

Interconnection System Impact Study Report REQUEST # GI-2004-1

150 MW Wind Generation Near Ft. Morgan, Colorado Interconnecting at Pawnee Station

Xcel Energy Transmission Planning
December 2004

Executive Summary

This Interconnection System Impact Study Report summarizes the analyses performed by the Transmission Planning group of Public Service Company of Colorado (PSCo) to interconnect 150 MW of wind powered generation located near Ft. Morgan, Colorado to the Pawnee Station 230 kV bus. The Customer proposed in-service date for commercial operation of the facility is December 31, 2006, with an assumed back-feed date of June 1, 2006. At the request of the Customer, the Project was evaluated as both an Energy Resource (ER) and as a Network Resource (NR) with the power going to PSCo customers. The request was studied primarily as a “stand-alone” project, without considering other projects in the Rocky Mountain Area OASIS queue¹, but some sensitivity analyses was also performed to consider some higher queued projects.

Energy Resource:

As an Energy Resource, an interconnected generator is only eligible to deliver on an available basis using the existing capacity of the transmission system. Other studies of interconnections at Pawnee have determined that as a stand-alone project, no firm energy could be delivered to the system without the construction of network reinforcements. Non-firm capability may be available depending on system conditions. The estimated cost of the PSCo Network Upgrades for interconnection as an Energy Resource is \$730,000 with an estimated time frame to implement those interconnection facilities is at least 9 months.

Network Resource:

For the Project to be considered a Network Resource, other studies have indicated that the integration of the full 150 MW of new generation would require transmission additions and modifications in order to prevent unacceptable conditions on the regional system. As a stand-alone project, the basic upgrades would consist of:

- Upgrade the 94 mile PSCo 230 kV line from Pawnee Station to Quincy and Smoky Hill Substations from 500 MVA to 800 MVA.
- Upgrade the PSCo 64 mile 230 kV line from Pawnee Station to Ft. Lupton Station to a 230 kV double circuit, 800 MVA per circuit rated transmission line.

¹ www.rmao.com



- Uprate the existing 230 kV line from Story to Pawnee Station from 576 MVA to 650 MVA.
- Uprate the existing 230 kV line from Ft. Lupton Station to Henry Lake Substation to Riverdale Substation to Cherokee Station from 435 MVA to 475 MVA.

The total estimated cost of the recommended system upgrades to accommodate the stand alone project is approximately **\$45.4** million and includes:

- \$0.395 million for Customer Interconnection Facilities at Pawnee Station
- \$0.325 million for PSCo Network Upgrades for Interconnection
- \$44.685 million for PSCo Network Upgrades for Delivery

The time required to engineer, permit, and construct all the required PSCo facilities for interconnection is estimated to be at least 9 months. The estimated time required to engineer, permit, and construct the Network Upgrade facilities for delivery is at least 30 months. According to the interconnection request, the Customer will engineer, permit, construct, and finance the 18-mile 230 kV transmission line to the proposed tap station.

A simple diagram of the Network Upgrades and the regional transmission system for this request is shown in Figures 1 and 2.

Sensitivity studies evaluated the system performance considering the higher queued Pawnee project GI-2003-01². If GI-2003-1 and its associated system upgrades are considered to be in place, studies indicate that the total estimated cost of the recommended system upgrades to accommodate GI-2004-1 would be approximately **\$15.54** million and include:

- \$0.21 million for Customer Interconnection Facilities at Pawnee Station
- \$0.46 million for PSCo Network Upgrades for Interconnection
- \$14.87 million for PSCo Network Upgrades for Delivery

Additional details of the studies can be found under the Power Flow Study Results and a simple diagram of the system is shown in Figures 3 and 4.

