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Interconnection Facilities Study Report

Request # GI-2004-11

69 MW Wind Farm Located Near Lamar, Colorado
Interconnecting at Lamar Switching Station

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Xcel Energy Services, Inc.
Transmission Planning – Denver, CO

I. Executive Summary

This Interconnection Facilities Study Report summarizes the analysis performed by Public Service Company of Colorado (PSCo) to specify and estimate the cost of the equipment, engineering, procurement, and construction needed to interconnect 69 MW of new wind powered generation at the Lamar Switching Station in Prowers County, Colorado. The new wind farm would be located South of Lamar, Colorado and would interconnect at the Lamar Switching Station via the Customer's 20-mile 230 kV transmission line. The requested commercial in-service date is December 31, 2005. However, the results of this study indicate that it is not feasible to implement the upgrades required to interconnect or to provide firm delivery for the project by the requested date.

The recommended Network Upgrades for Interconnection at Lamar Switching Station include a 230 kV circuit breaker, associated switches, metering, and transmission line rearrangement. The total estimated cost for the facilities required for interconnection is approximately **\$1.47 million**¹ including:

- \$0.40 million for Customer-funded Interconnection Facilities (Table 1)
- \$1.07 million for PSCo Network Upgrades for Interconnection (Table 2)

The estimated time required to engineer, permit, and construct the facilities described above is at least **9 months**.

The Network Upgrades recommended for full delivery of the generation on a firm basis consist of the following:

- Construct a new 99-mile, 230 kV line from Lamar to Boone
- Construct a new 43-mile, 230 kV line from Boone to Midway

The System Impact Study Report estimated the cost of these additional upgrades to be approximately \$67.01 million. The cost has been updated for this report and is now estimated to be approximately **\$73.85 million**² (Table 3). The estimated time required to engineer, permit, and construct the facilities for delivery is a minimum of **36 months** from the date a Transmission Service Agreement is executed. Therefore, it is not feasible to implement the facilities required for firm delivery of the project by the proposed in-service date.

The total estimated project cost for the PSCo facilities required for interconnection and delivery is approximately **\$75.32 million**.

A proposed Station One-Line diagram for the Lamar Switchyard is shown in Figure 1. Figure 2 shows the proposed Network Upgrades associated with Delivery for this transmission project.

¹ Appropriation estimate in 2005 dollars considered to have an accuracy of +/- 20%.

² Scoping, or planning level estimate considered to have an accuracy of +/- 30%.

