



Interconnection Feasibility Study Report Request # GI-2007-12

250 MW Wind Farm, Near Calhan, Colorado
PSCo Transmission Planning
July 11, 2008

Executive Summary

On November 5, 2007, Public Service Company of Colorado (PSCo) Transmission Planning received a generation interconnection request to determine the feasibility of injecting power from a 250 MW wind turbine generation farm into the bulk transmission system at the Jackson Fuller Substation near Colorado Springs. The proposed commercial operation date is December 31, 2010. The proposed back feed date is May 31, 2010.

This request was studied as both a Network Resource (NR)¹, and as an Energy Resource (ER)². These investigations included steady-state power flow and short-circuit studies only, and did not include transient dynamic stability analysis. The request was studied as a stand-alone project only, with no evaluations made of other potential new generation requests that may exist in the Large Generator Interconnection Request (LGIR) queue, other than the generation projects that are already approved and planned to be in service by the summer of 2010. The main purpose of this Feasibility Study was to evaluate the potential impact on the PSCo transmission infrastructure as well as that of neighboring utilities, when injecting the new 250 MW of generation into the Jackson Fuller 230 kV bus, and delivering the additional generation to native PSCo loads. The costs to interconnect the project with the transmission system at Jackson Fuller Substation have been evaluated by Engineering.

¹ **Network Resource Interconnection Service** shall mean an Interconnection Service that allows the Interconnection Customer to integrate its Large Generating Facility with the Transmission Provider's Transmission System (1) in a manner comparable to that in which the Transmission Provider integrates its generating facilities to serve native load customers; or (2) in an RTO or ISO with market based congestion management, in the same manner as all other Network Resources. Network Resource Interconnection Service in and of itself does not convey transmission service.

² **Energy Resource Interconnection Service (ER 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



Energy Resource

The results of the ER analysis indicate that the Customer could provide 0 MW as an energy resource without the construction of network reinforcements. Transmission upgrades will be required on PSCo's system and the Intermountain Rural Electric Association (IREA) system. The study considered the impact of leaving the Monument-Palmer 115 kV line out-of-service or placing the Monument-Palmer 115 kV line back in-service. If the Monument-Palmer 115 kV line is placed back in service, transmission upgrades will be required on the Colorado Springs Utilities (CSU) system. Non-firm transmission capability may be available depending upon demand levels, generation levels, dispatch patterns, marketing activities and the status of transmission facilities.

Network Resource

The results of the NR analysis indicate that the Customer could provide 250 MW if the following is completed:

- Place the Monument-Palmer Lake 115 kV transmission line out-of-service for an indefinite period of time. Studies demonstrate that this would mitigate potential overloads on the CSU system. CSU made this recommendation to PSCo and Tri-State G&T (TSGT) after studies demonstrated that this action would alleviate many potential overloads during outage conditions. Under an interim understanding with PSCo and TSGT, the line will be operated open for one year (through September 2008), after which the open or closed status of the line would be reevaluated.
- Upgrade substation facilities in the PSCo area that presently limit the ratings of certain lines in the study area below their thermal ratings. These facility enhancements are being evaluated as part of PSCo's Transmission Facility Equipment Ratings Project and would be funded through PSCo's Five Year Capital Construction Budget.
- Upgrade the two 100 MVA Waterton 230-115 kV transformers and the 150 MVA Daniels Park 230-115 kV transformer. PSCo plans to upgrade these transformers through its Five Year Capital Budget process.
- Upgrades on the IREA system are planned for 2008 (to reconductor the Parker-Bayou 115 kV line with 795 kcmil ACSS² conductor) and 2012 (the Brick Center-Spring Valley-Kiowa 115 kV line addition)
- Construct the MidwayPS-Waterton 345 kV Project.

² Aluminum Conductor Steel Supported (ACSS) conductor operates continuously at high temperatures and carries substantially more current than standard Aluminum Conductor Steel Reinforced (ACSR) conductor.



- If the Monument-Palmer 115 kV line cannot be left open indefinitely, transmission upgrades will be needed to allow the Customer to provide 250 MW to PSCo. Studies identified three contingency overloads that could occur on the CSU system - a contingency overload of the Cottonwood N-Kettle Creek 115 kV line, a contingency overload of the Fuller 230-115 kV transformer, and a contingency overload of the Kettle Creek-Flying Horse 115 kV line. These criteria violations may be mitigated through facility additions or upgrades. For example, the Cottonwood N-Kettle Creek 115 kV line could be surveyed and a determination made which transmission structures could be raised or replaced to increase the rating of the line. Because the final status of the Monument-Palmer Lake 115 kV line was unknown at the time of this study process, the study considered opening the Monument-Palmer Lake 115 kV line for an indefinite period of time. If this study continues into the System Impact Study phase, this assumption (opening the Monument-Palmer Lake 115 kV line indefinitely) will need to be re-evaluated.
- Approximately 40 MVAR of reactive power will be needed to meet the power factor requirements for the interconnection. Additional studies would be needed in the system impact study to define the reactive power requirements.

