



***Facility Study
For
Generation Interconnection
Request GEN-2008-124T***

***SPP Generation
Interconnection
(#GEN-2008-124T)
August 2012***

SUMMARY

Electric Power Engineers, Inc. on behalf of Generation Energy, Inc. and in collaboration with CG Power Solutions USA, Inc. has performed a facility study for the interconnection of the 42MW Keyes Wind Farm, in Keyes, Oklahoma, to Tri-County Electric Cooperative (TCEC) System on the Southwest Power Pool (SPP) transmission system.

Pursuant to the SPP Tariff, Generation Interconnection Customer and TCEC were asked to perform a detailed Facility Study for the generation interconnection request to satisfy the Facility Study Agreement executed by the requesting customer of SPP.

INTERCONNECTION CUSTOMER INTERCONNECTION FACILITIES

The Interconnection Customer will be responsible for the 34.5 kV/69 kV Keyes wind farm Collector Substation including the power transformer. The customer is required to maintain a +/-95% power factor at the 69 kV point of interconnection.

The Interconnection Customer shall be responsible for the cost of, and shall own, operate, and maintain the generation facility.

TRANSMISSION OWNER INTERCONNECTION FACILITIES AND NON-SHARED NETWORK UPGRADES

The Interconnection Customer System Impact study recommended interconnecting the new wind generation farm to the TCEC's system via a 69 kV tie-line into a new switching station that will be constructed adjacent to TCEC's existing Keyes substation, referred to as Keyes Switching Station. The addition of the new switching station shall also include any necessary upgrades to the terminal equipment at Keyes, Eva and Elkhart Substations.

The System Impact Study additionally identified thermal overloads on the regulating transformer between Eva and Elkhart substations, and recommended removing that regulating transformer from service. The regulating transformer shall be replaced by 4.3 MVARs of switched capacitor banks, in three steps, that will be owned by TCEC and installed at the 69 kV Keyes Switching Station, in order to maintain the voltage in the area particularly when the Keyes Wind Farm is generating low or no power output. Additionally, the Capacitor Banks at Keyes Switching station must be equipped with the relays and communication, and programmed to interface with TCEC and controlled to meet the required voltage schedule at the Point of Interconnection even when the Wind Farm is not in service.

The Interconnection Customer Substation shall also include revenue metering, remote terminal unit (RTU), 69 kV line arresters, and communication equipment which will be designated as Transmission Owner facilities. The revenue metering will be at the Keyes Switching station.

The total cost estimated for the Transmission Owner Interconnection Facilities and Non-Shared Transmission Upgrades is \$4,759,937, which is directly assigned to the Interconnection Customer.

Other Network Upgrades

Interconnection Customer was studied as an Affected System interconnection request in DISIS-2010-001 (ASGI-2010-011). Certain Other Network Upgrades are currently not the cost responsibility of the Customer but will be required for full Interconnection Service. These Network Upgrades include:

- Hitchland – Woodward 345kV double circuit, scheduled for 6/30/2014 in-service

Depending upon the status of higher or equally queued customers, the Interconnection Customer's in-service date is at risk of being delayed or their Interconnection Service is at risk of being reduced until the in-service date of these Other Network Upgrades. Earlier in service dates may be available through Limited Operation in accordance with Article 5.9 of the standard Generation Interconnection Agreement.



FACILITIES STUDY

For

42 MW Keyes Wind Farm
Keyes, Oklahoma



SPP #GEN-2008-124T

August 10, 2012

Hala N. Ballouz, P.E.
President and Senior Transmission Engineer



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1. EXECUTIVE SUMMARY

Interconnection Customer requested the interconnection of a wind energy facility located in Keyes, Oklahoma to the Tri-County Electric Cooperative (TCEC) transmission network. The facility has a net capacity of 42MW and will consist of 28 GE 1.5MW wind turbine generators. The wind farm will interconnect via a 69kV tie-line into a new switching station, referred to as Keyes Switching Station, which will be constructed adjacent to TCEC's existing Keyes substation as shown in the site layout of Figure 1 and the One Line of Appendix 1.