Figure 1 Lamar Switchyard: Proposed Substation One-Line Diagram

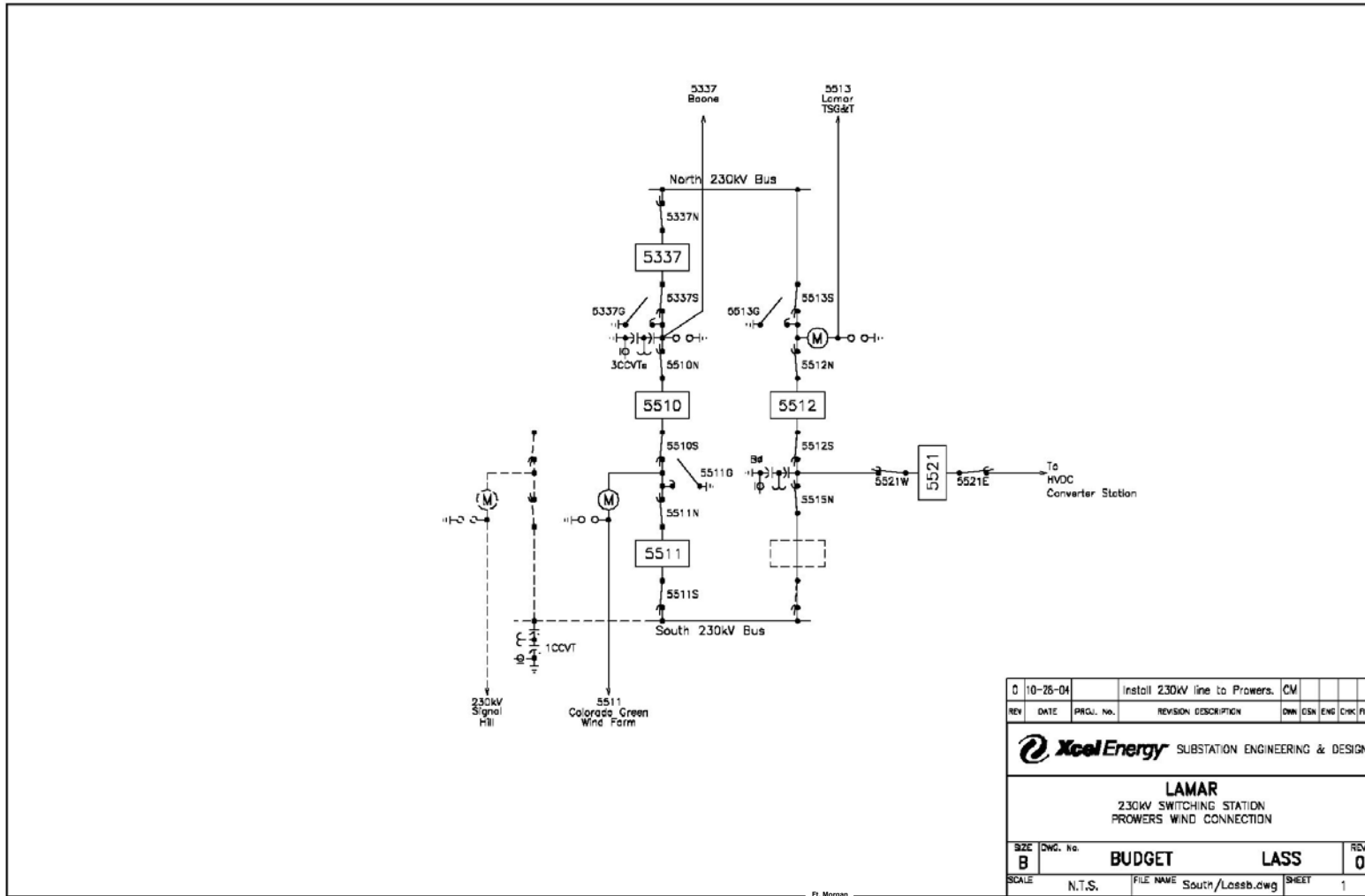
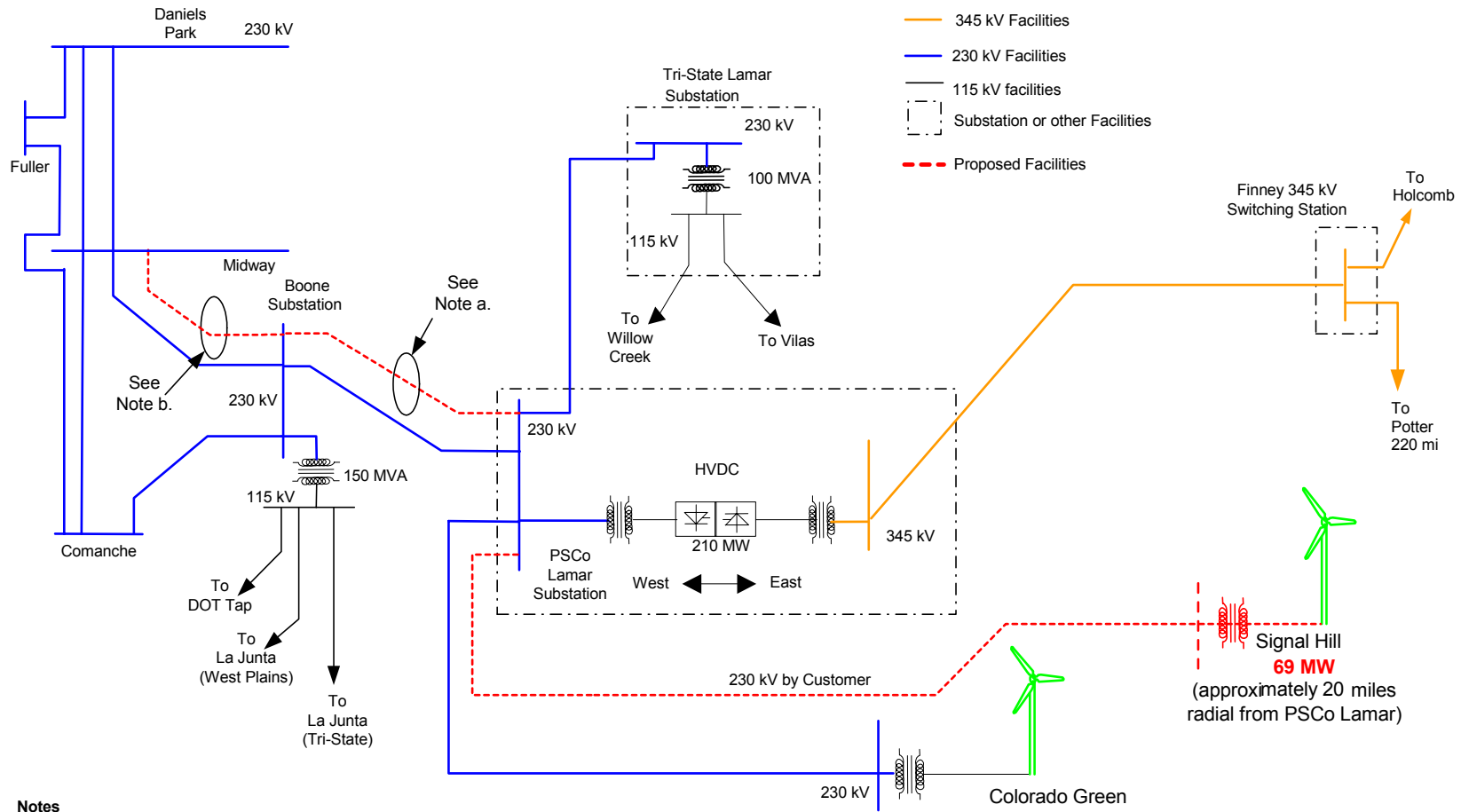


