

KNOXVILLE UTILITIES BOARD

DISTRIBUTED GENERATION

INTERCONNECTION PROCEDURES

UNDER

THE TVA/KUB

GENERATION PARTNERS PROGRAM

(For Generating Facilities Less Than 1 MW)

1. GENERAL PROCEDURES & STANDARDS

1.1. Scope

These procedures describe the steps Interconnection Customers (herein after called “Customer”) participating in the TVA Generation Partners Program must follow in order for their renewable distributed generation facility (DG Facility) to be evaluated and approved for interconnection to the Knoxville Utilities Board (herein after called “KUB”) distribution system for parallel operation. Requirements for interconnection will be based on the size of the system and will be broken into the following categories:

Tier 1 – 30 kW or less;

Tier 2 – Greater than 30 kW and less than or equal to 100 kW; or

Tier 3 – Greater than 100 kW and less than 1 MW.

1.2 Contact Information for Generation Partner Coordinator

For additional information or program requirements, please contact Graylan Gibson at 524-2365 or Brad White at 558-2562.

1.3 Delivery Voltage Requirements

Customer will provide, own, and maintain appropriate voltage transformation equipment to match existing secondary or primary voltage as specified by KUB.

1.4. Connection to KUB’s Downtown Network System

Applications to interconnect systems located in the downtown area may require additional analysis to determine whether the proposed installation is on KUB’s networked secondary system. Networked secondary systems are in place to provide heightened levels of reliability in densely populated areas and may affect the ability of KUB to interconnect Distributed Generation. If your proposed installation is in the area bounded by Henley Street on the West, Jackson Ave. on the North, S. Central Street on the East, and Hill Avenue on the South please contact KUB (see section 1.2 above) prior to initiating this process.

1.5. Prior to Initiating Interconnection Application

Contact KUB’s Generation Partners Coordinator (see section 1.2 above) and schedule a site visit. During the site visit, the Generation Partners Coordinator will spot the meter location, and determine the delivery point voltage and electrical configuration based on the planned size and type of facility.

1.6. Application for Interconnection

Each Customer must submit a completed application to KUB prior to purchasing any DG Facility equipment. If the DG Facility meets the criteria for Tier 1, complete the Attachment 1 (Application). If the DG Facility meets the criteria of Tier 2 or 3, complete the Attachment 2 (Application). Please provide the supporting documents identified with each application.

1.7. Application Processing (See Figure 1)

- 1.7.1. KUB will review the Application for sufficiency and completeness and notify the Customer within 10 business days of receipt of the Application that it has received all documents required or indicate how the Application is deficient.
- 1.7.2. Within 10 business days, KUB will evaluate the system using the criteria of Section 2 Fast Track Screening Process to determine if an interconnection study is necessary. If the project does not pass the Fast Track Screening Process, the requirements outlined in Section 3 Study Process will be followed. Otherwise, KUB will notify the Customer that they may proceed with purchase and installation of the project and will send an Interconnection Agreement to the Customer for execution. The Customer will also be notified of any additional requirements. **Customer will not be allowed to proceed with parallel operation until all provisions of these procedures have been met and KUB has given written notification to proceed with parallel operation.**
- 1.7.3. The Customer must execute the Interconnection Agreement and return it to the KUB at least 15 calendar days prior to desired date of parallel operation and within one year after KUB executes the agreement.
- 1.7.4. After installation, the Customer returns the Attachment 3 - Certificate of Completion to KUB. Prior to parallel operation, KUB may inspect the DG Facility for compliance with the proposed design and may require a Commissioning Test in accordance with the procedures defined by the latest version of IEEE 1547.1. KUB will have the option of witnessing the Commissioning test or may require documentation from the equipment owner describing which tests were performed and their results.
- 1.7.5. If the inspection of the completed system and any required Commissioning test are satisfactory, KUB will notify the Customer in writing that interconnection of the DG Facility is authorized for parallel operation. If the system does not pass the inspection and/or Commissioning test, KUB has the right to Lockout the Facility. **The Customer shall not under any circumstance take any action to operate the system in parallel until the problems have been corrected and a new inspection and Commissioning test are performed, or waived by KUB.**