² 300 MW Wind Facility

Figure 1 - Regional Transmission Network with Recommended Upgrades

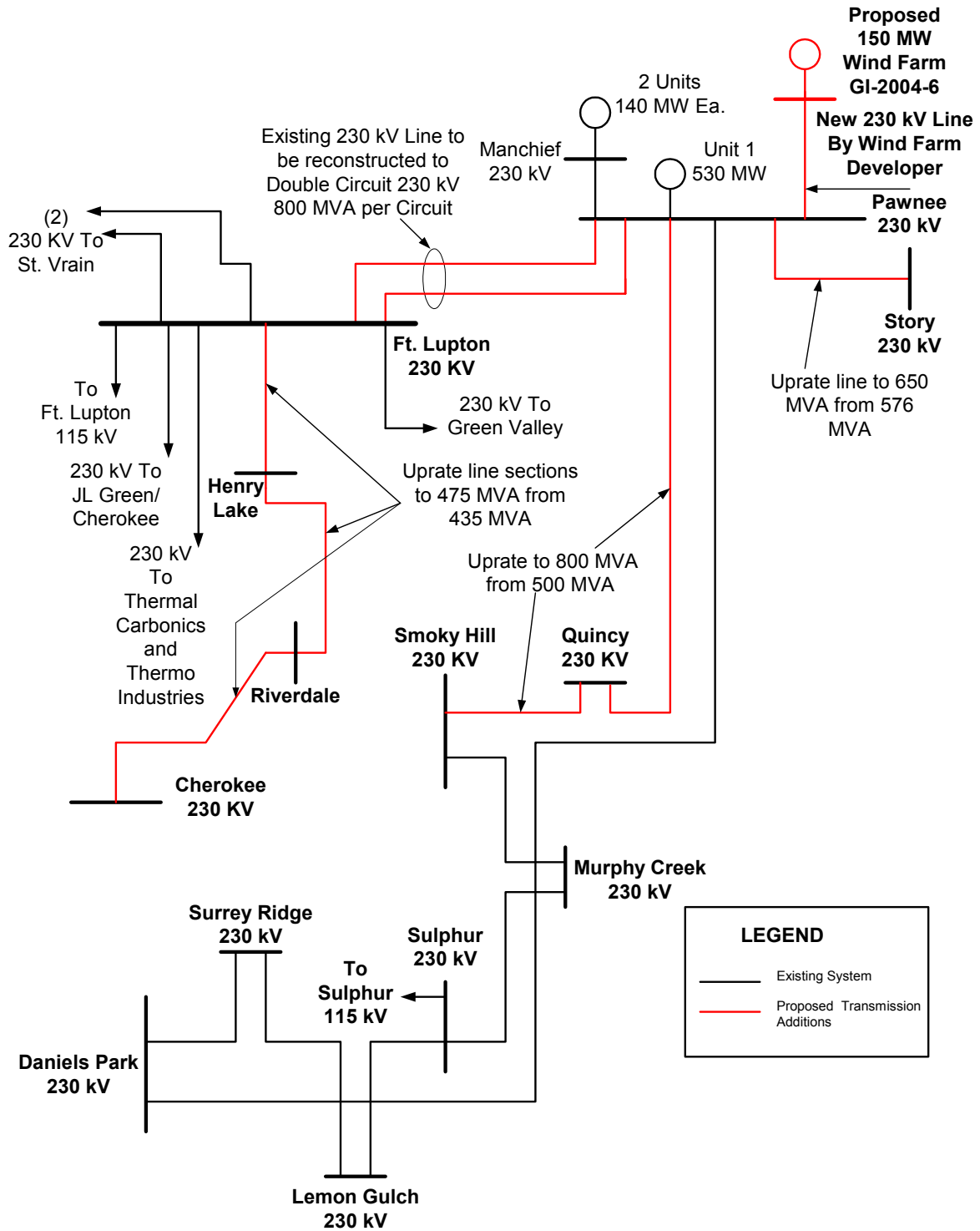


Figure 2 - Pawnee Station One-line with GI-2004-1