Figure 2: Regional Transmission System with GI-2004-11 Network Upgrades for Delivery



Notes

- A new 99 mile 230 kV single circuit line from Lamar to Boone, built to 345 kV specifications on double circuit structures. Requires additional ROW from Lamar to Boone.
- A new single circuit 230 kV line double circuit capable with 345 kV specifications adjacent to the existing line providing ROW is attainable.
- Substation expansion at Boone and Lamar.

II. Introduction

On November 19, 2004 Xcel Energy Transmission received a request to conduct a study to evaluate the integration of a 69 MW wind power generating facility in Prowers County, Colorado. The System Impact Study (SIS) report was issued and posted on the Rocky Mountain Area OASIS (RMAO) web site in May 2005. An Interconnection Facilities Study Agreement was executed with the Customer on July 1, 2005.

III. General Description (Project Design Guide)

The purpose of this project is to interconnect wind generation of approximately 69 MW into the existing Xcel Energy Lamar Switching Station. The customer proposes to construct a new 230 kV transmission line from their site to the Lamar switching station. The new line will interconnect to the existing 230 kV ring bus at Lamar.

Background

Lamar switching station presently is a 4-position ring bus transmission switching station that sits adjacent to the Xcel Energy Lamar HVDC Converter Station.

A. Physical Features

Fault Current

Existing 3 phase and SLG fault currents are 2076 Amps and 1618 Amps respectively at the Lamar 230 kV bus.

Physical - Electrical Installation

The installation at Lamar switching station will consist of adding one 230kV, 3000A SF6 circuit breaker, 3-230 kV, 3000A gang switches, 1-230 kV bus CCVT, 3-230 kV, 400/5, 0.15 accuracy combo CT/PT metering units, 3-230 kV surge arresters, metering equipment, and various structures.

In accordance with the "Xcel Energy Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20MW", version 2.0 dated 1/20/04, the customer shall be required to install a 230kV circuit breaker on the project end of the transmission line. The customer's step-up transformer(s) shall also be designed to meet the Interconnection Guidelines. The configuration of this transformer shall be **WYE** on the 230 kV side, **WYE** on the low voltage side, and **DELTA** on the tertiary. This will ensure that the customer meets the requirements for an effectively grounded system as stated in the guidelines.

AC & DC Systems

Existing AC and DC panels are adequate for new substation equipment.