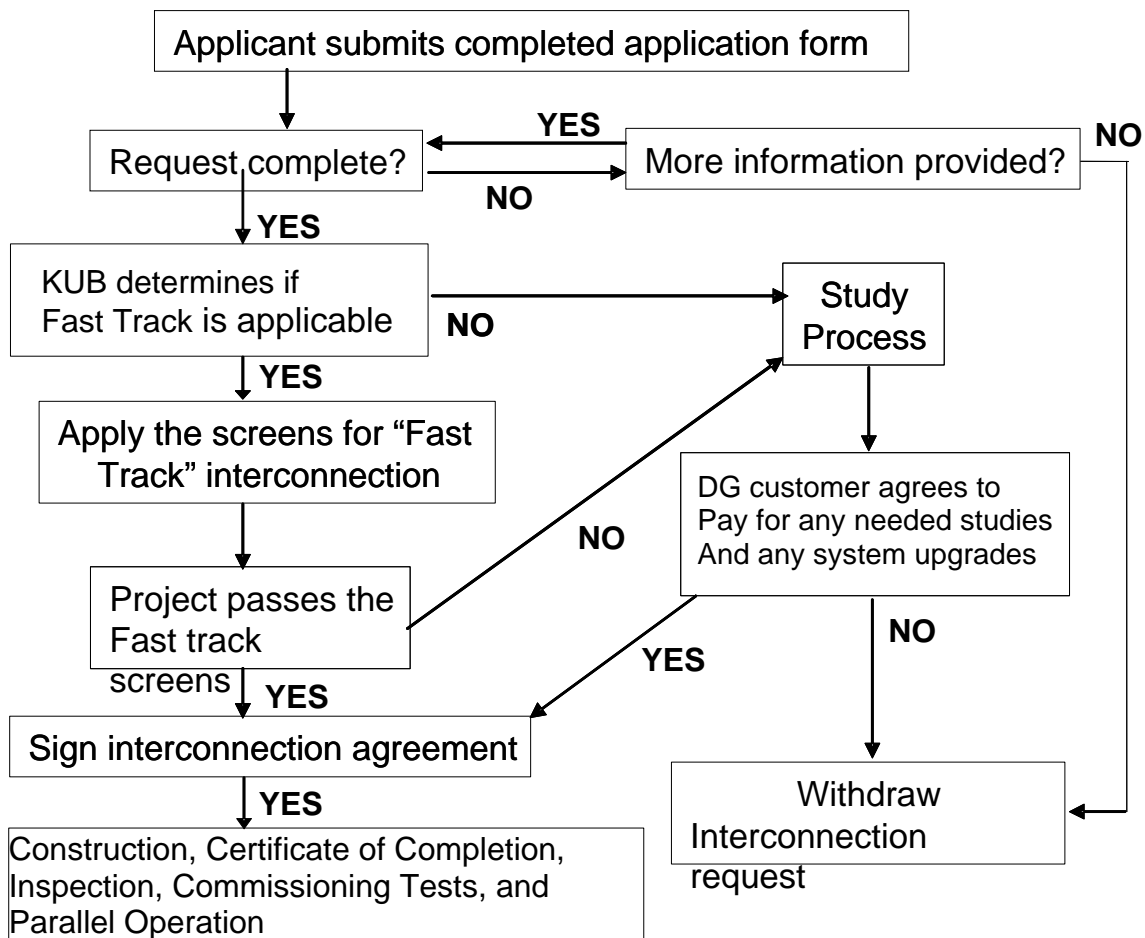


Figure 1. The Application Process

1.8. Standards and Certification Criteria

The DG Facility must comply with the latest revision of the following standards and the Customer must provide evidence of certification with the Application or with the Certificate of Completion:

- 1.8.1. IEEE1547 Standard for Interconnecting Distributed Resources with Electric Power Systems (including use of IEEE 1547.1 testing protocols to establish conformity)
- 1.8.2. IEEE1547.1 Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems
- 1.8.3. UL 1741 Inverters, Converters, and Controllers for Use in Independent Power Systems
- 1.8.4. NFPA 70 National Electrical Code
- 1.8.5. The DG Facility equipment shall be considered certified for interconnected operation if the generation equipment and all related interconnection components have been tested and listed by a Nationally Recognized Testing

Laboratory (NRTL certification by Department of Labor) for continuous interactive operation with an electric distribution system in compliance with the codes and standards outlined in 1.8.1 – 1.8.4 above.

- 1.8.6. The Customer must provide evidence that the installation has been inspected and approved by state or local code officials, as applicable, prior to its operation in parallel. This information will be submitted with the Certification of Completion.

2. FAST TRACK SCREENING PROCESS

2.1. Applicability

KUB will determine if the proposed system can follow the Fast Track process or if the design of the system would require evaluation under the Study Process of Section 3. Generally, this process is available to a Customer who's proposed DG Facility is no larger than 30 kW, utilizes inverters, and meets the codes, standards, and certification requirements of 1.5 above.