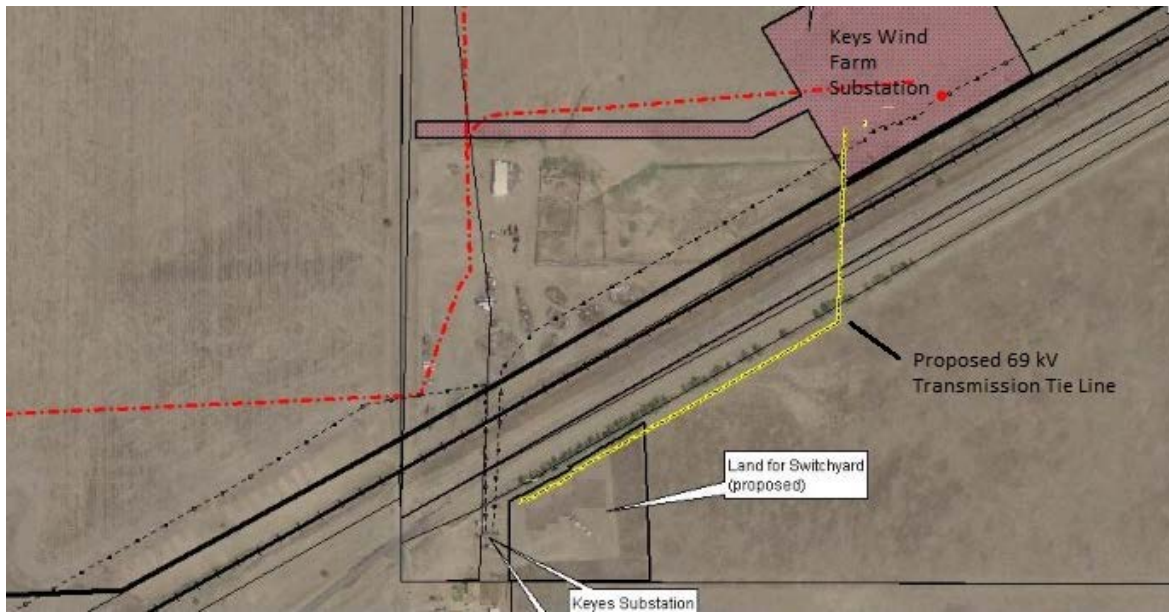


Figure 1 - Project Interconnection Site Layout Sketch

At the Interconnection Customer's expense, the following facilities must be built, and will be owned and operated by the Transmission Owner: a) a new 69 kV switchyard adjacent to TCEC's Keyes substation; b) 0.5 mile, 69 kV transmission tie-line interconnecting the Keyes Wind Farm Substation to the new 69kV Switchyard; c) 4.3MVAR, 69 kV switched capacitor banks, in 3 steps, at the 69 kV Keyes Switching Station. The capacitor banks are required to replace an existing regulating autotransformer, located between the Elkhart Substation and Eva Energy Tie, which will become overloaded with the addition of the Keyes Wind Farm and must be removed from operation.

These costs are summarized in Table 1 below.

Table 1 - Cost Summary

Network Upgrades	\$	3,979,937
Interconnection Facilities	\$	780,000
Total	\$	4,759,937

The Interconnection Customer will construct, own and operate a 34.5 kV/69 kV Collector Substation, at its own expense, at the Keyes Wind Farm.

For this interconnection request, the anticipated time for completing the new 69kV switchyard will be approximately fifteen months after the Interconnection Agreement is signed between the Interconnection Customer and TCEC and the work is commissioned, while also taking into consideration the lead-time of some of the equipment used in the construction of the switching station and recent construction of other stations within TCEC's system.

2. GENERAL DESCRIPTION OF TCEC FACILITIES

TCEC 69 kV Switchyard Facilities

2.1 Location and Interconnection

The new 69kV switchyard shall be located 0.5 miles from Keyes Wind Farm Substation, and adjacent to the existing Keyes TCEC substation. The wind farm will be interconnected to the 69kV switchyard via a new 69kV transmission line. The new switchyard shall be operated and maintained by TCEC. Figure 1 site sketch marks the potential site location of the Switching Station.