Control Building

All new equipment will fit into existing building.

Grounding

All equipment and associated structures will be connected to the ground mat.

Lightning Protection

The static wires on the transmission lines will be connected to the dead-end structures within the substation to provide overhead direct stroke protection.

B. Civil Features

Grading & Fencing

Grading and fencing is required to provide space for the new partial bay that is being constructed.

Foundations & Structural

New foundations will be required for 1-circuit breaker, 3-gang switches, 1-CCVT, 3-metering units, 3-arresters, and various bus supports. New structures will be required for 3-gang switches, 1-CCVT, 3-metering units, 3-arresters, and various bus supports.

Removals & Relocations

No removals or relocations are required for this installation.

C. Control and Protection Features

Removals & Relocations

No removals or relocations of the control and protection equipment are necessary for this installation.

Installations

A new relay panel will be installed in the control building. Line protection will consist of a primary relay with pilot communication over fiber in a differential scheme with step distance protection elements utilized as a backup feature, a

secondary relay also using fiber in a blocking scheme with step distance protection elements used as a backup feature, and a breaker-failure relay. Since this is a radial line owned by the customer, no automatic reclosing will be utilized. Transmission line relay settings and coordination will be performed in conjunction with the customer. Transmission line relay design by the customer shall be subject to review by PSCo.

Review of the Customer’s relay and control design at Signal Hill need to be periodically reviewed and coordinated with the existing relays and controls at Lamar and the Lamar HVDC Tie in addition to coordination with the existing Colorado Green Wind Project. Updated and detailed control models of the Signal Hill facility need to be provided by the Customer to determine if any control interactions occur between the Lamar HVDC Tie and the Colorado Green Facilities before this project goes into service.

Additional interconnection requirements will need to be satisfied as stated in “Xcel Energy Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20MW”.³

The existing RTU and LCU at Lamar will handle the additional SCADA information for the new transmission line. The existing Control Area Remote Site Metering/LF/AGC RTU will be utilized for the Signal Hill installation.

D. Outages

No outages are required for this installation due to the existing switch configuration.

E. Project and Operating Concerns

Work will be performed inside an energized 230 kV substation.

F. Assumptions

Assumptions for Signal Hill Wind

Customer will provide power factor correction equipment to meet voltage tolerances at point of interconnection, if needed.

Customer will engineer, procure, and construct all equipment up to the Lamar 230 kV dead-end structure. This includes transmission line relay equipment at customer’s site.

³ www.xcelenergy.com/XLWEB/CDA/0,3080,1-1-1_16699_16643-1428-2_424_756-0,00.html

The customer will need to arrange for station service power through the local utility/service provider, as customer's site is not in PSCO service territory.

Customer will build transmission line with fiber optic ground wire built into the static wire for relay communication. Line ownership demarcation is the first structure outside of the substation. The customer is responsible for stringing the line to the dead-end structure in our substation.

PSCo needs approximately 2-4 weeks for testing as required by "The Xcel Energy Interconnection Guidelines for Transmission Interconnected Producer-Owned Generation Greater Than 20 MW". Much of the testing can be performed in parallel with the construction schedule.

Assumptions for Lamar

PSCo meters will be 4-quadrant, bi-directional meters with recorders. Meters/recorders will be equipped such that they can be accessed remotely through a phone circuit.

PSCo will engineer, procure, construct, own, and maintain all 230 kV facilities associated with the substation expansion.

Equipment lead times will dictate the time needed to build facilities. Current lead times are 6 to 9 months.

Other Assumptions

Contract for interconnection with customer has been executed and project is underway.

Timeframe to complete all of the necessary network upgrades for delivery is substantially longer than customer's requested in service date.

The construction of the network upgrades for delivery will have to be carefully planned. Not all of the work can be performed at the same time due to transmission capacity restraints.

If other projects planned for this location are constructed ahead of this project, then this assumption may no longer be valid.

PSCo will engineer, procure, construct, own, and maintain all facilities associated with the network upgrades for delivery.

G. Network Upgrades for Delivery as a Stand Alone Project

In general the network upgrades for delivery shall mean the additions, modifications, and upgrades to the transmission provider's transmission system (PSCo) required at or beyond the point at which the interconnection facilities connect to the transmission provider's transmission system to accommodate the interconnection of the large generating facility (customer) to the transmission provider's transmission system. See FERC 2003-A definitions for further explanation.

