



Generation Interconnection Facilities Study Report Request # GI-2015-1

250MW Wind Generation Facility
Comanche – Daniels Park 345kV Line (L7015)
Elbert County, Colorado

Transmission Planning West - Xcel Energy

March 23, 2017

I. Executive Summary

This Interconnection Facilities Study Report summarizes the construction schedule and cost estimates of the siting, engineering, equipment procurement and construction needed to interconnect GI-2015-1, a 250MW wind generating facility. The Point of Interconnection (POI) of GI-2015-1 is located at the midpoint of Comanche – Daniels Park 345kV Line (L7015), i.e., at approximately 57.24 miles from the Comanche or the Daniels Park Substation. The POI will constitute tapping Line L7015 to build a new 345kV switching station, which will be referred to as “GI-2015-1 Substation” in this report.

The Generation Facility will be located in Elbert County, Colorado and connect to the POI using a forty-five (45) mile 345kV Customer owned tie-line.

The Generation Facility will be comprised of one hundred and forty (140) GE 1.79MW wind turbines connected in two groups. Each group will consist of seventy (70) wind turbines, one 0.69/34.5kV 140MVA generator step-up transformer and one 34.5/345kV, 140MVA Main Step-up Transformer (MST). The 34.5/345kV MST will be a grounded-wye primary, grounded-wye secondary and a buried delta tertiary configuration which differs from PSCo’s preferred configuration of grounded-wye (high side) /delta (low side). The IEEE calculations for the effectively grounded system provided by the customer are inadequate for PSCo to issue an exception to allow the Customer’s design of the MST.

The Feasibility Study was performed for a Commercial Operation Date (COD) of October 1, 2017 and a report was posted on January 21, 2016. However, for the System Impact Study (SIS), the Customer has revised the COD to December, 2018, so the power flow study results were revised and the System Impact Study (SIS) analysis report was posted on August 9, 2016.

Since the posting of the SIS report, Black Hills Colorado Electric (BHCE) and Colorado Springs Utilities (CSU) indicated to PSCo that system impacts on their facilities should be studied for multiple contingencies. Overloads from the multiple contingency analysis were identified in an addendum to the SIS report.

The total estimated cost for the Transmission Provider’s facilities required for the interconnection of GI-2015-1 is \$11.303M¹

- \$1.903 million for PSCo-Owned, Customer-Funded Interconnection Facilities
- \$9.089 for PSCo-Owned, PSCo-Funded Interconnection Facilities
- \$0.311 for PSCo Network Upgrades for Delivery

Before construction of GI-2015-1 Substation can begin, PSCo will need to obtain a Certificate of Public Convenience and Necessity (CPCN) from the Colorado Public

¹ Appropriation estimates are considered to have an accuracy of +/- 20%.

Utilities Commission (CPUC), which can take up to 18 months. The estimated time required to design, engineer, procure and construct the facilities described is 18 months after CPCN approval, resulting in a total 36 month estimated timeframe to complete construction of GI-2015-1 Substation. So the Interconnection Customer's June 2019 requested backfeed date is not be feasible.

