Interconnection Feasibility/System Impact Study Report
Request # GI-2004-2 Restudy

75 MW Expansion of the Existing Wind Generation
Lamar 230 kV Substation, Colorado

Public Service Company of Colorado
Transmission Planning
September 18, 2015

Executive Summary

The study request for GI-2004-2 was originally received in 2004. The initial request was for the interconnection of a 238MW wind farm, the feasibility study for the 238MW interconnection request was completed in May 2004 and System Impact Study was completed in December 2004. Post completion of the system impact study in December 2004, the GI capacity was reduced to 150MW. The studies performed in 2004 GI-2004-2 included 1.5MW GE doubly fed induction generators. Out of the 150MW, 75MW capacity is currently interconnected as Twin Buttes generation at PSCo's Lamar 230 kV bus. The purpose of the restudy is to evaluate the feasibility of interconnecting the remaining 75MW of the capacity from the original 2004 request and also study the impact of the change in the turbines to Gamesa G9x 2.1MW for the 75 MW expansion.

The study agreement for restudy of GI-2004-2 was executed on March 18, 2015. The 75MW expansion will be located adjacent to the existing Twin Buttes wind farm and interconnect to the Customer tie-line at approximately eight miles from the Twin Buttes switching station. The 75MW expansion will interconnect at the Lamar Substation at the existing POI using the existing customer owned 230kV tie line. The proposed in-service date of the 75MW expansion is November 1, 2016. The study request is for an Energy Resource interconnection only. The affected parties for this study are Colorado Springs Utilities (CSU), Black Hills Colorado Electric (BHCE) and Tri-State Generation & Transmission Inc. (TSGT).

This request was studied as a stand-alone project, with no evaluations made of other potential new generation requests that may exist in the Generator Interconnection Request queue, other than the resource acquisitions for which Power Purchase Agreements have been signed. The system impact study consisted of steady state power flow contingency analysis and short circuit analysis.

No dynamic stability analysis was performed for this GI, however, due to the close proximity of the interconnecting generator to the Lamar back-to-back DC tie and the

existing wind generation plants, all of which have a common POI at the Lamar 230 kV bus, transient stability analysis will need to be performed for this GI.

The total generation injection at the Lamar Substation in the current system is 447MW. The studies were performed using 2016 Heavy summer power flow model with heavy south – north flows in the Lamar, Comanche and Midway area, and full generation dispatch at the existing Lamar substation. The benchmark case showed several thermal violations at the current injection level of 447MW which resulted in Boone – Lamar 230 kV line flow at 296MVAV or 60% of the 478MVA rating. A full list of thermal violations is given in Table-5 on page 15 of this report. The CSU overloads can be mitigated by the Palmer Lake – Monument 115 kV line operating procedure. The current injection level at the Lamar Substation is limited by Lamar 230/115kV #T1 (transformer #1). The Lamar 230/115kV #T1 transformer is jointly owned by PSCo and TSGT but operated by TSGT. PSCo is not aware of any potential capital budget projects that are planned to upgrade the Lamar #T1 transformer. Under the current system configuration, the maximum allowable injection at the Lamar Substation is 237MW which is lower than the existing total interconnected generation of 447MW.

Energy Resource capacity: The energy resource injection capacity of GI-2004-2 Restudy can vary from 0MW to 75MW such that the total injection at Lamar 230 kV substation does not exceed 237MW (including the generation from the existing wind resources and the DC tie).

In order to allow injection of full capacity of 75MW from the GI-2004-2 expansion, the Lamar 230/115 kV, 100MVA #T1 transformer will need to be replaced with a 150MVA transformer.

There were no pre-existing voltage violations and addition of 75MW of the proposed interconnect at the Lamar 230 kV POI did not cause any new voltage violations.

GI-2004-2 Restudy ER capacity is between 0 to 75MW without network upgrades.
GI-2004-2 Restudy ER capacity is 75MW with network upgrades.

Short Circuit

The data related to the fault current levels at the POI contributed by the 75MW expansion, so a detailed short circuit analysis could not be done. See Table-1 for the single phase and three phase fault current levels at the Lamar 230 kV POI for the current system configuration.

Cost Estimates

The cost for the transmission interconnection (in 2015 dollars):

The total estimated cost of the recommended system improvements to interconnect the project is approximately **$169.4 Thousand** and includes:

- $ 169.24 thousand for PSCo-Owned, Customer-Funded Interconnection Facilities
- $ 0 million for PSCo-Owned, PSCo-Funded Network Upgrades for Interconnection
- $ 0 million for PSCo Network Upgrades for Delivery to PSCo Loads

This work can be completed in 12 months following receipt of authorization to proceed.

