



## **Load Interconnection System Impact Study Request # T-2014-02**

5.4 MW Distribution Load  
Jefferson County, Colorado

Xcel Energy Services  
Transmission Planning – West  
**September 30, 2014**

### **A. Executive Summary**

Public Service Company of Colorado (PSCo) received a Load Interconnection Request (T-2014-02) for a 5.4 MW (winter peaking) load interconnection in Jefferson County, Colorado. The Request was received March 11, 2014. The nature of the load served by this interconnection is residential and small commercial. The requested Point of Interconnection (POI) is the PSCo Bergen Park 115 kV Substation. Bergen Park 115 kV is connected to the PSCo Hogback 115 kV Substation via a radial 10.61 mile 115 kV transmission line (see Figure 1 below). This load is currently served from PSCo's distribution system connected to the Idaho Springs 230 kV Substation. The requested in-service date is the end of 2015 or First Quarter of 2016.

The Feasibility Study included steady-state power flow analyses to examine the impact of the proposed load interconnection on the thermal and voltage performance of the transmission grid. A 2016 peak summer power flow base case was used for the studies. The study also developed scoping level estimates for the facilities required to accommodate the Customer Load Interconnection Request.

The results of the NERC Category B & C contingency analyses show that no adverse impacts on the transmission system are expected as a result of the addition of the proposed load interconnection at the Bergen Park 115 kV Substation. Therefore, no transmission system reinforcements are required to deliver power to the Customer's proposed load interconnection at the Bergen Park 115 kV Substation. Cost estimates for the Bergen Park 115 kV interconnection facilities are as follows:

### **Cost Estimates**

#### **Transmission Proposal**

The total estimated cost of the recommended system improvements to interconnect the project is approximately **\$824.3 thousand** and includes:



- \$ 814.3 thousand for PSCo-Owned, Customer-Funded Interconnection Facilities
- \$ 10.00 thousand for additional Customer-Funded removal costs at Floyd Hill
- \$ 0.00 thousand for PSCo-Owned, PSCo-Funded Network Upgrades for Interconnection
- \$ 0.00 thousand for PSCo Network Upgrades for Delivery to PSCo Loads

PSCo Engineering estimates that it will require 18 months to complete the Customer Funded interconnection facilities at the Bergen Park Substation.





## **B. Introduction**

Public Service Company of Colorado (PSCo) received a Load Interconnection Request (T-2014-02) for a 5.4 MW (winter peaking) load interconnection in Jefferson County, Colorado. The Request was received March 11, 2014. The nature of the load served by this interconnection is residential and small commercial. The requested Point of Interconnection (POI) is the PSCo Bergen Park 115 kV Substation. Bergen Park 115 kV is connected to the PSCo Hogback 115 kV Substation via a radial 10.61 mile 115 kV transmission line (see Figure 1 above). This load is currently served from PSCo's distribution system connected to the PSCo Idaho Springs 230 kV Substation. The requested in-service date is the end of 2015 or First Quarter of 2016.

## **C. Study Scope and Analysis**

The Feasibility Study included steady-state power flow analyses to examine the impact of the proposed load interconnection on the thermal and voltage performance of the transmission grid. A 2016 peak summer power flow base case was used for the studies. The study also developed scoping level estimates for the facilities required to accommodate the Customer Load Interconnection Request.

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 (pu) of nominal and steady-state power flows below the continuous thermal ratings of all facilities. Based on the recommendations in the Colorado Coordinated Planning Group's (CCPG) Rocky Mountain Area Voltage Coordination Guidelines, in the area surrounding the Bergen Park POI, PSCo tries to maintain a transmission system voltage profile ranging from 1.02 per unit to 1.03 per unit at regulating (generation) buses and 1.0 per unit to 1.03 per unit at transmission load buses. Following a single NERC Category B contingency, transmission system steady state bus voltages should remain within 0.90 per unit to 1.05 per unit, power flows on transmission lines should remain within 100% of their continuous thermal ratings, and transformer flows should remain within their 8 hour emergency thermal ratings. Following a NERC Category C contingency, transmission system steady state bus voltages should remain within 0.90 per unit to 1.05 per unit, and power flows on transmission lines and transformers within 100% of their 30 minute emergency thermal ratings.