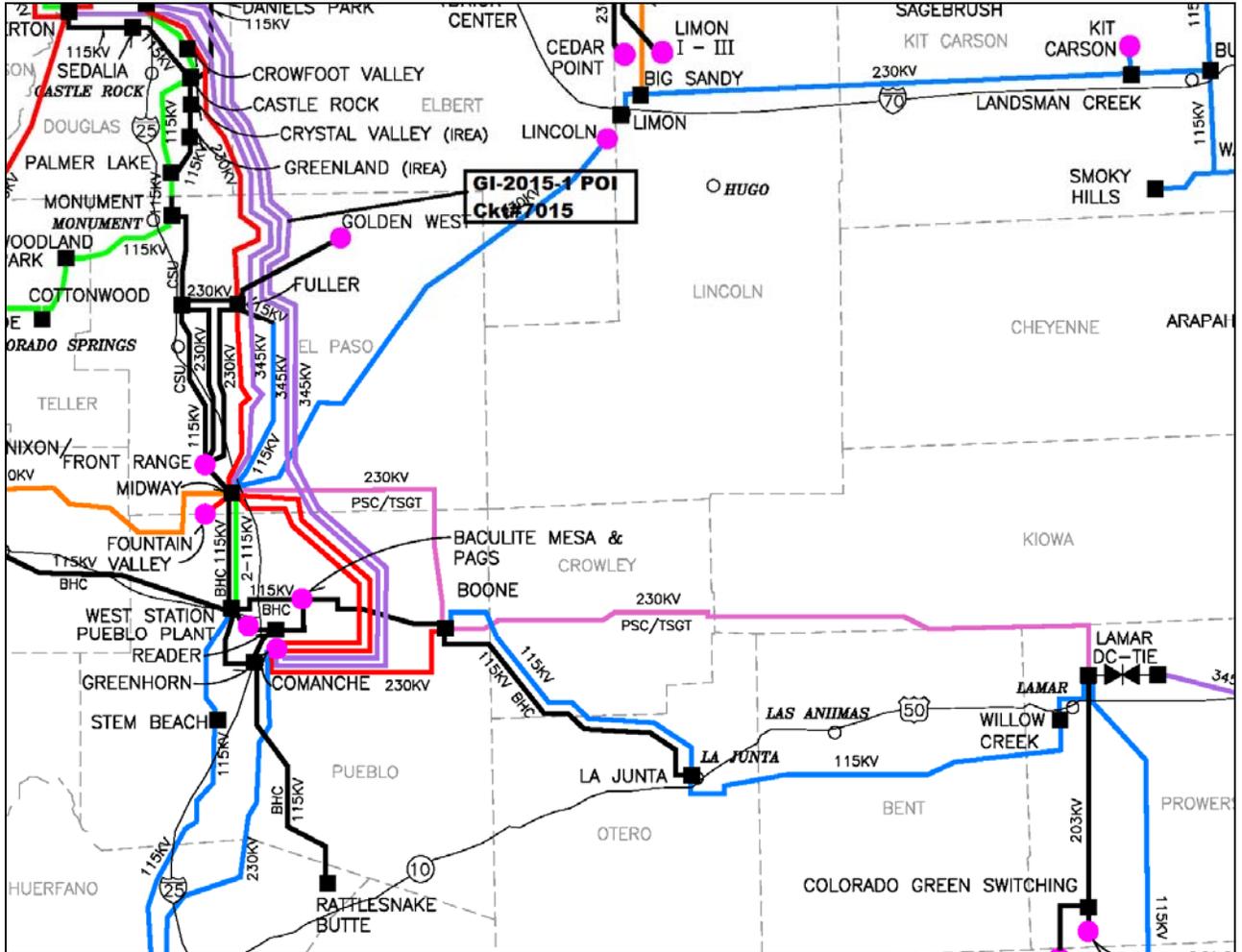


Figure 1 Primary POI and the Surrounding Transmission System

II. Introduction

This Interconnection Facilities Study Report summarizes the construction schedule and cost estimates of the siting, engineering, equipment procurement and construction needed to interconnect GI-2015-1, a 250MW wind generating facility. . The Point of Interconnection (POI) of GI-2015-1 is located at the midpoint of Comanche – Daniels Park 345kV Line (L7015), i.e., at approximately 57.24 miles from the Comanche or the Daniels Park Substation. The POI will constitute tapping Line L7015 to build a new 345kV switching station, which will be referred to as “GI-2015-1 Substation” in this report.

The Generation Facility will be located in Elbert County, Colorado and connect to the POI using a forty-five (45) mile 345kV Customer owned tie-line.

The GI facility will be comprised of one hundred and forty (140) GE 1.79MW wind turbines connected in two groups. Each group will consist of seventy (70) wind turbines, one 0.69/34.5kV 140MVA generator step-up transformer and one 34.5/345kV, 140MVA Main Step-up Transformer (MST). The 34.5/345kV MST will be a grounded-wye primary, grounded-wye secondary and a buried delta tertiary configuration which differs from PSCo’s preferred configuration of grounded-wye (high side) /delta (low side). The IEEE calculations for the effectively grounded system provided by the customer are inadequate for PSCo to issue an exception to allow the Customer’s design of the MST.

The Feasibility Study was performed for a Commercial Operation Date (COD) of October 1, 2017 and a report was posted on January 21, 2016. However, for the System Impact Study (SIS), the Customer has revised the COD to December, 2018, so the power flow study results were revised and the System Impact Study (SIS) analysis report was posted on August 9, 2016.

