



Interconnection Facilities Study Report GI-2014-4

60 MW Wind Generation Facility Expansion Interconnecting at Spring
Canyon in Logan County, Colorado

PSCo Transmission Planning
June 25, 2014

A. Executive Summary

This Interconnection Facilities Study Report summarizes the analysis performed by Public Service Company of Colorado (PSCo), designated as GI-2014-4, to specify and estimate the cost of the siting, engineering, equipment procurement and construction needed to interconnect a 60 MW wind generation expansion to the existing 60 MW Spring Canyon Energy wind generation facility in Logan, Colorado. The GI-2014-4 interconnection request is a continuation of the interconnection request identified as GI-2012-3, and was required to clarify that the new large generation facility will be an expansion of the existing 60 MW wind facility and will utilize the same Point of Interconnection (POI) as the existing 60 MW wind facility through the 230 kV termination on the 230 kV bus at the Spring Canyon Substation. The Generation Provider (Customer) has agreed that the results of the Feasibility Study and System Impact Study under GI-2012-3 designation are sufficient for the Interconnection Request GI-2014-4.

The 60 MW wind generation expansion will utilize the Customer's 230 kV line on the Customers side of the POI to interconnect at the POI at Spring Canyon. The Customer will be responsible for construction of the short transmission line from the generation facility to the POI. For cost estimating purposes it is assumed this line has already been constructed in this study. It has been determined that the Customer requested Commercial Operation Date (COD) of December 31, 2014, and expected back-feed for site energization of June 30, 2014 is feasible.

The GI-2014-4 System Impact Study determined the proposed 60 MW wind generation facility expansion may interconnect as an Energy Resource after the required system upgrades for delivery are completed. The required system upgrades for delivery include adjustments to the PSCo's existing bi-directional revenue meter and communications equipment.



Power flow studies have indicated the Sidney 230/115 kV transformer is overloaded by 115.5% when the North Yuma – Spring Canyon 230 kV line is taken out of service and the Alvin – Wauneta 115 kV line is overloaded by 110% when the North Yuma – Wray 230 kV line is taken out of service. The Customer has contacted both PSCo and Tri-State Generation and Transmission (TSGT) to determine an acceptable mitigation of Sidney 230/115 kV transformer overload by curtailing generation output from the wind generation expansion facility, and the Customer has contacted Western Area Power Administration (Western) to determine their schedule for a replacement or uprate of the transmission line.

No PSCo Network Upgrades for Delivery are required for this Interconnection.

