Final – Scenario A
Feasibility Study Report
Request # GI-2007-1

675 MW Integrated Gasification Combined Cycle (IGCC)
Facility in Morgan County, Colorado

PSCo Transmission Planning
May 31, 2007

Executive Summary

PSCo Transmission received a generation request to determine the feasibility of interconnecting 675 MW of new Customer IGCC plant into the PSCo transmission system at a future Pawnee Station 345 kV bus. The Customer proposed commercial operation date is May 2014 with an assumed back feed date of September 2012. This request was studied as a Network Resource (NR)[1]. The request was studied as a stand-alone project only.

Stand Alone Results

Network Resource:
PSCo evaluated the network to determine the upgrades required to deliver the full 675 MW of the IGCC facility to PSCo native load customers. Two alternatives have been recommended.

Alternative 1

The total estimated cost of the recommended system upgrades to accommodate the project for Alternative 1 is approximately **$101.71** million and includes:

- $ 0.85 million for PSCo-Owned, Customer Funded Interconnection Facilities
- $7.40 million for PSCo Network Upgrades for Interconnection
- $93.46 million for PSCo Network Upgrades for Delivery

These basic upgrades including interconnection as shown in Figure 1 would consist of:

- Constructing a new 115-mile 345 kV line from Pawnee to Daniels Park Substation. The new transmission can be described in three sections:

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

  - The first section consists of 80-miles of new 345 kV single circuit steel structures in new right of way from Pawnee and then join the existing PSCo transmission corridor near Brick Center Substation
  - Replace 15-miles of an existing single circuit line between Brick Center and Smoky Hill (part of the Pawnee-Daniels Park 230 kV line) with double circuit 345 kV capable structures. One side will operate at 230 kV to maintain the existing circuit. The other side will operate at 345 kV and make up the second section.
  - The final (third) section consists of constructing 20 miles of new 345 kV transmission from Smoky Hill to Daniels Park.
- Two 345/230 kV autotransformers at Pawnee
- One new 345 kV line termination at Daniels Park

A partial one-line of Pawnee Station detailing the Interconnection is shown in Figure 2.

Figure 1- Alternative 1 Transmission Network with Recommended Upgrades for Delivery

