Interconnection Feasibility Study Report
Request # GI-2013-4

19.9 MW Hybrid Generation
Jefferson County, Colorado

Public Service Company of Colorado
Transmission Planning
October 28, 2013

Executive Summary

Public Service Company of Colorado (PSCo) received a Generator Interconnection Request (GI-2013-4) on June 6, 2013 for a 19.9 MW hybrid wind/solar/energy storage generation facility in Jefferson County, Colorado. The requested in-service date is June 1, 2015 with a back-feed date of January 1, 2015.

The Interconnection Customer requested a primary Point of Interconnection (POI) at the Plainview Substation 115 kV bus. A secondary POI involves intersecting the Plainview-Eldorado 115 kV line near the Plainview Substation. The hybrid generation facility will be located approximately 2 miles from the Plainview Substation and will be connected to the POI using a 115 kV line.

This Generator Interconnection request was studied as a stand-alone project by disregarding all previous requests in PSCo's Generator Interconnection Request queue, other than those Generator Interconnection projects that are already planned to be in service by June 2015.

The main purpose of this Feasibility Study is to evaluate the potential impacts on the PSCo transmission system due to 19.9 MW injection from the hybrid generation facility into the Plainview 115 kV substation in addition to the alternate POI and delivering the additional generation to native PSCo loads. This request was studied as an Energy Resource only. The studies were performed using 2015 heavy summer load conditions and included steady-state power flow and short circuit analyses.

The current ISD cannot be met and needs to be re-evaluated. The construction schedule will be 36-48 months after authorization has been granted to proceed. This time period is primarily driven by an estimated time for obtaining siting and land rights, and also includes design, procurement, construction, testing and commissioning.

Energy Resource (ER)

Primary POI

For the primary Point of Interconnection (Plainview 115 kV bus), there were no overload or voltage issues under system intact conditions, N-1 contingencies and selected N-2 contingencies. Therefore, the proposed 19.9 MW hybrid generation facility can be interconnected to the PSCo system as an Energy Resource.

ER = 19.9 MW (at Plainview 115 kV Substation)

Alternate POI

For the alternate POI of Interconnection (Plainview-Eldorado 115 kV line), there were no overload or voltage issues under system intact conditions, N-1 contingencies and selected N-2 contingencies. Therefore, the proposed 19.9 MW hybrid generation facility can be interconnected to the PSCo system as an Energy Resource.

ER = 19.9 MW (on the Plainview - Eldorado 115 kV line)

Short Circuit

The short circuit study results (see Table 1) showed no overduty on circuit breakers due to the proposed hybrid generation facility.

Cost Estimates

The total estimated cost of the recommended system improvements to interconnect the proposed hybrid generation project at a new substation between Eldorado and Plainview is approximately **$5,735,000** (in 2013 dollars) and includes:

- $ 0.610 million for PSCo-Owned, Customer-Funded Transmission Provider Interconnection Facilities (see Table 2)
- $ 0.000 million for PSCo-Owned, PSCo-Funded Interconnection Network Facilities (see Table 3)
- $ 5.125 million for PSCo-Owned, PSCo-Funded Network Upgrades for Delivery (see Table 4)

Construction and Future Considerations

This work can be completed in 36-48 months following receipt of authorization to proceed. The June 2015 in service date is not feasible based on the construction schedule and needs to be reevaluated. This time period is primarily driven by an estimated time for obtaining siting and land rights, and also includes design, procurement, construction, testing and commissioning.

A potential future Interconnection Agreement (IA) would require that certain conditions be met, as follows:

1 The conditions of the Small Generator Interconnection Guidelines (SGIG) are met.
2 PSCO will require testing of the full range of 0 MW to 19.9 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.