For this project, potential Affected Parties were not anticipated.

## **D. Power Flow Study Models**

The power flow studies were based on previously existing 2016 peak summer load flow cases that were constructed as part of the GI-2007-12 Generator Interconnection study. The power flow base cases were developed from the WECC approved 17HS1AP\_r32 case. PSCo loads in the case were adjusted to reflect the most recent (April 2013) PSCo load forecast. IREA load



was also adjusted to reflect IREA's latest load forecast (November 2013). The topology was also updated to reflect current project plans. Updates were included for the PSCo, IREA, CSU, TSG&T, WAPA, PRPA, BHE, and BEPC systems. The PSCo updates included the addition of the new Cherokee combined cycle plant and associated transmission upgrades. The new IREA Happy Canyon distribution substation connected to the Crowfoot Valley – Daniels Park 115 kV circuit was also included.

Two sets of power flow generation dispatch scenarios were evaluated. One set was created to serve as benchmark scenarios and the other set was created with the proposed load moved from PSCo's Idaho Springs Substation to Bergen Park Substation. The original cases from the GI-2007-12 study included a generation dispatch that reflected a strong flow bias from southern Colorado to the Denver Metro area. The Bergen Park load interconnection request was studied both with and without that bias. The cases with the bias included additional generation or power injections from the Lamar DC tie (100 MW), the Colorado Green/Twin Buttes wind farm (97.3 MW), the Fountain Valley combustion turbines (242 MW), the planned wind farm at Jackson Fuller (249.9 MW), and the planned PV solar at Comanche (120 MW) and San Luis Valley (50 MW). Additional cases were also created with the Plains End peaking diesel generators at maximum output (224 MW) versus zero in the other cases.

Even though the study cases are summer peak models, to be conservative the cases with the proposed Bergen Park load connection used the 5.4 MW winter peak load level. The modeled power factor was 0.98 lag. Also, the load was modeled at the low side of a 115.0/12.5 kV 10/12/14 MVA distribution transformer with an assumed 8% impedance on 10 MVA base. Subsequent to case creation, we received information that the Customer was planning to purchase a transformer with a 7.5% impedance. However, based on the results of the contingency runs, it was not deemed necessary to modify the cases to include the revised slightly lower distribution transformer impedance.

#### **E. Power Flow Study Process**

Contingency power flow studies were completed on the reference models and the models with the proposed new load interconnection using PTI's PSSE Ver. 33.4.0 program. Results from each of the cases were compared and new overloads or overloads that increased significantly in the new generation case were noted. Voltage criteria violations were also recorded. The PSSE Ver. 33.4.0 Parallel ACCC contingency analysis activity was used to perform the power flow contingency analysis. The PSCo Category B & C analyses were performed using contingency definitions that reflect breaker to breaker outages. Single branch switching was also performed for branches in Zones 700, 703, 704, 705, 709 and 791 to capture contingencies for which breaker to breaker outage definitions were not available. Single unit outages were also modeled for generators in the same zones. The facilities in Zones 700, 703, 704, 705 and 709 were monitored for overloads and voltage problems.



**F. Power Flow Thermal Results**

The results of the NERC Category B & C contingency analyses show that no adverse impacts to the transmission system are expected that can be attributed to the proposed transfer of Customer load from the Idaho Springs Substation to the Bergen Park 115 kV Substation. Therefore, no transmission system reinforcements are required to deliver power to the Customer’s proposed load interconnection at Bergen Park 115 kV Substation.

**G. Short Circuit**

The calculated short circuit levels and Thevenin system equivalent impedances for the POI at the Bergen Park 115 kV station are shown in Table 1 below.