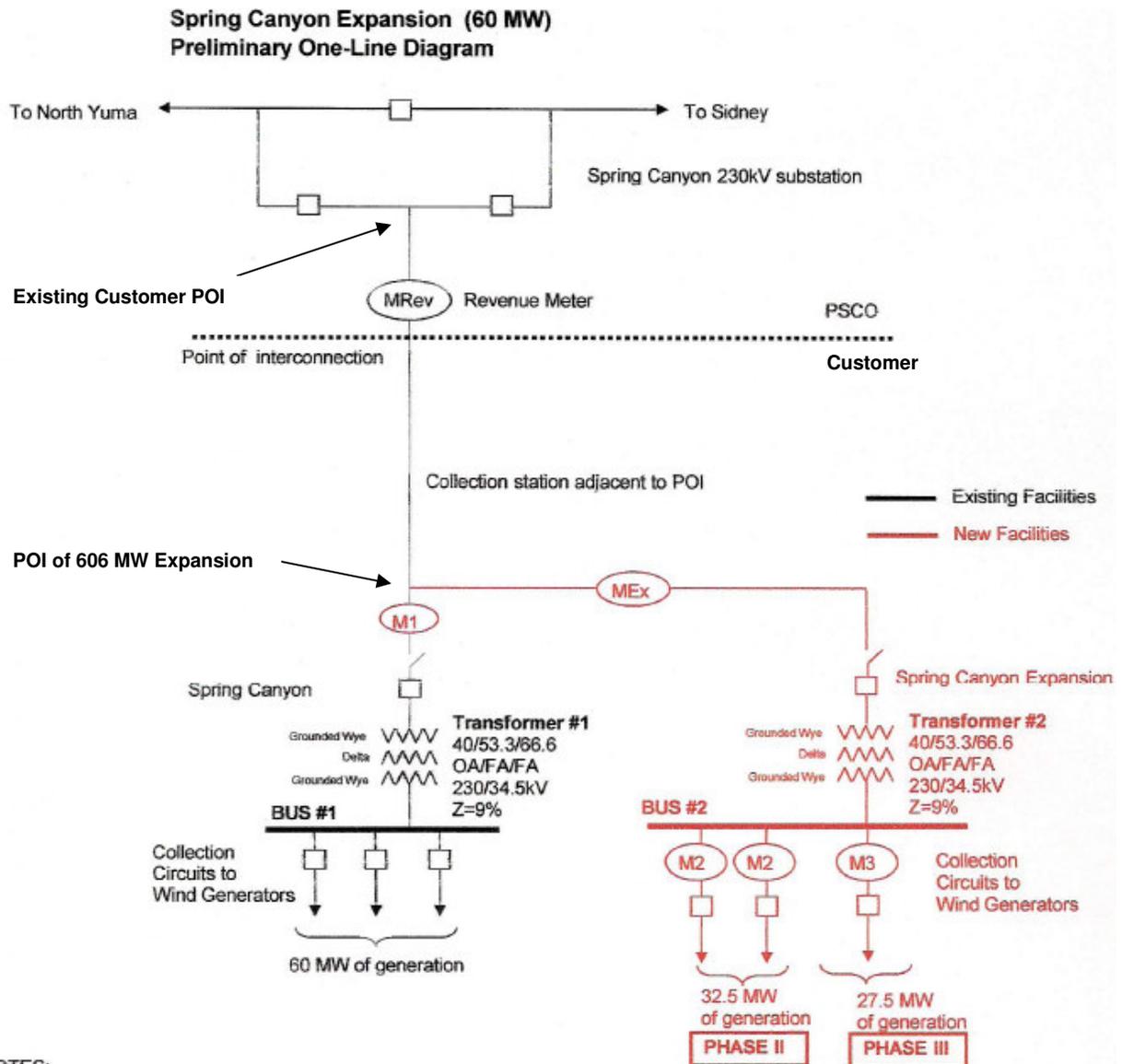
The total estimated cost of the recommended system upgrades to interconnect the project is approximately **\$ 83,000** and includes:

- \$0.083 million for PSCo Owned, Customer Funded Interconnection Facilities. This includes 230kV high side and revenue metering checks, current transformer and potential transformer (CT/PT) ratio adjustments, communications, relay setting changes, testing and commissioning.
- \$0.00 million for PSCo Owned, PSCo Funded Interconnection Facilities.
- \$0.00 million for PSCo Network Upgrades for Delivery.

A conceptual one-line of the proposed Interconnection is shown in Figure 1 below.



Figure 1: Diagram of the GI-2014-4 Interconnection at Spring Canyon 230 kV



NOTES:

- M2 and M3 will require revenue quality CTs in feeder breakers and revenue quality PT on 34.5kV bus

BASIC METERING LOGIC:

$SC1 = MREv - MEx$
 $SC2 = (M2/(M2+M3)) \times MEx$
 $SC3 = (M3/(M2+M3)) \times MEx$

M1 not necessary for calculations, but prudent to have as check to MEx and MRev



B. Introduction

On May 5, 2014, Public Service Company of Colorado (PSCo) and a Generation Provider (Customer) signed an Interconnection Facilities Study request to provide cost estimates, a project schedule and address the impacts of interconnecting a 60 MW wind generation expansion to the existing 60 MW Spring Canyon Energy wind generation facility, as identified in the System Impact Study, at PSCo's 230 kV Spring Canyon Substation. The Customer's project facility would consist of thirty-three (33) GE 1.7-100 1.79 MW wind turbines and would be located immediately adjacent to the existing Spring Canyon Energy Facility, near Peetz, Colorado, in Logan County. Generation from the expansion was modeled as supplying the PSCo Balancing Authority (BA) and was delivered to PSCo native load customers. Platte River Power Authority (PRPA) has indicated they have executed a Power Purchase Agreement (PPA) with the Customer for 32.5 MW of the 60 MW expansion; therefore, 32.5 MW will be provided to PRPA through Western Area Power Administration (Western) and will be dynamically metered into the PSCo BA. The remaining 27.5 MW remains out for bid. The Customer requested a primary Point of Interconnection (POI) on the 230 kV bus at the existing Spring Canyon Substation. No alternative POI was requested.