The required transmission upgrades are not all achievable by the summer of 2010 and the status of the Monument-Palmer Lake 115 kV line as operated open indefinitely has not been decided. The work required in PSCo's system would be accomplished through PSCo's Transmission Facility Equipment Ratings Project and would be funded through PSCo's Five Year Capital Construction Budget. While opening the Monument-Palmer 115 kV circuit will eliminate the loop flow through the Jackson Fuller 230/115 kV transformer and the Cottonwood-Kettle Creek 115 kV circuit, if it is found to be a temporary solution, then the affected utility (CSU) would need to fully develop system reinforcements to meet their own internal transmission needs. Please refer to Figure 1 for a diagram of the system upgrades necessary for delivery.

The cost for the transmission interconnection (in 2008 dollars):

Transmission Proposal

The total estimated cost of the recommended system upgrades to interconnect the project is approximately **\$1.705** million and includes:

- \$ 0.305 million for PSCo-Owned, Customer-Funded Interconnection Facilities
- \$1.400 million for PSCo-Owned, PSCo-Funded Network Upgrades for Interconnection
- \$ 0.000 million³ for PSCo Network Upgrades for Delivery

³ Assumes the Monument-Palmer Lake 115 kV line can be operated open indefinitely.

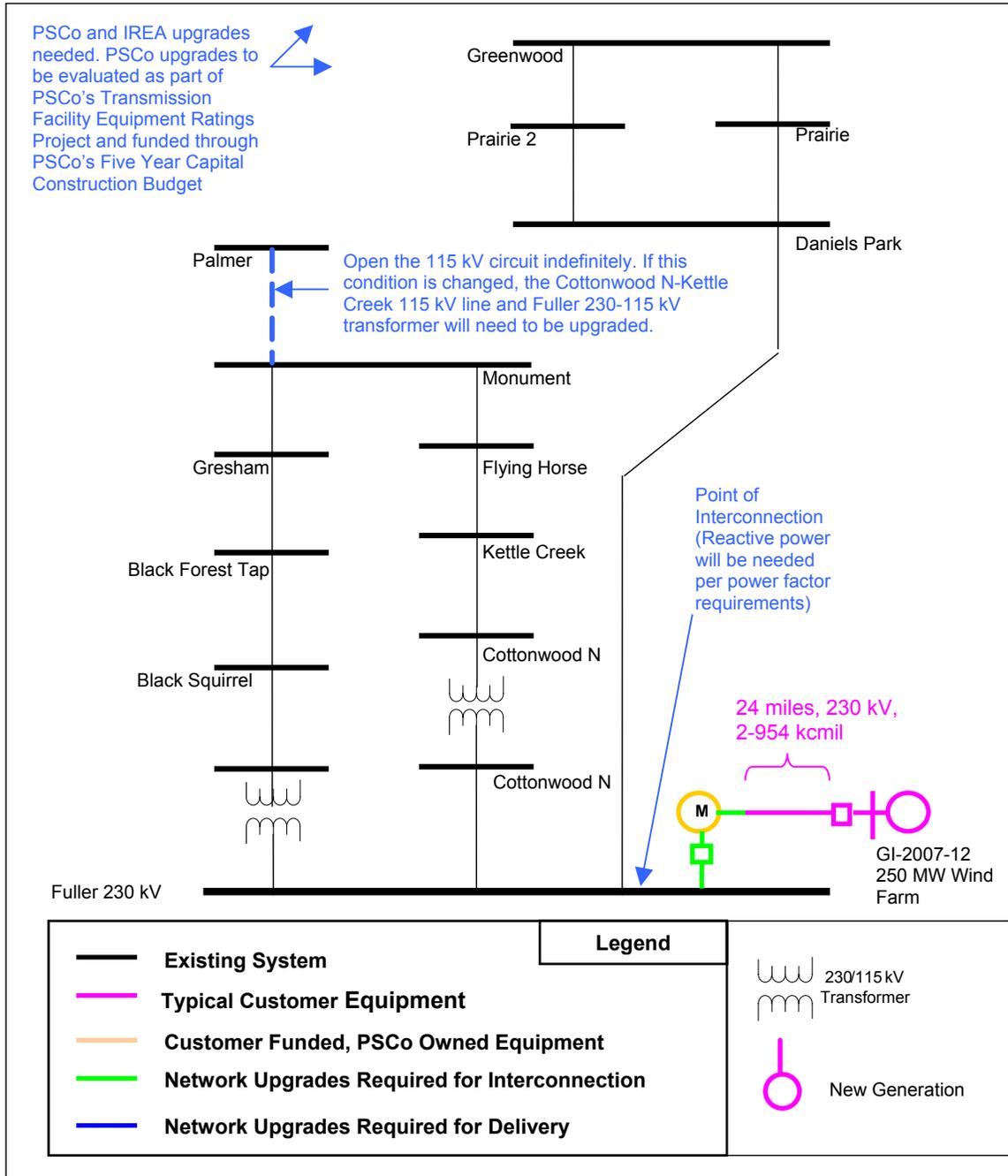


The transmission study shows that the addition of 250 MW of new wind generation connected to Jackson Fuller may not supply the full reactive power support necessary at the Point of Interconnection (POI) to control the power factor to between +/-0.95 across the full output range of the wind generation. Based upon supplied generator data concerning reactive power capabilities, the Customer may need to supply approximately 40 MVAR of reactive power on the Customer's facilities in order to meet the interconnection guidelines at the POI. This would make up for the reactive power losses at the Customer's 230/34.5 kV main transformer, the Customer's 230 kV transmission line, and the Customer's 34.5 kV collector system facilities. The Customer's facility as studied can be VAR neutral at the POI with full output. More detailed studies will have to be performed by the Customer to determine the specific reactive (capacitive and inductive) dynamic or static equipment that may be necessary to meet the requirements. The project costs do not reflect the addition of the reactive power requirements for interconnection.

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 250 MW operational capability of the facility. These tests will include, but not be limited to, power factor control, and VAR control as measured at the Jackson Fuller 230 kV bus POI for various generation output levels (0 to 250 MW) of the Customer's wind generation facility.
- 3 A single point of contact needs to be provided to PSCo Operations to manage the transmission system reliably for all wind projects on the proposed line.

Figure 1 Proposed Jackson Fuller One-Line Diagram (Upgrades Marked in Blue)