2.2. Fast Track Review Screens

Within 10 business days after KUB has received a sufficient and complete Interconnection Application, KUB will perform an initial review using the screens set forth below and will notify the Customer of the results.

2.2.1. Generation On Circuit As A Percent of Annual Peak Load

For interconnection of a proposed DG Facility to a radial distribution circuit, the aggregated generation, including the proposed DG Facility, on the circuit shall not exceed 15 % of the line section annual peak load as most recently measured at the substation. A line section is that portion of KUB's electric system connected to a Customer bounded by automatic sectionalizing devices or the end of the distribution line.

2.2.2. Maximum Fault Current

The proposed DG Facility, in aggregation with other generation on the distribution circuit shall not contribute more than 10% to the distribution circuit's maximum fault current at the point on the high voltage (primary) level nearest the proposed point of interconnection.

2.2.3. Short Circuit Interrupting capability

The proposed DG Facility, in aggregate with other generation on the distribution circuit, shall not cause any distribution protective devices and equipment (including, but not limited to, substation breakers, fuse cutouts, and line reclosers), or Customer equipment on the system to exceed 87.5 % of the short circuit interrupting capability; nor shall the interconnection be proposed for a circuit that already exceeds 87.5 % of the short circuit interrupting capability.

2.2.4. Type of Interconnection

Using the table below, determine the type of transformer connection allowable to interconnect a DG Facility with a primary distribution line through a

transformer. This screen includes a review of the type of electrical service provided to the Customer, including line configuration and the transformer connection to limit the potential for creating over-voltages on KUB’s electric power system due to a loss of ground during the operating time of any anti-islanding function.

Primary Distribution Line Type	Type of Interconnection to Primary Distribution Line	Result/Criteria
Three-phase, three wire	3-phase or single phase, phase-to-phase	Pass screen
Three-phase, four wire	Effectively-grounded 3 phase or Single-phase, line-to-neutral	Pass screen

2.2.5. Maximum Size for Single Phase

If the proposed DG Facility is to be interconnected on single-phase secondary, shared secondary, or individual service; the aggregate generation capacity on the single-phase secondary, shared secondary, or individual service shall not exceed 15 kW.

2.2.6. Load Balance

If the proposed DG Facility is single-phase and is to be interconnected on a center tap neutral of a 240 volt service, its addition shall not create an imbalance between the two sides of the 240 volt service of more than 20 % of the nameplate rating of the service transformer. If the proposed DG Facility is single-phase and is to be interconnected to a three phase service secondary or service, its addition shall not cause the load on any of the individual phases to exceed twice the load on any of the other two phases.

2.2.7. Transient Stability Problems

The DG Facility, in aggregate with other generation interconnected to the distribution side of a substation transformer feeding the circuit where the DG Facility proposes to interconnect shall not exceed 10 MW in an area where there are known, or posted, transient stability limitations to generating units located in the general electrical vicinity (e.g., three or four distribution busses from the point of interconnection).

2.2.8. No Upgrades Required

No construction of facilities by KUB on its own system shall be required to accommodate the DG Facility.

2.3. Fast Track Screening Results

If the proposed DG Facility passes the screens, the Customer’s Application will be approved and KUB will provide the Customer an executable Interconnection Agreement. If the proposed project does not pass the screens, the Customer will be

notified and offered the opportunity to attend a meeting where the processes outlined in **3.0 Study Process** will be explained and a course of action determined.

3. STUDY PROCESS

The study process (see Figure 3) consists of the minimum engineering review, the system impact study and the facilities study. At an initial meeting, the parties shall determine whether a minimum engineering review is sufficient, or the parties shall proceed directly to a system impact study, or a system upgrade study.

