



# Interconnection Feasibility Study Report Request # GI-2012-5

**Final Draft**

200 MW Wind Generating Facility  
Missile Site 230 kV Station, Colorado

Public Service Company of Colorado  
Transmission Planning  
October 29, 2013

## **Executive Summary**

Public Service Company of Colorado (PSCo) received an interconnection request for a 200 MW wind generating facility on October 25, 2012 that was assigned GI-2012-5 as the queue number. The proposed generating facility will consist of eighty seven (87) Siemens 2.3 MW wind turbines (SWT-2.3-113) located approximately 54 miles away from PSCo's Missile Site 345/230 kV Station. The primary point of interconnection (POI) requested for GI-2012-5 is the Missile Site 230 kV bus and the generating facility will interconnect to the POI using a new 230 kV, 54- miles long transmission line. The in-service date (ISD) requested for GI-2012-5 generating facility is December, 2014, and the requested service type is Energy Resource Interconnection Service (ERIS) \*.

This request was studied as a stand-alone generator interconnection that excluded any other new generation requests existing in the PSCo Generator Interconnection Request queue, except for the generator interconnection projects that are already planned to be in service by 2015 summer. The main purpose of this Feasibility Study was to evaluate the potential impact on the interconnected transmission system of PSCo and its neighboring utilities (the affected parties) due to an additional 200 MW of generation injected into the Missile Site 230 kV bus. It should be noted that PSCo evaluated the capacity adequacy of the transmission system beyond the POI – the Interconnection Customer is responsible for ensuring that the 230 kV tie line to the POI is adequately rated for the proposed 200 MW generation.

The Feasibility Study results indicate that there are no affected parties due to the system impact of GI-2012-5.

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\* Energy Resource Interconnection Service allows Interconnection Customer to connect the Large Generating Facility to the Transmission System and be eligible to deliver the Large Generating Facility's output using the existing firm or non-firm capacity of the Transmission System on an "as available" basis. Energy Resource Interconnection Service does not in and of itself convey any right to deliver electricity to any specific customer or Point of Delivery.

## Feasibility Analyses for GI-2012-5 Energy Resource Interconnection Service (ERIS)

The GI-2012-5 Feasibility Study was performed using a 2015 heavy summer (2015HS) power flow base case. The study includes steady state power flow and short circuit analyses for the Benchmark case (Before GI-2012-5) and the Study case (After GI-2012-5). The 2015HS base case was updated to set the TOT-3 major path flow (north-south) at 896 MW and to dispatch the existing and planned wind generation interconnected at Pawnee and Missile Site stations at their maximum expected coincident output (based on 2012-13 winter operating data). The resulting Benchmark case was then used to create the Study case by adding GI-2012-5 at the Missile Site 230kV bus and dispatching the generator at 200 MW rated output. The wind generation dispatch used at Pawnee and Missile Site stations in the two cases is as follows:

- ✓ Peetz Logan (Pawnee 230kV) = 80% of rated capacity = 460 MW
- ✓ Limon I and Limon II (Missile Site 345kV) = 96% of rated capacity = 384 MW
- ✓ Cedar Point (Missile Site 230kV) = 96% of rated capacity = 240 MW
- ✓ Planned Limon III (Missile Site 345kV) = 96% of rated capacity = 192 MW
- ✓ Proposed GI-2012-5 (Missile Site 230kV) = 100% of rated capacity = 200 MW

### Power Flow N-1 Contingency Analysis:

Based on the results given in Table 1, it can be seen that the proposed generator interconnection results in post-contingency thermal overload on the Smoky Hill 230/345 kV auto-transformer remaining in-service after the forced outage of any one of the two identical Smoky Hill 230/345 kV auto-transformers, each rated at 560 MVA summer normal. The differential impact due to GI-2012-5 is a 10.2% increase in the post-contingency loading of the Smoky Hill auto-transformer – the power flow increases from 98.3% to 109.5% of the summer 8-hour emergency rating (644 MVA) of the auto-transformer. Although the 1.1% differential impact of GI-2012-5 on the Clark – Jordan 230 kV line is relatively small, the line loading increases from 98.8% to ~100% of its 331 MVA normal/emergency rating.

No new violations of the voltage limit criteria (0.9 - 1.05 pu) or the voltage deviation criteria (< 5%) were caused in PSCo's interconnected transmission system due to the addition of GI-2012-5 generating facility.

N-1-1 and/or N-2 contingency analysis was not performed within this Feasibility Study since N-1 contingency analysis identified significant thermal constraints (resulting in the need for network upgrades) to interconnect GI-2012-5 as an ERIS at its full 200 MW output. However, the effect of N-1-1 and/or N-2 contingencies will be evaluated in the system impact study to identify significant operational constraints and potential need for operating procedures for their mitigation.

