Interconnection System Impact Study Report
REQUEST # GI-2003-1

300 MW Generation Addition Near Brush, Colorado
Interconnecting at Pawnee Station

Xcel Energy Transmission Planning
October 2004

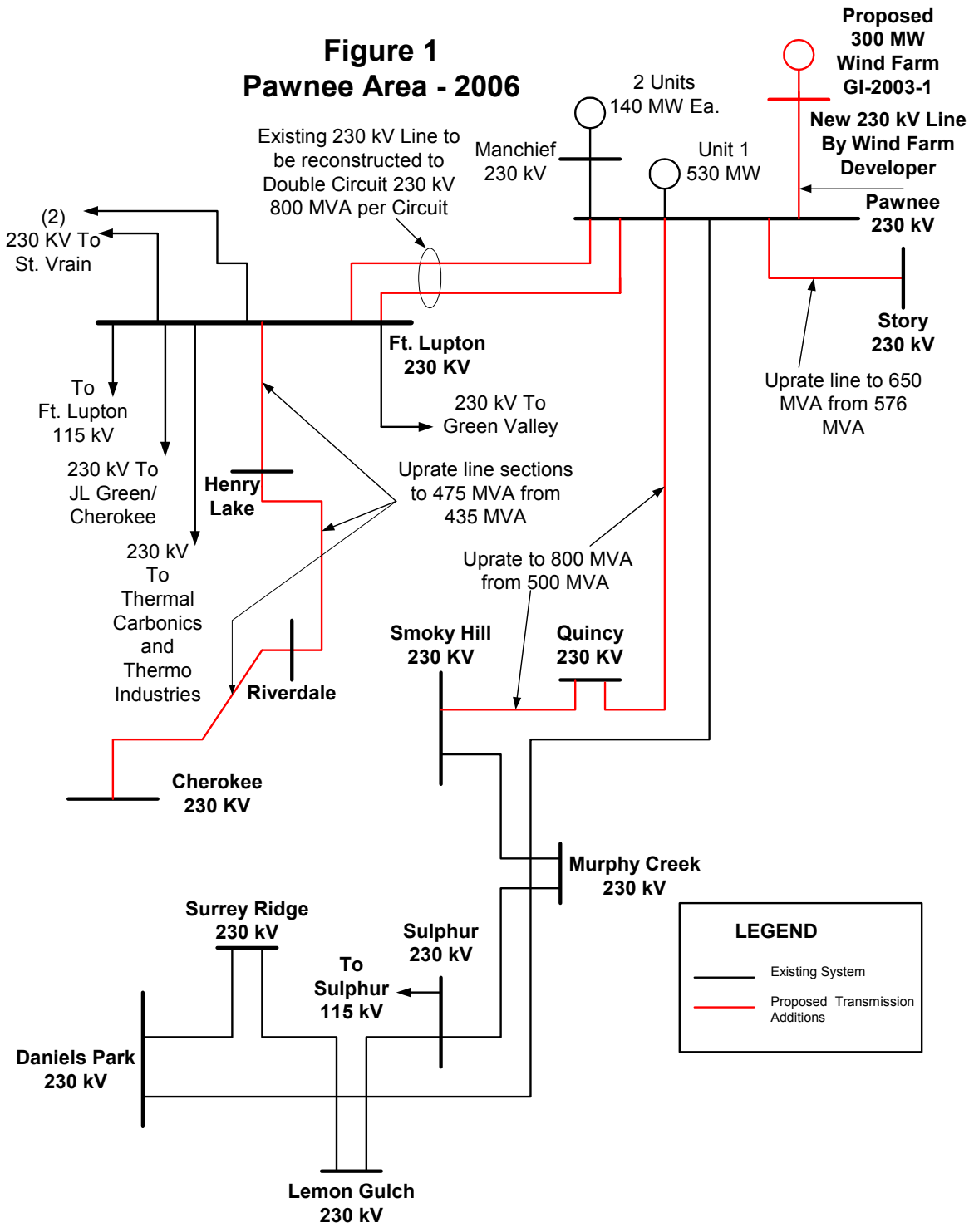
Executive Summary

This Interconnection System Impact Study Report summarizes the analyses performed by the Transmission Planning group of Public Service Company of Colorado (PSCo) to interconnect 300 MW of wind powered generation (200 1.5 MW units) located near Brush, Colorado to the Pawnee Station 230 kV bus. The Customer proposed in-service date for commercial operation of the 300 MW facility is December 1, 2006, with a 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.