Introduction

PSCo Transmission received a large generator interconnection request (GI-2007-12) to interconnect 100 Clipper 2.5 MW wind turbines, a total generation capability of 250 MW, with a commercial operation date of December 31, 2010, and a back feed date of May 31, 2010. The proposed wind farm would be located in El Paso County, near Calhan, Colorado and would interconnect with the transmission system via the Customer's planned 24-mile radial 230 kV line terminating at the jointly-owned Jackson Fuller substation. PSCo owns three 230 kV power circuit breakers and six disconnect switches that are used to terminate the Daniels Park-Jackson Fuller 230 kV and the Jackson Fuller-Comanche 230 kV lines. CSU owns three 230 kV power circuit breakers and six disconnect switches that are used to terminate the CSU Nixon-Jackson Fuller 230 kV and the Jackson Fuller-Cottonwood 230 kV lines. PSCo owns approximately 0.31 miles of new double circuit transmission line that taps the PSCo Daniels-Comanche 230 kV line into and out of the Jackson Fuller Substation. TSGT also has an interest in this substation as it presently has terminated two 115 kV transmission lines at Jackson Fuller Substation - the Jackson Fuller-Falcon 115 kV line and the Jackson Fuller-Black Squirrel 115 kV line.

The Customer has requested that this project be evaluated as a Network Resource (NR) and an Energy Resource (ER), with the energy delivered to PSCO customers.

Study Scope and Analysis

The Interconnection Feasibility Study evaluated the transmission impacts associated with the proposed interconnection of 250 MW of new wind generation at Jackson Fuller Substation. It consisted of steady-state power flow and short-circuit analyses only. The power flow analysis provided a preliminary identification of any thermal or voltage limit violations resulting from the interconnection, and for a NR request, a preliminary identification of network upgrades required to deliver the proposed generation to PSCo loads.

PSCo adheres to NERC / WECC Reliability Criteria, as well as internal Company criteria for planning studies. The following criteria was used for the study:

- For system intact conditions, transmission system bus voltages must be maintained between 0.95 and 1.05 per unit, and transmission line power flows must be maintained within 1.0 per unit of the transmission line thermal ratings.
- Operationally, PSCo tries to maintain a transmission system voltage profile ranging from 1.02 per unit or higher at generation buses, and 1.0 per unit or higher at transmission load buses.



- Following a single element outage, transmission system bus voltages must be maintained within 0.90 per unit to 1.10 per unit, and transmission line power flows must be maintained within 1.0 per unit of the transmission line thermal ratings.

For this project, potential affected parties include the IREA transmission system in the regions south of the Denver area, TSGT (Mountain View EA), and CSU. PSCo has contacted affected utilities during the course of this study.

