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Generation Interconnection System Impact Study Report
Request # GI-2007-13

Re-study of the
Cedar Point Wind Energy 300 MW Project
As a 250 MW Project

PSCo Transmission Planning
February 10, 2009

A. Executive Summary

On November 3, 2008, Public Service Company of Colorado (PSCo) and the Customer met to discuss the results of the GI-2007-13 System Impact Study that was completed by PSCo on October 20, 2008. The Interconnection System Impact Study examined potential impacts of interconnecting a 300 MW wind powered generation plant at a new PSCo 230-kV switching station called "Missile Site" on the PSCo Pawnee-Daniels Park 230 kV line.

The Customer requested that the size of the wind generation facility be decreased from 300 MW to 250 MW. Prior to the meeting on November 3, 2008, the Customer provided PSCo a list of questions pertaining to the System Impact Study. The list of questions was discussed at the meetings and answers provided. The Customer is modifying the design of the proposed wind facility site and asked PSCo if they would need to repeat any portion of the System Impact Study[1] due to the decrease in the size of the wind generation facility from 300 MW to 250 MW and the proposed site modifications. The Customer requested that PSCo finalize the System Impact Study with the assumption that the proposed design changes would not significantly affect the results of the study work, including the transient stability study results. PSCo disagreed and informed the Customer that a re-study would be necessary and the re-study would commence after the Customer provided a final site layout. On November 11, 2008, the Customer provided a revised 230 kV Interconnection plan for the Cedar Point 250.5 MW Wind Farm and re-studies were initiated. This report summarizes the results of the re-study at 250 MW.

The purpose of this re-study of the System Impact Study was to re-evaluate the potential impacts on the PSCo transmission infrastructure with an injection of the

[1] See Question "d. Transient Stability Analysis Results and Conclustions – Section E.3 pgs 12-13 part i"

Customer's 250 MW into the new PSCo Missile Site 230 kV bus point of interconnection (POI), and delivery of the generation to PSCo native loads.

Power flow re-studies show that interconnecting to the Pawnee-Brick Center-Smoky Hill 230 kV line would require system upgrades that an interconnection to the Pawnee-Daniels Park 230 kV line would not require. Therefore, an interconnection on the Pawnee-Daniels Park 230 kV line (Alternative 1) is still the preferred alternative.

The re-study of the power flow simulations confirmed that a generator interconnection on the Pawnee-Daniels Park 230 kV line would require the construction of interconnection facilities from the Customer facilities to the PSCo bulk transmission system. The work required would consist of:

- Constructing a new PSCo 230 kV Missile Site Switching Station, three-breaker ring-bus breaker station (laid out for a future breaker-and-a-half, sectionalizing the Pawnee-Daniels Park 230 kV transmission line (Circuit No. 5457), approximately 53 miles from the Pawnee station, and 62 miles from the new Daniels Park Substation. (PSCo funded costs)

- Transmission line work associated with interconnecting the new Missile Site breaker station into the Pawnee–Daniels Park 230 kV transmission line. (PSCo funded costs)

- Revenue metering equipment (CT/VT metering instrument transformers, meters, recorder) and line termination equipment at the new Missile Site switching station, associated with the Customer's 230 kV Cedar Point–Missile Site transmission line. (Customer funded costs)

- No transmission infrastructure upgrades required for delivery were identified. Criteria violations will be resolved through the PSCo Capital Construction Budget Process for FAC-009 projects.

This re-study of the System Impact Study examined whether the power factor and reactive power aspects of the interconnection requirements at the POI would be met. From the study, the following was determined:

- The delivery of the full 250 MW (minus losses) to the POI cannot be accomplished within PSCo's interconnection requirements. Although the generating station can operate within the 0.95 lagging and leading power factor requirement, the voltage requirement at the POI cannot be met. Per the Rocky Mountain Area Voltage Coordination Guidelines, the ideal voltage at 230 kV regulating[2] buses in the Northeast Colorado Area (Region 7) should be above

[2] A regulating bus is defined as any transmission or generation bus with controllable VARs.

1.02 per unit. This requirement is not met at the POI under normal operating conditions (see Table 3).

- A switched capacitor bank of approximately 80 MVAR connected at a Customer Switching Station adjacent to the proposed Missile Switching Station would be required for voltage support at the POI. The Customer has tentatively planned to install three 25-MVAR switchable capacitors on the 34.5 kV system. The three proposed 25 MVAR capacitors at the Customer site are not as effective in controlling the 230 kV Missile Site POI bus voltage as the proposed 80 MVAR capacitor bank at a switching station adjacent to Missile Site.

- The voltage at the Pawnee Substation is influenced by the level of generation at the Peetz Logan wind generating facility. The addition of the Cedar Point generation facility would also influence the 230 kV bus voltage at Pawnee Substation. When the Peetz Logan wind generating facility is generating at 400 MW, the voltage at the Pawnee bus is below 1.03 per unit. Lower voltages tend to occur at the Missile site POI when the Cedar Wind generating facility is at maximum generation and other nearby wind generators are at maximum output.