Energy Resource:
As an Energy Resource, an interconnected generator is only eligible to deliver on an "as available" basis using the existing capacity of the transmission system. This study indicated that the proposed project could inject up to 50 MW at Pawnee Station without requiring any additional Network Upgrades, depending on regional generation patterns and TOT 3 path flow. The estimated cost of the PSCo Network Upgrades associated with an Interconnection for an Energy Resource is $730,000. The time frame to get the interconnection constructed for the generation addition would be approximately 9 months from the signing of an Interconnection Agreement (IA).

Network Resource:
For the Project to be considered a Network Resource, studies indicate that the integration of the full 300 MW of new generation would require transmission additions and modifications in order to prevent unacceptable conditions on the regional system. The estimated cost for Network Upgrades associated with delivery is $44.7 Million. Therefore, the total estimated cost of the Network Upgrades associated with the interconnection and delivery of the 300 MW facility is $45.4 Million and the estimated time frame to construct those upgrades is a minimum of 27 months from the signing of the IA.

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



Introduction

On October 21, 2003 Xcel Energy Transmission received a request to conduct a feasibility study that would evaluate the integration of a 300 MW wind power generating facility in Morgan County, Colorado. The approximate location of the interconnection is approximately 9 miles northwest of the town of Brush, Colorado. The Customer proposed in-service date for commercial operation of the facility is December 1, 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 March 2004. An Interconnection System Impact Study Agreement was executed on or around April 21, 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. As per section 7.3 of the FERC LGIP, the Study considered the Base Case as well as all Generating Facilities (and with respect to (iii), any identified Network Upgrades) that, on the date the Interconnection Feasibility Study is commenced:

(i) are directly interconnected to the Transmission System;
(ii) are interconnected to Affected Systems and may have an impact on the Interconnection Request;
(iii) that have a pending higher queued Interconnection Request to interconnect to the Transmission System; and
(iv) have no Queue Position but have executed an LGIA or requested that an unexecuted LGIA be filed with FERC.

For this study, there were no higher queued requests to consider.

The Study consisted of power flow, short circuit, and dynamic stability analyses. The power flow analysis provided an identification of any 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 provided a preliminary identification of any 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.

Powerflow Study Models

For this analysis, a power flow model was developed to reflect 2006 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 a high level of over 1500 MW, and power transfers from north to south through Colorado were increased to study the regional transmission system[1].

The proposed project was modeled as two 150 MW units. 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 with a single 230kV line, approximately 18 miles long. As an NR request, the proposed generation was scheduled to PSCo peaking units located in and around Denver.

Study Results

Power Flow Analysis

At the request of the Customer, the Project was evaluated as both a Network Resource (NR) and as an Energy Resource (ER) with the power going to PSCo customers.

Energy Resource

Two cases were developed to model the TOT 3 transfer path at a two different flow levels. For the first case, with TOT 3 at 1540 MW, results showed that the wind project could not inject any amount of power into the PSCo transmission system unless additional Network Upgrades are constructed. The other case modeled the TOT 3 flow at 1145 MW. At that level, results indicated that the project could inject 50 MW into the PSCo system. Therefore, the amount that the wind project can inject into the PSCo is directly related to the loading of the TOT 3 interface. Contingency results for the ER analysis are shown in Table 1.

[1] 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 1535 MW. The 2004 summer transfer limit for that path is approximately 1540 MW.

Table 1 Power Flow Contingency Results for Energy Resource

								CASE	case: 06c1a.sav; TOT 3 =1145 MW TOT 7=363 MW, BRUSH WIND @ 0 MW	case: 06c1.sav; TOT 3 =1145 MW TOT 7=363 MW, BRUSH WIND @ 50 MW							
LOADED ELEMENT											CONTINGENCY						
----- #	FROM BUS --name--	---- -kv-	zon	---- #	TO BUS --name--	-kv-	---- ID	rating [MVA]	cont load	cont load	----- #	FROM BUS --name--	---- -kv-	---- #	TO BUS --name--	-kv-
73015	B.CK TRI	115	752	73020	BEAVERCK	115	1	200	97%	100%	73013	B.CK PS	115	73020	BEAVERCK	115
73020	BEAVERCK	115	752	73464	ADENA	115	1	109	98%	99%	73305	EFMORGTP	115	73379	FMWEST	115
73009	ARCHER	230	753	73190	STEGALL	230	1	400	99%	100%	73012	AULT	345	73108	LAR.RIVR	345
70444	VALMONT	115	703	70447	VALMONT	230	1	280	100%	100%	70266	LOOKOUT	230	70570	PLNENDSS	230
70192	FTLUPTON	230	706	70311	PAWNEE	230	1	413.5	90%	94%	70311	PAWNEE	230	70343	QUINCY	230