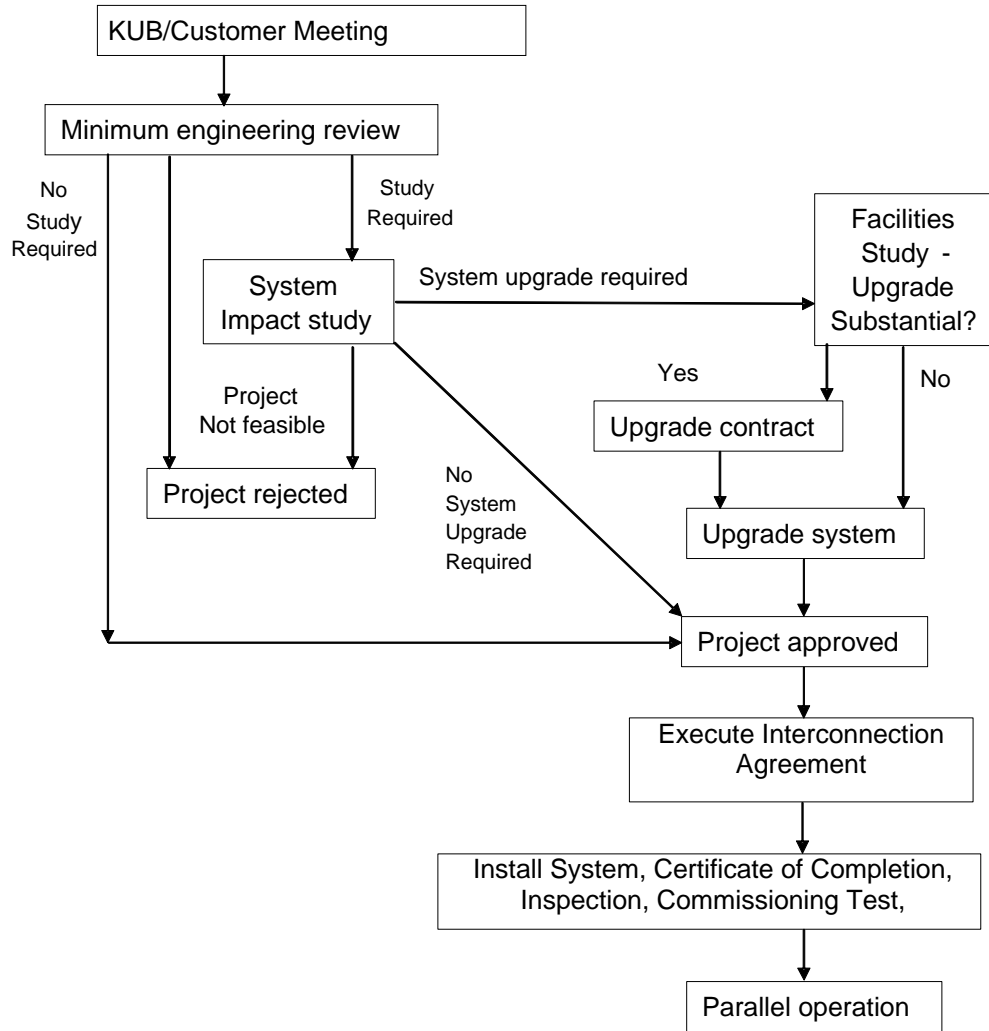


Figure 2. The Study Process

3.1. Minimum Engineering Review

The “Minimum Engineering Review” also known as the Feasibility Study in FERC Order 2006 is designed to identify any adverse system impacts that would result from interconnection of the DG Facility. Examples of such negative impacts would include exceeding the short circuit capability rating of any breakers, violations of thermal overload or voltage limits, and a review of grounding requirements and electric system protection. If KUB determines that the Minimum Engineering Review will require substantial time, KUB may ask Customer to reimburse it for the costs associated with this review.

3.2. System Impact and Facilities Studies

Beyond the minimum engineering review (or feasibility review), the study process includes the System Impact Study and the Facilities Study. A system impact study is designed to identify and detail the electric system impacts that would result if the proposed project were interconnected without project modifications or electric system modifications, focusing on the adverse system impacts identified in the feasibility study. A system impact study shall evaluate the impact of the proposed interconnection on the reliability of the electric system.

In instances where the system impact study shows potential for distribution system adverse impacts, KUB will send the Customer a distribution system impact study agreement, including an outline of the scope of the study and a non-binding good faith estimate of the cost to perform the study, if such a study is required. Once the Customer agrees to pay the cost of the study, the process continues.

Once the required system impact study is complete, a facilities study agreement if needed, including an outline of the scope of the study and a non-binding good faith estimate of the cost to perform the facilities study, will be sent to the Customer. Design for any required Interconnection Facilities and/or Upgrades would be performed under the facilities study agreement. Upon completion of the facilities study, and with the agreement of the Customer to pay for Interconnection Facilities and Upgrades identified in the facilities study, KUB will provide the Customer an executable Interconnection Agreement.