- The Customer plans to install three 8-MVAR switchable reactors on the 34.5 kV system. When the proposed Cedar Point Wind generation (GI-2007-13) is off-line, the Customer's transmission line delivers approximately 28 MVAR of reactive power at the POI at zero power factor due to charging current. Therefore in order for the Customer to operate within 0.95 lagging or leading requirement at the POI, the three 8-MVAR reactors need to be placed in-service.

The transient stability re-study was conducted assuming a 250 MW wind facility and the following was observed:

- The system remains stable during and after each contingency studied.
- All system oscillations were damped quickly and all the proposed generation remained online.
- For contingencies where generating units were suddenly lost (or would become isolated due to fault clearing activities), all remaining generation remained on line and the system exhibited stable operation.
- The voltage recovery at Pawnee, Peetz Logan, Daniels Park and Brick Center buses is slower when the 250 MW of generation at Cedar Point is online as compared to the benchmark case.
- The addition of the 345-kV line from Pawnee to Smoky Hill makes the system more stable, with more rapid voltage recovery.

The Customer requested that the proposed project be placed in-service by December 1, 2009 with an assumed in-service date for back feed of June 30, 2009. Based on the review of PSCo Engineering and Siting and Land Rights, achieving the desired in-service and in-service date for back feed is not possible. Therefore, the study assumed that the most optimistic in-service date would be December 1, 2010 with an assumed in-service date for back feed of June 30, 2010.

B. Study Scope and Analysis

The re-study of the generation System Impact Study evaluated the transmission impacts associated with the proposed interconnection of 250 MW of energy from the point of interconnection to native PSCo loads. This study involves both power flow analysis and transient stability analysis.

The following are the study criteria used for the power flow and the transient stability analysis:

1. Power Flow Studies

PSCo adheres to NERC / WECC criteria as well as internal company criteria for planning studies. The following criteria were used for this study:

- For system impact study, the transmission system bus voltage must be maintained between 0.95 and 1.05 per unit, and the transmission line power flows must be maintained within 1.0 per unit of the line thermal rating.
- PSCo tries to maintain a transmission system voltage profile ranging from 1.02 per unit or higher at regulated buses, and 1.0 per unit or higher at non-regulated buses.
- Following a single element outage, the transmission system bus voltages must be maintained between 0.9 per unit to 1.10 per unit, and transmission line flows must be maintained within 1.0 per unit of the transmission line thermal ratings.
- The ideal voltage schedule for the buses at the Pawnee Substation 230 kV bus is between 1.03 per unit to 1.04 per unit[3].

2. Transient Stability Studies

Transient stability analyses for system intact initial conditions are performed at the appropriate dispatch and demand scenario(s). The transient stability criteria require that

[3] See region specific notes on Page 22 of 34 of the Rocky Mountain Voltage Coordination Guidelines, July 2006.

all machines remain in synchronism, all voltage swings should be damped, and voltage/frequency performance must meet the following performance criteria:

- Following fault clearing for single contingencies, voltage on load buses may not dip more than 25% of the pre-fault voltage or dip more than 20% of the pre-fault voltage for more than 20 cycles.

- For double contingencies (i.e., breaker failures), voltage on load buses may not dip more than 30% of the pre-fault voltage or dip more than 20% of the pre-fault voltage for more than 40 cycles.

C. Power Flow Study Models

The re-study assumed that the proposed project is scheduled to be in-service by December 1, 2009 with an assumed in-service date for back feed of June 30, 2009. For this study, it was evaluated for the 2010 time frame for both of the Points of Interconnection (POI).

Western Electric Coordinating Council (WECC) creates near term and far term power flow cases for transmission planning purposes. The power flow re-study was 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. This budget case model was developed from WECC-approved models, modified as appropriate for PSCo planned and approved projects and associated topology. Demand levels reflect 2010 heavy summer peak system conditions. Since the POI is near Pawnee, generation schedules for the major sources of generation in this area were reviewed. The only significant resource not dispatched at maximum capacity was the Peetz Logan wind farm. For the purpose of this study, the generation in the PSCo Balancing Authority (Area 70) was re-dispatched to simulate a high north-to-south stress on the system. Therefore, the case reflects the generation at Peetz Logan increased to its maximum capability of 400 MW, with the wind farm modeled in detail. This constitutes the benchmark case. The Comanche Unit 1 was designated as the slack bus for the PSCo Balancing Authority (Area 70).

The proposed wind generation facility, as modified to reflect a 250 MW facility, consisted of 167 GE 1.5-MW wind turbines. The turbines have a terminal voltage of 575 volts and are connected to the 34.5-kV collector system through individual step-up transformers. The current layout indicates a total of twelve 34.5-kV feeder circuits for the entire wind farm. The facility has three 34.5-kV substation buses and four feeder circuits are connected to each bus. The 34.5-kV buses are connected to the 230-kV buses through identical 34.5/230-kV transformers. In addition to the reactive support provided by the GE wind turbines, the developer has included a 25-MVAR switched capacitor and an 8-MVAR switched reactor at each 34.5-kV substation bus.