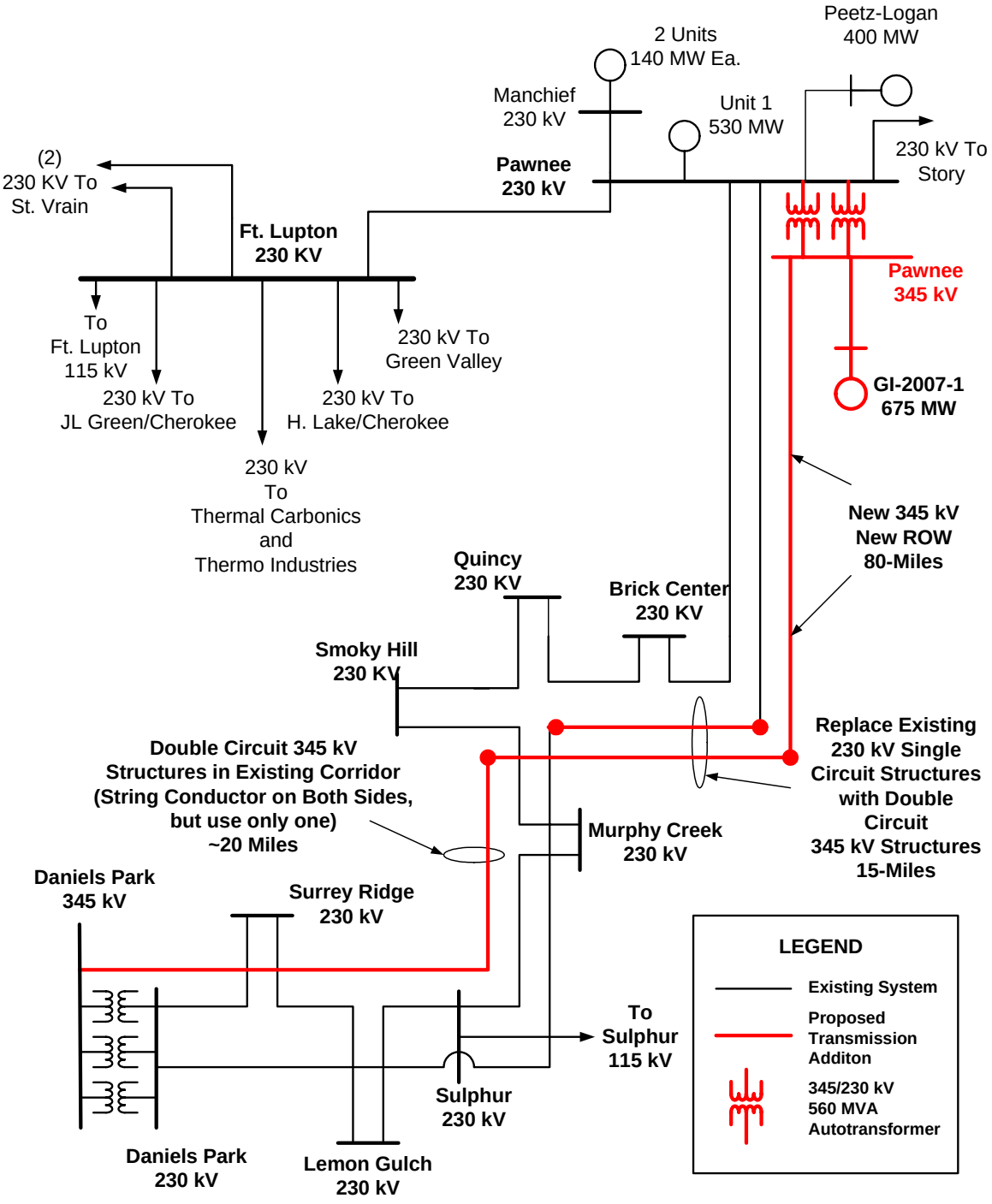
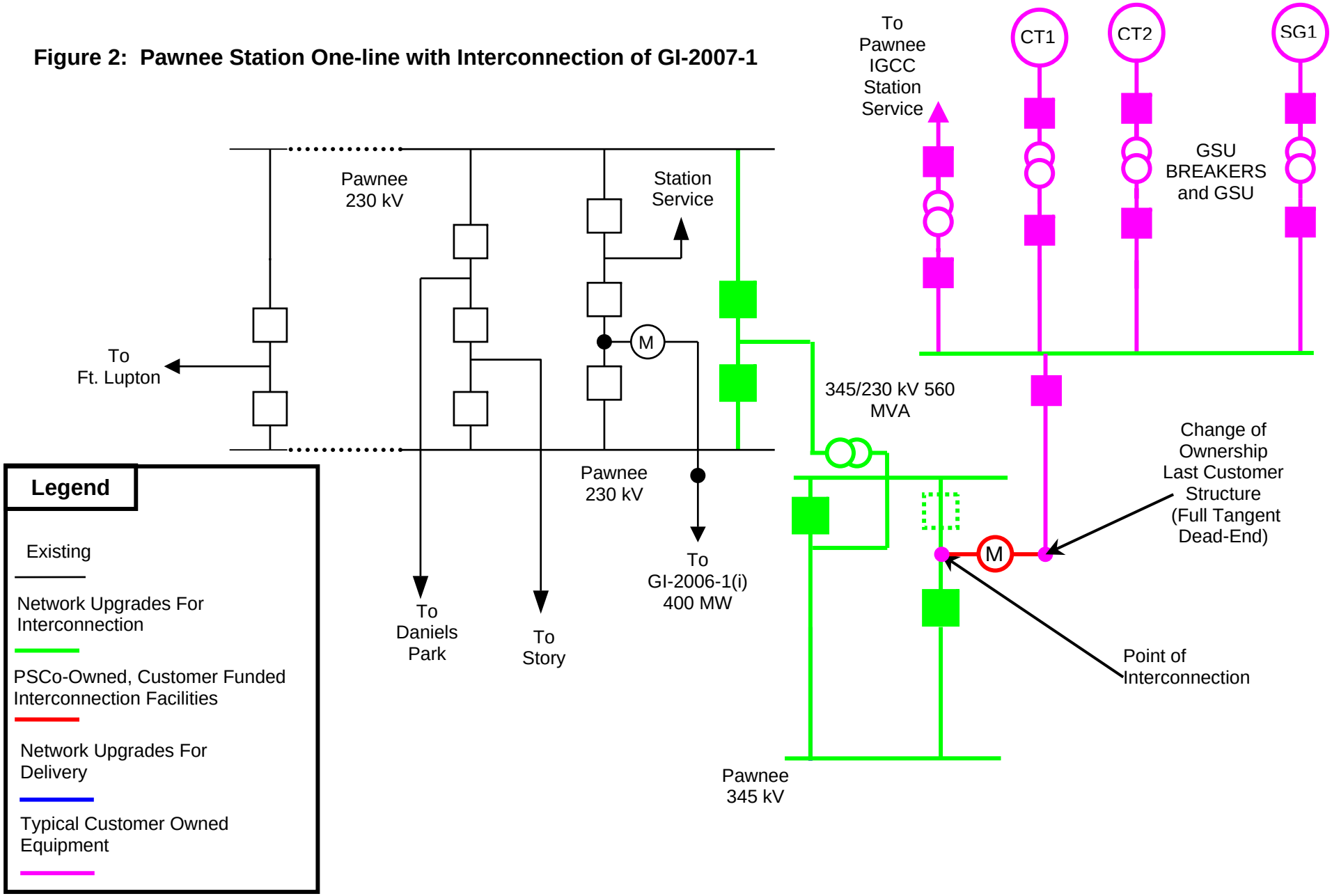