**Attachment 1 - Application for Interconnection of Distributed Generation
Generation Partners Program**

Tier 1(30 kW or less)

Customer

Name: _____
Address: _____
City: _____ State: _____ Zip: _____
Telephone (Day): _____ (Evening): _____
Fax: _____ E-Mail Address: _____
Electric Service Account Number: _____
Owner of Building if different than Customer: _____

Contact (if different from Customer)

Name: _____
Address: _____
City: _____ State: _____ Zip: _____
Telephone (Day): _____ (Evening): _____
Fax: _____ E-Mail Address: _____

Owner of System (If different than Customer)

Name: _____
Address: _____
City: _____ State: _____ Zip: _____
Telephone (Day): _____ (Evening): _____
Fax: _____ E-Mail Address: _____

ELECTRICAL CONTRACTOR (as applicable)

Company: _____
Mailing Address: _____
City: _____ County: _____ State: _____ Zip Code: _____
Phone Number: _____ Representative: _____
Email Address: _____ Fax Number: _____
Contractor's License # _____ City/County/State _____

Generating Facility Information

Location (if different from above): _____

Account Number: _____

Inverter Manufacturer: _____ Model _____

Nameplate Rating: _____ (kW) _____ (kVA) _____ (AC Volts)

Single Phase _____ Three Phase _____

System Design Capacity: _____ (kW) _____ (kVA)

Energy Source: Solar Wind Hydro Other (describe) _____

Attach support information to show testing and listing by a Nationally Recognized Laboratory for compliance with the codes and standards outlined in 1.4.1 – 1.4.4 for the proposed system.

Estimated Installation Date: _____ Estimated In-Service Date: _____

List components of the Small Generating Facility equipment package that are currently certified:

Equipment Type	Certifying Entity
1. _____	_____
2. _____	_____
3. _____	_____
4. _____	_____
5. _____	_____

ADDITIONAL INFORMATION – Single Line Diagram

In addition to the items listed above, please attach a detailed one-line diagram of the proposed facility, all applicable elementary diagrams, major equipment, (generators, transformers, inverters, circuit breakers, protective relays, batteries, number and location of PV Panels, etc.) specifications, test reports, etc., and any other applicable drawings or documents necessary for the proper design of the interconnection. Also describe the address or grid coordinates of the facility.

Permission to Interconnect

Customer must not operate their generating facility in parallel with KUB’s system until they receive written authorization for parallel operation from KUB. Unauthorized parallel operation could result in injury to persons and /or damage to equipment and/or property for which the Customer may be liable.

Interconnection Customer Signature

I hereby certify that, to the best of my knowledge, the information provided in this Application is true.

Signed: _____

Title: _____ Date: _____

Attachment 2 - Application for Interconnection of Distributed Generation

Generation Partners Program

**Tier 2 (Greater than 30 kW and less than or equal to 100 kW)
& Tier 3 (Greater than 100 kW and less than 1 MW)**

PART 1

CUSTOMER INFORMATION

Name: _____

Mailing Address: _____

City: _____ County: _____ State: _____ Zip Code: _____

Phone Number: _____ Representative: _____

Email Address: _____ Electric Service Account Number _____

Fax Number: _____

PROJECT DESIGN/ENGINEERING (as applicable)

Company: _____

Mailing Address: _____

City: _____ County: _____ State: _____ Zip Code: _____

Phone Number: _____ Representative: _____

Email Address: _____ Fax Number: _____

PE License _____ State _____

ELECTRICAL CONTRACTOR (as applicable)

Company: _____

Mailing Address: _____

City: _____ County: _____ State: _____ Zip Code: _____

Phone Number: _____ Representative: _____

Email Address: _____ Fax Number: _____

Contractor's License # _____ City/County/State _____

TYPE OF GENERATOR (as applicable)

Photovoltaic _____ Wind _____ Other _____

ESTIMATED LOAD AND GENERATOR RATING INFORMATION

The following information is necessary to help properly design the KUB Customer interconnection.