2.2 Bus Configuration

The 69kV switchyard shall have a four-breaker ring bus configuration. The general arrangement of the substation is given in Appendix 2

2.3 Line Terminals

The 69kV transmission lines and static wire terminals will be designed to accommodate 2,000 pounds per phase conductor at maximum tension, with a maximum 15-degree pull off from normal. The T-line design will be in accordance with the applicable utility transmission design standards, those of TCES, National Electrical Safety Code (NESC) C2-2007, NEC, and all county, EPA, and state permit requirements.

2.4 Station Power

A 69kV 50kVA single-phase 40.2kV-240/120V Station Service Transformer (SST) will be installed at the new 69kV switchyard for station power. For backup power, it is recommended to install a 75 kW standby generator for power supply if a local distribution line is not available. The standby generator cost will be an adder of \$75,000 which is not included in the total costs provided in this study, and will be an Interconnection Customer expense if incurred.

2.5 Control House

The control house for the new switchyard will house the AC and DC distribution systems, DC battery systems, relays and control panels, HVAC system and lighting.

2.6 Site Grading

Site shall be graded and rendered flat and leveled within +/-2% grade and be within +/-1 ft. of anticipated final grade.

2.7 Security Fence

Switchyard shall have an 8 feet high galvanized chain link fencing including OSHA approved "Danger: High Voltage" signs, a 16 feet vehicle gate and, a 3 feet personnel gate.

2.8 Ground Grid

A ground grid shall be installed per ANSI/IEEE STD 80-2000. The grounding design is based upon the onsite soil resistivity readings not exceeding 300 ohm-meters. Grounding calculations utilize WinIGS software. The design considers ground grid being bonded to each incoming transmission line shield wire to reduce resistance. Grid conductor is 4/0 19 strand AWG bare copper buried at a depth of 18" below sub-grade. Grid spacing is 20'x20'. Ground rods are 3/4" x 10' driven to a depth where the top of the grounding rod is 18" below sub-grade. Each rod to be embedded in a 4" diameter bore of bentonite, if pre-drilling is required.

2.9 Relay & Protection

The new 69kV switchyard shall have line differential scheme as primary and step distance as back up protection for the new 69kV transmission line.

2.10 Remote Terminal Unit (RTU)

TCEC will provide and install a new RTU to be utilized with communications for the new switchyard. Interconnection Customer shall be responsible for the cost of the RTU and is also required to make provisions in the control building at the substation for the RTU installation. The cost of installing an RTU is approximately \$50,000.

2.11 Revenue Metering

On the new 69kV switchyard line terminal to the Keyes Wind Farm Substation, an individual billing meter will be installed along with a meter per ANSI C12.1 accuracy class 0.2 (3-PTs IEEE C57.13 accuracy class 0.2 and 3 CTs IEEE C57.13 accuracy class 0.15) for full 3-phase 4-wire metering. There will be two meters per line terminal: one will be primary and the other will be back up; each will have full 4 quadrant metering. The primary billing meter pulse data will be sent via SCADA to the Transmission Owner's Control Center. The cost of Revenue Metering is estimated at \$45,000.

2.12 Operation and Maintenance

The new 69kV switchyard will be operated and maintained by TCEC.

2.13 Communications

TCEC indicated that the communications on their system in the area of the Keyes project are based on radio communications and that there are no plans to upgrade to fiber optic in the near future. Therefore the Interconnection Customer will be required to install radio communication devices at the new 69kV switchyard for pilot protection scheme of the existing 69kV lines.

The Interconnection Customer shall be responsible for making arrangements with the local phone company to provide telephone circuits and radio equipment as required by the Transmission Owner. Transmission Owner equipment may

include, but is not limited to, the following: relay communication equipment, RTU, and disturbance monitoring equipment at the Substation. A high level communications schematic diagram is included in Appendix 4.