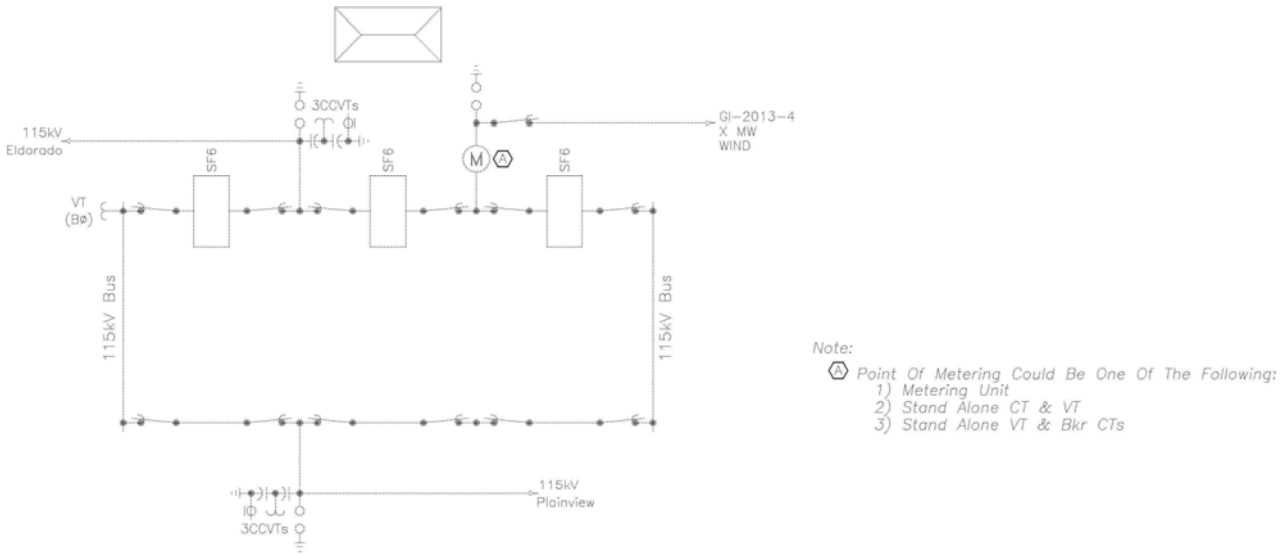

Figure 1. Preliminary One-line of the Alternate POI

Introduction

Public Service Company of Colorado (PSCo) received an interconnection request (GI-2013-4) for a 19.9 MW hybrid wind/solar/energy storage generation facility in Jefferson County, Colorado. The interconnection request was received on June 6, 2012.

The Interconnection Customer requested a primary Point of Interconnection (POI) at the Plainview Substation 115 kV bus. A secondary POI involves intersecting the Plainview-Eldorado 115 kV line near the Plainview Substation with a new substation. The hybrid facility will be located approximately two miles from the Plainview Substation and connected to the POI using a 115 kV line. The requested in-service date is June 1, 2015. The assumed backfeed date is January 1, 2015. Based on the construction schedule in Table 3, the Interconnection will not be able to meet the proposed back feed date of January 2015. This time period is primarily driven by an estimated time for obtaining siting and land rights, and also includes design, procurement, construction, testing and commissioning.

Study Scope and Analysis

The Feasibility Study evaluated the transmission impacts associated with the proposed hybrid generation facility. It consisted of power flow and short circuit analyses. The power flow analysis identified any thermal or voltage limit violations resulting from the installation of the proposed generation and an identification of network upgrades required to deliver the proposed generation to PSCo loads. The short circuit analysis identified any over-duty circuit breakers due to the proposed generation and the short circuit levels at the primary 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 profile ranging from 1.02 per unit or higher at regulating (generation) buses to 1.0 per unit or higher at transmission load buses. Following a single contingency, transmission system steady state bus voltages must remain within 0.90 per unit to 1.05 per unit, and power flows within 100% of the facilities' continuous thermal ratings.

The proposed facility was studied as an 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.

For this project, it was determined that PSCo and Tri-State G&T are affected parties.

Power Flow Study Models

The hybrid facility interconnection was studied using 2015 heavy summer loading conditions. The 2015HS case was built using the WECC approved 2015HS3 base case. PSCo loads in the case were adjusted to reflect the most recent (Oct 2012) PSCo load forecast for 2015.

Two main power flow generation dispatch scenarios were evaluated. One was created as a reference scenario and the other was created with the proposed generation. PSCo control area (Area 70) wind generation facilities were dispatched to 12.5%. Area solar resources were dispatched to 65%. Black Hills Corporation, Tri-State Generation and Transmission Inc., and Platt River Power Authority generators were mirrored in both cases to their 2015 heavy summer WECC case values submitted to PSCo in January 2013. The remaining generation was selectively dispatched to match loads.

In the second case with the proposed generation, the Customer owned 115 kV transmission line was modeled using modeling assumptions provided to PSCo for GI2012-2 as the Customer did not provide modeling information. The GSU was modeled based on parameters available for a similar transformer contained in the WECC approved 2015 HS3S base case model again as the Customer did not provide modeling information. The 19.9 MW of new hybrid generation was modeled as one generator with maximum real power capability of 19.9 MW and minimum real power capability of 0 MW.

The power factor of the proposed generation was set to 95% leading and lagging for the thermal analysis.