Power Flow Study Models

The power flow studies were based on a PSCo-developed 2010 heavy summer base case that originated from the study model developed in early 2008 as part of PSCo's normal annual Five Year Transmission Capital Budget project identification process. These budget case models are developed from Western Electricity Coordinating Council (WECC) approved models, modified as appropriate for PSCo planned and approved projects and associated topology. Load levels reflect 2010 heavy summer peak system conditions. The case reflects the addition of the Comanche Project. The Comanche Project includes the addition of the 750 MW Comanche #3 unit, two Comanche-Daniels Park 345 kV lines, two Comanche-MidwayPS 230 kV lines, the Midway-Fuller-Daniels Park 230 kV line and the MidwayPS-Waterton 345 kV transmission line (with a 560 MVA MidwayPS 345-230 kV transformer). The Waterton substation includes a 560 MVA 345-230 kV transformer and two 100 MVA 230-115 kV transformers.

The Project's 100 Clipper wind turbine generators (2.5 MW each) were modeled as two conventional 125 MW machines, each connected to a 690-volt bus. Output from each generator is raised to 34.5 kV through an equivalent 137.5 MVA step-up transformer and then raised to 230 kV through a 135 MVA transformer (10% impedance on an 81 MVA Base). The Project is connected to the Fuller Substation through a 24-mile 230 kV overhead transmission line with 1113-kcmil ACSR. The generators' reactive capability chart was taken into account, and generators' scheduled voltage was set-up so that the injected power at the POI was near a unity power factor. As discussed later in the report, the studies show that additional MVAR support will be required to enable the +/- 0.95 power factor capability with full rated output of 250 MW at the Customer's facility. The PSCo control area (Area 70) wind generation facilities, other than GI-2007-12, were dispatched to approximately 12% of facility ratings, consistent with other similar planning study models.

To evaluate the capabilities of the existing transmission system and the potential reinforcements that would be required for firm transfer levels, the power flow model was modified to simulate high flows from southeastern Colorado to the north. Specifically, generation from the Comanche units was near maximum capability and the generation at Fountain Valley was placed online at full capability, displacing generation at St. Vrain. The Lamar DC Tie is normally modeled as exporting in WECC power flow case. For this



study, the Lamar DC Tie was represented as importing at 200 MW with generation units in northern Colorado reduced to accommodate that 301 MW change in the Lamar DC Tie schedule. This condition represents a very stressed south-to-north dispatch.

Two main power flow case model generation dispatch scenarios were evaluated: a reference model without the proposed wind farm; and a model with the proposed new 250 MW (summer) of generation injected at the Jackson Fuller substation 230 kV bus. The GI-2007-12 case was re-dispatched to lower other PSCo control area generation by 250 MW, in the northern part of the PSCo system in order to maintain or maximize the south-to-north system stressing in the case. In particular, this was accomplished by decreasing the generation by 250 MW, split between the St. Vrain and Manchief power plants.

Power Flow Study Process

Automated contingency power flow studies were completed on all case models using the PSS[®]MUST program, switching out single elements one at a time for all of the elements (lines and transformers) in control areas 70 (PSCo) and 73 (WAPA RM). Upon switching each element out, the program re-solves with all voltage taps and switched shunt devices locked, and control area interchange adjustments disabled.

Stand Alone Power Flow Results

The stand-alone results reflect that the new generation interconnecting at the Jackson Fuller 230 kV bus is modeled in the power flow case at full output, or approximately 250 MW, and the rest of the generation and loads in the power flow model reflect a heavy summer load 2010 case. The contingency studies were performed for both the “with GI-2007-12” generation model, and the reference model without the proposed wind farm. The results of these two analyses listing the overloaded elements (power flows in excess of their continuous rating) were compared.

A list of the transmission facilities that either experience a new single contingency (N-1) overload, or that become significantly overloaded as a result of adding 250 MW of new generation at Jackson Fuller in the heavy summer 2010 power flow cases (i.e., 5% or more differential loading between the case with GI-2007-12 generation at 250 MW vs. 0 MW) can be found in Tables 5 and 6 in the Appendix.

Three of the identified facilities that would become overloaded due to the addition of GI-2007-12 under contingency conditions are located in the CSU system due to increased flows on the nearby underlying 115 kV transmission facilities. For the short-term, the affected utilities, TSGT and CSU, are willing to operate the area system with the Palmer – Monument 115 kV circuit open, thereby reducing the thru-flow. Near-term reinforcement plans for this area to meet growth and reliability issues have not been finalized. If a system impact study is performed for GI-2007-12, it is possible that the



projects planned by the affected utilities may cause one or more other transmission facilities to be adversely impacted due to the addition of the proposed wind farm.

Contingency overloads were also observed on PSCo's system. Under very high south-to-north stressed conditions, the 100 MVA Waterton transformers and 150 MVA Daniels Park transformer may experience contingency overloads. PSCo has identified the need to upgrade these transformers and this will be accomplished through the Five Year Capital Budget process. Additional contingency overloads in the PSCo system would be mitigated through PSCo's Transmission Facility Equipment Ratings Project and would be funded through PSCo's Five Year Capital Construction Budget. Contingency overloads on the IREA system could be mitigated by projects planned for completion in 2008 and 2012.