69 kV Underground Transmission Tie-Line

- 2.14** The Interconnection Customer will construct, and TCEC will own, operate and maintain an underground 69kV transmission line from the Keyes Wind Farm Substation to the 69kV Keyes new Switchyard (POI) at the Interconnection Customer's expense. The transmission design group of TCEC, prior to any construction by the Interconnection Customer or its contractor on the customer 69kV transmission line, when performing work in close proximity to any TCEC transmission line, will require an engineering review of customer's design. Interconnection Customer shall be responsible to initiate this review before any construction on any transmission line begins and if failed to do so, any subsequent delays shall be responsibility of the Interconnection Customer itself.

For the underground tie-line boring is assumed for highway crossing. The bores will be in steel pipe and then pressure grouted. This price does not include any concrete encasement outside of the bores.

An overhead cable can be an alternative option for the 69kV T-line between the collector substation and the POI. A budgetary cost estimate for the overhead T-line is \$467,000 .

69 kV Switched Capacitor Bank and Removal of Eva Regulating Transformer

- 2.15** 4.3MVAR capacitor banks in three steps shall be installed at the 69kV Keyes Switching Station to maintain a voltage schedule at POI as required by TCEC. Electric Power Engineers conducted a Capacitor Optimization Study which concluded that the 4.3 MVAR capacitor banks should be installed in three steps, Step 1: 0.5 MVAR, Step 2: 1.8 MVAR, and Step 3: 2.0 MVAR respectively. The transmission design group of TCEC, prior to any construction by the Interconnection Customer or its contractor, will require a review of customer's design.
- 2.16** A capacitor control relay (such as SEL-2411), control switch, and a communication relay (such as SEL-3530) shall be installed to be programmed to allow TCEC to control the capacitor bank switching in order to maintain the voltage at Keyes Switching Station.
- 2.17** The regulating transformer between Eva and Elkhart substations must be removed or bypassed, including any related terminal equipment upgrades at Eva and Elkhart.

3. GENERAL DESCRIPTION OF INTERCONNECTION CUSTOMER FACILITIES

34.5 kV/ 69 kV Collector Substation

- 3.1** The Interconnection Customer shall be responsible for engineering and construction of the generation facility. The Keyes Wind Farm Substation also referred to as the collector substation will be a 69 kV / 34.5 kV station and will consist of a 69 kV / 34.5 kV 29/38/47 MVA power transformer (MVA rating is based on the wind farm capacity of 42MW), two 69kV breakers, one 34.5kV SST and three collector feeders through 34.5 kV breakers that will collect the power generated by the wind farm. A 75kW generator for backup power is recommended (optional) to be installed in case a local distribution line is not available.

4. ESTIMATED COSTS

The cost of Transmission Owner’s interconnection facilities and non-shared network upgrades at the Interconnection Customer’s expense is estimated at \$4,759,937 and is outlined in the following Table:

Transmission Owner Network Upgrades (at the IC's expense)		
Project	Description	Estimated Cost
1	Engineering, Project Management and Construction of the 69kV, 3-Breaker Ring Bus	\$ 1,600,000
2	Equipment for the 3 breaker ring bus 69kV Switching Station	\$ 1,193,263
3	4.3MVAR switched (3-step) Capacitor Bank and equipment at 69 kV switching station	\$ 392,674
4	Radio communications between Switching Station and Remote Ends	\$ 450,000
5	Removal of Voltage Regulating Transformer at Eva	\$ 49,000
6	Upgrades to Terminal Equipment at Keyes Substation (Budgetary)	\$ 125,000
7	Upgrades to Terminal at Eva and Elkhart Substations (Budgetary)	\$ 125,000
8	Disturbance Monitoring Device	\$ 45,000
	Subtotal	\$ 3,979,937
Transmission Owner Interconnection Facilities (at the IC's expense)		
Project	Description	Estimated Cost
9	69kV Tie Line--Underground*	\$ 633,000
10	Revenue metering	\$ 45,000
11	Remote Terminal Unit (RTU)	\$ 50,000
12	Communications at Collector Substation	\$ 40,000
13	69kV Line arrestors	\$ 12,000
	Subtotal	\$ 780,000
Grand Total		\$ 4,759,937

Note 1: Note: Above prices were provided by CG Power Solutions for budgetary purposes and provided in 2012 figures; actual construction price may vary up to +/-20%.