The Spring Canyon Substation consists of a 230 kV yard with three (3) power circuit breakers in a ring configuration. The new 60 MW wind generation expansion will utilize the Customer's existing Point of Interconnection (POI) and termination on the 230 kV bus at the Spring Canyon Substation. No new power circuit breakers will be required for interconnection.

The Feasibility Study was completed on June 12, 2013, subsequent to which the proposed commercial operation date and back-feed (for site energization) were postponed until December 31, 2014 and June 30, 2014 respectively. Power flow analysis indicated that the Sidney 230/115 kV transformer overloaded by 115.5% when the North Yuma – Spring Canyon 230 kV line was taken out of service and the Alvin – Wauneta 115 kV line overloaded by 110% when the North Yuma – Wray 230 kV line was taken out of service. Tri-State Generation and Transmission (TSGT) and Western were notified of these impacts as affected parties. Discussions were held between the Customer, PSCo and the affected parties. The Customer, TSGT and PSCo have developed an acceptable generation curtailment scheme to mitigate the Sidney 230/115 kV transformer overload, and the Customer and Western have developed a schedule for the replacement or upgrade of the Alvin – Wauneta 115 kV line.

The System Impact Study was completed on December 3, 2013 and found no criteria violations in the pre-project or post-project analysis for any of the studied outages.

Subsequent to the System Impact Study, conversations between PSCo led to a request that the Customer submit a new interconnection request, GI-2014-4, indicating the new large generation facility will be an expansion of the existing 60 MW Spring Canyon Energy facility, utilizing the Customer's existing POI. During the scoping meeting held on April 24, 2014, the Customer agreed to use and accept the results the Feasibility and



System Impact Studies developed under GI-2012-3 in order to proceed with this Facilities Study.

C. General Interconnection Facilities Description

PSCo's requirements for interconnection can be found in the Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater than 20 MW – Version 6.0¹, found on the Xcel Energy website. Xcel Energy requires the Interconnection Generation Provider to construct the Interconnection Facilities in compliance with this document. The guidelines describe the technical and protection requirements for connecting new generation to the Xcel Energy Operating Company transmission system and also requires that the Interconnection Generation Provider be in compliance with all applicable criteria, guidelines, standards, requirements, regulations, and procedures issued by the North American Electric Reliability Council, Public Utility Commission or their successor organizations.

I. Project Purpose & Scope

The Customer will be increasing generation on the existing 5923 line. Transmission engineering will not be installing any additional meters. The existing feed to the Customer will be modified to handle the additional generation. Xcel Energy scope of work will involve revising the relay settings for the 230kV 5923 line in order to accommodate an increase in power from the connected Customer's wind farm. There will also be hard wire contacts that Xcel Energy will provide Spring Canyon II Substation. Spring Canyon II will also provide similar contacts for Xcel Energy. The only metering data Xcel Energy will be responsible for modifying will be the one located in Xcel Energy switchyard at the point of interconnection. All material needed inside Xcel Energy substation is included in this estimate. Xcel Energy is assuming the existing conduit is sufficient.

Background

The Customer will be increasing their power generation on the 230kV 5923 line by 60 MW. This is being accomplished by the Customer adding thirty three (33) GE 1.7-100, 1.79 MW wind turbines. The only work that is required by Xcel Energy is to modify minor wiring changes, relay setting modifications and changing metering unit taps. Xcel Energy would like to review the settings at Spring Canyon Substation.

Distribution vs. Transmission Asset Ownership and Cost Responsibility

The project cost will be funded by PSCo.