The re-study represented the turbines on each 34.5 kV feeder circuit as an equivalent generator with total generation capacity equal to the total capacity of the turbines on that circuit, +/- 0.95 power factor, and a terminal voltage of 575 volts. The collector system for each circuit was simplified, with equivalent feeder impedances calculated. The generation facility was connected to Xcel's 230-kV transmission system by a 35.5-mile radial line. Two power flow cases were studied. Each included the two potential 230-kV interconnection points by Missile Site and proposed 250 MW generation facility. One connection is tapping the Pawnee – Daniels Park 230 kV circuit, while the second is ties into the Pawnee – Brick Center 230 kV circuit.

The new generation was assumed to displace generation in the southern part of PSCo system, in particular, the generation at Comanche units 2 and 3. The PSCo control area (Area 70) wind generation facilities, other than GI-2007-13 and Peetz Logan, were dispatched to approximately 12% of facility ratings, consistent with other similar planning studies.

D. Power Flow Study Process

The re-study included automated contingency power flow studies that were completed on all case models using the PSS®MUST program. This process was undertaken to determine if interconnecting the new facility would result in thermal overloads or voltage violations for both the benchmark case and the power flow case with the proposed generation facility. The studies included all single line contingencies in Area 70 (PSCo) and Area 73 (WAPA RM). Upon switching each element out, the program re-solves the power flow cases with all transformer taps and switched shunt devices locked, and control area interchange adjustments disabled.

E. Stand Alone Power Flow Results

The re-study stand-alone results reflect that the new generation interconnecting at the two 230-kV interconnection points was 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-2007-13" generation model, and the reference model without the proposed wind farm. These contingency studies were performed for the two potential interconnection points –

- POI Alternative 1- tapping the Pawnee – Daniels Park 230 kV at a point referred to as Missile Site in the power flow case, and
- POI Alternative 2 - tapping the Pawnee – Brick Center 230 kV circuit at the same geographic location but with the power flow case name referenced as Brick Tap.

AC Contingency analysis was performed to determine if interconnecting the wind generation facility results in thermal overloads or voltage violations. For the 2010 case

with the proposed generation addition of 250 MW and without any transmission system reinforcements, there are several facilities that are adversely impacted by the new generation.

The results for the AC contingency re-study analysis for the POI Alternative 1, the Pawnee – Daniels Park 230 kV circuit, were compared with the benchmark case. Those facilities that were adversely impacted are listed in Table 1. It should be noted that although the rating of the 230 kV line from Ft. Lupton to Pawnee is 478 MVA in the base case, the actual rating of the line is 518 MVA as per the Substation/Transmission Facility Equipment Rating FAC-009 list. Similarly the rating of the 230-kV line from Pawnee to Brick Center has been revised to 734 MVA. Therefore, these lines should not be considered overloaded.

Table 1. Branch Overloads With No Reinforcements-POI Alternative 1

** From bus ** ** To bus ** CKT	Branch Rating (MVA)	Loading as % of Branch Rating		Contingency
		Bench-mark Case	With SI-2007 13	
70139 DANIELPK 230 70630 MISSILE SITE 230 1	637.0	<100.0	102.3	70311 PAWNEE 230 70545 BRICKCTR 230 1
70192 FTLUPTON 230 70311 PAWNEE 230 1	478.0	<100.0	110.5	70139 DANIELPK 230 70630 MISSILE SITE 230 1
70311 PAWNEE 230 70545 BRICKCTR 230 1	637.0	<100.0	100.6	70139 DANIELPK 230 70630 MISSILE SITE 230 1
70395 SMOKYHIL 115 70416 STRASBRG 115 1	144.6	103.9	111.5	70343 QUINCY 230 70545 BRICKCTR 230 1
73015 B.CK TRI 115 73016 B.CK TRI 230 1	224.0	108.2	115.1	70397 B.CK PS 115 73020 BEAVERCK 115 1
73015 B.CK TRI 115 73020 BEAVERCK 115 1	200.0	115.4	122.8	70397 B.CK PS 115 73020 BEAVERCK 115 1

Table 1 shows that for Alternative 1, the contingency overload of the Daniels Park-Missile Site 230 kV line (part of Circuit No. 5457) is 102.3% of its 637 MVA rating. The line rating (based on FAC-009) is 490 MVA (1229 amps) due to 1272 kcmil aluminum jumpers at the Daniels Park Substation and the Pawnee Substation between the breakers and the line traps. Bundling these jumpers to create 2-1272 kcmil aluminum jumpers will eliminate this circuit limitation and increase the rating to 637 MVA, the rating of the line traps at Daniels Park and Pawnee Substation. Replacing these line traps with a 2000 amp line traps would remove the overload. At the Daniels Park Substation (but not the Pawnee Substation), there is an additional 1-1272 kcmil jumper from the line trap to a connector that connects the single 1272 kcmil jumper to two 1272 kcmil jumpers that connect to the line. The series combination of a 1-1272 jumper connected to a 2-1272 kcmil jumper should be replaced with a 2-1272 kcmil jumper. The next limiting element would be the 2-636 kcmil conductor of the transmission line. It has a continuous thermal rating of 734 MVA. These circuit limitations will be eliminated through the PSCo Capital Construction Budget FAC-009 Rating Process.