Permit fees and Right of Way Charges are not included in these costs.

Note 2: Engineering (\$280K), Project Management (\$80k) and Construction, \$1,240k)

Note 3: The transmission tie-line, although not designated as a Network Upgrade, will be owned and operated by the Transmission Owner. Boring is assumed for highway crossing. The bores will be in steel pipe and then pressure grouted. This price does not include any concrete encasement outside of the bores. An overhead cable can be an alternative option for the 69kV T-line between the collector substation and the POI. A budgetary cost estimate for the overhead T-line is \$467,000 .

5. ENGINEERING AND CONSTRUCTION

For this interconnection request, the anticipated time for completing the new 69kV switchyard will be approximately fifteen months after the Interconnection Agreement is signed between the Interconnection Customer and Tri-County Electric Cooperative (TCEC) and the work is commissioned, while also taking into consideration the lead-time of some of the equipment used in the construction of the switching station and recent construction of other stations within TCEC’s system. The engineering and construction schedule for the completion of the four breaker 69 kV ring bus switching station, underground 69kV transmission tie-line and all other projects outlined in this study is depicted in detail in Appendix 3 and estimated at approximately eleven months from the date of commissioning.

All additional cost for work not identified in this study is the sole responsibility of the Interconnection Customer unless other arrangements are made.