Interconnection / Customer Cost Responsibility

¹ Guidelines can be found at http://www.xcelenergy.com/Colorado/Company/Transmission/Pages/Transmission_Services_Interconnection_Guidelines.aspx



The project cost will be responsible of the Customer.

II. FERC and/or NERC Compliance Requirements

Critical Infrastructure Protection (CIP) Asset

The CIP status of this substation has not been verified at this time. This verification will take place during the appropriation estimate phase of the project.

Facility Ratings and One-Lines

A one-line diagram already exists for the Spring Canyon substation. This one-line has dual differentials wrapping Xcel Energy's two circuit breakers 5922 and 5920, Spring Canyon I and Spring Canyon II. This is a total of 4 current transformer inputs in both the primary and secondary relaying. The existing one-line will be updated to include the changes made by this project.

III. Right of Way/Permitting

Right of way permitting will not be required as part of this project.

IV. Electrical Features

Fault Current

A fault study was conducted on the future system with the proposed wind generation facility interconnected at the Spring Canyon 230kV bus. The study found that for the system, the three-phase fault and the single-line-to-ground fault currents are expected to be 4,134.5 amps and 4,127.7 amps respectively at the proposed Spring Canyon 230 kV bus. These values can be found in Table 1 below.

Table 1: Fault Current Information for the Spring Canyon 230kV Bus with GI-2014-4 Contribution Represented

System Condition	Three-phase (amps)	Thevenin System Equivalent Impedance (R,X) in per unit	Single-line-to-ground (amps)	Thevenin System Equivalent Impedance (R,X) in per unit
System Intact	$I_1=4,134.5$ $I_2=I_0=0.0$ $I_A=I_B=I_C=4,134.5$	$Z_1(\text{pos})=$ 0.0074683,0.0600136 $Z_2(\text{neg})=$ 0.0078200,0.0656363 $Z_0(\text{zero})=$ 0.0250209,0.1799366	$I_1=I_2=1,375.9$ $3I_0=4,127.7$ $I_A=4,127.7$ $I_B=I_C=0.0$	$Z_1(\text{pos})=$ 0.0074683,0.0600136 $Z_2(\text{neg})=$ 0.0078200,0.0656363 $Z_0(\text{zero})=$ 0.0250209,0.1799366

The fault current values listed in Table 1 may increase as additional generators and transmission lines are added to the system.



V. Protection Features

Transmission Line Protection (230 kV)

The existing 230kV 5923 line to the Customer is currently being protected by a BE1-P (primary) and a B-PRO (secondary). The settings for these relays will need to be changed in order to accommodate the new additional 60MW that will be put on this line. Minor wiring modifications will also be needed.

Outages/Temporary Configurations

A short outage is required to change the metering unit ratio from 200 to 400.

VI. Related Projects

No related work-orders (WOs) exist at this time.

D. Costs Estimates and Assumptions

The cost responsibilities associated with the facilities described in the following estimates shall be handled per current FERC guidelines. The estimated engineering, procurement & construction schedule can be found in Table 2 below.

Appropriation level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 20% accuracy) were developed by Xcel Energy/PSCo Engineering. The cost estimates are in 2014 dollars with escalation and contingency applied (AFUDC is not included) and are based upon typical construction costs for previously performed similar construction. These estimated costs include all applicable labor and overheads associated with the siting support, engineering, design, material/equipment procurement and construction of these new PSCo 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 for is **\$83,000**. Figure 1 above represents a conceptual one-line of the proposed expansion/interconnection at the Spring Canyon 230kV Substation/Bus. 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. (Millions)
PSCo's Spring Canyon 230kV Transmission Substation	Interconnect/Upgrade Customer to the 230kV bus at the Spring Canyon 230kV Substation. The new activities include: <ul style="list-style-type: none"> • Metering adjustments • Relay settings changes • Drawing revisions 	\$0.083
Time Frame	Design and construct	6 Months

Table 3: PSCo Owned; PSCo Funded Interconnection Network Facilities

	Description	Cost Estimate (Millions)
PSCo's Spring Canyon 230kV Transmission Substation	<ul style="list-style-type: none"> • Not Applicable 	\$0
	Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities	\$0
Time Frame	Site, design, procure and construct	

Table 4: PSCo Network Upgrades for Delivery

Element	Description	Cost Est. (Millions)
	Not Applicable	
	Total Cost Estimate for PSCo Network Upgrades for Delivery	\$0
Time Frame	Site, design, procure and construct	
	Total Project Estimate	\$0.083

Cost Estimate Assumptions

- Appropriation level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 20% accuracy) were developed by Xcel Energy/PSCo Engineering.