Energy Resource (ER):

This Study has determined that any increase in the generation injected at the Jackson Fuller 230 kV bus directly increases the loading / overloading on the PSCo and CSU regional transmission system. Therefore, the ER value, i.e., the amount of generation injection that the transmission network can accommodate without requiring upgrades, is 0 MW.

ER = 0 MW (without any Network Upgrades)

Network Resource (NR):

This Study has determined that any increase in the generation injected at the Jackson Fuller 230 kV bus directly increases the loading / overloading on the PSCo regional transmission system. Therefore, the 250 MW NR value requested will require interconnection and Transmission Network Upgrades.

NR = 250 MW (with required Network Upgrades)

Voltage Control at the Point of Interconnection:

Studies show that under certain conditions the Customer's wind turbine generators cannot meet the interconnection guidelines as mandated by PSCo in their Interconnection Guidelines for Transmission Interconnected-Producer Owned Generation Greater than 20 MW. One of the issues is with power factor control at the POI in the full range of +/- 0.95 p.f. Although the Clipper turbines have the capability to operate within the desired range, the reactive power losses in the transmission facilities of the developer can limit the ability of the developer to meet the power factor requirements at the POI. While the facility as proposed can deliver 250 MW, less losses, at the POI at a unity power factor, the equipment proposed has a limited reactive power capability, and would not be able to provide sufficient reactive power at the POI to control voltage.



Additional Customer designed, specified and supplied reactive control equipment, which could include DVAR, SVC, switched capacitors, and switched reactors, will likely be required in order to meet the following reactive control requirements. Voltage-related issues will be addressed in dynamic studies as part of the system impact and facilities studies.

- The Customer needs to demonstrate that the proposed facility is designed to be capable of providing or absorbing reactive power at the POI sufficient to control to +/- 0.95 power factor across the full operating range. In addition, the Customer's facility needs to be VAR neutral at the POI and control to zero MVAR.
- It is the responsibility of the Customer to determine what type of equipment (DVAR, added switched capacitors, SVC, reactors, etc.), the ratings (MVAR, voltage--34.5 kV or 230 kV), and the locations of those facilities to meet these reactive power controllability standards.

Short Circuit Study Results

A short circuit study was conducted to determine the fault currents (single-line-to ground or three-phase) at the Jackson Fuller Substation. The addition of the proposed 250 MW wind farm did not significantly increase the fault current at the Jackson Fuller Substation. Table 1 summarizes the anticipated fault currents that could be expected after the addition of GI-2007-12.

Table 1 Short-Circuit Study Results With and Without the Proposed 250 MW Wind Farm

System Condition	Three-phase (amps)	Thevenin System Equivalent Impedance (R,X) (ohms)	Single-line-to-ground (amps)	Thevenin System Equivalent Impedance (R,X) (ohms)
Jackson Fuller-Calhan (customer site) o/s	I ₁ =12,359.7 I ₂ =I ₀ =0 I _A =I _B =I _C =12,359.7	Z ₁ (pos)= 1.04584,10.6928 Z ₂ (neg)=1.04998,10.6972 Z ₀ (zero)=3.53994,17.0086	I ₁ =I ₂ =3,421.56 I ₀ =10,264.7 I _A =10,264.7 I _B =I _C =0	Z ₁ (pos)= 1.04584,10.6928 Z ₂ (neg)=1.04998,10.6972 Z ₀ (zero)=3.53994,17.00860
System Intact	I ₁ =14,322.0 I ₂ =I ₀ =0 I _A =I _B =I _C =14,322.0	Z ₁ (pos)= 0.87945,9.22998 Z ₂ (neg)=0.88252,9.23323 Z ₀ (zero)=3.53994,17.00860	I ₁ =I ₂ =3,702.4 I ₀ =11,107.3 I _A =11,107.3 I _B =I _C =0	Z ₁ (pos)= 0.87945,9.22998 Z ₂ (neg)=0.88252,9.23323 Z ₀ (zero)=3.53994,17.00860

PSCo will share the study results with CSU and TSGT so that CSU and TSGT can verify that the proposed wind farm addition will not necessitate the replacement of circuit breakers, switches or other substation equipment due to the increased fault current levels.

Costs Estimates and Assumptions

The Customer has requested a 250 MW Wind Generation Project interconnecting on the 230 kV bus at Jackson Fuller Substation. A 230 kV radial transmission line will



connect the Customer's collector site with the PSCo transmission system at the Point of Interconnection. The estimated total cost for the required upgrades for is **\$1,705,000**. The estimated costs shown are (+/-30%) scoping estimates in 2008 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 did not include the cost 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. 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.