The Interconnection Agreement (IA) requires that certain conditions be met, as follows:

1 The conditions of the Large Generator Interconnection Guidelines (LGIG) are met.
2 PSCO will require testing of the full range of 0 MW to 75 MW operational capability of the facility to verify that the facility can safely and reliably operate within required power factor and voltage ranges.
3 A single point of contact needs to be provided to PSCo Operations to facilitate reliable management of the transmission system.

The cost estimates do not include costs for upgrading the Lamar 230/115 kV, 100MVA #T1 transformer.

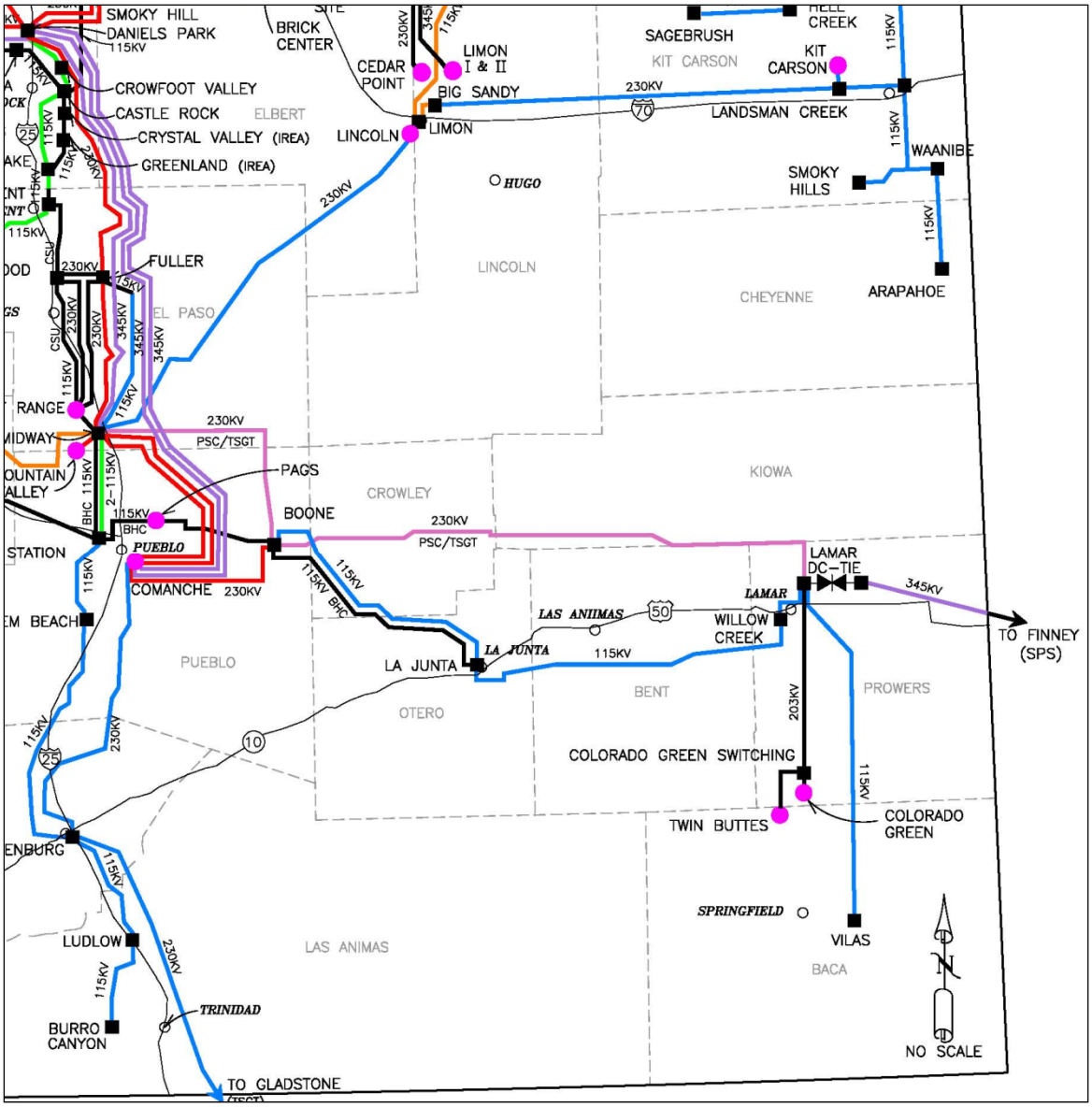


Figure 1 Lamar Substation and Surrounding Transmission System

Introduction

The study request for GI-2004-2 was originally received in 2004. The initial request was for the interconnection of a 238MW wind farm, the feasibility study for the 238MW interconnection request was completed in May 2004 and System Impact Study was completed in December 2004. Post the system impact study completion in December 2004, the GI capacity was reduced to 150MW. The studies performed in 2004 assumed GI-2004-2 included 1.5MW GE doubly fed induction generators. Out of the 150MW, 75MW capacity is currently interconnected as Twin Buttes generation at PSCo's Lamar 230 kV bus. The purpose of the restudy is to evaluate the feasibility of interconnecting the remaining 75MW of the original request and also study the impact of the change in the turbines to Gamesa G9x 2.1MW for the 75 MW expansion.