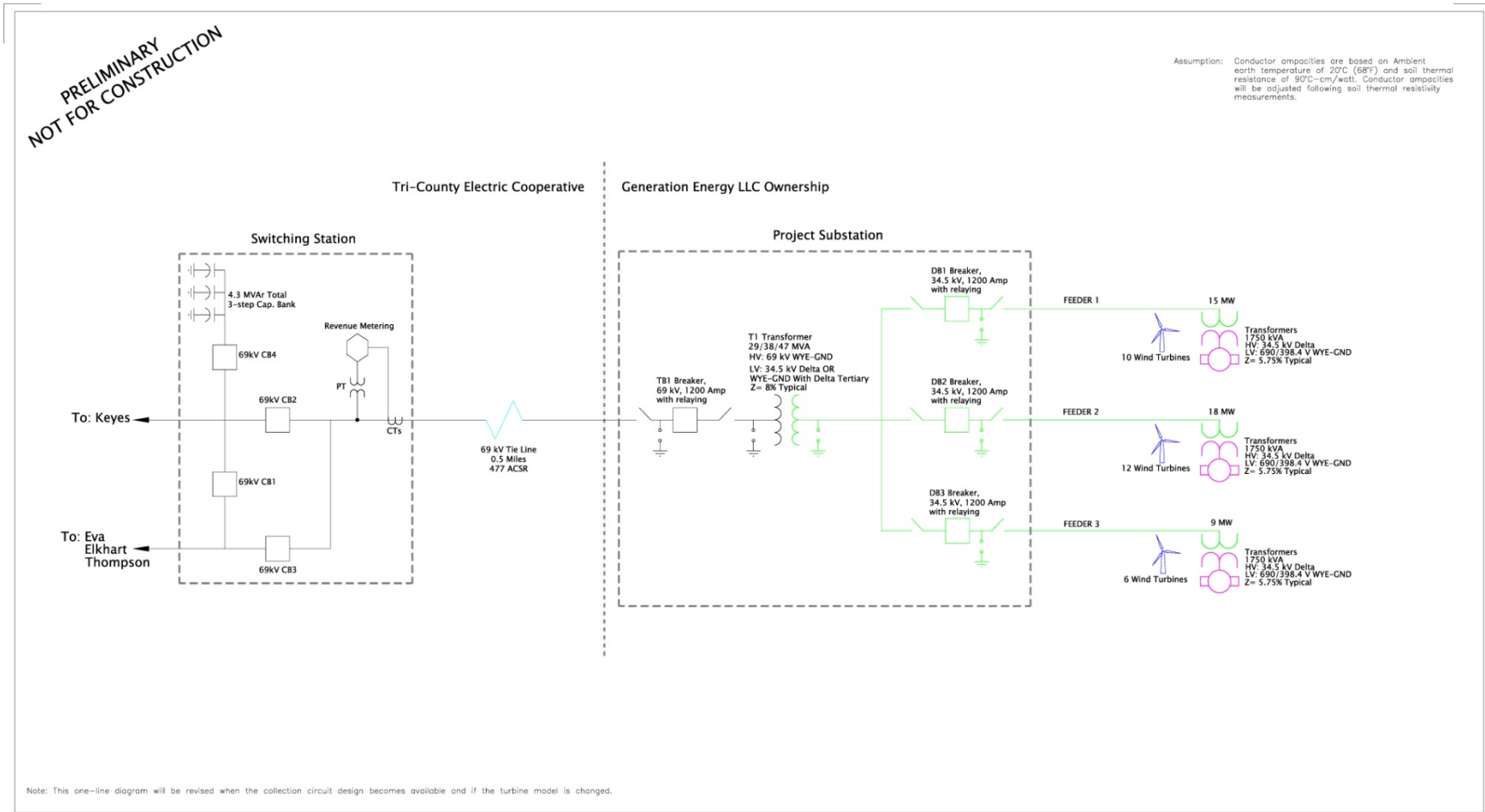
6. ASSUMPTIONS

- 6.1 It is assumed that all the design and construction shall be as per standard utility practices.
- 6.2 It is assumed that standard practices for line protection shall be applicable at the new 69kV switchyard and the new 69kV transmission line.
- 6.3 Right of Way and Permits: The Interconnection Customer shall collaborate with Transmission Owner on the permitting required for the transmission line construction across state highway and through railroad Right of Way.
- 6.4 Construction Power and Distribution Service: The Interconnection Customer shall be responsible for making arrangements for both construction and station power, which may be required for the Interconnection Customer’s wind farm facility. If a local utility distribution line is not available on site to provide station power (retail distribution service), the Interconnection Customer will make arrangements to provide a standby generator for power supply..
- 6.5 *Fault Level at POI*

As per the System Impact Study carried out by S&C Electric, the available fault current at 69 kV at the POI without the wind farm contribution is given in the table below.