As shown above in Table 1, the 50 MW injection limit was established by modeling heavy north to south flows in the region and a mid-level flow on TOT 3. The limiting contingency was an outage of the PSCo 115 kV line from PSCo's Beaver Creek Substation to Western's Beaver Creek Substation. That contingency loaded the parallel Tri-State Beaver Creek 115 kV line to 100% of its flow limit (case 06c1 in Table 1). Higher TOT 3 flows will result in lower delivery capability.

Network Resource

By modeling the proposed project at 300 MW and a high TOT 3 flow of 1535 MW, studies revealed contingency overloads. Some sensitivity studies were performed to analyze other generation dispatch scenarios and those scenarios revealed similar contingency overloads. A table of contingency results is provided in Appendix B. To alleviate the overloads and accommodate the full 300 MW of generation, the following upgrades were required:

- 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.

TOT 3 Analysis

TOT 3 analysis was performed by the Western Area Power Administration (Western). The results show that integrating the Brush 300 MW Wind Farm with the transmission infrastructure required for delivery will not have any adverse impact on the TOT 3 limit. The detailed report on the analysis of TOT 3 is available upon request.

Short Circuit Study Results

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 in Tables 2, 3, and 4. 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. Plots and detailed analysis are available upon request

Table 2

Fault	Description	Fault Current (kA, RMS)		
		1 cycle	3 cycles	6 cycles
2	LLLG Fault at Fort Lupton 230	25.95	24.34	22.38
3	LLLG Fault at Story 230	13.80	12.72	11.57
4	LLLG Fault at Daniel Park 230	27.15	26.93	26.71
5	LLLG Fault at Quincy 230	13.43	13.25	13.14
6	LLLG Fault at Pawnee 230	16.86	14.97	10.85
8	SLG Fault at Fort Lupton 230	18.41	18.34	18.04
9	SLG Fault at Story 230	11.73	11.50	11.32
10	SLG Fault at Daniel Park 230	25.78	25.52	25.42
11	SLG Fault at Quincy 230	9.65	9.47	9.40
12	SLG Fault at Pawnee 230	19.21	18.39	16.75

Table 2: PSCAD Short Circuit Study Results
(Case 1: Base Case, no network upgrades and Brush Wind not in service)

Table 3

Fault	Description	Fault Current (kA, RMS)		
		1 cycle	3 cycles	6 cycles
1	LLLG Fault at Brushwind 230	8.68	7.80	6.28
2	LLLG Fault at Fort Lupton 230	25.23	23.96	22.00
3	LLLG Fault at Story 230	13.41	12.77	10.96
4	LLLG Fault at Daniel Park 230	27.24	26.62	26.53
5	LLLG Fault at Quincy 230	13.37	13.13	13.01
6	LLLG Fault at Pawnee 230	16.68	14.23	9.36
7	SLG Fault at Brushwind 230	7.29	7.18	7.02
8	SLG Fault at Fort Lupton 230	18.62	18.17	17.88
9	SLG Fault at Story 230	12.03	11.76	11.43
10	SLG Fault at Daniel Park 230	25.78	25.37	25.32
11	SLG Fault at Quincy 230	9.55	9.33	9.32
12	SLG Fault at Pawnee 230	19.64	18.47	16.49

Table 3: PSCAD Short Circuit Study Results
(Case 2: No Network Upgrades and 300MW Brush Windfarm in Service)

Table 4

Fault	Description	Fault Current (kA, RMS)		
		1 cycle	3 cycles	6 cycles
1	LLLG Fault at Brushwind 230	8.94	8.11	6.90
2	LLLG Fault at Fort Lupton 230	26.32	24.88	22.62
3	LLLG Fault at Story 230	13.43	12.57	11.27
4	LLLG Fault at Daniel Park 230	26.62	26.10	25.77
5	LLLG Fault at Quincy 230	13.44	13.18	13.01
6	LLLG Fault at Pawnee 230	17.71	15.33	10.73
7	SLG Fault at Brushwind 230	7.44	7.31	7.17
8	SLG Fault at Fort Lupton 230	19.71	19.24	18.93
9	SLG Fault at Story 230	11.95	11.53	11.34
10	SLG Fault at Daniel Park 230	25.38	24.94	24.84
11	SLG Fault at Quincy 230	9.63	9.38	9.36
12	SLG Fault at Pawnee 230	20.84	19.72	17.92

Table 4: PSCAD Short Circuit Study Results
(Case 3: Network Upgrades Included, 300MW Brush Wind Farm in service)

Stability Study Results

Transient stability analysis of the Pawnee area was 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 are shown in Table 5. Plots of the stability analysis are available upon request.