The proposed GI-2012-5 generator interconnection caused no voltage violations on the PSCo system but resulted in significant N-1 thermal violation for the Smoky Hill 345/230 kV auto-transformers based on applicable Summer Facility Ratings. Therefore, the proposed GI-2012-5 cannot be interconnected as an ERIS at its full 200 MW output.



Without any network upgrades to mitigate the thermal constraint at Smoky Hill – that is, by utilizing the existing transmission capability of PSCo’ transmission system – GI-2012-5 may be interconnected as an ERIS at partial output of approximately 30 MW.

**GI-2012-5 ERIS = 30 MW Firm (at Missile Site 230 kV POI)**

Typically PSCo has experienced high capacity factors (>90%) for wind generation during the winter season and its shoulder months (typically April and October). This operating condition corresponds to high coincident wind generation output in the Pawnee – Missile Site – Smoky Hill study area and would be considered a non-typical generation dispatch scenario within a summer season power flow case. Since the capacity factor for wind generation is typically much lower in the summer months, the post-contingency overload on Smoky Hill auto-transformers would be smaller during summer season (and may even drop below the 8-hour emergency rating during certain summer days/hours). However, this probable thermal constraint mitigation during the summer season cannot be relied on to provide long-term firm transfer of the full 200 MW output of GI-2012-5. Therefore, without requiring any network upgrades to mitigate the thermal constraint at Smoky Hill, GI-2012-5 may only achieve ERIS greater than 30 MW on an as-available basis.

**GI-2012-5 ERIS > 30 MW on As Available basis (at Missile Site 230 kV POI)**

Short Circuit Analysis

The short circuit study results show that no circuit breakers in the Missile Site 230kV switchyard will be over-dutied due to the proposed GI-2012-5 wind generation facility.

**Short Circuit Levels at the Missile Site 230 kV POI Before and After GI-2012-5**

| System Condition       | Three-Phase (3-Ph) Fault Level (Amps) | Single-Line-to-Ground (SLG) Fault Level (Amps) | 3 Ph Fault X/R | SLG Fault X/R |
|------------------------|---------------------------------------|--|----------------|---------------|
| Y2014 Before GI-2012-5 | 14,309                                | 13,122   | 12.910         | 11.458        |
| Y2014 After GI-2012-5  | 15,095                                | 14,059   | 12.339         | 10.713        |



## Power Flow N-1 Contingency Analysis Results

**Table 1 – Differentially Overloaded Facilities <sup>1</sup> for High Coincidence Wind Generation Dispatch at Pawnee and Missile Site  
 Pawnee 230kV = 460 MW (80%); Missile Site 345kV = 576 MW (96%); Missile Site 230kV = 235 MW (96%)  
 200 MW output of GI-2012-5 dispatched against RMEC (–100 MW) and Spruce (–100 MW)**

| Monitored Facility<br>(Line or Transformer) | Type | Owner | Summer Normal<br>(Continuous)<br>Facility Rating<br>MVA | Summer 8-hour<br>(2-hour) Emerg.<br>Facility Rating<br>MVA | Branch N-1 Loading<br>Before GI-2012-5 |                                      | Branch N-1 Loading<br>After GI-2012-5 |                                      | Differential<br>% Impact | N-1 Contingency Outage             |
|---|------|-------|---|--|--|--------------------------------------|---------------------------------------|--------------------------------------|--------------------------|------------------------------------|
|   |      |       |   |  | N-1 Flow in<br>MVA                     | N-1 Flow in<br>% of 8-hour<br>Rating | N-1 Flow in<br>MVA                    | N-1 Flow in<br>% of 8-hour<br>Rating |                          |                                    |
| Smoky Hill 230/345 kV # T4                  | Xfmr | PSCo  | 560   | 644 (700)  | 633                                    | 98.3%                                | 705.4*                                | 109.5%                               | 10.2%                    | Smoky Hill 230/345 kV # T5         |
| Smoky Hill 230/345 kV # T5                  | Xfmr | PSCo  | 560   | 644 (700)  | 633                                    | 98.3%                                | 705.4*                                | 109.5%                               | 10.2%                    | Smoky Hill 230/345 kV # T4         |
| Clark – Jordan 230 kV                       | Line | PSCo  | 331   | 331  | 327.4                                  | 98.8%                                | 330.5                                 | 99.9%                                | 1.1%                     | Missile Site – Daniels Park 230 kV |

\* GI-2012-5 output curtailed to ~30 MW reduces post-contingency flow to 644 MVA

<sup>1</sup> Due to proposed 200 MW generation increase at Missile Site 230 kV Station