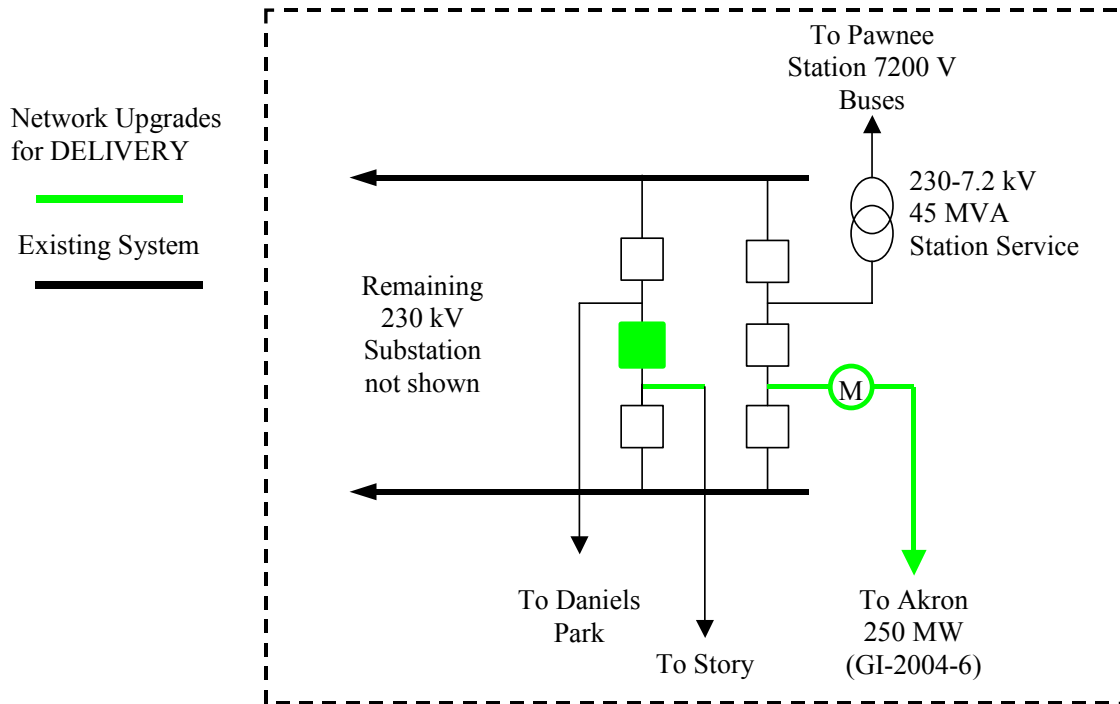


Figure 3 – System Reinforcements Including GI-2003-1

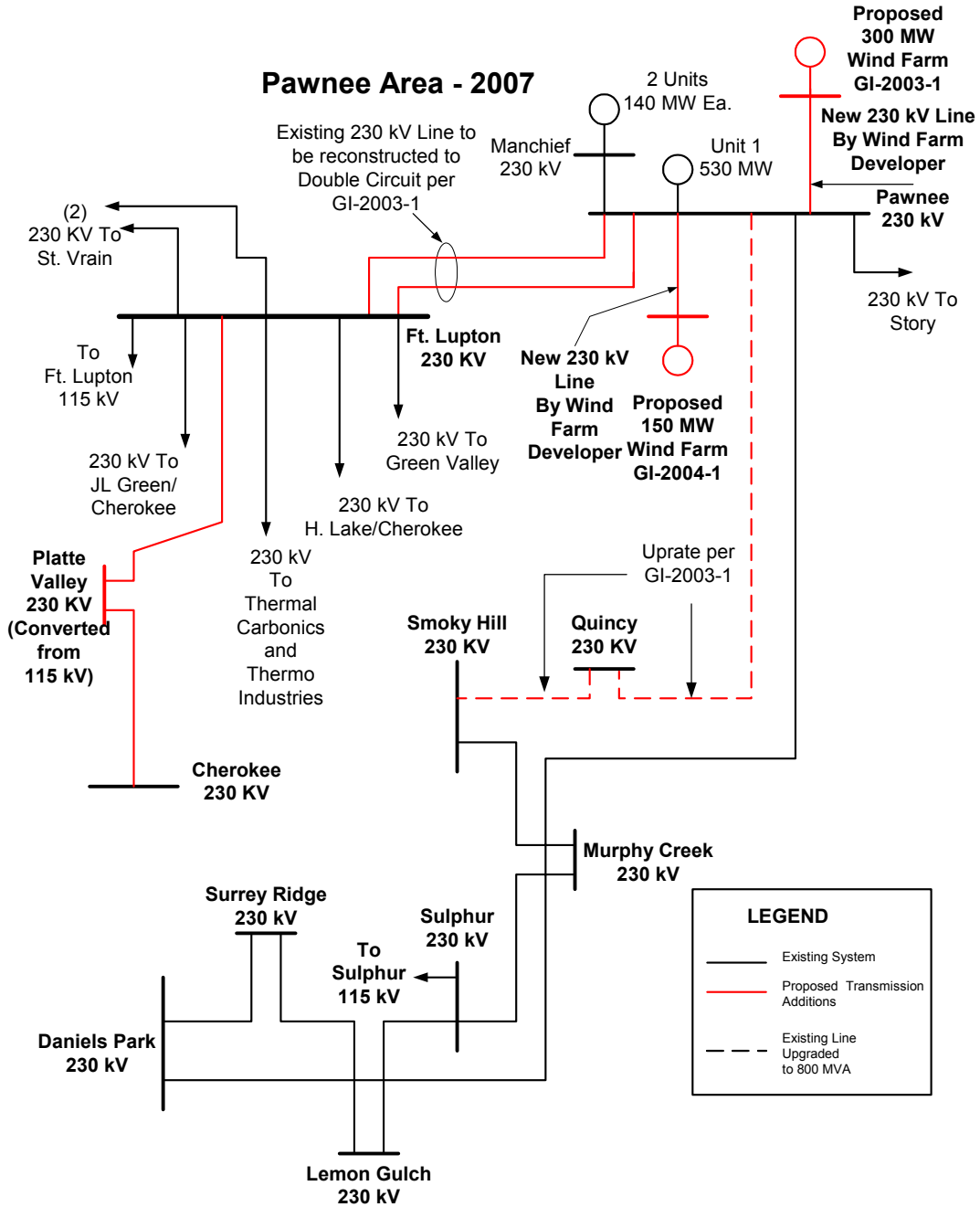
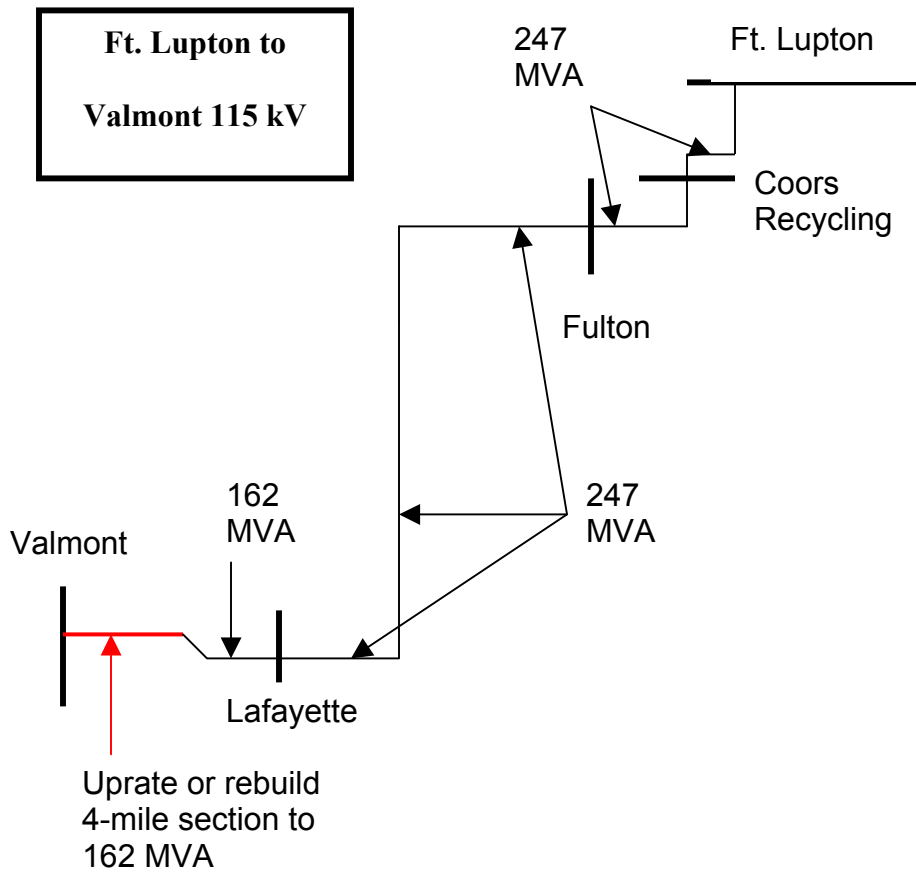