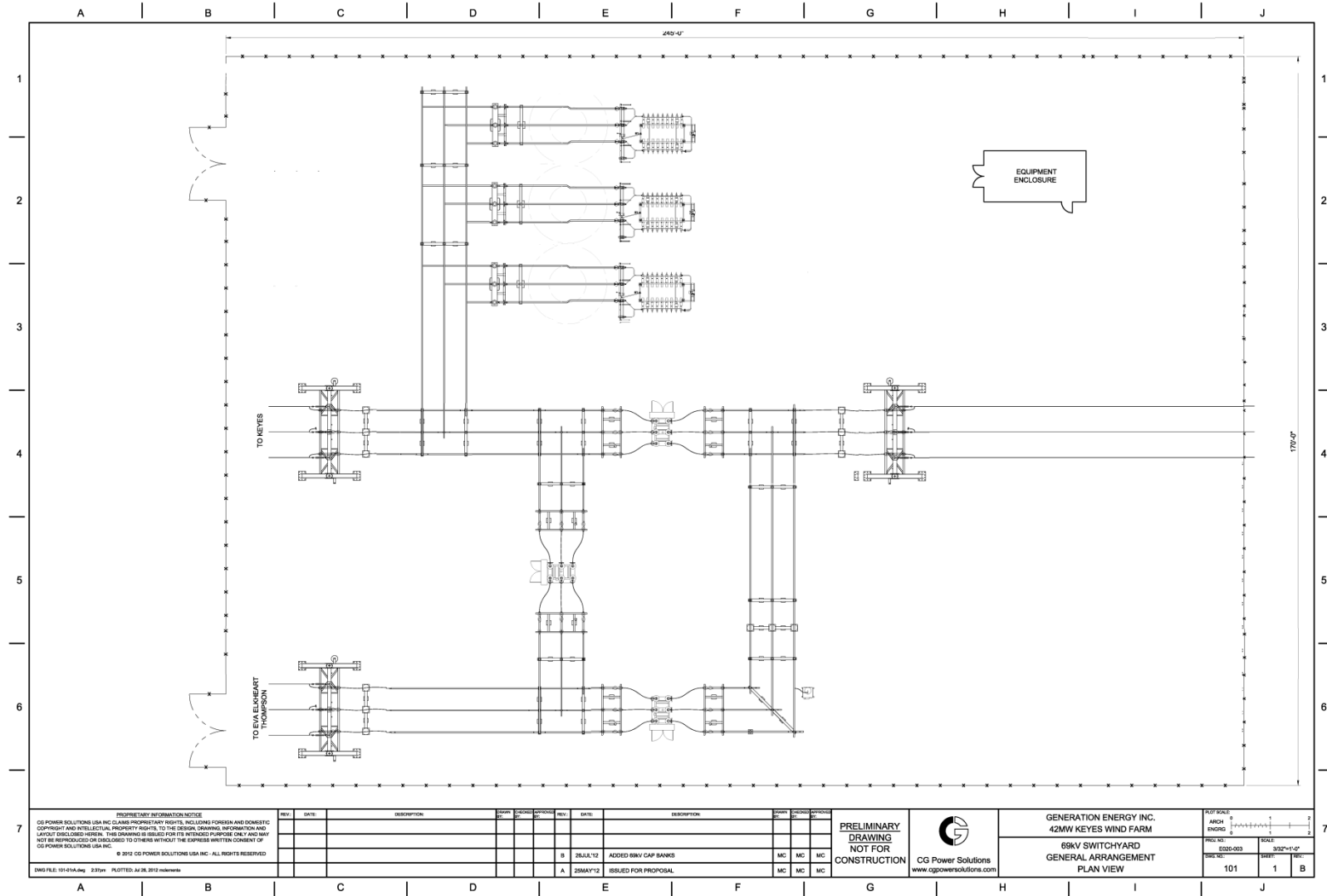
Three Phase			Single Phase to Ground		
Short Circuit MVA	Fault Current	X/R	Short Circuit MVA	Fault Current	X/R
79.14	663A	2.23	20.61	518A	2.47