TOT 3 Analysis

Western performed TOT 3 stability analysis 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 300 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 Table 5a. Plots of the TOT 3 stability analysis are available upon request.

Table 5 Summary of Transient Stability Results

Fault	Transient Stability Fault List	Bus From	Bus To	Fault Cases		
				Case 1	Case 2	Case 3
S1	3-Phase Fault midway between Brushwind and Pawnee; Clear after 6 cycles	70600	70311	N/A	*Wind Farm Trip	*Wind Farm Trip
S2	3-Phase Fault midway between Story and Pawnee; Clear after 6 cycles	73192	70311	No Trip	†Wind Farm Trip	†Wind Farm Trip
S3	3-Phase Fault midway between Fort Lupton and Pawnee; Clear after 6 cycles	70192	70311	No Trip	No Trip	No Trip
S4	3-Phase Fault midway between Daniel Park and Pawnee; Clear after 6 cycles	70139	70311	No Trip	No Trip	No Trip
S5	3-Phase Fault midway between Pawnee and Quincy (one cct); Clear after 6 cycles	70311	70343	No Trip	No Trip	No Trip
S6	3-Phase Fault at Pawnee 22kV Bus; Generator trip or disconnect after 3 cycles	70311	-	No Trip	No Trip	No Trip
S7	Sudden Loss of Power due to Wind Gust at new Brushwind Site	-	-	N/A	No Trip	No Trip

† Wind Farm Trips on dV = -0.7 pu, no LVRT; Machine bus voltage remains above 0.15pu
* Wind Farm Trips on dV = -0.7 pu, no LVRT; Machine bus voltage falls to zero

The transient stability cases are as follows:

Case 1 is the base case before the wind project is added.
Case 2 has the wind project and without any required delivery infrastructure.
Case 3 has the wind project and the required delivery infrastructure.

Table 5a Summary of Transient Stability Results for TOT 3

Fault Location	Open	From Bus	To Bus	Case	Result
3-phase at LRS 345	Open LRS-Ault 345 kV	73108	73012	Base Case without Generation Addition	System Stable Volt Dip at Laramie 115 kV to 0.67 p.u
3-phase at LRS 345	Open LRS-Ault 345 kV	73108	73012	Paw-Ft Lupt double Ckt 230 kV Added.	System Stable Volt Dip at Laramie 115 kV to 0.74 p.u.
3-phase at LRS 345	Open LRS-Ault 345 kV	73108	73012	Wind Farm and Paw-Ft. Lupt. Dbl Ckt added.	System Stable Volt Dip at Laramie 115 kV to 0.72 p.u.

Cost Estimates and Assumptions

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:
Table 6 describes the costs associated with providing an interconnection to PSCo's system. It does not include all of the costs required for full delivery of the generation. Those costs are included in Table 7.

Table 6 PSCo Network Upgrades Required for Interconnection

PSCo Interconnection Facilities

Substation	**Description**	**Cost**
Pawnee Generation 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: • a new 230 kV 3000 A, 50 kA circuit breaker • 230 kV bi-directional revenue metering • two 230 kV switches • required steel supporting structures • associated control and relaying changes and additions. (See one-line in Appendix D)	$660k
	1. Transmission line relocation	**$50k**
	2. Siting and Land Rights for misc. permits	**$20k**
	3. Total Cost	**$730k**

PSCo Network Upgrades required to deliver the proposed 300 MW as an NR Request:
Table 7 lists the costs associated with developing the transmission system in order to deliver the full 300 MW of generation. The cost of the Network Delivery facilities is the additional change in cost between Interconnection and Delivery.