- Estimates are based on 2014 dollars (appropriate contingency and escalation applied).
- AFUDC has been excluded.
- Engineering will be completed in-house (PSCo).
- Work scope is limited to Spring Canyon 230kV Substation and no evaluation of adequacy of proposed interconnection increase of 60 MW's.
- No new substation facility upgrades required.
- Changes are limited to metering adjustments, relay settings and drawing revisions.
- The Wind Generation Facility is not PSCo's retail service territory.
- PSCo (or it's Contractor) crews will perform all construction, wiring, testing and commissioning for PSCo owned and maintained facilities.
- Labor is estimated for straight time only – no overtime included.
- The estimated time to design and construct the interconnection facilities is approximately 6 months after authorization to proceed has been obtained.
- This project is completely independent of other queued projects and their respective ISD's.
- A CPCN will not be required for the interconnection facilities construction.
- No line or substation outages will be required.

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Appendix

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B. Generic Testing Procedures

TESTING PROCEDURES

*NOTE** Performance test period begins upon 1) successful commissioning of all turbines and other major electrical equipment to be connected to the Point of Interconnection, 2) SCADA in place, with all points available and active, and 3) Notification to PSCo by owner of readiness to start. Test Period ends upon successful completion of all tests. Additionally, test requirements are subject to change based on changes to the Facilities and System Impact Studies.*

Line	Requirement	Criteria	Test	Pass/Fail	Conditions	Other
1.	Reactive Control over generating range	Demonstrate ability to maintain VAR neutrality at the POI per the System Impact Study (SIS).	Maintain 0 MVAR reactive flow at the POI within a deadband of ± 25 MVAR and a system voltage within $\pm 5\%$ of nominal at the POI.	Allowed bandwidth not exceeded, except in the case of performing the capacitor test below	Two ramp-ups and ramp-downs between zero and $>85\%$ output	Demonstrates normal plant operation over the full range using reactive power control. 4-second telemetered values charted at Lookout Center will be used for evaluation, and provided to Interconnection Customer for review.
2.	Acceptable operation of all installed equipment	Demonstrate proper operation of capacitors installed at the POI.	All generator-operated capacitors installed near the POI (~ 40 MVAR) online, either automatically to maintain MVAR bandwidth, or due to manual change to MVAR/voltage setpoint to deliver reactive power to Transmission System.	All capacitors online for at least five minutes.	$>85\%$ output, at a time approved by System Operator (Lookout).	Interconnection Customer's representative, Mr. Kerry Franklin, will be on standby at Lookout Control Center waiting for wind conditions suitable for testing.
3.	Reactive Control at zero or less net MW output	Demonstrate ability to maintain VAR compensation at the POI per the SIS.	Maintain ≤ 10 MVAR reactive flow into the PSCo system.	Plant always net inductive when appearing as a net load (MW delivered to plant).	All generators off-line	Demonstrates automatic operation of shunt reactors adequate to offset transmission line charging.
4.	Communication	Series of reasonable requests, i.e. "Report # turbines online", "Curtail to XX MW."	Respond professionally and promptly to reasonable requests.	Professional, prompt (within one minute) response, accurate and complete. 99.9% compliance for one week.	0-250 MW, full range at least once during test period	Requests may come in via phone call or via EMS
		Dedicated phone circuit	Have a tested phone line to Lookout Center from Wind Op. Center	Documentation and testing prior to operational testing	No operational requirement	
		Provide EMS/SCADA points from plant to Lookout	Have points verified to and from PSCo SCADA	Provide points via EMS, including MW/MVAR output at POI	No operational requirement	Other points may be requested



C. Customer Questions and Comments

Question / Comments:

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