Figure 2: Pawnee Station One-line with Interconnection of GI-2007-1



The estimated time required to engineer, permit, and construct all the required PSCo facilities for interconnection is estimated to be 45 months. This time frame will achieve the requested back feed date of September 2012. The estimated time required to obtain a CPCN approval, engineer, permit, and construct the Network Upgrade facilities for delivery is 65 months concurrent with the interconnection. According to the interconnection request, the Customer will engineer, permit, construct, and finance all facilities up to the point of interconnection.

Alternative 2
The total estimated cost of the recommended system upgrades to accommodate the project for Alternative 2 is approximately **$123.76** million and includes:

- $ 0.85 million for PSCo-Owned, Customer Funded Interconnection Facilities
- $7.40 million for PSCo Network Upgrades for Interconnection
- $115.52 million for PSCo Network Upgrades for Delivery

These basic upgrades including interconnection as shown in Figure 3 would consist of:

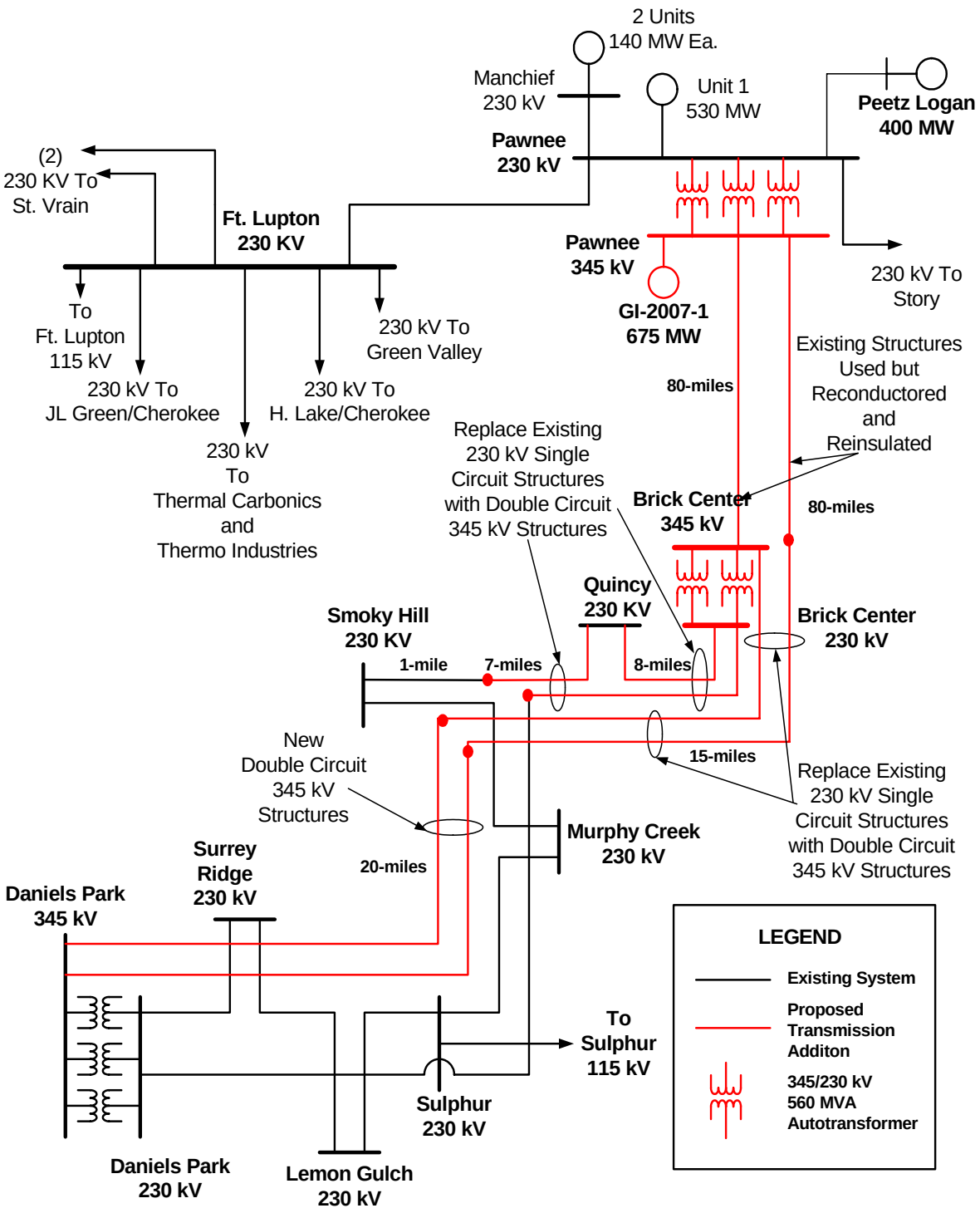
- Converting the existing 115-mile 230 kV line from Pawnee to Daniel Park Substation from 230 kV operation to 345 kV operation and converting the existing 80-mile 230 kV line from Pawnee to Brick Center Substation from 230 kV operation to 345 kV operation. This can be described in four sections:
    - The first section would re-insulate and reconductor 80 miles of the existing Pawnee to Brick Center 230 kV line and the parallel Pawnee to Daniels Park 230 kV line for 345 kV operation.
    - The second section would require rebuilding 15-miles of single circuit wood structures with double circuit 345 kV structures from Brick Center to just outside of Smoky Hill that currently make up the a portion of the Pawnee-Daniels Park 230 kV line.
    - The third section would require rebuilding 15-miles of single circuit wood structures and rebuild with double circuit 345 kV structures operated at 230 kV from Brick Center to just outside of Smoky Hill that currently make up the a portion of the Brick Center to Quincy/Smoky Hill 230 kV line. One circuit to continue on to Smoky Hill and the other to connect to the current double circuit structure that hold the existing Pawnee-Daniels Park 230 kV line making a Brick Center to Daniels Park 230 kV line
    - The fourth and final section requires constructing 20 miles of new double circuit 345 kV structures from just outside of Smoky Hill to Daniels Park utilizing the existing vacant corridor.
- Three 345/230 kV autotransformers at Pawnee
- Two 345/230 kV autotransformers at Brick Center and associated 230 kV yard expansion.
- Two 345 kV line terminations at Brick Center
- One New 230 kV line termination at Brick Center
- Two New 345 kV line terminations at Daniels Park