Table 7 PSCo Network Upgrades Required for Power Delivery

	Description	**Cost**
Pawnee Station	New 230 kV Line terminal to Ft. Lupton requiring the following equipment:	$1,430k

	• one new 230 kV breaker and half bay on the west side of the 230 kV switch yard • two (2) 3000 Amp, 50 kA circuit breakers • four (4) 230 kV switches • associated steel • electrical bus work • associated metering, control, and relaying Uprate the 230 kV line from Pawnee to Story requires the following: • replace four (4) 230 kV 1600 Amp switches with 3000 Amp switches Uprate the Pawnee to Smoky Hill 230 kV line requires the following: • 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: • 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: • 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	$1,060k

	kCMIL strain buses with 5” aluminum tube bus • associated metering, control, and relaying	
Riverdale	Replace equipment jumpers and transmission line jumpers.	$65k
Quincy Substation	Replace existing 1200 Amp line-rupters with 2000 Amp line rupters	$310k
Cherokee	• 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
	Uprate the existing Pawnee to Quincy/Smoky Hill 230kV Line to 800 MVA from 500 MVA by installing approximately 15 phase raisers.	$210k
	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	**$44,685k**
Time Frame		**27 Months**

Total costs for Network Upgrades for Interconnection and Delivery Costs = $45,425,000

Major Assumptions for Cost Estimates

1. PSCo (or its contractor) crews will perform all construction and wiring associated with PSCo-owned and maintained equipment.

2. A Certificate for Convenience and Public Necessity (CCPN) will be required for the transmission line.
3. Any NEPA requirements imposed on transmission because of the generation addition will most likely have adverse effects on schedule and deliverables.
4. No screening has been estimated at any of the substations. If this is required the cost will be significant at each location.
5. Detailed field investigations (surveys, etc.) have not been conducted and could increase these estimates.
6. Approximately 5 miles of new transmission line ROW acquisition is assumed for Network Delivery related facilities, since existing ROW will be utilized. The Customer Interconnection requires new ROW.
7. These estimates do not include any cost for legal fees.
8. All necessary transmission line outages can be obtained. If not, construction duration times will be longer.
9. All cost estimates have been escalated to reflect the appropriate year of project activity.

The overall timeline to complete all required transmission and substation facilities is expected to require a minimum of 27 months. If there are problems with local and state approvals, this could require an additional year.

APPENDIX A
PSCo Generation Interconnection Request Queue

GENERATION INTERCONNECTION REQUESTS
September 1, 2004

Queue Number	Date Received	Generation Type	Service Type	Location County/State	Interconnection Point Station or Line	Net Plant Max MW Sum	Win	In-Service Date	Comments/Status/Reason not Completed
GI-2003-1	10/21/2003	Wind	Network Resource	Morgan Co., CO	Pawnee Substation	300	300	12/1/2006	Feasibility Study complete System Impact Study underway
GI-2003-2	11/3/2003	Coal	Network +Energy Resource	Elbert Co., CO	Smokey Hill-Pawnee 230kV line	500	500	6/1/2008	Feasibility Study complete System Impact Study complete Facilities Study underway
GI-2003-3	11/7/2003	Coal	Network Resource	Pueblo Co., CO	Comanche Substation	750	750	10/1/2009	Feasibility Study complete System Impact Study complete Facilities Study underway
GI-2003-4	11/11/2003	Wind	Network +Energy Resource	Laramie Co., WY	Ponnequin Substation	30	30	Q2:2004	Feasibility Study complete System Impact Study complete
GI-2003-5	12/29/2003	Coal	Network Resource	Morgan Co., CO	Pawnee Substation	750	750	10/1/2009	Request withdrawn 2/20/04
GI-2004-1	1/19/2004	Wind	Network +Energy Resource	Morgan Co., CO	Pawnee Substation	150	150	12/31/2005	Feasibility Study complete
GI-2004-2	2/9/2004	Wind	Network +Energy Resource	Baca Co., CO	Lamar Substation	238	238	9/31/2005	Feasibility Study complete
GI-2004-3	7/16/2004	Wind	Network +Energy Resource	Weld Co., CO	Ault Substation	275	275	12/31/2006	Feasibility Study underway
GI-2004-4	8/9/2004	Wind	Network +Energy Resource	Prowers Co., CO	Lamar Substation	280	280	12/31/2006	
GI-2004-5	8/16/2004 9:05am	Wind	Network +Energy Resource	Weld Co., CO	Fort St. Vrain-Green Valley 230kV Line	402	402	12/30/2006	
GI-2004-6	8/16/2004 9:05am	Wind	Network +Energy Resource	Washington Co., CO	Story Substation	250	250	12/30/2006	
GI-2004-7	8/20/2004 10:25am	Wind	Network +Energy Resource	Elbert Co., CO	Midway-Daniels Park 230kV Line	200	200	12/1/2006	