The following network upgrades required for delivery are:

- Construct a new 99-mile, 230 kV line from Lamar to Boone
- Construct a new 43-mile, 230 kV line from Boone to Midway

Assumptions

Contract for interconnection with the customer has been executed and project is underway.

Timeframe to complete all of the necessary network upgrades for delivery is **substantially longer** than customer's requested in service date.

The construction of the network upgrades for delivery will have to be carefully planned and outages coordinated. Not all of the work can be performed at the same time due to transmission capacity restraints.

Enough space will be available at Lamar Switching Station to accommodate the substation expansion. If other projects planned for this location are constructed ahead of this project, then this assumption may no longer be valid.

PSCo will engineer, procure, construct, own, and maintain all facilities associated with the network upgrades for delivery.

IV. Costs Estimates and Assumptions as a Stand Alone Project:

A. Interconnection

The estimated non-binding good faith total cost for the PSCo Interconnection Facilities and Network Upgrades to provide an Interconnection for the Customer requested generation is:

- **\$ 0.40 million for Customer Interconnection Facilities at Lamar Switching Station (Customer funded).**
- **\$1.07 million for PSCo Network Upgrades for Interconnection.**
- **Total Estimated cost of Interconnection = \$1.47 million**

The estimated costs shown above are "appropriation estimates" with an accuracy of $\pm 20\%$. These estimates do not include any costs for any Customer-owned,

supplied, and installed equipment and associated design and engineering for the Customer’s facilities. Detailed appropriation level estimates were not performed for estimating the Network Upgrades for Delivery; these upgrades are discussed later, with only scoping level estimates repeated here as performed for the earlier System Impact Study.

B. Stand-Alone

“Stand Alone Network Upgrades” are defined by the FERC LGIP as Network Upgrades that the Interconnection Customer may construct without affecting the day-to-day operations of the Transmission System during their construction. The Transmission Provider and Interconnection Customer must agree as to what constitutes Stand Alone Network Upgrades and identify them in Appendix A to the Standard Large Generator Interconnection Agreement.

For this generation interconnection request, it is assumed that there are not any Stand Alone Network Upgrades.

C. Delivery

The additional costs for PSCo Transmission Network Upgrades for Delivery of the full new generation output to PSCo native loads were estimated at:

- **\$73.85 million⁴ for additional PSCo Transmission Network Upgrades for Delivery**

Therefore, the total estimated project cost for the PSCo facilities required for interconnection and firm delivery is approximately **\$75.32 million**.

The Project Design Guide included in Part III of this report describes the assumptions and additional details associated with this project. The cost responsibilities associated with these facilities shall be handled as per current FERC guidelines.

D. Interconnection Facilities Component Costs Estimates and Assumptions:

Table 1 describes the improvements assumed necessary to be performed by PSCo Transmission, as dedicated “sole-use” facilities at PSCo Lamar Switching Station for the new Customer interconnection. It does not include all of the costs associated with Network Upgrades, required at or beyond the Point of Interconnection (POI) to the PSCo transmission system, and delivery (NR) of the generation. Those costs are identified in Tables 2 and 3. It is assumed that all of the Customer owned, supplied, and operated equipment, both installed at PSCo Lamar Switching Station, and equipment installed between and at the Customer generation site, will be designed, and installed by the Customer, or its contractors.

⁴ Scoping, or planning level estimate considered to have an accuracy of +/- 30%.

(Such as the Customer’s 230 kV transmission line from their site to Lamar and other associated Customer–owned substation / plant equipment). The costs of these Customer owned / operated facilities have not been estimated for by PSCo Transmission. The General Arrangement drawing for the Lamar Switching Station is shown in Figure 4.

Table 1: PSCo Transmission Interconnection Facilities (Customer funded):

Substation	Description	Cost (\$Million)
Lamar Switching Station (PSCo)	Interconnect Customer to tap PSCo’s 230kV bus. The new equipment includes 230kV bi-directional transformer metering, relaying and associated equipment and material.	\$0.360
	Transmission tie line into substation.	\$0.020
	Siting and Land Rights for required easements, reports, permits and licenses.	\$0.020
	Total Cost Estimate for Interconnection Facilities	\$0.400

Table 2 describes the costs associated with providing an interconnection to PSCo Transmission’s system. It does not include all of the costs required for full delivery of the generation. Those costs are included in Table 3.