Since the posting of the SIS report, Black Hills Colorado Electric (BHCE) and Colorado Springs Utilities (CSU) indicated to PSCo that system impacts on their facilities should be studied for multiple contingencies. Overloads from the multiple contingency analysis were identified in an addendum to the SIS report.

The GI-2015-1 Interconnection study request was for both Energy Resource Interconnection Service (ERIS) and Network Resource Interconnection Service (NRIS). The Feasibility Analysis identified the following thermal overloads attributable to GI-2015-1 Interconnection

- Greenwood – Prairie1 230kV line loading increased from 88.7% to 102.9%
- Greenwood – Prairie3 230kV line loading increased from 91.8% to 105.9%
- Greenwood – Monaco 230kV line loading increased from 96.2% to 105.9%
- Waterton – Martin2tap 115kV line loading increased from 96.5% to 101.8%

The incremental overloads on the following BHCE facilities are attributable to GI-2015-1 Interconnection

- Portland – Skala 115kV line loading increased from 110.7% to 118.1%
- Canyon City – Skala 115kV line loading increased from 98.7% to 105.5%
- West Canyon 230/115kV transformer loading increased from 104.2% to 105.5%
- Fountain Valley – Desertcove 115kV line loading increased from 102.6% to 121.6%
- Fountain Valley – MidwayBR 115kV line loading increased from 101.6% to 120.5%
- Hydepark – West Station 115kV line loading increased from 87.7% to 109.1%
- Desertcove – West Station 115kV line loading increased from 121.4% to 141.2%

The incremental overloads on the following TSGT facilities are attributable to GI-2015-1 Interconnection

- Black Forest Tap – BLK SQMV 115kV line loading increased from 195.0% to 198.8%
- BLK SQMV – Fuller 115kV line loading increased from 125.3% to 127.5%
- Fuller 230/115kV line loading increased from 150.8% to 151.8%
- Monument – Gresham 115kV line loading increased from 102.7T to 104.9%

The incremental overloads on the following WAPA facilities are attributable to GI-2015-1 Interconnection

- Midway PS – Midway BR 230kV tie line loading increased from 88.3% to 105.4%

The incremental overloads on the following CSU facilities are attributable to GI-2015-1 Interconnection

- Fountain_S – RD_Nixon 115kV line loading increased from 122.3% to 123.8%

An agreement for a Facility Study was executed on October 17, 2016.

Before construction of GI-2015-1 Substation can begin, PSCo will need to obtain a Certificate of Public Convenience and Necessity (CPCN) from the Colorado Public Utilities Commission (CPUC), which can take up to 18 months. The estimated time required to design, engineer, procure and construct the facilities described is 18 months after CPCN approval, resulting in a total 36 month estimated timeframe to complete construction of GI-2015-1 Substation. So the Interconnection Customer's June 2019 requested backfeed date may not be feasible.

III. General Interconnection Facilities Description

A. Project Purpose & Scope

This report stipulates the requirements of the GI-2015-1 Substation which is the POI for GI-2015-1. Also, this report stipulates the interconnection facilities required to accommodate interconnection of the GI-2015-1 wind generation facility.

Notable Items

For the purpose of the cost estimates and the Facility study report development, the Commercial Operation Date (COD) of GI-2015-1 is assumed to be December 1, 2019 as stated by the Customer. However, the time required for obtaining a CPCN and design, engineer, procure and construct of GI-2015-1 Substation is estimated to be up to thirty-six (36) months, so the December 1, 2019 COD may not be feasible.

Future Considerations

The costs for future configuration additions are not included in the current project scope or cost estimates.

Distribution vs. Transmission Asset Ownership and Cost Responsibility

The substation primary function will be Transmission. No Costs are assigned to Distribution.

Interconnection / Customer Cost Responsibility

The project cost will be reimbursable by the customer as per the LGIA.

B. FERC and/or NERC Compliance Requirements

Critical Infrastructure Protection (CIP) Asset

The CIP status of this substation will be confirmed at a later date.

Power System Restoration Plan Impact

The Power System Restoration Plan Impact was not verified.

Facility Ratings and Smart One-Lines

This substation will have Bulk Electric System facilities.

A smart one-line diagram does not yet exist for this substation. A smart one-line diagram will not be created as part of this project for the following reasons: Facility rating changes will be managed via existing pre-GIST2 facility rating processes.