The second case was created by adding the GI-2013-4 request to the first case. The GI-2013-4 request was sunk to the Spruce units 1 and 2 equally in both the Primary and the Secondary POI analyses.

Power Flow Study Process

Power flow studies were completed on models without and with the proposed new generation interconnection using PTI's PSSE Ver. 32.1.0 and MUST Ver. 10.1 programs. The studies included N-1 contingency analysis of the potentially impacted transmission system surrounding the proposed generation facility. PSCo also analyzed selected N-2 contingencies within the same area.

Power Flow Results

Primary POI: Plainview Substation
Alternate POI: New substation along Plainview-Eldorado 115 kV line

The proposed hybrid facility has not caused any thermal violations or voltage violations.

Therefore, the Energy Resource Capability of the proposed generation is:

ER = 19.9 MW (at Plainview 115 kV and Alternate POI)

Short Circuit

For the Customer proposed interconnection at the POIs, no circuit breakers are expected to exceed their capabilities following installation of the new generation.

GI-2013-4

19.9MW of Mixed Generation at Plainview 115kV

	SLG (Amps)	3PH (Amps)	SLG X/R	3PH X/R
Existing Fault Currents (2013)	1,316	5,969	5.294	5.382
Future Fault Currents (2014+ with 19.9MW generation addition)	8,546	12,389	4.313	4.389

Cost Estimates and Assumptions

GI-2013-4 (Feasibility Study Report)
October 23, 2013

Scoping level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 30% accuracy) were developed by Public Service Company of Colorado (PSCo) Engineering. The cost estimates are in 2013 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, construction, testing and commissioning 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 **$5,735.000.** 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 1 – PSCo Owned; Customer Funded Transmission Provider Interconnection Facilities

Element	Description	Cost Est. (Millions)
PSCo's New NREL 115kV Transmission Substation	Interconnect Customer into PSCo's New NREL 115kV Transmission Substation. The scope includes all switches, arresters, instrument transformers, bus, wiring, foundations, structures and relaying.	**$0.350**
Customer's 115kV Substation	Load Frequency/Automated Generation Control (LF/AGC) RTU and associated equipment.	**$0.185**
	Siting and Land Rights support for siting studies, land and ROW acquisition and construction.	**$0.075**
	Total Cost Estimate for PSCo-Owned, Customer-Funded Interconnection Facilities	**$0.610**
Time Frame	**To site, design, procure and construct after receiving authorization to proceed.**	**18 Months**

Table 2: PSCo Owned; PSCo Funded Interconnection Network Facilities

Element	Description	Cost Estimate (Millions)
PSCo's New NREL 115kV Transmission Substation	N/A	**$0**

Table 3 – PSCo-Owned, PSCo-Funded: Network Upgrades for Delivery

Element	Description	Cost Est. (Millions)
PSCo's New NREL 115kV Transmission Substation	Construct new NREL 115kV Substation. The scope includes: the complete construction of a new 3 position 115kV substation with all associated breakers, switches, arrestors, bus, wiring, site development, foundations and relaying. Transmission line tap into substation. Structures, conductor, hardware and installation labor.	**$3.200** **$0.850**
PSCo's Plainview and Eldorado 115kV Transmission Substation	Upgrade the Plainview and Eldorado 15kV Substations line relaying and communications equipment.	**$0.400**
PSCo's New NREL115kV Transmission Substation	Siting and Land Rights activities for substation land acquisition and permits.	**$0.675**
	Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities	**$5.125**
Time Frame	**To site, design, procure and construct after receiving authorization to proceed.**	**36-48 Months**

Cost Estimate Assumptions

- Referenced Interconnection Guidelines for < 20 MW.
- Radially fed generation interconnection customer at the new (NREL) 115kV Substation. Customer is responsible to fund all interconnection facility upgrades. (See Table 1)
- Scoping level cost estimates for Interconnection Facilities and Network/Infrastructure Upgrades for Delivery (+/- 30% accuracy) were developed by PSCo Engineering.
- Estimates are based on 2013 dollars (appropriate contingency and escalation applied).
- AFUDC has been excluded.
- Labor is estimated for straight time only – no overtime included.
- Lead times for materials were considered for the schedule.
- The Hybrid Generation Facility is in PSCo's retail service territory. Therefore, costs for retail load metering are included in these estimates.
- PSCo (or it's 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 network upgrades for delivery is approximately 36 to 48 months after authorization to proceed has been obtained.
- A CPCN will not be required for the interconnection facilities construction.
- Customer will string optical ground wire (OPGW) cable into the substation as part of the transmission line construction scope.
- The new substation land will need to be acquired.