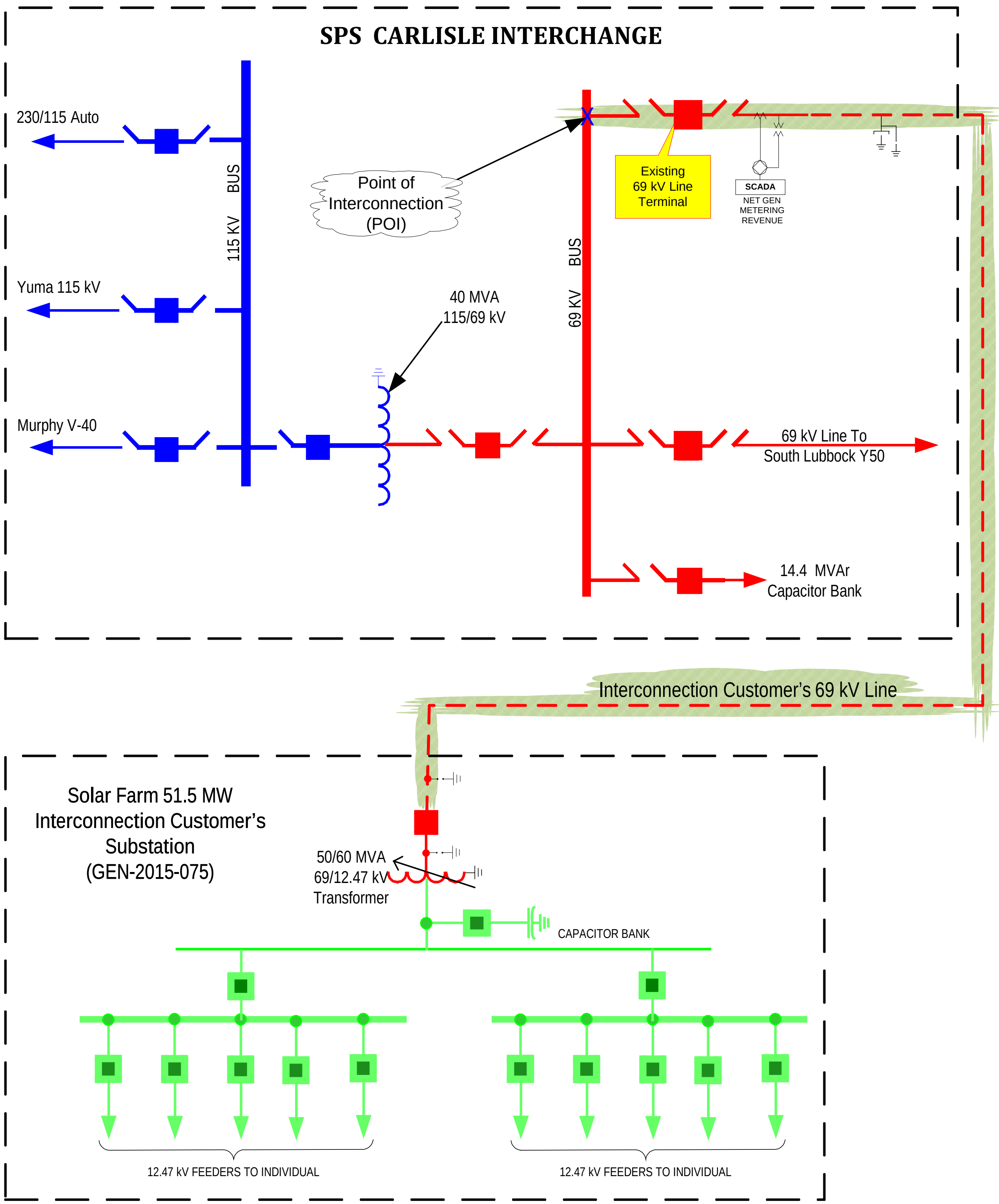


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Figure A-2 One-line Diagram of Carlisle Interchange

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