The Pawnee-Ft.Lupton 230 kV line contingency overload of 110.5% is based on a 478 MVA rating that has been revised. The new rating of the Pawnee-Ft.Lupton 230 kV line is 518 MVA and is based on the current limitation of the Pawnee Substation-Ft Lupton

230 kV line conductor (1-954 kcmil). Based on the new rating of 518 MVA, the Pawnee-Ft.Lupton 230 kV contingency overload is approximately 102%. This potential facility impact will be investigated in more detail in the Facilities Study.

The Pawnee-Brick Center 100.6% contingency overload is based on a 637 MVA rating that has been revised. The new rating is 734 MVA and is based on the current limitation of the Pawnee Substation-Brick Center 230 kV line conductor (2-636 kcmil). This potential facility impact will be investigated in more detail in the Facilities Study.

The contingency overload of the Intermountain Rural Electric Association (IREA) Smoky Hill-Strasburg 115 kV line (for an outage of the Brick Center-Quincy 230 kV line) increases due to the addition of GI-2007-13. An operating guide has been developed to mitigate this overload that involves opening the IREA Strasburg-Bennett 115 kV line without requiring load shedding. IREA is an affected utility and will be provided a copy of the GI-2007-13 System Impact Study report.

Tri-State's Beaver Creek 224 MVA 230-115 kV transformer contingency overload and Beaver Creek TS-Beaver Creek 115 kV transmission line contingency overload may be mitigated with projects that would need to be coordinated with Tri-State. Tri-State is an affected utility and will be provided a copy of the GI-2007-13 System Impact Study report. Any Tri-State facilities affected by this project will be addressed in the Facilities Study. If Tri-State facilities require upgrades, it will be the Developer's responsibility to arrange these improvements with Tri-State.

The results for the AC contingency analysis for the POI Alternative 2, the Pawnee – Brick Center 230 kV, were also compared with the benchmark case. Those facilities that are adversely impacted are listed in Table 2. As previously discussed, the line ratings for the Ft. Lupton to Pawnee and Pawnee to Brick Center 230-kV circuits have been revised above the contingent loadings observed. Therefore, these lines should not be considered overloaded.

Table 2. Branch Overloads With No Reinforcements-POI Alternative 2

** From bus ** ** To bus ** CKT	Branch Rating (MVA)	Loading as % of Branch Rating		Contingency
		Bench-mark Case	With GI-2007 13	
70192 FTLUPTON 230 70311 PAWNEE 230 1	478.0	<100.0	115.8	70545 BRICKCTR 230 70636 BRICKTAP 230 1
70395 SMOKYHIL 115 70416 STRASBRG 115 1	144.6	103.9	135.4	70343 QUINCY 230 70545 BRICKCTR 230 1
70545 BRICKCTR 230 70546 BRICKCTR 115 T1	200.0	93.4	115.5	70343 QUINCY 230 70545 BRICKCTR 230 1
70545 BRICKCTR 230 70636 BRICKTAP 230 1	637.0	<100.0	109.5	70139 DANIELPK 230 70311 PAWNEE 230 1
73015 B.CK TRI 115 73016 B.CK TRI 230 1	224.0	108.2	114.6	70397 B.CK PS 115 73020 BEAVERCK 115 1
73015 B.CK TRI 115 73020 BEAVERCK 115 1	200.0	115.4	122.0	70397 B.CK PS 115 73020 BEAVERCK 115 1

This POI alternative results in 15.5% contingent overload of the Brick Center 230/115-kV transformer and much larger contingent overload of the Smoky Hills – Strasburg 115-kV circuit, that would require reinforcement. Based upon these results, the recommended POI is connecting the proposed facility to the Pawnee-Daniels Park 230-kV line.

Energy Resource (ER):

Energy Resource Interconnection Service is 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.

The ER portion of this study determined that the Customer could provide 0 MW of firm injection at the POI without construction of network reinforcements. Non-firm transmission capability may be available depending upon marketing activities, dispatch patterns, generation levels, demand levels, import path levels (TOT3, etc.) and the operational status of transmission facilities.

Network Resource (NR):

Network Resource Interconnection Service is 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. A Network Resource is any designated generating resource owned, purchased, or leased by a Network Customer under the Network Integration Transmission Service Tariff. Network Resources do not include any resource, or any portion thereof, that is committed for sale to third parties or otherwise cannot be called upon to meet the Network Customer's Network Load on a non-interruptible basis. Network Resource Interconnection Service in and of itself does not convey transmission service.