Figure 4: System Reinforcements for Only GI-2004-1



Introduction

Xcel Energy Transmission received a request to conduct a feasibility study that would evaluate the integration of a 150 MW wind power generating facility in Morgan County, Colorado. The approximate location of the interconnection is approximately 9 miles northwest of the town of Ft. Morgan, Colorado. The Customer proposed in-service date for commercial operation of the facility is December 31, 2006, with a back-feed date of June 1, 2006. The Feasibility Study was completed and the report issued to the Customer and posted on the RMAO web site in June 2004. An Interconnection System Impact Study Agreement was executed on or around July 28, 2004 indicating a targeted completion date for studies of 120 days from that date.

Study Scope and Analysis

The Interconnection System Impact Study evaluated the transmission requirements associated with the proposed interconnection to the PSCo Transmission System.

The Study consisted of power flow, short circuit, and dynamic stability analyses. The power flow analysis identified thermal or voltage limit violations resulting for the

interconnection, and for the NR request, a preliminary identification of Network Upgrades required to deliver the proposed generation to PSCo loads. The short circuit analysis identified circuit breaker short circuit capability limits exceeded as a result of the Interconnection and for the NR request, the delivery of the proposed generation to PSCo loads. The dynamic stability analysis verified that there were no limitations due to angular instability of the system for regional disturbances.

PSCo adheres to NERC / WECC Reliability Criteria, as well as internal Company criteria for planning studies. During system intact conditions, criteria are to maintain transmission system bus voltages between 0.95 and 1.05 per-unit of system normal conditions, and steady state power flows within 1.0 per-unit of all elements thermal (continuous current or MVA) ratings. Operationally, PSCo tries to maintain a transmission system voltage profile ranging from 1.02 per-unit or higher at generation buses, to 1.0 per-unit or higher at transmission load buses. Following a single contingency element outage, transmission system steady state bus voltages must remain within 0.90 per-unit to 1.10 per-unit, and power flows within 1.0 per-unit of the elements continuous thermal ratings.

Impacts on the neighboring utilities were monitored, and were addressed in the scope of this study. Should the Customer continue this request and move on to the Facility Study. Further studies would also include participation from these utilities which are Tri-State Generation and Transmission, and Western Area Power Administration.

Powerflow Study Models

For this analysis, a power flow model was developed to reflect 2007 heavy summer loading conditions. Data representation in the area of study was reviewed and modified to accurately reflect the Rocky Mountain regional transmission system. The TOT 3 transfer path was increased to 1440 MW, and power transfers from north to south through Colorado were increased to study the regional transmission system³.

The 150 MW wind farm was modeled as two 75 MW conventional generators with a 0.95 per unit (p.u.) lagging power factor (overexcited) and a 0.90 p.u. leading power factor (under-excited) capability to simulate the VAR requirements of the generators, assumed to be GE 1.5 MW DFIG turbines.

The specified point of interconnection for the new generation is Pawnee Station near Brush, Colorado. The proposed project was connected to the Pawnee Station 230 kV bus, and modeled as a single 18-mile 230kV line, according to Customer provided data. The project generation was scheduled to PSCo peaking units located in and around the Denver-metro area.

³ High north to south transfers are generally used to analyze the transmission system between Pawnee and Denver. The Tot 3 transfer path was modeled at approximately 1440 MW. The 2004 summer transfer limit for that path is approximately 1540 MW.

Study Results

Power Flow Analysis

Energy Resource

The results of the previous ER study indicate that with the existing system and with existing firm reservations across TOT 3, there is no available capacity at Pawnee Station; therefore, the ER is zero MW. Non-firm transmission capability may be available depending on marketing activities, dispatch patterns, demand levels, and the status of transmission facilities. The limiting contingency was an outage of the PSCo 230 kV line from Pawnee Station to Smoky Hill Substation. That contingency loaded the parallel Pawnee to Ft. Lupton 230 kV line to 100% of its flow limit. Some sensitivity studies modeled a higher queued project, GI-2003-1, as being in service with its associated infrastructure. For the TOT 3 level studied, results indicated that the project could inject 80 MW into the PSCo system before any system upgrades are required. However, other studies have indicated that at maximum TOT 3 levels, there would be no capacity. The amount that the wind project can inject into the PSCo is directly related to the loading of the TOT 3 interface.