APPENDIX 1 - Keys Wind Farm Interconnection One Line Diagram

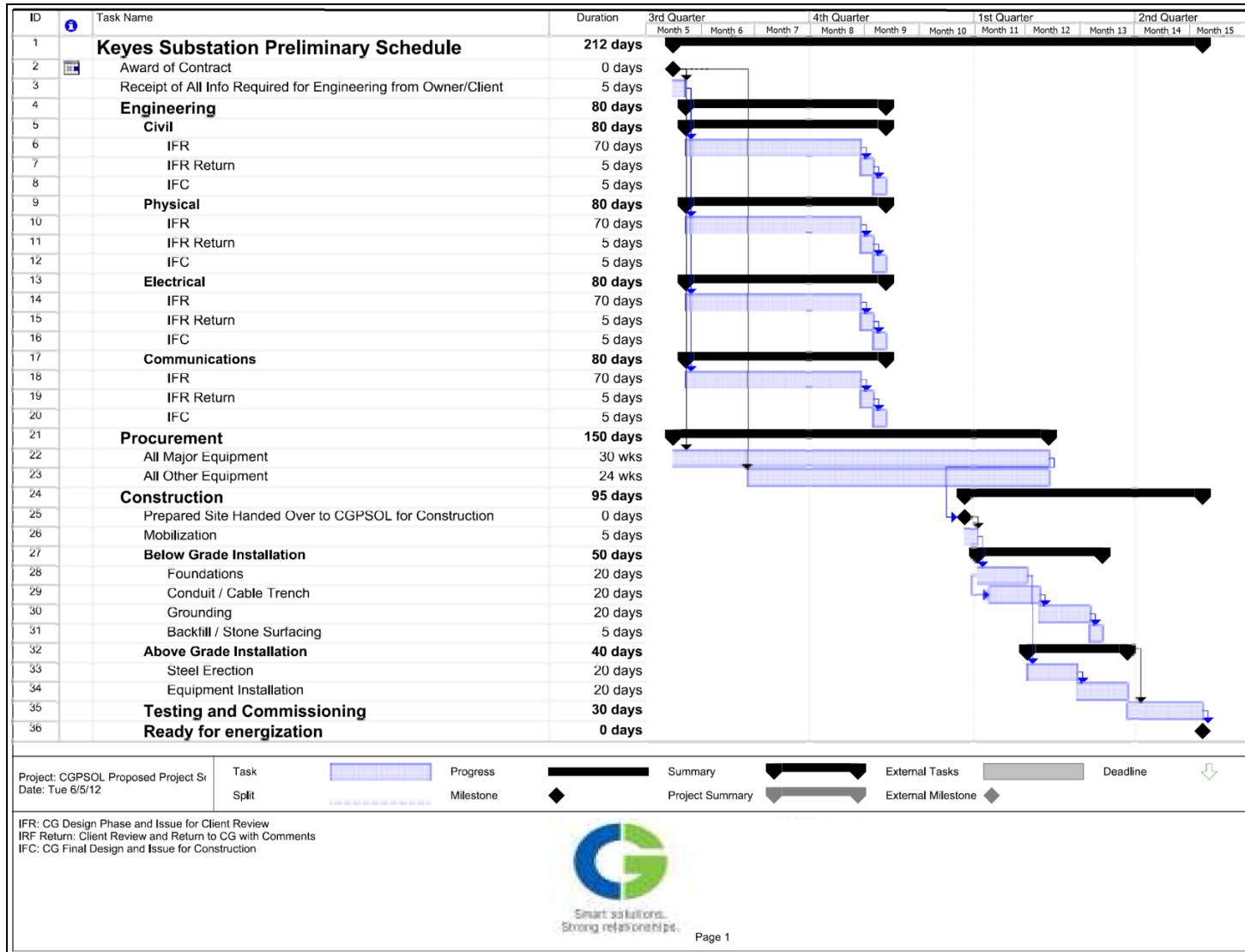


<p>LEGEND</p> <ul style="list-style-type: none"> — 690 V — 34.5 kV — 69 kV SURGE ARRESTOR REVENUE METER WIND TURBINE CIRCUIT BREAKER GE 1.5 MW WIND TURBINE GENERATORS 	<p>EP ELECTRIC POWER ENGINEERS, INC. 11614 Bee Caves Rd, Suite 200 Austin, TX 78738 Office: (512) 382-6200 ext. 301 Fax: (254) 716-1170 Email: contact@epconline.com</p>	<p>"The seal appearing on this document was authorized by Hugo E. Mensa, P.E. 110112, on August 9, 2012."</p>	<table border="1" style="width: 100%; border-collapse: collapse; font-size: 0.7em;"> <thead> <tr> <th>DATE</th> <th>REVISIONS</th> </tr> </thead> <tbody> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> <tr><td> </td><td> </td></tr> </tbody> </table>	DATE	REVISIONS																					<p>GENERATION ENERGY, INC. KEYES WIND FARM 42 MW ONE LINE DIAGRAM</p> <p style="font-size: 0.7em;">EP ELECTRIC POWER ENGINEERS, INC. Austin, TEXAS FILENAME: Keyes_OneLine.dwg Date: 8/9/12 SCALE:</p>
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APPENDIX 2 - Switchyard General Arrangement



APPENDIX 3 - Project Schedule and Milestones



APPENDIX 4- Communication between Keyes Wind Farm and Terminal Stations