Table 2 – PSCo Owned; Customer Funded Interconnection Facilities

Element	Description	Cost Est. Millions
Jackson Fuller 230 kV Substation	Interconnect Customer to tap the bus at the Jackson Fuller 230 kV substation. The new equipment includes: <ul style="list-style-type: none"> • 230 kV bidirectional metering • Three 230 kV combination CT/PT instrument transformers • Associated foundations and structures • Associated transmission line communications, relaying and testing 	\$0.210
	Transmission – labor to install slack span into Jackson Fuller. Materials furnished by Customer.	\$0.070
	Customer Generator Communication to Lookout	\$0.010
	Customer LF/ACG and Generator Witness Testing	\$0.010
	Siting and Land Rights for required easements, reports, permits and licenses	\$0.005
Total Cost Estimate for Customer Interconnection Facilities		\$0.305



Table 3: PSCo Owned; PSCo Funded Interconnection Facilities

Element	Description	Cost
Jackson Fuller 230 kV Substation	Interconnect Customer to tap the bus at the Jackson Fuller 230 kV substation. The new equipment includes: <ul style="list-style-type: none"> • Two 230 kV, 3000 amp, circuit breakers • Four 230 kV, 3000 amp gang switches • Associated communications and SCADA equipment • Line relaying and testing • Electrical bus work • Associated foundations and structures • Associated yard surfacing, landscaping, fencing and grounding 	\$1.395
Jackson Fuller 230 kV Substation	Siting and Land Rights for required easements, reports, permits and licenses	\$0.005
Total Estimated Cost for PSCo Interconnection Facilities		\$1.400
Time Frame	The estimated time to site, design, procure and construct the interconnection facilities.	18 Months

Table 4 – PSCo Network Upgrades for Delivery Not Applicable

Element	Description	Cost Est. Millions

Assumptions

- The cost estimates provided are “scoping estimates” with an accuracy of +/- 30%.
- Estimates are based on 2008 dollars.
- There is no contingency added to the estimates. AFUDC is not included.
- Labor is estimated for straight time only – no overtime included.
- The Generator is not in PSCo’s retail service territory. Therefore no costs for retail load metering are included in these estimates.
- 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 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.
- Customer will string OPGW fiber into substation as part of the transmission line construction scope.
- PSCo crews to perform checkout, relay panel construction and final commissioning.
- No new substation land required. Substation work to be completed within existing property boundaries.



Appendix

A. Generation Dispatch

The power flow studies were based on a PSCo-developed 2010 heavy summer base case that originated from the study model developed in early 2008 as part of PSCo's normal annual 5-year transmission capital budget project identification process. Load levels reflect 2010 heavy summer peak system. In order to evaluate the capabilities of the existing transmission system and the potential reinforcements that would be required for firm transfer levels, the power flow model was modified to simulate high flows from southeastern Colorado to the north. Specifically, generation from the Comanche units was near maximum capability and the generation at Fountain Valley was placed on-line at full capability, displacing generation at Ft. St. Vrain. The Colorado Green and Twin Butte Wind Farms were modeled as generating at 12% of their respective maximum ratings.

B. Power Flow Contingency Results

The initial study results indicated two significant overloads on the CSU system. The study also found that with the Monument-Palmer Lake 115 kV line open, the loading issues within CSU were mitigated. These results of the power flow studies are summarized in Table 5 below. The elements identified in this study report as overloaded in these contingency runs, are limited to the new or significantly increased overloads, and do not address all of the elements that may have been indicated as overloaded in the contingency runs. The other elements that may be overloaded, independent of the new 250 MW generation injection at Jackson Fuller substation, will be addressed through other separate Transmission Planning project proposals or by other affected utilities. The table also includes contingency overloads on the IREA system. These overloads would be mitigated by upgrades planned by IREA on their system; however, these upgrades are intended to increase the reliability of IREA customers, not to mitigate overloads associated with GI-2007-12.

While opening the Monument-Palmer 115 kV circuit addresses loading issues in the CSU system, three overloaded transformers (the two 100 MVA Waterton 230-115 kV transformers and 150 MVA Daniels Park 230-115 kV transformer) on the PSCO system will experience higher contingent loading and three PSCO 115 kV circuits will become overloaded. PSCo is planning to upgrade the Waterton 230-115 kV transformers through its Five Year Capital Budget process. In addition, other facilities in the PSCO system experience contingency overloads under this high stressed conditions. These criteria violations will also be mitigated through the Five Year Capital Budget Process. Contingency overloads on the IREA system could be mitigated with projects planned in 2008 and 2012.



Table 6 provides a list of elements that experience contingency overloads for the highly stressed south-to-north case. The table includes a column that describes the network upgrades required in PSCo's system that would be mitigated through PSCo's Five Year Capital Construction Budget.