The results of this study indicate that interconnecting 250 MW of new generation at Missile Site POI overloads certain facilities under single line contingencies. Therefore, the 250 MW NR value requested will require interconnection and network upgrades. After these upgrades are complete, the proposed 250 MW facility could be considered as a network resource with firm transmission capability for the entire output of the plant to be delivered to native PSCo loads.

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F. Voltage Control at the Point of Interconnection

Interconnecting to the PSCo bulk transmission system requires the Customer to adher to certain interconnection requirements. Many of these requirements are contained in the Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater than 20 MW (Guidelines). The Interconnection Guidelines make reference to interconnection requirements resulting from FERC Order 661A. FERC Order 661A describes the interconnection requirements for wind generation plants. In addition, PSCo System Operations conducts commissioning tests prior to the commercial in-service date for a Customer's facilities. Some of the requirements that the Customer must adhere to include the following:

1. A wind generating plant shall maintain a power factor within the range of 0.95 leading to 0.95 lagging, measured at the POI. The Transmission Provider's System Impact Study is needed to demonstrate that such a power factor requirement is necessary to ensure safety or reliability.
2. The voltage at the Missile Site POI shall be maintained in the ideal voltage range for the Northeast Colorado Area (Region 7) as found in the Rocky Mountain Area Voltage Coordination Guidelines[4]. The System Impact Study will investigate pertinent demand, dispatch, and outage scenarios based on the defined study area that includes the proposed POI. The study will conform to the NERC Transmission System Planning Performance Requirements (TPL standards).
3. The results of the System Impact Study (mentioned in Item #1 and Item #2 above) do not absolve the Customer from its responsibility to demonstrate to the satisfaction of PSCo System Operations prior to the commercial in-service date that it can safely and reliably operate within the required power factor and voltage ranges.
4. Reactive Power Control at the POI is the responsibility of the Customer. Additional Customer studies should be conducted by Customer to ensure that the facilities can meet the power factor control test and the voltage controller test when the facility is undergoing commissioning testing.
5. PSCo System Operations will require the Customer to perform operational tests prior to commercial operation that would verify that the equipment installed by the Customer meets operational requirements.
6. 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 that may be needed for acceptable performance during the commissioning testing.

[4] The Voltage Coordination Guidelines Subcommittee (VCGS) of the Colorado Coordinated Planning Group developed the guidelines. The subcommittee consisted of representatives from major Colorado utilities including Colorado Springs Utilities, Platte River Power Authority, Tri-State Generation and Transmission, Public Service Company of Colorado, and Western Area Power Administration-Rocky Mountain Region. Other major utilities outside of Colorado were also involved in the development of these guidelines.

7. PSCo requires the Customer to provide a single point of contact to coordinate compliance with the power factor and voltage regulation at the POI. The reactive flow at the end of 230 kV line near the POI will need to be controlled according to the Interconnection Guidelines.

This re-study of the System Impact Study examined whether the power factor and reactive power aspects of the interconnection requirements at the POI could be met. From the study, it was determined that the delivery of the full 250 MW minus losses to the POI can be accomplished within the 0.95 lagging and leading power factor criteria without the need for any reactive compensation. However, as per the Rocky Mountain Area Voltage Coordination Guidelines (last revised in July 2006), the ideal voltage range at all regulating buses in the Northeast Colorado Area (Region 7) should be above 1.02 per unit. As seen from Table 3, this requirement is not met at the POI under all normal operating conditions. The operation of the 25 MVAR 34.5 kV capacitor banks connected to each 34.5 kV bus at Cedar Point do not significantly impact the voltage at the Missile site POI. Therefore, an 80 MVAR capacitor bank, connected to a new Customer station adjacent to or near the Missile Switching Station, is required to keep the voltage at the POI at 1.02 per unit when the facility is at maximum generation. The voltage at Pawnee is influenced by the generation at Peetz Logan. The addition of Cedar Point further exacerbates the situation. When Peetz Logan generates 400 MW, the voltage at the Pawnee bus is below 1.03 per unit (the minimum voltage for the Pawnee 230 kV bus).

When the proposed wind generating facility is off-line, the Customer's 230 kV open-ended transmission line delivers approximately 28 MVAR of reactive power to the Missile site POI due to charging current. Therefore, in order to maintain VAR neutrality at the POI the 8 MVAR of reactors at each of the 34.5 kV buses need to be switched on.