Network Resource

The NR study determined the stand-alone network upgrades that would be required to accept the full 150 MW from the proposed wind farm for the conditions studied. For the study, the project generation was scheduled to the southern PSCo system by reducing generation in that area. At 150 MW of generation, there were numerous contingency overloads.

The Customer's interconnection request is similar to previously studied interconnection requests at Pawnee Substation. The upgrades were determined to be comparable with the network upgrades identified for GI-2003-1 and were previously shown in Figure 1. The basic recommended network upgrades to alleviate the overloads and accommodate the generation include the following:

- Between Pawnee Station and Smoky Hill Substation, uprate the existing 230 kV line from 500 MVA to 800 MVA by using phase raisers to raise 15 transmission structures.
- From Pawnee Station to Ft. Lupton Station rebuild the existing 64 mile 230 kV 413 MVA rated line to a double circuit 230 kV, 800 MVA per circuit configuration.
- Uprate the existing 230 kV line from Story to Pawnee Station from 576 MVA to 650 MVA by adjusting the rating methodology for that line to allow for a higher conductor temperature.
- Uprate the existing 230 kV line from Ft. Lupton Station to Henry Lake Substation to Riverdale Substation to Cherokee Station from 435 MVA to 475 MVA. This can be accomplished by replacing transmission line and equipment jumpers at Riverdale and Cherokee. The 230 kV main buses at Cherokee must also be replaced with 5-inch aluminum bus tube from the existing 1272 kCMIL ACSR.

The total estimated cost for the recommended upgrades is \$45.4 million. The Project was also evaluated taking into consideration the relevant project ahead in the queue. The project considered GI-2003-1, which is 300 MW interconnected at Pawnee 230kV station. Figure 1 details the improvements associated with that Study. The details of GI-2003-1 can be seen on the RMAO web page www.rmao.com.

To alleviate the overloads and accommodate the full 150 MW of generation, the following upgrades were required:

- Convert the existing PSCo 28 mile Ft. Lupton Station to Platte Valley to Cherokee Station 115 kV line to 230 kV operation with an 800 MVA capacity.
- Upgrade the Ft. Lupton to Valmont 115 kV line from 135 MVA rating to a 162 MVA rating by reconductoring 4 miles of line with 636 kCMIL ACSR Conductor and remove the existing 477 kCMIL ACSR.

Figures 3 and 4 show these network upgrades. The facility costs are described in more detail in the Cost Estimates and Assumptions section. These upgrades are required to relieve overloads caused by the loss of one of two parallel lines overloads the other. These lines are the 230 kV line from Ft. Lupton to Henry Lake and the other is the Ft. Lupton to J.L. Green. Both of these lines eventually tie together at PSCo’s Cherokee Station. Contingency results are available upon request. The total estimated cost for the recommended upgrades is \$15.54 million.

TOT 3 Analysis

TOT 3 analysis was performed and the results show that integrating the Ft. Morgan 150 MW Wind Farm with the transmission infrastructure required for delivery will not have any adverse impact on the TOT 3 limit.

Short Circuit Analysis

The short circuit analysis consisted of faulting and measuring the current at 230kV buses in the region of study. Three-phase and single-line to ground faults were evaluated and the three-phase faults were found to be more severe. The results are shown below. Results indicated that there are not any major increases in fault currents and that current breaker ratings are sufficient to integrate this project into the PSCo system.

Table 1 Before the addition of GI-2004-1

Location	3 Phase	Single Phase
Pawnee	23,625A	26,079A
Ft. Lupton	30,544A	26,033A
Smoky Hill	20,317A	21,134A

Table 2 After the addition of GI-2004-1

Location	3 Phase	Single Phase
Pawnee	23,668A	26,114A
Ft. Lupton	30,552A	26,037A
Smoky Hill	27,103A	24,031A
Ft. Morgan Wind Farm	699A	32A

Stability Analysis

Transient stability analyses of the Pawnee area and TOT 3 were performed by modeling three-phase faults and single line to ground fault contingencies in the region of study. The three-phase faults were cleared and elements removed after six cycles. Dynamic models for the proposed project were prepared using Customer supplied data. The analysis indicated that the project would not adversely affect the transient stability performance of the system and results met WECC/NERC Reliability Criteria and that the system is stable before, during, and after contingencies. The disturbances modeled with associated results are shown in Tables 3 and 4.

TOT 3 stability analysis was also completed by modeling a three-phase fault at the Laramie River 345-kV bus and loss of the Laramie River to Ault 345 kV line. The results showed that the 150 MW wind farm addition, with the proposed network resource additions does not adversely impact the transient performance in the region of the TOT 3 path. These results are shown in Tables 3 and 4. Plots of the TOT 3 stability analysis are available upon request. Plots of the stability analysis are available upon request.

Table 3: Summary of Transient Stability Results for case without Ft. Morgan.