APPENDIX B

POWER FLOW CONTINGENCY RESULTS

								Case	2006 HS Base Case TOT 3=1535, TOT7=634 MW, (6b.sav)	Base with 300 MW Wind TOT 3 = 1517 MW TOT 7 = 675 MW (6e.sav)	300 MW with 2 Paw-Ft. Lup lines, TOT 3 = 1530 MW TOT7 = 572 MW, (06-fix.sav)	300 MW with 2 Paw-Ft. Lup lines TOT3=1455 MW, TOT7=525 MW, (06-fix-r1.sav)	Base with 300 MW Wind (6e-r1.sav) TOT 3 = 1431 MW TOT 7 = 621 MW	Base Case (6b-r1.sav) TOT 3=1470 TOT 7 = 592						
FROM				TO				rating	cont	cont	cont	cont	cont	cont		From	CONTINGENCY		To	-	
BUS #	--name--	-kv-	ZONE	BUS #	--name--	-kv-	ID	[MVA]	load	load	load	load	load	load	Cnt #	BUS #	--name--	-kv-	BUS #	--name--	-kv-
73031	BRUSHTAP	115	752	73305	EFMORGTP	115	1	121.7	125%	130%	109%	107%	128%	114%	245	73020	BEAVERCK	115	73464	ADENA	115
70192	FTLUPTON	230	706	70311	PAWNEE	230	1	413.5	100%	126%	<90%	<90%	123%	99%	129	70311	PAWNEE	230	70343	QUINCY	230
70192	FTLUPTON	230	706	70311	PAWNEE	230	1	413.5	<90%	<90%	<90%	<90%	118%	96%	233	73012	AULT	345	73108	LAR.RIVR	345
73031	BRUSHTAP	115	752	73305	EFMORGTP	115	1	121.7	125%	132%	113%	110%	136%	121%	233	73012	AULT	345	73108	LAR.RIVR	345
73009	ARCHER	230	753	73190	STEGALL	230	1	400	123%	125%	118%	110%	122%	117%	233	73012	AULT	345	73108	LAR.RIVR	345
73023	BIJOUTAP	115	752	73379	FMWEST	115	1	80	112%	122%	94%	<90%	126%	111%	233	73012	AULT	345	73108	LAR.RIVR	345
73192	STORY	230	752	70311	PAWNEE	230	1	576	101%	<90%	113%	105%	<90%	95%	233	73012	AULT	345	73108	LAR.RIVR	345
73020	BEAVERCK	115	752	73031	BRUSHTAP	115	1	160	101%	106%	92%	<90%	109%	98%	233	73012	AULT	345	73108	LAR.RIVR	345
73044	COBBLKTP	115	754	73201	TIMNTHTP	115	1	85.1	100%	105%	93%	<90%	97%	93%	233	73012	AULT	345	73108	LAR.RIVR	345
73020	BEAVERCK	115	752	73464	ADENA	115	1	109	99%	106%	<90%	<90%	109%	98%	233	73012	AULT	345	73108	LAR.RIVR	345
73088	HOYT	115	752	73464	ADENA	115	1	109	97%	104%	<90%	<90%	107%	95%	233	73012	AULT	345	73108	LAR.RIVR	345
73305	EFMORGTP	115	752	73379	FMWEST	115	1	121	97%	102%	<90%	<90%	106%	96%	233	73012	AULT	345	73108	LAR.RIVR	345
73030	BRIGHTNW	115	752	73493	SANDCRK	115	1	85.1	95%	104%	<90%	<90%	106%	93%	233	73012	AULT	345	73108	LAR.RIVR	345
73180	SIDNEY	230	756	73181	SIDNEYDC	230	1	240	93%	DNS	93%	96%	105%	95%	233	73012	AULT	345	73108	LAR.RIVR	345
73145	"NUNN "	115	754	73552	"AULT "	115	1	85.1	<90%	110%	100%	94%	105%	101%	233	73012	AULT	345	73108	LAR.RIVR	345
73024	"BLKHLWTP"	115	754	73552	"AULT "	115	1	85.1	106%	110%	100%	93%	104%	101%	233	73012	AULT	345	73108	LAR.RIVR	345
73024	BLKHLWTP	115	754	73044	COBBLKTP	115	1	85.1	<90%	107%	<90%	90%	101%	98%	233	73012	AULT	345	73108	LAR.RIVR	345
73013	B.CK PS	115	706	73020	BEAVERCK	115	"1 "	319	<90%	<90%	<90%	<90%	105%	<90%	233	73012	AULT	345	73108	LAR.RIVR	345
73015	B.CK TRI	115	752	73020	BEAVERCK	115	1	200	108%	124%	101%	100%	122%	107%	234	73013	B.CK PS	115	73020	BEAVERCK	115