The study agreement for restudy of GI-2004-2 was executed on March 18, 2015. The geographical location of the 75MW expansion will be adjacent to the existing Twin Buttes wind farm and interconnect to the Customer tie-line at approximately eight miles from the exiting Twin Buttes switching station. The 75MW expansion will interconnect at the Lamar Substation at the existing POI using the existing customer owned 230 kV tie line. The Lamar 230 kV POI is shown in Figure 1 above. The proposed in-service date of the 75MW expansion is November 1, 2016. The study request is for an Energy Resource interconnection only.

The study request is for a combined Feasibility and System Impact study. The Feasibility Study consists of steady-state power flow analyses to evaluate the thermal and voltage impacts of the proposed generating plant on the transmission system, as well as determine the adequacy of the generating plant's power factor range (reactive power capability) at the POI.

The Gamesa 9X 2.1 MW wind turbine generator is a doubly-fed induction generator (Type-3) that is asynchronous from the transmission system and has an inverter-connected rotor with automatic voltage control capability. It is expected that these machines will have at least +/- 0.95 power factor capability and be operated in voltage control mode at all times.

The dynamic performance of the interconnecting wind generation facility (that is, low voltage ride through performance per FERC Order 661-A) for normally cleared faults is expected to be satisfactory based on the Voltage Ride Through (VRT) capability of the Gamesa 9XMW 2.1MW wind turbine generator provided by the Interconnection Customer. Furthermore, it is the responsibility of the Interconnection Customer to ensure that its generating facility is capable of meeting the voltage ride-through and frequency ride-through (VRT and FRT) performance specified in the NERC Reliability Standard PRC-024-1. Therefore, no positive sequence stability analysis was considered necessary for the System Impact Study since it would not identify any network upgrades needed for satisfactory fault ride-through performance.

However, network upgrades may be identified based on transient stability analysis conducted using detailed three-phase PSCAD models. Detailed PSCAD based stability analysis is needed due to the close electrical proximity of the interconnecting generator to the Lamar back-to-back DC tie and to the existing wind generating plants, all of which have a common POI at the Lamar 230kV bus.

It should be noted that during the last few years PSCo has experienced several events that resulted in adverse impact (malfunction and/or damage) to the Lamar DC tie equipment. Therefore, PSCo has recently commissioned a PSCAD study to benchmark the transient stability performance for the existing system topology and operating conditions.

Verification of any additional adverse system impact or lack thereof, due to the interconnecting generating plant therefore requires three-phase transient stability analysis using the PSCAD model for the Gamesa G9X 2.1MW wind turbines. The PSCAD stability analysis part of this SIS will be conducted after receiving the Interconnection Customer's confirmation on availability of PSCAD model for the Gamesa G9X 2.1MW wind turbines, as well as concurrence to proceed with the PSCAD study.

Study Scope and Analysis

The Feasibility part of the Study evaluated the potential impacts on the PSCo transmission infrastructure as well as that of neighboring utilities when an additional 75 MW of generation is injected at the existing Lamar 230 kV POI. The power flow analysis identified any thermal or voltage limit violations resulting from the installation of the proposed generation. Several single and double contingencies were studied. The short circuit analysis identified any new circuit breakers overdutied due to the proposed generation and the short circuit current levels at the POI.

PSCo adheres to NERC & WECC Reliability Criteria, as well as internal Company criteria for planning studies. During system intact conditions, criteria are to maintain transmission system bus voltages between 0.95 and 1.05 per unit of nominal and steady-state power flows below the thermal ratings of all facilities. Operationally, PSCo tries to maintain a transmission system voltage of 1.02 per unit or higher at regulating (generator) buses and 1.0 per unit or higher per unit at transmission load buses in the study area. Following a single or double contingency, transmission system steady state bus voltages must remain within 0.90 - 1.05 per unit, and power flows must remain within 100% of the facility's continuous thermal ratings. Also, voltage deviations should not exceed 5%.

The proposed facility was requested to be studied as Energy Resource only.

Energy Resource Interconnection Service shall mean an Interconnection Service that allows the Interconnection Customer to connect its Generating Facility to the

Transmission Provider's Transmission System to be eligible to deliver the Generating Facility's electric output using the existing firm or non-firm capacity of the Transmission Provider's Transmission System on an as available basis. Energy Resource Interconnection Service in and of itself does not convey transmission service.

The affected parties for this study are CSU, TSGT and BHCE.