Table 2: PSCo Transmission Network Upgrades Required for Interconnection:

Location	Description	Cost (Millions)
Lamar Switching Station (PSCo)	Interconnect Customer’s 230 kV line by converting the Lamar 230 kV four-breaker ring bus into a three bay, breaker-and-a-half layout. The new equipment required includes: <ul style="list-style-type: none"> • One 230 kV, 3000 A, 50 kA circuit breaker • Three 230 kV switches • Required electrical bus work, relaying and wiring, and steel supporting structures 	\$1.065
	Total Cost Estimate for PSCo Network Upgrades for Interconnection	\$1.065
Time Frame		9 Months (Back-feed)

E. Delivery Component Costs Estimates and Assumptions

Table 3 describes the estimated “scoping level” (+/- 30%) costs of PSCo Network Upgrades for Delivery, those associated with firm delivery of the 69 MW generation to PSCo Transmission native load. These costs were first determined during the System Impact Study, and have been refined for this Facilities Study. More detailed, and higher accuracy estimates will need to be performed at later

stages in this project, due to the high level of uncertainty regarding specific line routes, permitting, and other details typical for transmission line design and construction of this nature.

Table 3: PSCo Transmission Network Upgrades Required for Delivery

Location	Description	Cost (Millions)
Lamar Switching Station (PSCo)	New line terminal for 230 kV circuit #2 to Boone. The new equipment required includes: <ul style="list-style-type: none"> • Four 230 kV, 3000 A, 50 kA circuit breaker • Five 230 kV switches 	\$1.469
Boone Substation	New line terminal for 230 kV circuit #2 to Lamar and new terminal equipment for 230 kV circuit #2 to Midway. The new equipment required includes: <ul style="list-style-type: none"> • Five 230 kV, 3000 A, 50 kA circuit breaker • Eight 230 kV switches 	\$2.674
Midway Substation	New line terminal for 230 kV circuit 2 to Boone. The new equipment required includes: <ul style="list-style-type: none"> • One 230 kV, 3000 A, 50 kA circuit breaker • Two 230kV switches 	\$0.520
Transmission	Construct a new 99-mile, single-circuit, 230 kV line from Lamar to Boone, built to 345 kV specifications on double-circuit structures.	\$44.142
	Construct a new 43-mile, single-circuit, 230 kV line from Boone to Midway, built to 345 kV specifications on double-circuit structures.	\$19.828
Siting and Permitting	Obtain necessary siting, permits, and ROW as required.	\$5.221
	Total Cost Estimate for PSCo Network Upgrades for Delivery	\$73.584
	Total Cost of Project	\$75.318
Time Frame		36 Months

Total costs for Network Upgrades for Interconnection and Delivery Costs = **\$75,318,000**

Assumptions:

1. The estimated costs provided for Interconnection costs are “Appropriation Estimates” with an accuracy of $\pm 20\%$. The estimated costs provided for Delivery/Infrastructure upgrade costs are “Scoping Estimates” with an accuracy of $\pm 30\%$.

2. All applicable overheads are included. AFUDC has been removed.
3. Estimates are based on 2005 dollars.
4. PSCo (or its contractor) crews will perform all construction and wiring associated with PSCo-owned and maintained equipment.
5. 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 36 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.
6. Any NEPA requirements imposed on transmission because of the generation addition will most likely have adverse effects on schedule and deliverables.
7. No screening has been estimated at any of the substations. If this is required the cost will be significant at each location.
8. Detailed field investigations (surveys, etc.) have not been conducted and could increase these estimates.
9. New transmission ROW is assumed to be adjacent to the existing transmission lines. The Customer Interconnection requires new ROW.
10. These estimates do not include any cost for legal fees.
11. All necessary transmission line outages can be obtained. If not, construction duration times will be longer.
12. The overall timeline to complete all required transmission and substation facilities is expected to require a minimum of 36 months. If there are problems with local and state approvals, this could require an additional year.