Table 3. Reactive Power Results at POI

	Pawnee Generation Online, Peetz=400 MW		Pawnee Generation Offline, Peetz=400 MW		Pawnee Generation Online, Peetz Offline	
	0 MW at Cedar Point	250 MW at Cedar Point	0 MW at Cedar Point	250 MW at Cedar Point	0 MW at Cedar Point	250 MW at Cedar Point
Real Power Delivered at the POI, MW	0.0	243.8	0.0	243.9	0.0	244.0
Reactive Power Delivered to POI, MVAR	27.3	2.9	28.2	-11.9	28.4	-14.1
Power Factor at the POI	0.0	0.99	0.0	0.99	0.0	0.98
Voltage at 230 kV wind farm buses, pu	1.016	1.016	1.033	1.022	1.036	1.024
Voltage at Missile Site (POI), pu	1.010	0.997	1.022	1.011	1.025	1.014
Voltage at Pawnee	1.026	1.025	1.026	1.024	1.037	1.035

G. Dynamic Analysis

The re-study of the transient stability studies determined the response of the transmission system to system disturbances such as the occurrence of faults, tripping of generators, tripping of transmission lines, or tripping of loads in the study area. These studies evaluate generator frequency, generator rotor angles, bus voltages and power flows before, during and after a disturbance to determine if the system remains stable after the disturbance. In addition, FERC Order 661A requires wind generating plants to remain on-line during voltage disturbances up to the time periods and associated voltage levels set for in the Low Voltage Ride-Through (LVRT) capability standard.

Transient stability analyses were performed for a number of three-phase faults near the Cedar Point POI, including by Pawnee, Missile Site and Daniel Park. Norrmal fault clearing times of 5 cycles for 230-kV facilities were used in this study; delayed clearing cases were not considered in this study. The 400 MW of wind generation at Peetz Logan was modeled in detail, reflecting the GE wind turbines and the feeder impedances. The GI-2007-13 wind generating facility was modeled at the 575-volt level, with the wind turbines connected through GSUs to 34.5 kV. The 34.5-kV collector system at Cedar Point consists of 12 circuits. Two of these circuits were modeled in complete detail, while the turbines for the other circuits were represented by composite generator on connected to feeders with an equivalent impedance for each circuit.

Most of the system disturbances simulated were three-phase faults at the indicated location, shown in Table 4. For each of those contingencies, the three-phase fault was applied at a bus for 5 cycles and appropriate action was taken to clear the fault. This procedure was done for both cases with and without generation at Cedar Point. For two contingencies, sudden loss of generation without a fault was studied.

The results of the re-study indicate that the system remains stable during and after each contingency studied. All system oscillations were damped quickly and all expected generation remained online. For contingencies where generating units were suddenly lost or would become isolated due to fault clearing activities, all remaining generation remained on line and the system exhibited stable operation. The voltage recovery at Pawnee, Peetz Logan, Daniels Park and Brick Center buses is slower when the 250 MW of generation at Cedar Point is online as compared to the benchmark case. The addition of the 345-kV line from Pawnee to Smoky Hill makes the system more stable, with more rapid voltage recovery.

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Table 4. Transient Stability Analysis Results

Cont	Fault Location	Action	Benchmark Case	With Generation at Cedar Point
1	Pawnee 230	Trip Pawnee - Daniels Park 230 KV	Stable	-
2	Pawnee 230	Trip Pawnee - Ft.Lupton 230 KV	Stable	Stable
3	Pawnee 230	Trip Pawnee - BrickCtr 230 KV	Stable	Stable
4	Daniel Park 230	Trip Pawnee - Daniels Park 230 KV	Stable	-
5	Ft. Lupton 230	Trip Pawnee - Ft. Lupton 230 KV	Stable	Stable
6	Pawnee 230	Trip Pawnee 22/230 KV Transformer ckt 1A and Drop Pawnee Unit G1	Stable, generation disconnected	Stable, generation disconnected
7	Daniel Park 230	Trip Daniel Park 230/345 KV ckt 1	Stable	Stable
8	Pawnee 230	Trip Pawnee - Story 230 KV	Stable	Stable
9	-	Drop Pawnee Unit G1	Stable, generation disconnected	Stable, generation disconnected
10	Pawnee 230	Trip Pawnee - Pawneecap 230 KV and Trip Pawneecap - Peetz Logan 230 KV	Stable, generation disconnected	Stable, generation disconnected
11	-	Trip Pawnee - Pawneecap 230 KV and Trip Pawneecap - Peetz Logan 230 KV	Stable, generation disconnected	Stable, generation disconnected
12	Story 230	Trip Pawnee - Story 230 KV	Stable	Stable
13	34KV_3 34.5	Trip a Cedar Point 34.5/230 kV Transformer	-	Stable, generation disconnected
14	CP230SUB2 230	CP230SUB1- CP230SUB2 230 KV	-	Stable, generation disconnected
15	Missile Site	Trip Missile Site - CP230SUB2 230 KV	-	Stable, generation disconnected
16	Missile Site	Trip Missile Site - Daniels Park 230 KV	-	Stable
17	Missile Site	Trip Missile Site - Pawnee 230 KV	-	Stable
18	Pawnee 230	Trip Pawnee - Missile Site 230 KV	-	Stable
19	Daniel Park 230	Trip Missile Site- Daniels Park 230 KV	-	Stable

Note: CP230SUB1 and CP230SUB1 are 230-kV buses located at the Customer facility

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H. Costs Estimates and Assumptions

Scoping level cost estimates (+/- 30%) were determined by PSCo Engineering. The cost (+/-30%) estimates are in 2008 dollars (no escalation applied) 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, 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 estimated total cost for the required upgrades for is **$ 4,576,000.** Figure 1 below represents a conceptual one-line of the proposed interconnection at the Missile Site Substation. 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 generation output. 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.