Power Flow Study Models

The study was based on 2016HS power flow case created from the WECC 2015HS power flow case released on December 5, 2014. The updates included topology, generation, load and rating updates to the PSCo, TSGT, BHCE, IREA and CSU systems.

The second 230/115 kV, 150 MVA Lamar transformer is modeled in the powerflow case.

BHCE updates included modeling of a fifth 90MW Baculite Mesa Generator connecting to BHCE's Baculite substation.

To assess the impact of the proposed generation on the interconnected transmission system, the generation dispatch in the reference case was adjusted to create a south to north power flow stress on the Comanche – Midway - Jackson Fuller – Daniels Park transmission path. This was accomplished by adopting the generation dispatch described in Table - 8 below. PSCo generation dispatch in the study area (zones 700, 704, 710, 712, 752, 757, 790 and 791) is dispatched such that wind generation is at 85% name plate capacity, solar generation is at 80% name plate capacity and conventional non-coal generation is at 90% name palate capacity, coal generation is dispatched at 100% name plate capacity. The study did not include any generation in the Generation Interconnection queue except resources for which a Power Purchase Agreements (PPA's) have been signed.

The Lamar DC tie and existing wind generation at Colorado Green and Twin Buttes is dispatched such that no thermal violations exist in the benchmark case, which resulted in the combined generation total of 237MW from the Wind farms and the DC tie.

Two power flow cases were created for evaluating the system impact of the proposed generator – the benchmark case and the study case. The study case included the 75 MW generation addition at Lamar 230kV POI due to the proposed GI-2004-2 restudy. PSCo's Fort Saint Vrain is used as the sink for the generation addition. The GI was modeled using the PSSE modeling data provided by the customer.

Power Flow Study Process

In the current system configuration, the total generation interconnected at the Lamar 230 kV bus is 447MW (210MW at Lamar DC tie and 237MW of combined generation from Colorado Green and Twin Buttes wind plants). However, the maximum generation injection allowed at any time at the Lamar 230 kV bus is limited by the overloads on the Lamar 230/115 kV, 100MVA # T1 transformer. Without exceeding the thermal rating of the Lamar 230/115 kV, 100MVA #T1 transformer, the maximum allowable generation at Lamar 230 kV POI is 237MW. For any injection level above 237MW, the Lamar 230/115 kV, 100MVA#T1 transformer overloads above 100% of the thermal rating for the loss of the Lamar230/115 kV, 150MVA # T2 parallel transformer. Currently, there are no identified capital budget projects to mitigate this thermal overload, and the procedure used by operations is to curtail the wind generation, so the benchmark case was modeled using 237MW current injection at Lamar substation.

Contingency power flow studies were completed on the reference power flow case and the study case (power flow case with GI 2014-8) using PTI's PSSE Ver. 33.4.0 program. Results from each of the two cases were compared and, the monitoring criteria are to list any new thermal and voltage violations. The PSSE Ver. 33.4.0 ACCC contingency analysis activity was used to perform the load flow contingency analysis. The PSCo Category C analysis was performed using contingency definitions that reflect breaker to breaker outages, Category B analysis was performed using bus-bus contingencies and all breaker – breaker contingencies in the study area are run. Category B outages were run in areas 70 and 73 whereas Category C contingencies were studied for zones 700, 704, 705, 709, 712, 752, 757, 790, and 791. The facilities in Zones 700, 704, 710, 712, 752, 757, 790 and 791 were monitored for overloads and voltage problems.

Power Flow Results

Energy Resource Interconnection Service

As defined above, Energy Resource Interconnection Service allows the Customer to deliver a Generating Facility's electric output using the existing firm or non-firm capacity of the Transmission Provider's Transmission System on an as available basis. The current system limits the existing 447MW available generation at Lamar 230 kV to 237MW. Therefore, the maximum allowable generation at Lamar 230 kV POI before any network upgrades are performed is only 237MW. ER capacity is dependent on system condition and can be between 0 to 75 MW on as available basis as long as the total injection capacity of 237 is not exceeded.

However, when the identified network upgrades are performed, the injection capacity of the proposed 75MW expansion can be 100%. The identified network upgrade is

Replacement of the Lamar 230/115 kV, 100MVA # T1 transformer with 150MVA capable transformer .

The results of the single contingency analysis for 237MW total injection at the Lamar 230 kV bus are given Table -5. The Cherokee – Federal Ht 115 kV# 2 line overload is caused due to reduction in the Fort Saint Vrain generation which is used as system sink and is not attributable to the Lamar 230 kV injection.

The Lamar 230/115 kV # T1 transformer loading increases from 100% to 111.1% when the GI-2004-2 75MW expansion is added to the case.