								Case	2006 HS Base Case TOT 3=1535, TOT7=634 MW, (6b.sav)	Base with 300 MW Wind TOT 3 = 1517 MW TOT 7 = 675 MW (6e.sav)	300 MW with 2 Paw-Ft. Lup lines, TOT 3 = 1530 MW TOT7 = 572 MW, (06-fix.sav)	300 MW with 2 Paw-Ft. Lup lines TOT3=1455 MW, TOT7=525 MW, (06-fix-r1.sav)	Base with 300 MW Wind (6e-r1.sav) TOT 3 = 1431 MW TOT 7 = 621 MW	Base Case (6b-r1.sav) TOT 3=1470 TOT 7 = 592							
-----	FROM	----		----	TO		----	rating	cont	cont	cont	cont	cont	cont		From	CONTINGENCY		To	---------	----
BUS #	--name--	-kv-	ZONE	BUS #	--name--	-kv-	ID	[MVA]	load	load	load	load	load	load	Cnt #	BUS #	--name--	-kv-	BUS #	--name--	-kv-
73023	BIJOUTAP	115	752	73379	FMWEST	115	1	80	112%	123%	94%	<90%	<90%	<90%	245	73020	BEAVERCK	115	73464	ADENA	115
73043	CHEYENNE	115	753	73480	CROWCRK	115	1	80	117%	119%	116%	116%	118%	117%	221	73008	ARCHER	115	73043	CHEYENNE	115
70396	SMOKYHIL	230	700	70283	MEADOWHL	230	1	434.6	111%	117%	117%	114%	113%	114%	153	70396	SMOKYHIL	230	70067	BUCKLEY1	230
73179	SIDNEY	115	756	73180	SIDNEY	230	1	167	118%	116%	119%	115%	112%	114%	379	73143	N.YUMA	230	73180	SIDNEY	230
70444	VALMONT	115	703	70447	VALMONT	230	1	280	110%	114%	116%	115%	112%	108%	118	70266	LOOKOUT	230	70570	PLNENDSS	230
73020	BEAVERCK	115	752	73464	ADENA	115	1	109	<90%	110%	<90%	<90%	110%	<90%	514	73305	EFMORGTP	115	73379	FMWEST	115
73015	B.CK TRI	115	752	73016	B.CK TRI	230	1	224	<90%	109%	101%	<90%	107%	94%	234	73013	B.CK PS	115	73020	BEAVERCK	115
73088	HOYT	115	752	73464	ADENA	115	1	109	<90%	108%	<90%	<90%	107%	<90%	514	73305	EFMORGTP	115	73379	FMWEST	115
70395	SMOKYHIL	115	700	70396	SMOKYHIL	230	2	168	101%	107%	105%	105%	106%	106%	621	70395	SMOKYHIL	115	70396	SMOKYHIL	230
73020	BEAVERCK	115	752	73031	BRUSHTAP	115	1	160	101%	105%	<90%	<90%	<90%	<90%	245	73020	BEAVERCK	115	73464	ADENA	115
73011	AULT	230	754	70474	WINDSOR	230	1	495	100%	104%	94%	<90%	98%	95%	567	70471	WELD PS	230	73212	WELD LM	230
73305	EFMORGTP	115	752	73379	FMWEST	115	1	121	<90%	104%	<90%	<90%	<90%	<90%	524	73413	MIDWAYBR	230	73531	LINCOLNT	230
70108	CHEROKEE	115	700	70154	DERBY 2	115	1	135	112%	102%	104%	102%	100%	111%	37	70108	CHEROKEE	115	70153	DERBY 1	115
70471	WELD PS	230	706	70410	ST.VRAIN	230	1	500	97%	102%	<90%	101%	95%	92%	568	73011	AULT	230	70474	WINDSOR	230