C. Right of Way/Permitting

As this is a new substation project, Xcel Energy will need to purchase and develop land to construct the substation, as well as acquire any necessary Right-of-Ways as required to tap the current Daniels Park to Comanche 345kV Line #7015. Additionally, all standard permits for substation construction will be required.

D. Electrical Features

Fault Current

The Customer did not provide the required information to calculate the fault current contributions and perform a breaker duty study to determine the impact of the fault currents from the GI-2015-1 on the neighboring substations. A detailed breaker duty study and fault current contribution calculations will need to be performed before construction of GI-2015-1 can begin.

The fault current contributions at the GI-2015-1 Substation with the existing system are given below

	Existing System
Three Phase Fault Current	7998A
Single Line to Ground Fault Current	5891A
Positive Sequence Impedance	1.853+j24.836 ohms
Negative Sequence Impedance	1.880+j24.834 ohms
Zero Sequence Impedance	9.170+j50.942 ohms

Electrical Removals & Relocations

There are no removals or Relocations associated with this project.

Electrical Equipment Enclosure (EEE)

A large EEE will be required at GI-2015-1 Substation.

AC System

A station service transformer will be required at GI-2015-1 Substation.

DC System

A DC battery system is to be included in the EEE. Appropriate sizing will be determined once engineering has started on the project.

Grounding

A new ground grid will need to be installed. Initial estimates assumed 40 foot ground grid spacing.

Lightning Protection

Lightning protection will be required.

Trenching & Cable

Trenching and all associated control and power cable will be required to each piece of new equipment, as well as for station service, fiber communications, and others as required.

Wave/Line Traps

New wave traps will be installed for the sectionalized line section.

E. Civil Features

Grading & Fencing

Approximately 2,200 feet of new fencing and associated vehicle and personnel access gates will be required. As no site has presently been chosen for the substation, the degree of grading that will be required is unknown, but the site will need to be graded prior to construction.

Storm Water Permit

A storm water permit will be required for this project.

SPCC (Oil Containment)

Oil containment will not be required for this project.

Civil Removals & Relocations

There are no civil removals or relocations required.

Foundations & Structures

Foundations for all major equipment will be required.

F. Protection Features

Standard Xcel Energy protection schemes will be utilized for transmission line and breaker failure protection. At this time, replacement of relays at Comanche and Daniels Park is not anticipated.

Protection Schemes for the New Line Termination to GI-2015-1:

The primary protective scheme will be line current differential (87L) and the secondary protection scheme will be DCUB. It is assumed the wind generator developer will install OPGW with the transmission line, which can be utilized as the differential channel.

The 345kV buses will utilize high impedance bus differential protection packages.

All other relaying shall follow the current Xcel Energy protection design standards.

G. Control Features

General

New traditional controls will be installed.

Transmission Breaker Reclosing Controls

Remote close will be required.

Transformer LTC Controls

N/A

Digital Fault Recorder (DFR)

A DFR will be installed.

Control Panel Locations

Control panels will be installed.

Removals

N/A

H. Communication Features

A communication recommendation has not been developed yet for this project

Wide Area Network (WAN)

TBD

Remote Terminal Unit (RTU)

A new RTU will be required at GI-2015-1 Substation.

Local Annunciation

Annunciation will be via the RTU.

Telephone Protection

There will be new phone service with surge protection.

Relay Remote Access

Remote access will be established.

Programmable Logic Controller (PLC)/Feeder Load Monitoring/Information-flow/Others

N/A

Interconnections

AGC will be sent directly to the Control Center and is the responsibility of the developer

Removals

N/A

I. Project Operating Concerns and Outages

Design and construction may be delayed by the CPCN and siting process.

Outages/Temporary Configurations

Schedule coordination and outages may be an issue to take L7015 out of service.

Mobile Substation or Transformer

There will not be a need for a mobile transformer or substation

Environmental

Environmental issues will depend on the site location.

J. Material Staging Plan

Major material will be shipped and stored at the job site. Stock materials will be ordered and staged through the assigned material coordinator.

K. Related Projects

There are no related Work Orders at this time.