The existing thermal overloads on the CSU lines BrairgateS- CottonwoodS 115 kV, CottonwoodN-KettleCreekS 115 kV and Monument - Flyhorse 115 kV line increase when GI-2004-2 75MW expansion is added at Lamar. However, PSCo has an operating procedure to open the Palmer Lake – Monument 115 kV line that will mitigate these overloads. The revised line loadings with Palmer Lake – Monument 115 kV line open are given in Table-6.

The study did not cause any new voltage violations and none of the existing voltage violations increased, the highest increase seen in voltage range violations is 0.006p.u. and the highest increase seen in voltage deviations is 0.01p.u, so there were no voltage violations attributable to GI-2004-2 Restudy.

The Energy Resource interconnection capacity of GI-2004-2 Restudy is between 0 to 75MW such that total generation from all resources at Lamar Substation does not exceed 237MW

The Energy Resource interconnection capacity of GI-2004-2 Restudy could be 75MW when the Lamar 230/115 kV, 100MVA#T1 transformer is replaced with a 150 MVA transformer.

Note that the provided cost estimates do not include costs for upgrading the transformer. The Customer is advised to work with TSGT who is the operator of the transformer to come up with possible mitigation measures.

Voltage Regulation and Reactive Power Capability

Interconnection Customers are required to interconnect their Large Generating Facilities with Public Service of Colorado's (PSCo) Transmission System in conformance to the *Xcel Energy Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW* (available at http://www.xcelenergy.com/staticfiles/xe/Regulatory/Transmission-Interconnection-Guidelines-Great-20MW.pdf). Wind and Solar generating plant interconnections (Variable Energy Resources) must also conform to the performance requirements in FERC Order 661-A. Accordingly, the following voltage regulation and reactive power capability requirements (at the POI) are applicable to this interconnection request:

- To ensure reliable operation, all Generating Facilities interconnected to the PSCo transmission system should adhere to the Rocky Mountain Area Voltage Coordination Guidelines. Accordingly, since the POI for this interconnection request is located within Southeast Colorado Region 4; the applicable ideal transmission system voltage profile range is 1.02 – 1.03 per unit at regulated buses and 1.0 – 1.03 per unit at non-regulated buses.
- Xcel Energy's OATT requires all Interconnection Customers to have the reactive capability to achieve +/– 0.95 power factor at the POI, with the maximum "full output" reactive capability available at all output levels. Furthermore, Xcel Energy requires all Interconnection Customers to have dynamic voltage control and maintain the voltage specified by the Transmission Operator within the limitation of +/– 0.95 power factor at the POI, as long as the generating plant is on-line and producing power.
- It is the responsibility of the Interconnection Customer to determine the type (switched shunt capacitors and/or switched shunt reactors, etc.), the size (MVAR), and the locations (690 V, 34.5 kV or 230 kV bus) of any additional static reactive power equipment needed within the generating plant in order to have the reactive capability to meet the +/– 0.95 power factor and the 1.02 – 1.03 per unit voltage range standards at the POI. The Interconnection Customer may need to perform additional studies for this purpose.
- It is the responsibility of the Interconnection Customer to ensure that its generating facility is capable of meeting the voltage ride-through and frequency ride-through (VRT and FRT) performance specified in NERC Reliability Standard PRC-024-1.
- The Interconnection Customer is required to demonstrate to the satisfaction of PSCo Transmission Operations prior to the commercial in-service date of the generating plant that it can safely and reliably operate within the required power factor and voltage ranges noted above.

Dynamic Stability Analysis – Results

As explained above, a transient stability study is recommended for this GI. Furthermore, it is the responsibility of the Interconnection Customer to ensure that its generating facility is capable of meeting the voltage ride-through and frequency ride-through (VRT and FRT) performance specified in the NERC Reliability Standard PRC-024-1.

Short Circuit

The calculated short circuit levels and Thevenin system equivalent impedances for the Lamar 230 kV bus for the current system configuration are tabulated below. The customer has to provide detailed model along with GSU data in order to verify the breaker over duty limits. Short circuit analysis will be performed during Facilities study.

Table 1 – Short Circuit Parameters at the Lamar 230 kV POI

System Condition	Three-Phase Fault Level (Amps)	Single-Line-to-Ground Fault Level (Amps)	SLG X/R	3 Phase X/R
System Intact	2241.8	1742.95	9.3745	8.4579

Costs Estimates and Assumptions

Scoping level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 30% accuracy) were developed by Public Service Company of Colorado (PSCo) / Xcel Energy (Xcel) Engineering. The cost estimates are in 2015 dollars with escalation and contingency included. AFUDC is not included. Estimates are developed assuming typical construction costs for previous completed projects. These estimates include all applicable labor and overheads associated with the siting support, engineering, design, material/equipment procurement, construction, testing and commissioning of these new substation and transmission line facilities. This estimate does not include the cost for any other Customer owned equipment and associated design and engineering.