Fault Location, Duration	Action	Result
3PH @ Pawnee 230 kV bus; 6 cycle	Trip Pawnee – Quincy 230 kV line	System Stable, Brush Wind Tripped
3PH @ Pawnee 230 kV bus; 6 cy	Trip Pawnee – Story 230 kV line	System Stable, Brush Wind Tripped
3PH @ Story 345 kV; 6 cy	Trip Laramie River – Story 345 kV line	System Stable
3PH @ Ft Lupton 230 kV; 6 cy	Trip Pawnee – Ft. Lupton 230 kV line	System Stable
3PH @ Daniels Park 230 kV; 6 cy	Trip Pawnee – Daniels Park 230 kV Line	System Stable
3PH @ Ft. Morgan 230 kV Bus; 6 cy	Trip Ft.Morgan – Pawnee 230kV line & Ft.Morgan gen	System Stable
3PH @ Pawnee 22 kV Bus; 3 cy	Trip Pawnee Generator and station load.	System Stable
SLG @ Story 345 kV Bus; 20 cy	Trip Laramie River – Story 345 kV line	System Stable
3PH @ LRS 345 kV Bus; 6 cy	Trip Laramie River – Ault 345 kV line	System Stable Volt Dip at Laramie

Fault Location, Duration	Action	Result
		115 kV to 0.7 p.u.

Table 4: Summary of Transient Stability Results for case with Ft. Morgan.

Fault Location, Duration	Action	Result
3PH @ Pawnee 230 kV bus; 6 cy	Trip Pawnee – Quincy 230 kV line	System Stable, Brush Wind Tripped; Ft Morgan Wind Tripped
3PH @ Pawnee 230 kV bus; 6 cy	Trip Pawnee – Story 230 kV line	System Stable, Brush Wind Tripped; Ft. Morgan Wind Tripped
3PH @ Story 345 kV; 6 cy	Trip Laramie River – Story 345 kV line	System Stable
3PH @ Ft Lupton 230kV; 6 cy	Trip Pawnee – Ft. Lupton 230 kV line	System Stable
3PH @ Daniels Park 230kV; 6 cy	Trip Pawnee – Daniels Park 230 kV Line	System Stable
3PH @ Ft.Morgan 230kV Bus;6 cy	Trip Ft. Morgan – Pawnee 230 kV line and Ft. Morgan wind generation	System Stable
3PH @ Pawnee 22 kV Bus; 3 cy	Trip Pawnee Station Generator and station load.	System Stable
SLG @ Story 345 kV Bus; 20 cy	Trip Laramie River – Story 345 kV line	System Stable
3PH @ LRS 345 kV Bus; 6 cy	Trip Laramie River – Ault 345 kV line	System Stable Volt Dip at Laramie 115 kV to 0.70 p.u.

Cost Estimates and Assumptions

The estimated total cost for the required upgrades is \$15.54 Million

The estimated costs shown are “indicative” (+/-30%) preliminary budgetary costs in 2006 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, and construction of these new PSCo facilities. The estimates do not include any costs for any Customer-owned, supplied, and installed equipment and associated design and engineering, other than the transmission line between the generation and Corner Point. This estimate also does not include any costs that may, or may not be required for other entities’ systems. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines

Based upon the System Impact Study performed here, in order for PSCo to provide an interconnection for the Customer, facilities must be constructed at the PSCo Pawnee Station.

PSCo Network Upgrades for Interconnection:

Tables 5 and 6 describe the costs associated with providing an interconnection and network upgrades to PSCo’s system for interconnection. It does not include all of the costs required for full delivery of the generation.

Table 5 Customer Interconnection Facilities

Substation	Description	Cost Est.
Pawnee Station	Interconnect Customer to tap PSCo's 230kV bus. The new equipment includes 230kV bi-directional transformer metering, relaying and associated equipment and material.	\$335k
	Transmission tie line into Pawnee Station.	\$40k
	Siting and Land Rights for required easements, reports, permits and licenses.	\$20k
	Total Cost Estimate for Customer Interconnection Facilities	\$395k

Table 6 PSCo Network Upgrades for Interconnection

Substation	Description	Cost Est.
Pawnee Station	Interconnect Customer's 230 kV line, which will require the relocation of the existing Pawnee to Story 230 kV line to one bay west to allow the new Customer owned line to terminate in this position. The new equipment required includes: <ul style="list-style-type: none"> • a new 230 kV 3000 A, 50 kA circuit breaker • two 230 kV switches • required steel supporting structures 	\$325k
	Total Cost Estimate for PSCo Network Upgrades for Interconnection	\$325k

Table 7 describes the costs associated with providing network upgrades for delivery to PSCo Customers.

Table 7 PSCo Network Upgrades for Delivery

Element	Description	Cost
Pawnee Station	New 230 kV Line terminal to Ft. Lupton requiring the following equipment: <ul style="list-style-type: none"> • one new 230 kV breaker and half bay on the west side of the 230 kV switch yard • (2) 3000 Amp, 50 kA circuit breakers • (4) 230 kV switches • associated steel • electrical bus work • associated metering, control, and relaying Upgrade the 230 kV line from Pawnee to Story requires the following: <ul style="list-style-type: none"> • replace four 230 kV 1600 Amp switches with 3000 Amp switches 	\$1,430k