L. Estimate Discussion

The standard contingency factors for estimates are as follows:

Material: 10%; Labor and Equipment: 10%

The estimate contingency levels have been modified for the Communications portion of this project. Specifically, the Material Contingency Factor has been modified to 20% to allow for changes. The Labor Contingency Factors has been modified to 20% to allow for changes.

IV. Cost Estimates and Assumptions

PSCo Engineering has developed Appropriation level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades required for the interconnection of the proposed generation facility. Appropriation Estimates (AE's) are based upon typical construction costs for previously performed similar construction projects and have an assumed +/- 20% level of accuracy. The estimates do not include the cost for any other Customer owned equipment and associated design and engineering.

The estimated total cost for the required upgrades is \$11.303 Million

Appendix A, below, is a conceptual one-line of the proposed interconnection. The Point of Interconnection (POI) will be at a proposed new substation (GI-2015-1 Substation) tapping the Comanche-Daniels Park 345kV Transmission Line.

The following (Tables 1-3) list the improvements required to accommodate the interconnection and the delivery of the customer's 250 MW wind facility generation output. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to revision as a more detailed and refined design is produced.

- Appropriation level project cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/-20% accuracy) were developed by PSCo / Xcel Engineering.
- Estimates are based on 2016 dollars (appropriate contingency and escalation included).
- AFUDC has been excluded.
- Labor is estimated for straight time only – no overtime included.

- Lead times for materials were considered for the schedule.
- The Wind Generation Facility is not in PSCo's retail service territory. Therefore, no costs for retail load (distribution) facilities and metering required for station service are included in these estimates.
- PSCo / Xcel (or our Contractor) crews will perform all construction, wiring, testing and commissioning for PSCo owned and maintained facilities.
- The estimated time to site, design, procure and construct the interconnection and network delivery facilities is approximately 18 months after authorization to proceed has been obtained.
- A CPCN will be required for the interconnection facilities construction and will add 18 months in front of the siting, design, procure construct window (of 18 months), totaling an estimated 36 month window to complete from authorization to proceed.
- The Customer will be required to design, procure and install a Load Frequency/Automated Generation Control (LF/AGC) RTU at their Customer Substation. PSCo / Xcel will need indications, readings and data from the LFAGC RTU.
- Customer will string OPGW fiber into substation as part of the transmission line construction scope.
- Land for the new substation will need to be acquired.
- Breaker duty study determined that no breaker replacements are needed in neighboring substations.

Table 1 – PSCo Owned; Customer Funded Transmission Provider Interconnection Facilities

Element	Description	Cost Est. (Millions)
GI-2015-1 Substation	Interconnect Customer to tap at the proposed 345kV Substation. The new equipment includes: <ul style="list-style-type: none"> • (3) 345kV Metering Units • (1) 345kV line switch • (1) dead end structure • (3) 345kV CCVTs • (2) 345kV Line Traps • (3) Surge Arresters • Relaying for the line position • Associated bus, wiring, and equipment • Associated foundations and structures • Associated transmission line communications, relaying, and testing 	\$1.267
	Transmission line relocation and tap into substation. Structures, conductor, insulators, hardware and labor.	\$0.616
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction.	\$0.020
	Total Cost Estimate for PSCo-Owned, Customer-Funded Interconnection Facilities	\$1.903

Time Frame	<u>Site, design, procure and construct</u>	36 Months
-------------------	--	------------------