V. Engineering, Procurement & Construction Schedule

The following schedule (Figure 3) identifies milestones needed to complete the interconnection of the proposed 69 MW Signal Hill wind project.

Figure 3: Engineering, Procurement & Construction Schedule

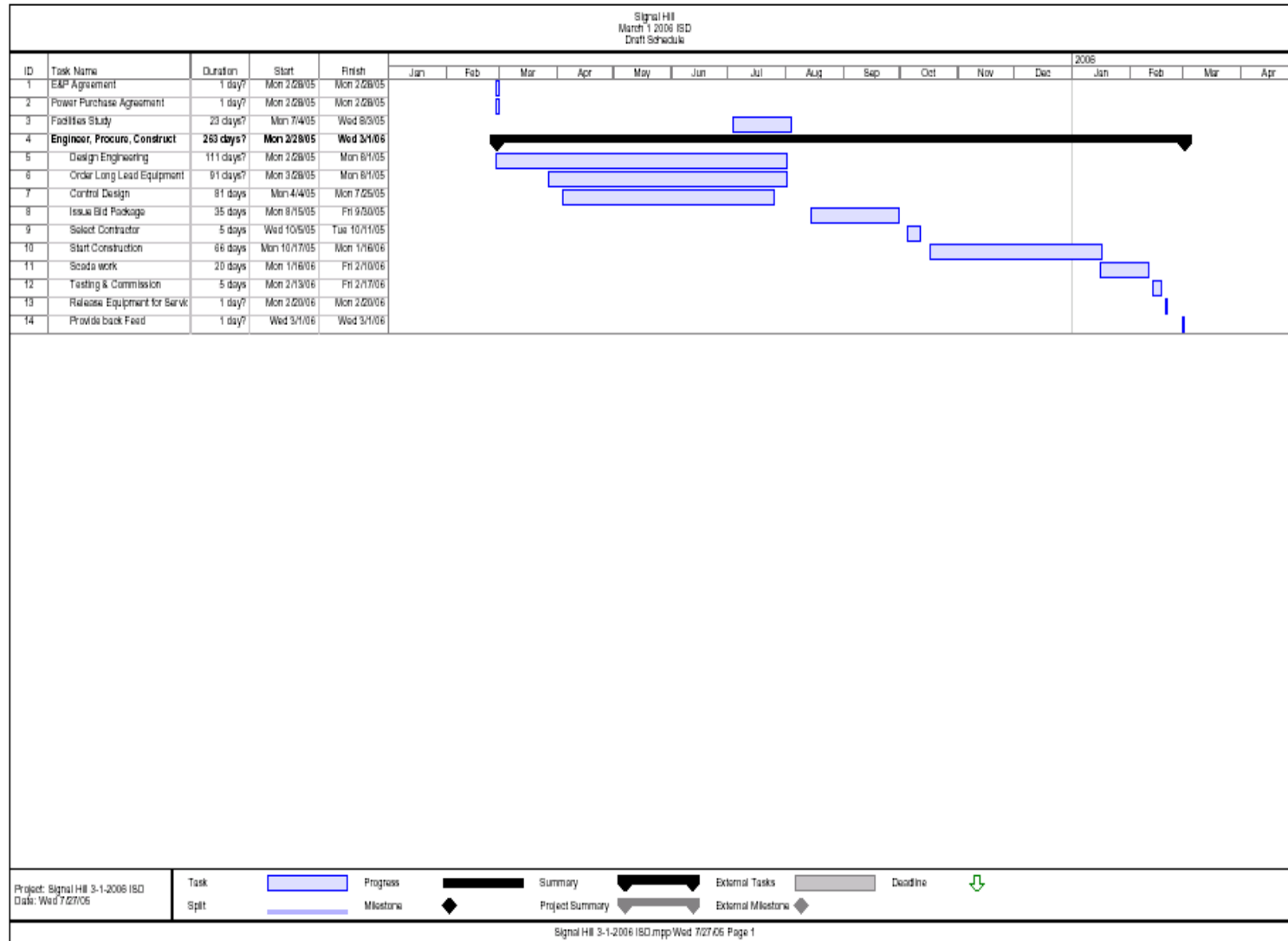


Figure 4: Lamar Switching Station: Proposed General Arrangement Drawing as a Stand Alone Project