Total Site Load _____ (Highest kW Demand Last 12 Months)
Residential _____ Commercial _____ Industrial _____
System Rating _____ (kW) Annual Estimated Generation _____ (kWh)

PART 2

(Complete all applicable items. Copy this page as required for additional generators)

SYNCHRONOUS GENERATOR DATA

Identification per Single Line Drawing: _____
Total number of units with listed specifications on site: _____
Manufacturer: _____
Type: _____ Date of manufacture: _____
Serial Number (each): _____
Phases: Single Three R.P.M.: _____ Frequency (Hz): _____
Rated Output (for one unit): _____ Kilowatt _____ Kilovolt-Ampere
Rated Power Factor (%): _____ Rated Voltage (Volts): _____ Rated Amperes: _____
Field Volts: _____ Field Amps: _____ Motoring power (kW): _____
Synchronous Reactance (Xd): _____ % on _____ KVA base
Transient Reactance (X'd): _____ % on _____ KVA base
Negative Sequence Reactance (Xs): _____ % on _____ KVA base
Sequence Reactance (Xo): _____ % on _____ KVA base
Neutral Grounding Resistor Size (if applicable): _____
I₂²t or K (heating time constant): _____
Additional information: _____

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INDUCTION GENERATOR DATA

Rotor Resistance (Rr): _____ ohms Stator Resistance (Rs): _____ ohms
Rotor Reactance (Xr): _____ ohms Stator Reactance (Xs): _____ ohms
Magnetizing Reactance (Xm): _____ ohms Short Circuit Reactance (Xd''): _____ ohms
Design letter: _____ Frame Size: _____ Exciting Current: _____
Temp Rise (deg C°): _____ Reactive Power Required: _____ Vars (no load), _____
Vars (full load) Additional information: _____

PRIME MOVER (Complete all applicable items)

Identification per Single Line Diagram _____ Unit Number: _____
Type: _____
Manufacturer: _____
Serial Number: _____ Date of manufacture: _____
H.P. Rated: _____ H.P. Max. _____ Inertia Constant: _____ lb.-ft.²
Energy Source (hydro, wind, etc.) _____

INVERTER DATA (if applicable)

Manufacturer: _____ Model: _____
Rated Power Factor (%): _____ Rated Voltage (Volts): _____ Rated Amperes: _____
Inverter Type (Ferro resonant, step, pulse-width modulation, etc): _____
Single or Three Phase _____ Type commutation: forced _____ line _____
Harmonic Distortion: Maximum Single Harmonic (%) _____
Maximum Total Harmonic (%) _____

POWER CIRCUIT BREAKER (if applicable)

Manufacturer: _____ Model: _____
Rated Voltage (kilovolts): _____ Rated ampacity (Amperes) _____
Interrupting rating (Amperes): _____ BIL rating: _____
Interrupting medium / insulating medium (ex. Vacuum, gas, oil) _____ / _____
Control Voltage (Closing): _____ (Volts) AC DC
Control Voltage (Tripping): _____ (Volts) AC DC Battery Charged Capacitor
Close energy: Spring Motor Hydraulic Pneumatic Other: _____
Trip energy: Spring Motor Hydraulic Pneumatic Other: _____
Bushing Current Transformers: _____ (Max. ratio) Relay Accuracy Class: _____
Multi ratio? No Yes: (Available taps) _____
Description of Control System _____

ADDITIONAL INFORMATION – Single Line Diagram

In addition to the items listed above, please attach a detailed one-line diagram of the proposed facility, all applicable elementary diagrams, major equipment, (generators, transformers, inverters, circuit breakers, protective relays, batteries, number and location of PV Panels, etc.) specifications, test reports, etc., and any other applicable drawings or documents necessary for the proper design of the interconnection. Also describe the address or grid coordinates of the facility.

Permission to Interconnect

Customer must not operate their generating facility in parallel with KUB’s system until they receive written authorization for parallel operation from KUB. Unauthorized parallel operation could result in injury to persons and /or damage to equipment and/or property for which the Customer may be liable.

Interconnection Customer Signature

I hereby certify that, to the best of my knowledge, the information provided in this Application is true.

Signed: _____

Title: _____ Date: _____

Attachment 3 - Certificate of Completion Generations Partners Program

Interconnection Customer: _____

Contact Person: _____

Address: _____

Location of the Small Generating Facility (if different from above):

City: _____ State: _____ Zip Code: _____

Telephone (Day): _____ (Evening): _____

Fax: _____ E-Mail Address: _____

Electrician:

Name: _____

Address: _____

City: _____ State: _____ Zip Code: _____

Telephone (Day): _____ (Evening): _____

Fax: _____ E-Mail Address: _____

License number: _____

Inspection:

The Small Generating Facility has been installed and inspected in compliance with the local building/electrical code of _____

Signed (Local electrical wiring inspector, or attach signed electrical inspection):

Print Name: _____ Date: _____

As a condition of interconnection, you are required to send a copy of this form along with a copy of the signed electrical permit to:

Name: New Service Department

Company: Knoxville Utilities Board

Address: P.O, Box 59017

City, State ZIP: Knoxville TN, 37950