Table 5 Summary Listing of Differentially Overloaded Elements⁴ on the Colorado Springs Utilities System With Monument-Palmer In-Service

			Branch N-1 Loading With GI-2007-12, 250 MW										
			Branch N-1 Loading Without GI-2007-12			Existing Configuration			Open Monument-Palmer 115 kV				
Monitored Element (Line or Transformer) From Bus To Bus	Type	Branch Rating MVA	N-1 Flow in % of Rating	Total # of Violations	N-1 Flow in MVA	N-1 Flow in % of Rating	Total # of Violations	N-1 Flow in MVA	N-1 Flow in % of Rating	Total # of Violations	N-1 Contingency Outage From Bus To Bus		
73391 CTTNWD N 115 73410 KETTLECK 115 1	LN	132.0	105.6	1	154.6	117.1	1	<132	<100%	0	73389 BRIARGT 115 73393 CTTNWD S 115 1		
73410 KETTLECK 115 73576 FLYHORSE 115 1	LN	132.0	80.9	0	132.6	100.4	1	<132	<100%	0	73460 BLK SQMV 115 73481 FULLER 115 1		
73477 FULLER 230 73481 FULLER 115 1	TR	100.0	92.4	0	115.8	115.8	19	<100	<100%	0	73410 KETTLECK 115 73576 FLYHORSE 115 1		

Table 6 Summary Listing of Differentially Overloaded Elements on the PSCO System With Monument-Palmer in Service

			Branch N-1 Loading With GI-2007-12, 250 MW							
			Branch N-1 Loading Without GI-2007-12			Existing Configuration				
Monitored Element (Line or Transformer) From Bus To Bus	Type	Branch Rating MVA	N-1 Flow in % of Rating	Total # of Violations	N-1 Flow in MVA	N-1 Flow in % of Rating	Total # of Violations	N-1 Contingency Outage From Bus To Bus		
70138 DANIELPK 230 70139 DANIELPK 115 T1	TR	150.0	106.9	1	153.7	102.5	1	70517 PARKERPS 115 70518 BOYOU 115 1		
70463 WATERTON 115 70463 WATERTON 230 T1	TR	100.0	119.9	3	123.7	123.7	4	70463 WATERTON 115 70463 WATERTON 230 T2		
70463 WATERTON 115 70463 WATERTON 230 T2	TR	100.0	121.0	4	124.8	124.8	5	70463 WATERTON 115 70463 WATERTON 230 T1		

⁴ New overloads or existing overloads greater than 5% of facility rating caused by the 250 MW wind injection at the POI.



Table 7 Impact of GI-2007-12 250 Mw Wind Farm on Transmission Facilities⁵ with Monument-Palmer 115 kV Open