								Case	2006 HS Base Case TOT 3=1535, TOT7=634 MW, (6b.sav)	Base with 300 MW Wind TOT 3 = 1517 MW TOT 7 = 675 MW (6e.sav)	300 MW with 2 Paw-Ft. Lup lines, TOT 3 = 1530 MW TOT7 = 572 MW, (06-fix.sav)	300 MW with 2 Paw-Ft. Lup lines TOT3=1455 MW, TOT7=525 MW, (06-fix-r1.sav)	Base with 300 MW Wind (6e-r1.sav) TOT 3 = 1431 MW TOT 7 = 621 MW	Base Case (6b-r1.sav) TOT 3=1470 TOT 7 = 592						
FROM				TO				rating	cont	cont	cont	cont	cont	cont		From	CONTINGENCY		To		
BUS #	--name--	-kv-	ZONE	BUS #	--name--	-kv-	ID	[MVA]	load	load	load	load	load	load	Cnt #	BUS #	--name--	-kv-	BUS #	--name--	-kv-
73013	B.CK PS	115	706	73020	BEAVERCK	115	1	319	<90%	102%	<90%	<90%	<90%	<90%	129	70311	PAWNEE	230	70343	QUINCY	230
70108	CHEROKEE	115	700	70153	DERBY 1	115	1	135	111%	101%	103%	101%	99%	109%	38	70108	CHEROKEE	115	70154	DERBY 2	115
73078	HARMONY	230	754	73199	TIMBERLN	230	1	472.1	99%	101%	96%	93%	97%	96%	567	70471	WELD PS	230	73212	WELD LM	230
73145	NUNN	115	754	73552	AULT	115	1	85.1	107%	101%	91%	<90%	<90%	<90%	226	73009	ARCHER	230	73011	AULT	230
65425	DAVEJOHN	115	679	73071	GLENRCKS	115	1	109	101%	101%	92%	99%	100%	99%	560	65425	DAVEJOHN	115	73070	GLENRCKN	115
73024	BLKHLWTP	115	754	73552	AULT	115	1	85.1	106%	101%	101%	<90%	<90%	<90%	226	73009	ARCHER	230	73011	AULT	230
73011	AULT	230	754	73212	WELD LM	230	2	442.2	98%	100%	94%	90%	95%	94%	231	73011	AULT	230	73212	WELD LM	230
73011	AULT	230	754	73212	WELD LM	230	1	442.2	98%	100%	94%	90%	95%	94%	232	73011	AULT	230	73212	WELD LM	230
70313	ORCHARD	230	700	70283	MEADOWHL	230	1	434.6	95%	100%	101%	97%	96%	92%	153	70396	SMOKYHIL	230	70067	BUCKLEY1	230
70191	FTLUPTON	115	706	70192	FTLUPTON	230	1	280	92%	100%	107%	105%	98%	91%	178	70447	VALMONT	230	70410	ST.VRAIN	230
73104	LAGRANGE	115	753	73189	STEGALL	115	1	121.7	96%	100%	94%	<90%	<90%	92%	227	73009	ARCHER	230	73190	STEGALL	230
70192	FTLUPTON	230	706	70605	HENRYLAK	230	1	435	92%	99%	109%	107%	97%	91%	81	70192	FTLUPTON	230	70529	JLGREEN	230
73113	LNGMNTNW	115	754	73133	MEADOW	115	1	110.2	100%	99%	102%	102%	99%	101%	360	73115	LONGPEAK	115	73196	TERRY	115
70354	RIDGE	115	700	70355	RIDGE	230	2	100	111%	98%	101%	104%	99%	111%	619	70354	RIDGE	115	70355	RIDGE	230
70610	REUNION	230	700	70047	BARRLAKE	230	1	434.6	90%	98%	100%	99%	96%	96%	82	70192	FTLUPTON	230	70605	HENRYLAK	230
70470	WELD PS	115	706	70471	WELD PS	230	2	150	99%	95%	101%	<90%	95%	98%	677	73211	WELD LM	115	73212	WELD LM	230
70073	CALIFOR1	115	700	70299	NORTH542	115	1	150	107%	94%	<90%	98%	96%	<90%	27	70087	CAPHILL1	115	70215	HARRISPS	115
70605	HENRYLAK	230	706	70362	RIVERDAL	230	1	435	<90%	94%	104%	102%	92%	<90%	81	70192	FTLUPTON	230	70529	JLGREEN	230
70087	CAPHILL1	115	700	70300	NORTH547	115	1	150	105%	91%	94%	94%	91%	<90%	23	70073	CALIFOR1	115	70299	NORTH542	115
73013	B.CK PS	115	706	73020	BEAVERCK	115	1	319	101%	101%	101%	99%	<90%	99%	573	73192	STORY	230	70311	PAWNEE	230
73020	BEAVERCK	115	752	73031	BRUSHTAP	115	1	160	<90%	<90%	101%	97%	<90%	<90%	575	73192	STORY	230	70311	PAWNEE	230