The Interconnection requirements for Alternate 2 would be the same as Figure 2.

The estimated time required to engineer, permit, and construct all the required PSCo facilities for interconnection is estimated to be 45 months. This time frame will achieve the requested back feed date of September 2012. The estimated time required to obtain a CPCN approval, engineer, permit, and construct the Network Upgrade facilities for delivery is 65 months concurrent with the interconnection. According to the interconnection request, the Customer will engineer, permit, construct, and finance all facilities up to the point of interconnection.

Additional details of the studies can be found under the Power Flow and Short Circuit sections.

Figure 3 **Alternative 2 Transmission Network with Recommended Upgrades for Delivery**



Study Scope and Analysis

The Interconnection Feasibility Study evaluated the transmission requirements associated with the proposed interconnection to the PSCo Transmission System. It consisted of power flow and short circuit analyses. The power flow analysis provided a preliminary identification of any thermal or voltage limit violations resulting for the interconnection, and for a NR request, a preliminary identification of network upgrades required to deliver the proposed generation to PSCo loads. The short circuit analysis identified any circuit breaker short circuit capability limits exceeded as a result of the Interconnection and for a NR request, the delivery of the proposed generation to PSCo loads.

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 nominal / 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 1.03 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.

Study Models

The power flow studies were based on a 2014 power flow case that was developed from the approved Western Electricity Coordinating Council (WECC) 2011 heavy summer base model. The loads were adjusted in the Rocky Mountain Region for the 2014 summer time frame. The Customer's 675 MW IGCC unit was modeled with Customer provided details and a +/-0.95 per unit (p.u.) power factor capability to simulate required VAR output. The project generation was dispatched to replace southern PSCo generation.

The Point of Interconnection (POI) between the Customer and PSCo is assumed to be the Pawnee Substation 345 kV bus. For the 345 kV interconnection, typical GSU transformer impedances were used for the Customer's equipment.

To evaluate the capabilities and system requirements for firm transfer levels, the power flow model was modified to simulate high TOT 3 path flows. Efforts were made to include in the models all transmission projects expected to be in service for the 2014 heavy summer season. The studies assumed 2014 peak summer demand conditions in the PSCo system and in other utility systems.

Power Flow Study Results and Conclusions

Network Resource (NR) Study Results

The NR study determined the network upgrades that would be required to accept the full 675 MW from the proposed generating plant for the conditions studied. At 675 MW of generation from the Customer, there were a number of contingency overloads. Appendix A shows the most significant contingencies and the associated overloads along with results from the benchmark case and with the Network Upgrades.

Studies indicated that if either of the proposed alternatives for Network Upgrades for Delivery are implemented for this project, there are no significant impacts to the TOT 3 transmission path. However, studies show that there exists the potential for minor impacts on the neighboring transmission system between Daniels Park and Brick Center. Additional transmission may be needed to address these impacts. These issues will be evaluated during the System Impact Study in coordination with the Affected Utilities.