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Figure 1 Conceptual One-Line for GI-2007-13

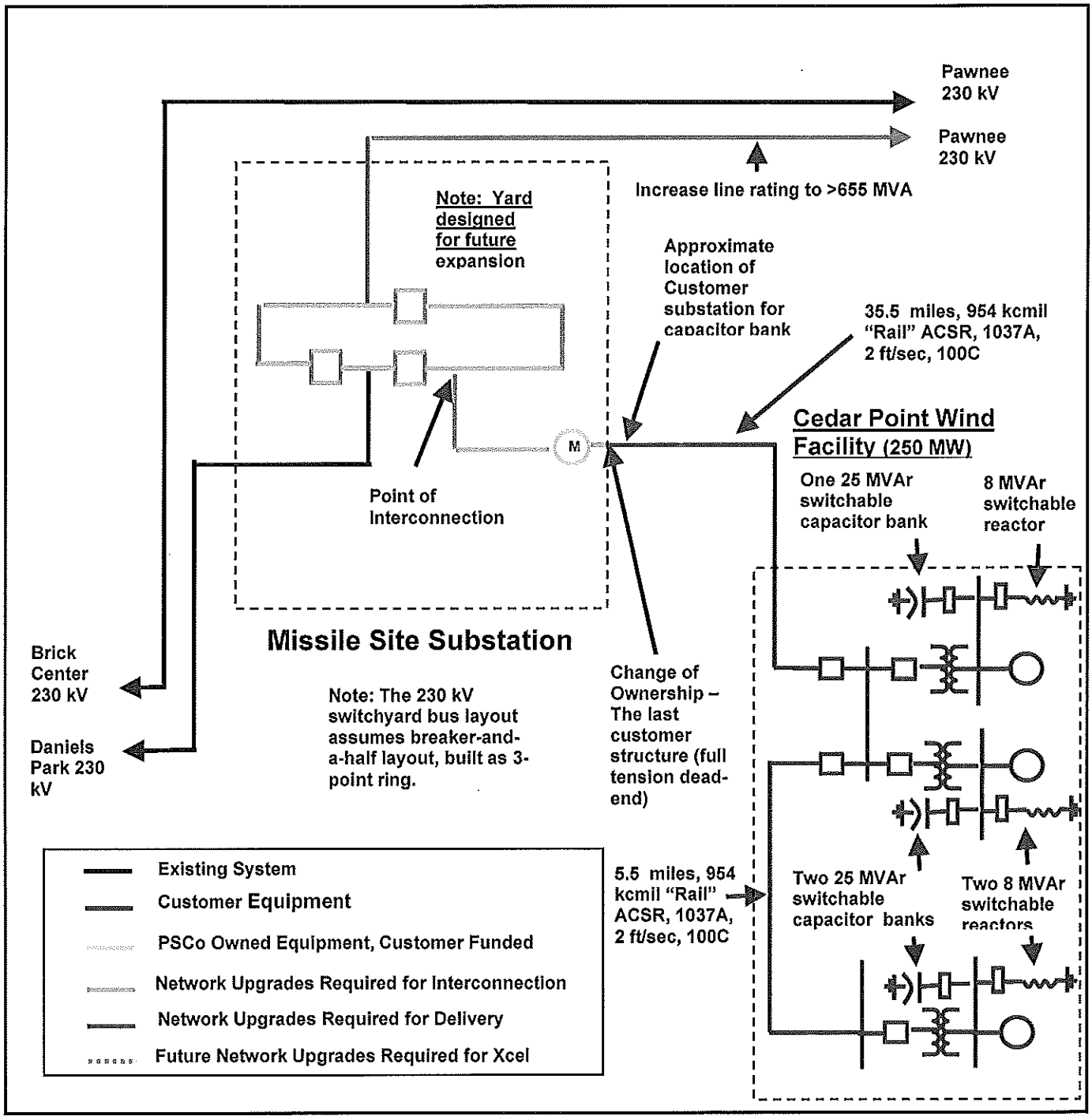

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Table 5 – PSCo Owned; Customer Funded Interconnection Facilities