Element	Description	Cost
	Update the Pawnee to Smoky Hill 230 kV line requires the following: <ul style="list-style-type: none"> • replace six (6) 1600 Amp switches with 3000 Amp switches • replace 1200 Amp Line trap with 2000 Amp Line Trap 	
Ft. Lupton Station	New 230 kV 2000 Amp Line Terminal to Pawnee which will require rearranging of the existing line terminations for the Henry Lake and Green Valley lines. The following equipment will be required: <ul style="list-style-type: none"> • a new 230 kV breaker and a half bay on the east side of the station • three (3) 230 kV 3000 Amp 50 kA circuit breakers that includes replacing one 1600 Amp breaker • ten (10) 230 kV switches that includes four (4) new and six (6) replacements from 1600 Amp to 3000 Amp • misc. supporting steel • electrical bus work • associated metering control and relaying 	\$1,400k
Smoky Hill Substation	Upgrade existing facilities on the Pawnee 230 kV line terminal which includes the following: <ul style="list-style-type: none"> • replace two (2) underrated 230 kV 1600 Amp circuit breakers with new 3000 Amp 50 kA circuit breakers • replace four (4) 1600 Amp switches with 3000 Amp switches • replace 1200 Amp Line trap with 2000 Amp Line Trap • replace existing east and west main 1272 kCMIL strain buses with 5" aluminum tube bus • associated metering, control, and relaying 	\$1,060k
Riverdale	Replace equipment jumpers and transmission line jumpers.	\$65k
Quincy Substation	Replace existing 1200 Amp line-rupters with 2000 Amp line rupters	\$310k
Cherokee	<ul style="list-style-type: none"> • Replace existing equipment jumpers and transmission line jumpers with (2) 1272 kCMIL ACSR, • Replace existing north and south 1272 kCMIL ACSR strain bus with 5" aluminum tube bus • Replace one 1600 Amp circuit breaker with a 3000 Amp 50 kA breaker 	\$720k
Transmission	Rebuild existing 413 MVA 230 kV line from Pawnee to Ft. Lupton with new double circuit 230 kV 834 MVA transmission utilizing existing ROW as much as possible	\$38,700k
	Update the existing Pawnee to Quincy/Smoky Hill 230kV Line to 800 MVA from 500 MVA by installing approximately 15 phase raisers.	\$210k

Element	Description	Cost
	Uprate Ft. Lupton to Henry Lake to Riverdale to Cherokee 230 kV line from 435 MVA to 475 MVA. Need an aerial survey to determine current ground clearances.	\$190k
	Uprate Story to Pawnee 230 kV line from 576 MVA to 650 MVA	\$0
Siting and Permitting	Obtain necessary siting, permits, and ROW as required	\$610k
	Total Cost Estimate for PSCo Network Upgrades for Delivery	\$44,685k
	Total Cost of Project	\$45,415k
Time Frame		27 Months

Assumptions

- The cost estimates provided are “scoping estimates” with an accuracy of +/- 30%.
- Estimates are based on 2006 dollars.
- PSCo (or it’s Contractor) crews will perform all construction and wiring associated with PSCo owned and maintained facilities.
- The estimated time for design and construction of PSCo network upgrades for interconnection at the Pawnee Station is at least 9 months, and is completely independent of other queued projects and their respective ISD’s.
- It is anticipated that in order to construct the PSCo network upgrades for delivery, a Certificate of Public Convenience and Necessity (CPCN) will be required by the Colorado Public Utilities Commission (CPUC). The application for a CPCN will not be submitted until the Interconnection Agreement is fully executed. The estimated time frame for the CPCN process, siting, permitting, easement and right-of-way acquisition, design and construction for the PSCo network upgrades is at least 27 months from the time the Interconnection Agreement is fully executed. This time frame is also based on other identified assumptions for Siting and Land Rights, Substation Engineering and Transmission Engineering as listed below.
- The Customer will be responsible for funding and constructing approximately 28 miles of transmission line from the wind farm to the point of interconnection (Pawnee Station).
- The last span into Pawnee Station from the Customer owned 230 kV line will be a slack span between the PSCo substation dead-end and the Customer’s last structure, which is assumed to be a dead-end tangent structure.
- A siting study will not be required if network upgrades for delivery (transmission line construction) is in existing right-of-way. Extensive public involvement is anticipated. Permit applications and possible minor right-of-way acquisition will be required. Land use permits will be required from multiple local jurisdictions.

Tables 8 through 10 describe costs associated with interconnection and delivery for GI-2004-1 taking into consideration that GI-2003-1 is also interconnected at Pawnee. Tables 8 and 9 describe the costs associated with providing an interconnection and network upgrades to PSCo's system for interconnection. It does not include all of the costs required for full delivery of the generation.

Table 8 Customer Interconnection Facilities

Substation	Description	Cost
Pawnee Station	Interconnect Customer to tap PSCo's 230kV bus. The new equipment includes 230kV bi-directional transformer metering, relaying and associated equipment and material.	\$145k
	Transmission tie line into Lamar Substation.	\$45k
	Siting and Land Rights for required easements, reports, permits and licenses.	\$20k
	Total Cost	\$210k

Table 9 PSCo Network Upgrades required for interconnection the proposed 150 MW Wind Generation Facility

Substation	Description	Cost
Pawnee Generation Station	Interconnect Customer's 230 kV line, which will connect to the far west bay of the 230 kV switchyard. The new equipment required includes: <ul style="list-style-type: none"> • a new 230 kV 3000 A, 50 kA circuit breaker • two 230 kV switches • required steel supporting structures • associated control and relaying changes and additions. (See one-line in Appendix C)	\$460k
	Transmission line relocation	\$0
	Siting and Land Rights for misc. permits	\$0
	Total Cost	\$460k
Time Frame		9 Months

Table 10 describes the costs for network upgrades that provide full delivery for the proposed 150 MW wind generation facility near Ft. Morgan, Colorado.