Short Circuit Study Results

The study results are not yet complete. Once the fault study is completed, this report will be revised to reflect the fault study results.

The fault study will examine faults at Pawnee, Brick Center, Ft. Lupton and Daniels Park substations.

Costs Estimates and Assumptions

Alternative 1
The estimated total cost for the required upgrades for Alternative 1 is **$101,710,000.**

The estimated costs shown are “scoping” (+/-30%) estimates in 2007 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. This estimate does not include any costs for any Customer owned, supplied, and installed equipment and associated design and engineering. This estimate also does not include any costs that may be required for other entities’ systems. The following tables list the improvements required to accommodate the interconnection and the delivery of the Project. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to change upon more detailed analysis.

The estimated costs for interconnection are detailed in Tables 1 and Table 2. The customer is responsible for the construction of all facilities from the IGCC generating

station to the point of interconnection at Pawnee Station. Table 3 shows the detailed costs for Network Upgrades required for Firm Delivery.

Table 1 – PSCo Owned Customer Funded Interconnection Facilities

Element	Description	Cost Est. Millions
Pawnee Station	Interconnect Customer to tap PSCo's new 345 kV bus. The new equipment includes 345 kV bi-directional metering, relaying and associated equipment and material.	**$0.43**
	Transmission tie line into Pawnee Station.	**$0.25**
	Customer Generator Communication to Lookout	**$0.12**
	Customer Generator Witness Testing	**$0.02**
	Siting and Land Rights for required easements, reports, permits and licenses.	**$0.02**
	Total Cost Estimate for Customer Interconnection Facilities	**$0.85**

Table 2 – PSCo Network Upgrades for Interconnection

Element	Description	Cost Est. Millions
Pawnee Station	Interconnect Customer's generation into the new 345 kV Yard and tying the 345 kV yard into the existing 230 kV yard. The new equipment required includes: • Two new 345 kV 2000 A, 40 kA circuit breakers • Two 230 kV 3000 A, 40 kA, circuit breakers • One 345/230 kV 560 MVA autotransformer • Eight 345 kV switches • Four 230 kV switches • transmission line relaying and testing • required steel supporting structures and foundations	**$7.31**
Lookout Center	Communications with Plant	**$0.09**
	Total Cost Estimate for PSCo Network Upgrades for Interconnection	**$7.40**
Time Frame		**45 Months**

Table 3 – PSCo Network Upgrades for Delivery – Alternative 1

Element	Description	Cost Est. Millions
Pawnee Station	New 345 kV Line terminal to Daniels Park requiring the following equipment: • One 345 kV, 2000 Amp, 40 kA circuit breaker • One 345/230 kV 560 MVA autotransformer • Two 345 kV 2000 Amp gang switches • Two 230 kV 3000 Amp, 50 kA circuit breakers • Four 230 kV 3000 Amp gang switches • required steel and foundations • electrical bus work • metering, control, relaying and testing	**$6.11**

Element	Description	Cost Est. Millions
Daniels Park	New 345 kV Line Terminal to Pawnee. The following equipment will be required: • Two 345 kV 3000 Amp 50 kA circuit breakers • Six 345 kV 2000 Amp gang switches • required supporting steel and foundations • electrical bus work • metering, control, relaying, and testing	**$1.76**
Transmission	Add a new single circuit 345 kV line from Pawnee -Daniels Park. This includes: • Single Circuit 345 kV from Pawnee to just outside of Brick Center Switching Station including new ROW (80 –Miles). • Rebuild existing Pawnee-Daniels Park single circuit 230 kV line from Brick Center to outside of Smoky Hill (15-miles) to double circuit 345 kV line One side operated at 345 and the other operated at 230 kV for the Pawnee-Daniels Park line. • Construct new double circuit 345 kV line from just outside of Smoky Hill to Daniels Park utilizing existing ROW (20-miles). String both sides of double circuit tower.	**$80.15**
Siting and Permitting	Obtain necessary siting, permits, and ROW as required	**$5.45**
	Total Cost Estimate for PSCo Network Upgrades for Delivery	**$93.46**
	Total Cost of Project	**$101.71**
Time Frame		**65 Months**

Alternative 2

The estimated total cost for the required upgrades for Alternative 2 is **$123,760,000.**

The estimated costs shown are “scoping” (+/-30%) estimates in 2007 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. This estimate does not include any costs for any Customer owned, supplied, and installed equipment and associated design and engineering. This estimate also does not include any costs that may be required for other entities’ systems. The following tables list the improvements required to accommodate the interconnection and the delivery of the Project. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines. System improvements are subject to change upon more detailed analysis.

The estimated costs for interconnection are detailed in Table 4 and Table 5. The customer is responsible for the construction of all facilities from the generating IGCC station location to the point of interconnection at Pawnee Station. Table 6 shows the detailed costs for Network Upgrades required for Firm Delivery.