**Table 1 – Short Circuit Parameters at the Bergen Park 115 kV Substation**

System Condition	Three-Phase Fault Level (Amps)	Single-Line-to-Ground Fault Level (Amps)	Thevenin System Equivalent Impedance (R + j X) (ohms)
System Intact	5542.6	3490.6	Zpos 2.59518 +j 11.6947 Zneg = 2.59922 +j 11.6908 Z0 = 9.01679 +j 31.8805
Hogback-Lookout 115 kV Out	4050.2	2754.2	Zpos 3.45426 +j 16.0251 Zneg = 3.45708 +j 16.0124 Z0 = 10.2309 +j 38.2234

**H. Costs Estimates and Assumptions**

T-2014-2 (System Impact Study Report)  
 Revised September 5, 2014 – Bergen Park  
 Revised September 24, 2014 – Floyd Hill

The Customer has requested a 5.4 MW transmission service interconnecting on the 115kV bus at Bergen Park Substation. The Customer’s load will be connected via a customer owned 115/12.5 kV 10/12/14 MVA distribution transformer. The estimated total cost for the required upgrades is **\$824,321**.

The estimated costs shown are scoping level estimates (+/-30%) or indicative level estimates (no level of accuracy) as noted, in 2014 dollars and are based upon typical construction costs for previously performed similar construction. These estimated costs include all applicable labor and overheads associated with the engineering, design, 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.



Table 2 lists the improvements required to accommodate the interconnection and the delivery of the Project. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to change upon more detailed analysis. Station one-line and general arrangement drawings for the Bergen Park 115 kV Substation with the proposed load interconnection can be found in the Appendix.

Table 3 lists the removal costs associated with the Floyd Hill 24.9 kV Customer tap disconnection. These costs are also subject to change upon more detailed analysis.

**Table 2 – PSCo Owned; Customer Funded Interconnection Facilities**

Element	Description	Cost Est. Thousands
<b>Bergen Park 115kV Substation</b>	Interconnect Customer to tap the bus at the Bergen Park 115kV substation. The new equipment includes: <ul style="list-style-type: none"> <li>• 115kV bidirectional metering</li> <li>• Three 115kV combination CT/PT instrument transformers</li> <li>• Two 115kV gang switches and conductor</li> <li>• Associated foundations and structures, yard improvements (incl. fence, grading, grounding)</li> <li>• Associated communications, relaying and testing</li> </ul>	<b>\$739.3</b>
	Siting and Land Rights support for required substation land expansion, reports, permits and licenses.	<b>\$75</b>
	<b>Total Cost Estimate for Customer Interconnection Facilities</b>	<b>\$814.3</b>
<b>Time Frame</b>	<b>To site, design, procure and construct</b>	<b>18 Months</b>

**Table 3 – Additional Customer Funded Costs**

Element	Description	Cost Est. Thousands
<b>PSCo Distribution Tap to Customer Floyd Hill 24.9kV Substation</b>	Distribution Removal Costs – meter and overhead tap removal	<b>\$10</b>
	<b>Total Cost Estimate for Customer Interconnection Facilities</b>	<b>\$10</b>
<b>Time Frame</b>	<b>To site, design, procure and construct</b>	<b>18 Months</b>

**Assumptions**

- The cost estimates provided in Table 2 are “scoping estimates” with an accuracy of +/- 30%.
- The cost estimates provided in Table 3 are “indicative estimates”.
- Estimates are based on 2014 dollars.
- There is contingency and escalation included in the Bergen Park estimates. AFUDC is not included.



- Labor is estimated for straight time only – no overtime included.
- PSCo (or it's Contractor) crews will perform all construction and wiring associated with PSCo owned and maintained facilities.
- The estimated time to site, design, procure (long lead time materials) and construct the interconnection facilities is at least 18 months, and is completely independent of other queued projects and their respective ISD's.
- A CPCN will not be required for interconnection facility construction.
- PSCo crews to perform checkout, relay panel construction and final commissioning.
- New substation land is required at Bergen Park.

## Appendix

### A. Bergen Park Substation One-Line