The estimated total cost for the required upgrades is **$169,353.** Figure 2 below represents a conceptual one-line of the proposed interconnection into the 230kV bus at the Lamar Transmission Substation. These estimates do not include costs for any other Customer owned equipment and associated design and engineering. The following tables list the improvements required to accommodate the interconnection and the delivery of the Project generation output. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to change upon a more detailed and refined design.

Table 2 – PSCo Owned; Customer Funded Transmission Provider Interconnection Facilities

Element	Description	Cost Est. (Thousands)
Lamar 230kV Transmission Substation	Interconnect Customer to tap the existing, customer owned 230kV transmission line that interconnects at the Lamar 230kV Transmission Substation (into the 230kV bus). The new equipment includes: • Transmission line communications, station controls, line relaying and testing upgrades	**$169.4**

	Total Cost Estimate for PSCo-Owned, Customer-Funded Interconnection Facilities	**$169.4**
Time Frame	**Site, design, procure and construct**	**12 Months**

Table 3: PSCo Owned; PSCo Funded Interconnection Network Facilities

Element	Description	Cost Estimate (Millions)
	N/A	

Table 4 – PSCo Network Upgrades for Delivery

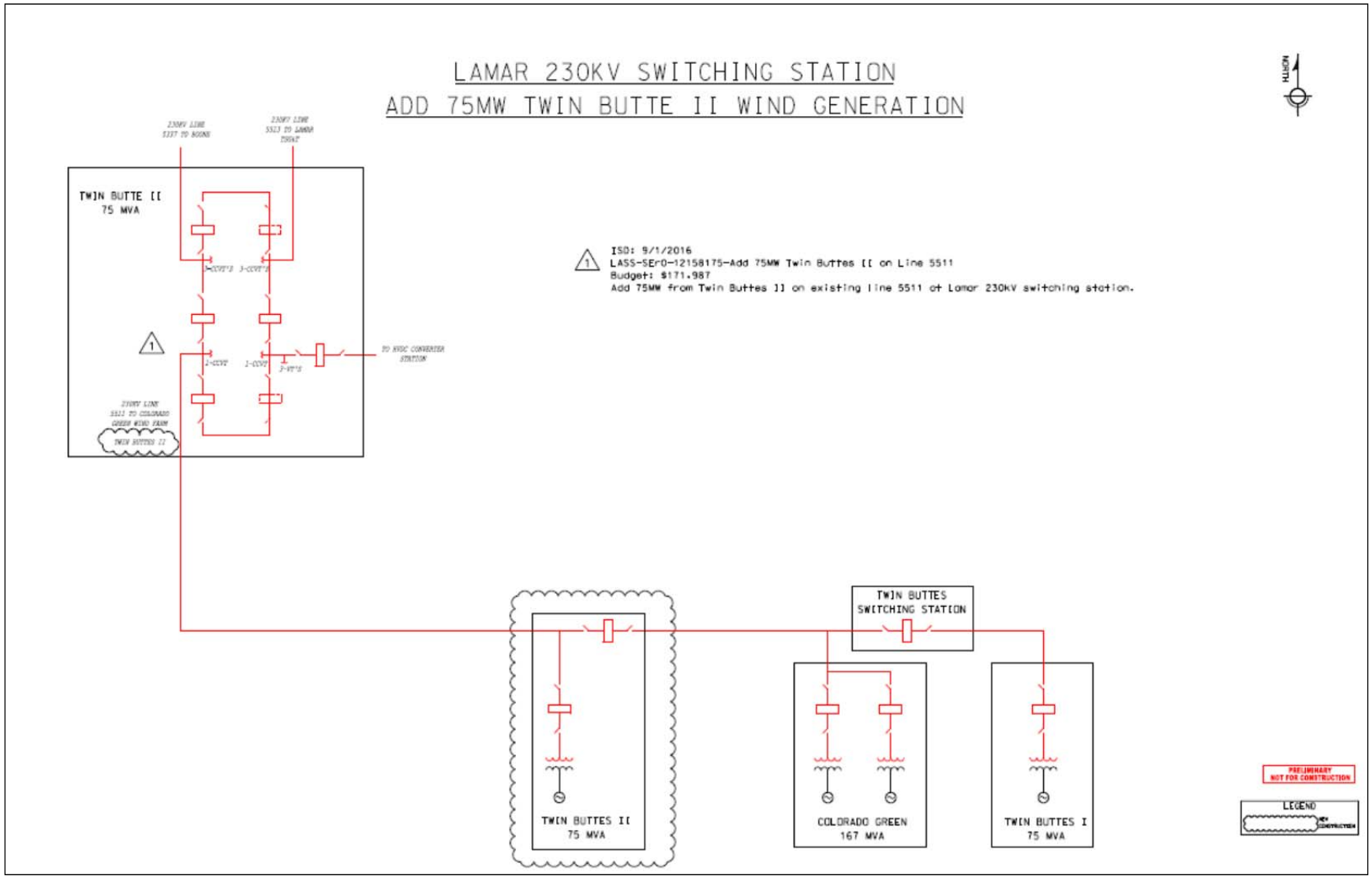
Element	Description	Cost Est. (Millions)
	N/A	