Table 4 – PSCo Owned Customer Funded Interconnection Facilities

Element	Description	Cost Est. Millions
Pawnee Station	Interconnect Customer to tap PSCo's new 345 kV bus. The new equipment includes 345 kV bi-directional metering, relaying and associated equipment and material.	**$0.43**
	Customer Generator Communication to Lookout	**$0.25**
	Customer Generator Witness Testing	**$0.12**
	Generator Testing	**$0.02**
	Siting and Land Rights for required easements, reports, permits and licenses.	**$0.02**
	Total Cost Estimate for Customer Interconnection Facilities	**$0.85**

Table 5 – PSCo Network Upgrades for Interconnection

Element	Description	Cost Est. Millions
Pawnee Station	Interconnect Customer's generation into the new 345 kV Yard and tying the 345 kV yard into the existing 230 kV yard. The new equipment required includes: • Two new 345 kV 2000 A, 40 kA circuit breakers • Two 230 kV 3000 A, 40 kA, circuit breakers • One 345/230 kV 560 MVA autotransformer • Eight 345 kV 2000 Amp gang switches • Four 230 kV 3000 Amp gang switches • transmission line relaying and testing • required steel supporting structures and foundations	**$7.31**
Lookout Center		**$0.09**
	Total Cost Estimate for PSCo Network Upgrades for Interconnection	**$7.40**
Time Frame		**45 Months**

Table 6 – PSCo Network Upgrades for Delivery – Alternative 2

Element	Description	Cost Est. Millions
Pawnee Station	New 345 kV Line terminals to Daniels Park and Brick Center requiring the following equipment: • Six 345 kV, 2000 Amp, 40 kA circuit breakers • Two 345/230 kV 560 MVA autotransformers • Eight 345 kV 2000 Amp gang switches • required steel and foundations • electrical bus work • metering, control, relaying and testing	**$13.66**

Element	Description	Cost Est. Millions
Daniels Park	New 345 kV Line Terminal to Pawnee. The following equipment will be required: • Three 345 kV 3000 Amp 50 kA circuit breakers • Six 345 kV 2000 Amp gang switches • misc. supporting steel and foundations • electrical bus work • associated metering control, relaying and testing	**$2.51**
Brick Center Substation	New 345 kV Yard with 230 kV yard expansion including two line terminals, one each to Daniels Park and Pawnee. This includes the following equipment: • Six 345 kV 3000 Amp 50 kA circuit breakers • Two 345/230 kV 560 MVA autotransformers • Fourteen 345 kV 2000 Amp, gang switches • Five 230 kV 3000 Amp, 50 kA circuit breakers • Eleven 230 kV gang switches • associated steel and foundations • associated metering, control, relaying and testing • electrical bus work	**$18.82**
345 kV Transmission	Converting the existing 115-mile 230 kV line from Pawnee to Daniel Park Substation from 230 kV operation to 345 kV operation and converting the existing 80-mile 230 kV line from Pawnee to Brick Center Substation from 230 kV operation to 345 kV operation by reinsulating and reconductoring 80 miles of the existing Pawnee to Brick Center 230 kV line and the parallel Pawnee to Daniels Park 230 kV line for 345 kV operation.	**$25.27**
	Construct 35 miles of 345 kV double circuit transmission line which consists of rebuilding 15-miles of single circuit wood structures with double circuit 345 kV structures from Brick Center to just outside of Smoky Hill that currently make up the a portion of the Pawnee-Daniels Park 230 kV line and continue for 20 additional miles on existing corridor to Daniels Park.	**$33.07**
230 kV Transmission	Operate one 345 kV double circuit from Brick Center to just outside of Smoky Hill at 230 kV. One circuit will continue on to Smoky Hill and the other to connect to the current double circuit structure that hold the existing Pawnee-Daniels Park 230 kV line making a Brick Center to Daniels Park 230 kV line.	**$17.87**
Siting and Permitting	Obtain necessary siting, permits, and ROW as required	**$4.32**
	Total Cost Estimate for PSCo Network Upgrades for Delivery	**$115.52**
	Total Cost of Project	**$123.76**
Time Frame		**65 Months**

Assumptions for Alternatives 1 & 2.