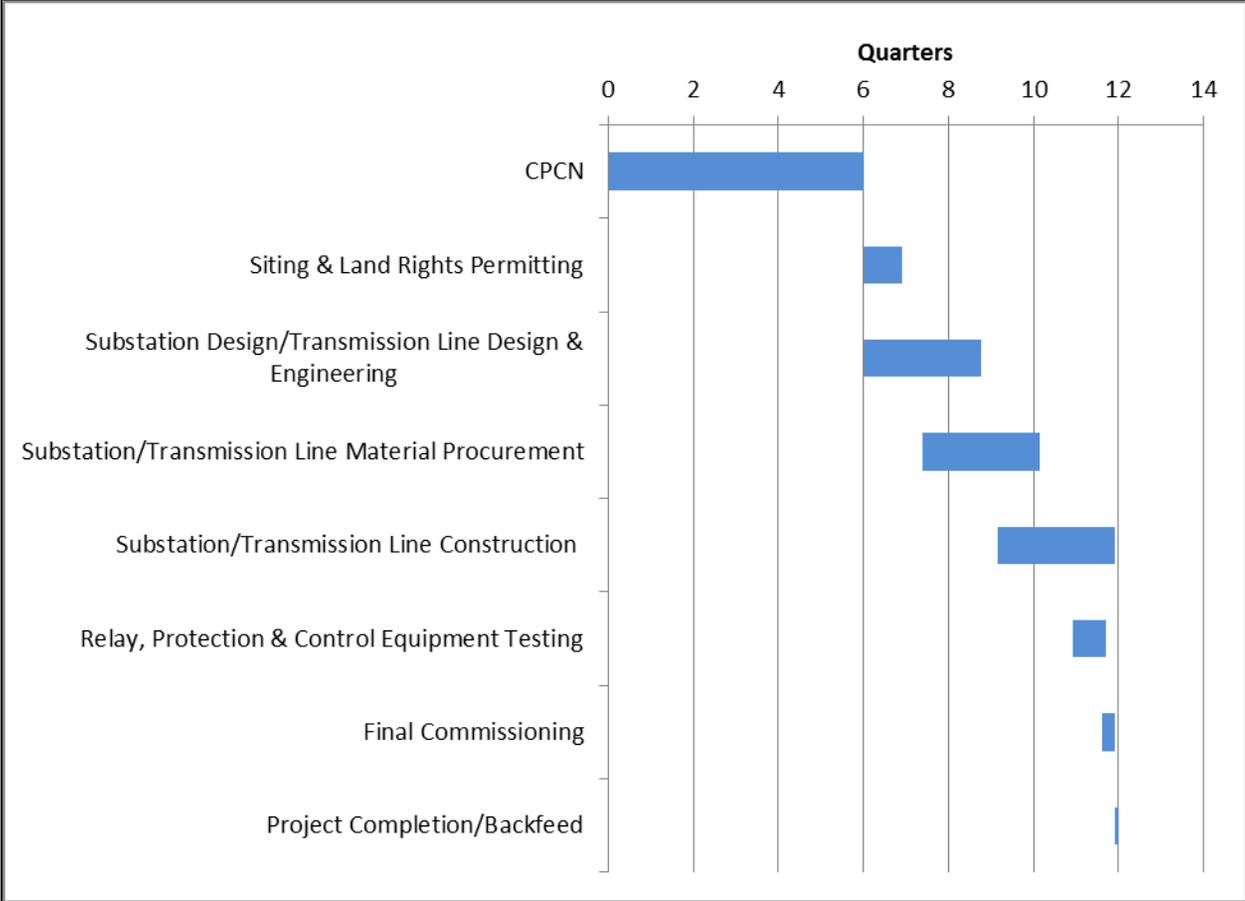
Table 2 - PSCo Owned; PSCo Funded Transmission Provider Interconnection Facilities

Element	Description	Cost Estimate (Millions)
GI-2015-1 Substation	PSCo to construct new 345kV Substation. The new equipment includes: <ul style="list-style-type: none"> • (3) 345kV SF6 circuit breakers • (2) dead end structures • (14) 345kV disconnect switches • (8) 345kV CCVTs • (2) 345kV Line Traps • (126) 345kV insulators • (6) Surge Arresters • Relaying for Xcel line positions • New relay panels for breaker protection • Associated line relaying and testing • Associated bus, wiring, and equipment • Associated foundations and structures • Associated transmission line communications, relaying, and testing • Site development, earthwork ground grid, EEE, fencing 	\$8.881
	Siting and Land Rights support for substation land acquisition and construction.	\$0.208
	Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities	\$9.089
Time Frame	<u>Site, design, procure and construct</u>	36 Months

Table 3 – PSCo Network Upgrades for Delivery

Element	Description	Cost Est. (Millions)
Greenwood Substation	Upated Line Trap and Associated Wiring	\$0.172
Monaco Substation	Upated Jumpers and Associated Equipment	\$0.041
Prairie Substation	Upated Jumpers and Associated Equipment	\$0.053
Waterton Substation	Upated Jumpers and Associated Equipment	\$0.045
	Total Cost Estimate for PSCo Network Upgrades	\$0.311

V. Engineering, Procurement & Construction Schedule



Appendix – A

Project One-Line of the GI-2015-1 Substation, tapping the Comanche – Daniels Park 345kV Line 7015