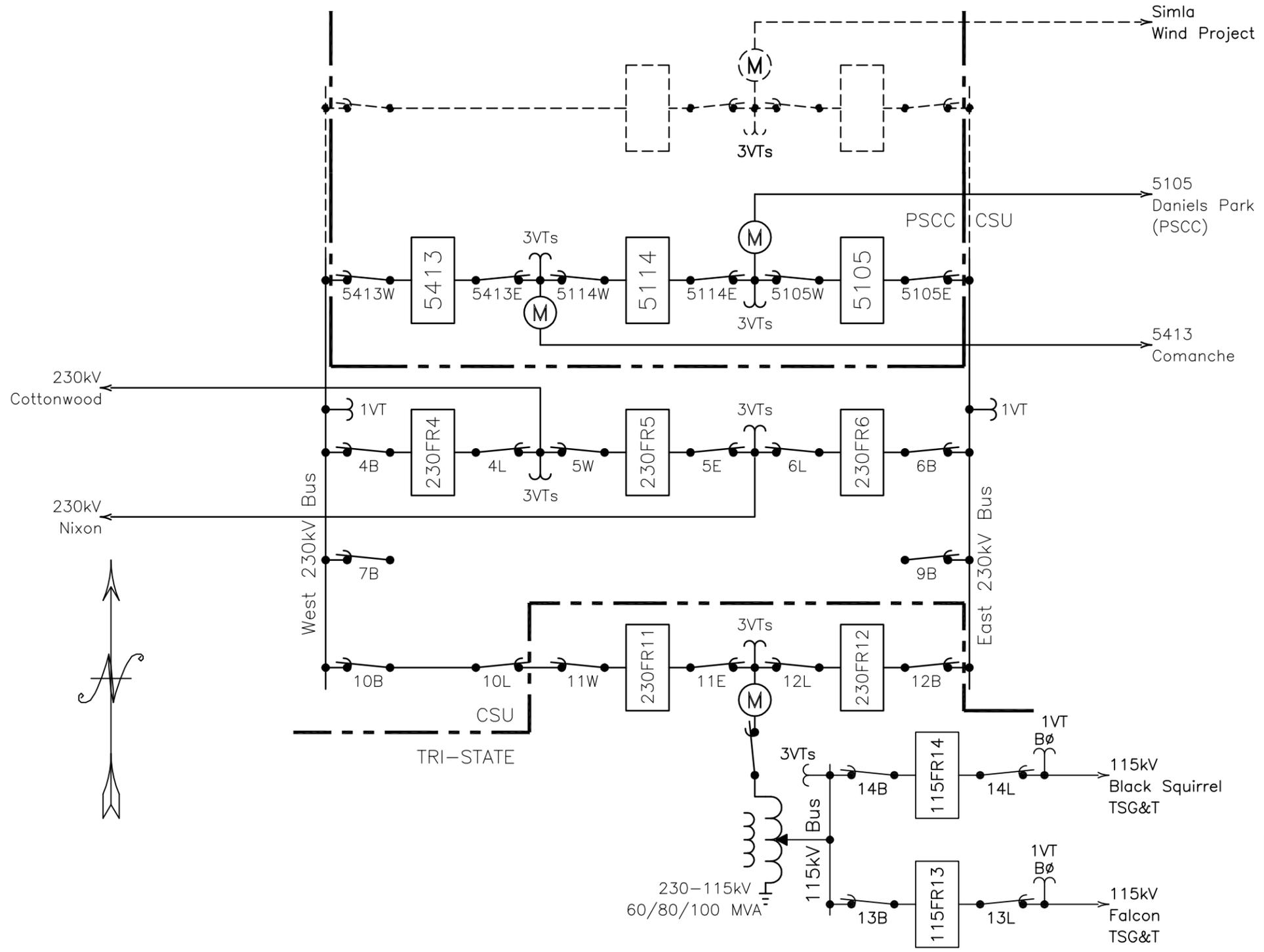
Monitored Element (Line or Transformer) From Bus To Bus	Type	Rating MVA	Reference Case Branch N-1 Loading		With GI-2007-12 Branch N-1 Loading		N-1 Contingency Outage From Bus To Bus	Network Upgrades in PSCo's System to Mitigate the Criteria Violation
			N-1 Flow in % of Rating	# of Violations	N-1 Flow in % of Rating	# of Violations		
70115 HPCYN 115 70117 CRWFTVLY 115 1	LN	155.0	80.4	0	106.7	1	70517 PARKERPS 115 70518 BAYOU 115 1	The Brick Center-Spring Valley-Kiowa 115kV line addition (that is in IREA's Long Term Plan for completion in 2012) could mitigate the contingency overload of the Happy Canyon-Crowfoot Valley 115kV line; however, this project is being constructed to increase the reliability for IREA customers, and is not intended as a remedy to the overload associated with GI-2007-12.
70115 HPCYN 115 70138 DANIELPK 115 1	LN	155.0	106.9	0	112.7	1	70517 PARKERPS 115 70518 BAYOU 115 1	The Brick Center-Spring Valley-Kiowa 115kV line addition (that is in IREA's Long Term Plan for completion in 2012) could mitigate the contingency overload of the Daniels Park-Happy Canyon 115kV line; however, this project is being constructed to increase the reliability for IREA customers, and is not intended as a remedy to the overload associated with GI-2007-12
70517 PARKERPS 115 70518 BAYOU 115 1	LN	186.6	82.5	0	101.8	1	70138 DANIELPK 115 70139 DANIELPK 230 T1	IREA plans to reconductor the Parker-Bayou 115kV line with 795 kcmil ACSS conductor (241.6 MVA) in 2008.
70138 DANIELPK 115 70139 DANIELPK 230 T1	TR	150.0	106.9	1	134.8	8	70517 PARKERPS 115 70518 BAYOU 115 1	PSCo to upgrade transformer to 280 MVA in 2010
70463 WATERTON 115 70464 WATERTON 230 T1	TR	100.0	119.9	3	134.2	17	70463 WATERTON 115 70464 WATERTON 230 T2	PSCo to upgrade transformer to 280 MVA in 2010
70463 WATERTON 115 70464 WATERTON 230 T2	TR	100.0	121.0	4	135.4	24	70463 WATERTON 115 70464 WATERTON 230 T1	PSCo to upgrade transformer to 280 MVA in 2010

⁵ New overloads or existing overloads greater than 5% of the facility rating caused by the 250 MW wind injection at the POI.



C. Jackson Fuller Substation Proposed One-Line

A revised one-line diagram of the Jackson Fuller Substation after the addition of the proposed wind farm is shown below.



A	02-20-08		New 230kV Bay Addition.	CO				
REV	DATE	PROJ. No.	REVISION DESCRIPTION	DWN	DSN	ENG	CHK	FILM

XcelEnergy SUBSTATION ENGINEERING & DESIGN

JACKSON FULLER

Lat. 38Deg 56Min 13Sec. Long. -104Deg 37Min 46Sec.

SIZE	DWG. No.	REV.
B	BUDGET	A
SCALE	FILE NAME	SHEET
N.T.S.	South/Budget/JfulC.dwg	1