- The estimates and time frames given are for reference only are subject to change with a more detailed system study.
- The cost estimates provided are “scoping estimates” with an accuracy of +/- 30%.
- Estimates are based on **2007** dollars.
- PSCo crews will perform all construction and wiring associated with PSCo owned and maintained facilities. Contractor crews may perform the transmission line construction.
- Implementation of the recommended infrastructure for delivery will require that existing facilities be taken out of service for sustained periods. In most cases, these outages cannot be taken during peak load periods due to operational constraints. As a result, the estimated time frame for implementation could be increased.
- The 345 kV transmission line construction will require up to 200-foot wide easements along the planned route.
- The 345 kV transmission line construction will require up to 20 temporary staging areas of 5 acres each, which are included in the estimate.
- The interconnection and delivery portions of this project go through several counties and entities including Morgan County, Adams County, Arapahoe County, Douglas County, City of Aurora and City of Parker.
- It is anticipated that in order to construct the PSCo network upgrades for delivery and interconnection, 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 is at least 14 months from the time the Interconnection Agreement is fully executed.
- The Customer will be responsible for funding and constructing all facilities from the proposed generating IGCC station to the point of interconnection (Pawnee 345 kV Station).
- The last span into Pawnee Station from the Customer owned 345 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.

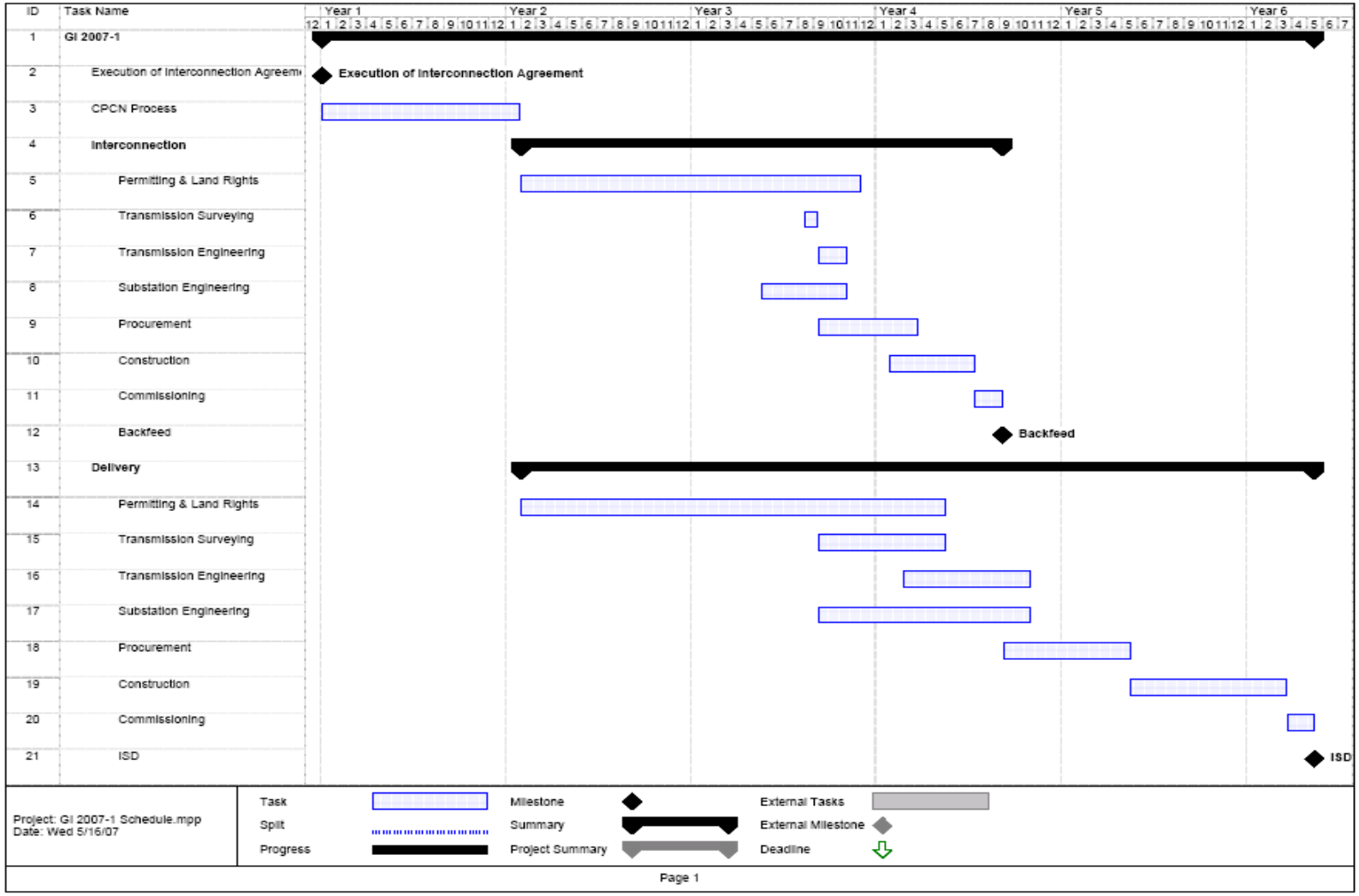
- A siting study will be required for network upgrades for delivery. Extensive public involvement is anticipated. Permit applications and possible minor right-of-way acquisition will be required. Land use permits will be required from multiple local jurisdictions.