Table 10 PSCo Network Upgrades required to deliver the proposed 150 MW increase from Wind Generation Facility as an NR Request

Facility	Description	Cost (Millions)
Ft. Lupton Station	<p>New 230 kV 2000 Amp Line Terminal to Cherokee Station via Platte Valley Substation which will be located on the far west bay o f the 230 kV switchyard sharing the middle circuit breaker with one of the Ft. St. Vrain lines. The following equipment will be required:</p> <ul style="list-style-type: none"> • one (1) 230 kV 3000 amp 50 kA circuit breaker • two (2) 230 kV switches • misc. supporting steel • electrical bus work • associated metering control and relaying <p>(See One-line in Appendix C)</p>	\$0.665
Platte Valley Substation	<p>Convert this Tri-State/Untied Power 115 kV delivery point to 230 kV operation. The following equipment will be required:</p> <ul style="list-style-type: none"> • two (2) 230 kV 2000 amp circuit breakers • two (2) 230 kV 1200 amp circuit switchers • two 230/13 kV, 25 MVA transformers • misc. supporting steel • electrical bus work • associated metering, control and relaying <p>(See One-line in Appendix C)</p>	\$2.96
Cherokee Station	<p>New 230 kV 2000 Amp Line Terminal to Ft. Lupton via Platte Valley Substation which will be located on the far west bay o f the 230 kV switchyard sharing the middle circuit breaker with one of the Ft. St. Vrain lines. The following equipment will be required:</p> <ul style="list-style-type: none"> • one (1) 230 kV 3000 amp 50 kA circuit breaker • two (2) 230 kV switches • misc. supporting steel • electrical bus work • associated metering control and relaying <p>(See One-line in Appendix C)</p>	\$0.670
Valmont Station	<p>Upgrade equipment for line uprate:</p> <ul style="list-style-type: none"> • one 800 Amp line trap • one 115 kV switch • electrical bus work • associated metering control and relaying <p>(See One-line in Appendix C)</p>	\$0.085
Transmission	<p>Convert the existing 115 kV line from Ft. Lupton Station to Cherokee Station via Platte Valley to 230 kV operation with 800 MVA capacity.</p>	\$9.5

	Upgrade the existing FT. Lupton to Valmont 115 kV line from 135 MVA to 162 MVA by reconductoring 4 miles of line starting from Valmont.	\$0.32
Siting and Permitting	Obtain necessary siting, permits, and ROW as required	\$0.67
	TOTAL DELIVERY COST	\$14.870
	TOTAL COST ALL PROJECTS FOR INTERCONNECTION AND DELIVERY	\$15.540
Time Frame		30 Months

Assumptions:

- The cost estimates provided are “scoping estimates” with an accuracy of +/- 30%.
- Estimates are based on 2006 dollars.
- PSCo (or it’s Contractor) crews will perform all construction and wiring associated with PSCo owned and maintained facilities.
- The estimated time for design and construction of PSCo network upgrades for interconnection at the Pawnee Station is at least 9 months and is completely independent of GI-2003-1.
- Infrastructure associated with Interconnection Request GI-2003-1 is assumed to be constructed (see previous description) and it was determined that these network upgrades required a minimum of **30** months to complete following the execution of an Interconnection Agreement. The feasibility study report for GI-2003-1 is available via www.RMAO.com.
- It is anticipated that in order to construct the PSCo network upgrades for delivery, a Certificate of Public Convenience and Necessity (CPCN) will be required by the Colorado Public Utilities Commission (CPUC). The application for a CPCN will not be submitted until the Interconnection Agreement is fully executed. The estimated time frame for the CPCN process, siting, permitting, easement and right-of-way acquisition, design and construction for the PSCo network upgrades is **at least 30 months** from the time the Interconnection Agreement or EPC Contract is fully executed. This time frame is also based on other identified assumptions for Siting and Land Rights, Substation Engineering and Transmission Engineering as listed below.
- The Customer will be responsible for funding and constructing approximately XX miles of transmission line from the wind farm to the point of interconnection (Pawnee Station).
- The last span into Pawnee Station from the Customer owned 230kV line will be a slack span between the PSCo substation dead-end and the Customer’s last structure, which is assumed to be a dead-end tangent structure.
- A siting study will not be required if network upgrades for delivery (transmission line construction) is in existing right-of-way. Extensive public involvement is anticipated. Permit applications and possible minor right-of-way acquisition will be required. Land use permits will be required from multiple local jurisdictions.

- For all of the fault cases studied, the wind turbines for the Ft. Morgan Wind Project were modeled as conventional synchronous generators. A more accurate model is not currently available for such short circuit programs as Aspen or CAPE. This study was performed using CAPE.
- New Ft. Lupton Station-Platte Valley-Cherokee Station 230 kV line has a two conductor bundled 954 ACSR conductors per phase. Rebuild is constructed within existing ROW with daily outages and rebuilt one section at a time.
- Permitting to take at least 16 months and will be difficult in obtaining permits through six (6) local jurisdictions. It is also anticipated that a Certificate of Public Convenience and Necessity (CPCN) will be required from Colorado Public Utility Commission (CPUC).
- No land requirements for substations.