Cost Estimate Assumptions

- Scoping level project cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 30% accuracy) were developed by PSCo / Xcel Energy Engineering.
- Estimates are based on 2015 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 12 months after authorization to proceed has been obtained.
- A CPCN will not be required for the interconnection and network delivery facilities construction.
- The Customer will be required to design, procure and install a Load Frequency/Automated Generation Control (LF/AGC) RTU at their Customer Substation.
- Customer will string OPGW fiber into substation as part of the transmission line construction scope.

- No new substation land will need to be acquired.

A. One-Line of Proposed GI-2004-2 75MW expansion at Lamar 230 kV POI



B. Load Flow Thermal Results

Table 5 – Summary of thermal violations from Single Contingency Analysis

				Branch Contingency Loading Without GI-2004-2 Restudy		Branch Contingency Loading With GI-2004-2 Restudy			
Monitored Facility (Line or Transformer)	**Type**	**Owner**	**Branch Rating MVA (Norm/Emer)**	**N-1 Flow MVA**	**N-1 Flow % of Rating**	**N-1 Flow MVA**	**N-1 Flow % of Rating**	**% Change**	**NERC Cat B Contingency**
Cherokee-Federal Ht 115 kV#2	Line	PSCo	139/153	140.4	101%/91.8%	141.8	102%/92.7%	1%	Cherokee – Federal ht - Semper
Lamar 230/115 kV # T1	Xfmr	PSCo/ TSGT	100/100	100	100%/100%	111.1	111.1%/111.1%	11.1%	Lamar 230/115 kV # 2
BrairgateS – CottonwoodS 115 kV	Line	CSU	162/180	175	108%/97.2%	178.2	110%/99%	2%	Cottonwood N - Kettle Creek S 115 kV
Cottonwood N - Kettle Creek S 115 kV	Line	CSU	150/192	160.5	107%/83.6%	165	110%/86%	3%	BrairgateS – CottonwoodS 115 kV
Monument – Flyhorse 115 kV	Line	CSU	120/120	116.4	97%/97%	122.4%	102%/102%	5%	Daniels Park – Fuller 230 kV

Table 6 – Summary of thermal violations from Single Contingency Analysis with Palmer Lake – Monument 115 kV line open

				Branch Contingency Loading Without GI-2004-2 Restudy		Branch Contingency Loading With GI-2004-2 Restudy			
Monitored Facility (Line or Transformer)	**Type**	**Owner**	**Branch Rating MVA (Norm/Emer)**	**N-1 Flow MVA**	**N-1 Flow % of Rating**	**N-1 Flow MVA**	**N-1 Flow % of Rating**	**% Change**	**N-1 Contingency Outage**
Cherokee-Federal Ht 115 kV#2	Line	PSCo	139/153	140.4	101%/91.8%	141.8	102%/92.7%	1%	Cherokee – Federal ht - Semper
Lamar 230/115 kV # T1	Xfmr	PSCo/ TSGT	100/100	100	100%/100%	111.1	111.1%/111.1 %	11.1%	Lamar 230/115 kV # 2
BrairgateS – CottonwoodS 115 kV	Line	CSU	162/180	150.5	86%/83.6%	155	87%/86.1%	1%	Cottonwood N - Kettle Creek S 115 kV
Cottonwood N - Kettle Creek S 115 kV	Line	CSU	150/192	124.5	83%/64.8%	126	84%/65.6%	1%	BrairgateS – CottonwoodS 115 kV
Monument – Flyhorse 115 kV	Line	CSU	120/120	50.4	42%/42%	52.8	44%/44%	2%	Daniels Park – Fuller 230 kV

Table 7 – Summary of thermal violations from Category-C contingency analysis Without Palmer Lake Series Reactor.