Engineering, Procurement & Construction Schedule

The following schedule, depicted in Figure 4, identifies the main milestones needed to complete the interconnection and the delivery portion of the proposed 675 MW IGCC generation facility.

The following schedule identifies project milestones for three separate phases of work needed to complete the proposed interconnection: Siting, Permitting & Land Acquisition, Substation Design & Construction and Transmission Line Design & Construction. The total estimated duration to complete all of the required activities and tasks is 65 months.

Figure 4 Milestone Schedule



Appendix A
Contingency Results

Table 7 Most Significant Contingencies

IGCC (GI-2007-1)

		Bench Mark		Alternatives		
				1A	2A	
Overload Branches	Rate	2014 HS	2014 HS + IGCC	Pawnee - Daniels Park	Pawnee - Daniels Park, Pawnee - Brick center - Daniels Park	Contingency
Beaver Creek TSGT - 230/115 kV auto	224					Beaver Creek TSGT - Beaver Creek WAPA 115 kV
Beaver Creek TSGT - Beaver Creek WAPA 115 kV	200					Beaver Creek TSGT - Beaver Creek WAPA 115 kV
Beaver Creek PSCo - 230/115 kV auto	224					Beaver Creek TSGT - 230/115 kV auto
Happy Canyon - Daniel Park 115 kV	135			112	109	Parker PSCo - Bayou 115 kV
Happy Canyon- Crowfoot 115 kV	135			107	104	Castle Rock - Bayou 115 kV
Castle Rock - Crowfoot 115 kV	135			101		Castle Rock - Bayou 115 kV
Castle Rock - Bayou 115 kV	135	105	110	103	103	Daniels Park - 230/115 kV auto
Parker PS - Grandview 115 kV	187	110	111	109	108	Smoky Hill - Peakview 115 kV
Parker PS - Sulphur #1 115 kV	180			101	101	Parker PS - Sulphur #2 115 kV
Parker PS - Sulphur #2 115 kV	180			101	101	Parker PS - Sulphur #1 115 kV
Smoky Hill - Peakview 115 kV	187	108	114	108	108	Parker PS - Grandview 115 kV
Daniels Park - Pawnee 230 kV	640		124			Pawnee - Brick Center 230 kV
Ft Lupton - Pawnee	555		127			Pawnee - Daniels Park 230 kV
Pawnee - Story 230 kV	625		118			Pawnee - Daniels Park 230 kV
Brick Center - Smoky Hill 230 kV	640		110			Pawnee - Daniels Park 230 kV
Pawnee - Brick Center 230 kV	640		130			
Pawnee - Brick Center 345 kV	1200					Pawnee - Daniels Park 345 kV
Pawnee - Daniels Park 345 kV	1200					Pawnee - Brick Center 345 kV
Brick Center 345/230 kV auto	560					Brick Center - Smoky Hill 345 kV
Brick Center 230/115 kV auto	200		145	120		Quincy - Brick Center 230 kV
Daniels Park - 230/115 kV auto	150	120	118	X	X	Castle Rock - Bayou 115 kV
Daniels Park - 230/115 kV auto	280					Castle Rock - Bayou 115 kV
Daniels Park - 345/230 kV auto #1	560					Daniels Park - 345/230 kV auto #2
Daniels Park - 345/230 kV auto #2	560					Daniels Park - 345/230 kV auto #1
Daniels Park - 345/230 kV auto #3	560					Daniels Park - 345/230 kV auto #1
Washington - JL Green 230 kV	495	105	111			Ft. Lupton - Henry Lake 230 kV
Ft. Lupton - 230/115 kV auto	280	110	115	102	101	Valmont - Spindle #1 230 kV
Ft. Lupton - JL Green 230 kV	495	109	114			Ft. Lupton - Henry Lake 230 kV
Ft. Lupton - St. Vrain #1 230 kV	435	107	103			Ft. Lupton - St. Vrain #2 230 kV
Ft. Lupton - St. Vrain #2 230 kV	435	107	103			Ft. Lupton - St. Vrain #1 230 kV
Cherokee - Conoco 115 kV	135	107	110	102	101	Ckerokee - Mapleton 115 kV
Cherokee - Silver Saddle 230 kV	326	101	106			Ft. Lupton - JL Green 230 kV
Silver Saddle - Reunion 230 kV	326	112	116	104	103	Ft. Lupton - JL Green 230 kV

Note: Peetz Logan total generation at 400 MW

Added Story - Beaver Creek 230 kV line mitigates contingency overloads around Beaver Creek

Added IREA projects improves 115 kV system around Smoky Hill

Peetz Logan - Pawnee impedance data revised

Alts 1A & 2A: Heavy North to South flows across Wyoming to Colorado