Element	Description	Cost Est. (Millions)
Missile Site 230 kV Substation	Interconnect Customer to tap at PSCo's New Missile Site 230 kV Substation. The new equipment includes: • One 230 kV, 2000 amp gang switch • One bidirectional revenue meter & recorder • Three 230 kV combination CT/PT instrument transformers • Three 230 kV lightning arresters • Associated bus, wiring and equipment • Associated foundations and structures • Associated transmission line communications, relaying and testing.	**$0.434**
	Transmission line tap into substation. One double circuit steel pole, conductor, hardware and installation labor.	**$0.287**
	Customer LF/ACG and Generator Witness Testing. (Customer generation telemetry equipment, and witnessing the Customer generator commissioning testing).	**$0.128**
	Siting and Land Rights support for required easements, reports, permits and licenses.	**$0.010**
	Total Cost Estimate for PSCo-Owned, Customer-Funded Interconnection Facilities	**$0.859**
Time Frame	**Site, engineer, procure and construct**	**18 Months**

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Table 6: PSCo Owned; PSCo Funded Interconnection Facilities

Element	Description	Cost Estimate (Millions)
Missile Site 230 kV Substation	Interconnect Customer to tap at PSCo's New Missile Site 230 kV Substation. The new equipment includes: • Three 230 kV, 3000 amp circuit breakers • Eight 230 kV, 3000 amp gang switches • Six 230 kV, 2000-1200 amp CCVT's • One electric equipment enclosure • Associated communications, supervisory and SCADA equipment • Line relaying and testing • Associated bus, miscellaneous electrical equipment, cabling and wiring • Associated foundations and structures • Associated yard surfacing, landscaping, fencing and grounding	**$3.232**
Pawnee 230 kV Substation	Interconnection and substation upgrades required at PSCo's Pawnee Substation (relaying and testing).	**$0.092**
Daniels Park 230 kV Substation	Interconnection and substation upgrades required at PSCo's Daniels Park Substation (relaying and testing).	**$0.092**
	Siting, permitting and acquisition of a 35-acre substation site and associated transmission line tap.	**$0.160**
	Total Cost Estimate for PSCo-Owned, PSCo-Funded Interconnection Facilities	**$3.576**
Time Frame	**Site, engineer, procure and construct**	**18 Months**

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Table 7 – PSCo Network Upgrades for Delivery

Element	Description	Cost Est. (Millions)
PSCo's Transmission Network	• Uprate the Daniels Park-Missile Site 230 kV line to at least 655 MVA. The line is limited by a 1-1272 kcmil aluminum jumper at Pawnee and Daniels Park that limits the line rating to 490 MVA (summer normal rating of 1229 amps). After bundling the jumpers at Pawnee and Daniels Park, the line would then be limited by 637 MVA line traps at Pawnee and Daniels Park. Resolving the line trap limitations at Pawnee and Daniels Park would result in the line being rated to its thermal limit of 734 MVA (based on 2-636 kcmil conductor on 230 kV double circuit steel lattice structures).	----------
Beaver Creek Sub	Replace 1200 amp switch #9409-1 with a 2000 amp switch, upgrade 115 kV bus from 1272 Al to 2000 amp, replace 1200 amp switches 9400N and 9400S to 2000 amp.	**$.141**
	Total Cost Estimate for PSCo Network Upgrades for Delivery	**$.141**
Time Frame	**Network Upgrades for Delivery – to be constructed via the PSCo Capital Budget Construction Process.**	----------
	Total Cost of Project	**$4.576**

Assumptions for Alternatives

- The cost estimates provided are "scoping estimates" with an accuracy of +/- 30%.
- Estimates are based on 2008 dollars (no escalation applied).
- There is no contingency or AFUDC included in the estimates.
- Labor is estimated for straight time only – no overtime included.
- The cost estimates for the PSCo network upgrades for delivery are not included as they are part of PSCo's Capital Budget Construction process.
- Lead times for materials were considered for the schedule.
- The Wind Generation Facility 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, engineer, procure and construct the interconnection facilities is at least 12 months, The estimated time for PSCo to site, engineer, procure and construction the scope of work identified in Table 8 is **18 months** after authorization to proceed has be obtained. This is completely independent of other queued projects and

their respective ISD's. This does not include any time for preparation and receipt of a CPCN, which would add an additional 10 to 12 months to this schedule.

- A CPCN will not be required for interconnection facility construction. However, this would be determined by the CPUC as part of the annual Rule 3206 filing by PSCo with the CPUC. Should a CPCN be required, this would add approximately 10 to 12 months time to the at the beginning of the project, increasing the 18 month time frame listed to 28 to 30 months total schedule time, after authorization to proceed has be obtained.
- Customer will string OPGW fiber into substation as part of the transmission line construction scope.
- Contractor to construct the new substation, PSCo crews to perform checkout, relay panel construction and final commissioning.
- Acquisition of a new site this size eliminates the subdivision process.
- New site is adjacent to the existing transmission line corridor, most likely assumed to be on the north and / or west side of the existing 230 kV double-circuit transmission lines at this location (see Appendix). However, the specific details regarding the new Missile Site switching station layout, location, potential transmission line exits and line crossings, and detailed requirements necessary to meet both the initial station design / construction requirements, and still meet the ultimate expansion capabilities will need to be further reviewed in the later Facilities Study phase.