				Branch N-2 Loading Without GI-2004-2 Restudy		Branch N-2 Loading With GI-2004-2 Restudy			
Monitored Facility (Line or Transformer)	**Type**	**Owner**	**Branch Rating MVA (Norm/Emer)**	**N-1 Flow MVA**	**N-1 Flow % of Rating**	**N-1 Flow MVA**	**N-1 Flow % of Rating**	**% Change**	**NERC Cat C Contingency**
Airport Park – Baculite 115 kV	Line	BHCE	195/195	195	100%/100%	198.7	101.9%/101.9%	1.9%	Baculite – West Station 115 kV#1 &2
Baculite – Northridge 115 kV	Line	BHCE	119/119	120.3	101.1%/101.1%	124.4	104.5%/104.5%	3.4%	Baculite – West Station 115 kV#1 &2
Daniels Park – Fuller 230 kV	Line	PSCo	478/478	511.5	107%/107%	535.4	112%/112%	5%	Comanche – Daniels Park 345 kV #1&2
Fountain Valley – DesertCov 230 kV	Line	BHCE	115/115	121.7	105.8%/105.8%	129.5	112.6%	6.8%	MidwayBR 230 kV breaker failure
Fountain Valley – MidwayBR 115 kV	Line	BHCE	115/115	120.3	104.6%/104.6%	128.11	111.4%/111.4%	6.8%	MidwayBR 230 kV breaker failure
Midway 230/115 kV #T1	Xfmr	PSCo	97/97	101	104.1%/104.1%	106.6	109.9%/109.9%	5.8%	Comanche – Daniels Park 345 kV #1&2
MidwayPS-Midway BR 230 kV	Bus tie	WAPA/ PSCo	430/478	468.7	109%/98%	496.7	115.5%/103.9%	6.5%	Comanche – Daniels Park 345 kV #1&2
Palmer Lake – Monument 115 kV	Line	PSCo	120/120	148.9	124.1%/124.1%	155.8	129.9%/129.9%	5.8%	Comanche – Daniels Park 345 kV #1&2
Monument – FlyhorseN 115 kV	Line	CSU	120/120	156.6	130.5%/130.5%	163.8	136.5%/136.5%	6%	Comanche – Daniels Park 345 kV #1&2
Waterton – Martin2tap 115 kV	Line	PSCo	125/138	128.4	102.7%/93%	131.4	105.1%/95.2%	2.4%	Sodalake 230 kV Breaker Failure
BrairigateS-CottonwoodS 115 kV	Line	CSU	162/180	191.3	118.1%/106.3%	194.9	120.3%/108.3%	2.2%	Cottonwood North Bus outage
CottonwoodN-KettlecreekS 115 kV	Line	CSU	150/192	147.2	98.1%/76%	150.5	100.3%/78.4%	2.2%	Cottonwood South Bus outage
BlackForest Tap – BLK SQMV 115kV	Line	CSU	81/81	121.6	150.2%/150.2%	124.3	153.4%/153.4%	3.2%	Cottonwood 115 kV tie breaker outage
BLk SQMV – Fuller 115 kV	Line	CSU	143/143	214.8	150.2%/150.2%	219.4	153.4%/153.4%	3.2%	Cottonwood 115 kV tie breaker outage
Fountain S-RD_Nixon 115kV	Line	CSU	195/212	229.7	117.8%/108.3%	232.0	119%/109.4%	1.2%	KelKer 230 kV Tie breaker outage

Table 8- Generation Dispatch of Major Generating Units in the Study area (MW is Gross value)

PSCo:

Bus	LF ID	MW
Comanche PV	S1	102
Comanche	C1	360
Comanche	C2	365
Comanche	C3	805
Lamar DC Tie	DC	0
Fountain Valley	G1	36
Fountain Valley	G2	36
Fountain Valley	G3	36
Fountain Valley	G4	36
Fountain Valley	G5	36
Fountain Valley	G6	36
Colorado Green	1	81
Colorado Green	2	81
Twin Buttes	1	75
Jackson Fuller	W1	200
Comanche PV	S1	120
Alamosa CT	G1	0
Alamosa CT	G2	0
Cogentrix	S1	25.5
Greater Sandhill	S1	14.5
Blanca Peak	S1	19.5
SLV Solar	S1	44.2

BHE:

Bus	LF ID	MW
BUSCHWRTG1	G1	3.6
BUSCHWRTG2	G2	3.6
E Canon	G1	0
PP_MINE	G1	0
Pueblo Diesels	G1	0
Pueblo Plant	G1	0
Pueblo Plant	G2	0.0
R.F. Diesels	G1	0.0
Airport Diesels	G1	0.0
Canyon City	C1	0
Canyon City	C1	0
Baculite 1	G1	90
Baculite 2	G1	90
Baculite 3	G1	40.0
Baculite 3	G2	40.0
Baculite 3	S1	20
Baculite 4	G1	40.0

Baculite 4	G2	40.0
Baculite 4	S1	20
Baculite 5	G1	90

CSU:

Bus	LF ID	MW
Birdsale1	1	0.0
Birdsale 2	1	0.0
Birdsale 3	1	0.0
RD_Nixon	1	225.39
Tesla	1	13.2
Drake 5	1	49.65
Drake 6	1	83.19
Drake 7	1	138.03
Nixon CT 1	1	0.0
Nixon CT 2	1	0.0
Front Range CC 1	1	120.4
Front Range CC 2	1	120.8
Front Range CC 3	1	120.0