

INTERCONNECTION MANUAL
For Distributed Generation Projects



Tucson Electric Power

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2. 1. INTRODUCTION

This document, in accordance with Arizona Administrative Code (A.A.C.) Title 14, Chapter 2, Article 26, Interconnection of Distributed Generation Facilities, specifies the technical requirements for interconnecting and operating a Generating Facility in parallel with the Tucson Electric Power Company (TEP) Distribution System. TEP Customers, TEP Customers' authorized representatives, and TEP personnel shall use this document when planning for the installation of a Generating Facility. Information presented herein conforms to the Customer Rights and Responsibilities and the Utility Rights and Responsibilities articulated in the above referenced article of the A.A.C.

3. 2. SCOPE

This document addresses the technical requirements of interconnection. Website <https://www.tep.com/get-started-with-solar> has additional information regarding the TEP interconnection application process, including application forms and instructions.

TEP will interconnect Distributed Generation Facilities according to the applicable provisions of the Arizona Administrative Code (A.A.C.) Title 14, Chapter 2, Article 26, Interconnection of Distributed Generation Facilities (i.e. A.A.C. R14-2-2614 and R14-2-2616 through 2623). A copy of A.A.C. Title 14, Chapter 2, Article 26 can be found here: <https://docket.images.azcc.gov/E000005485.pdf?i=1620401618330>.

The requirements in this document may not cover all technical details in specific cases. Other applicable requirements may be found in the TEP Electric Service Requirements Book (ERSB) at <https://www.tep.com/electric-service-requirements>.

4. 3. APPLICABILITY

3.1 Covered

This document applies to all Generating Facilities that intend to operate in parallel, either on a continuous or momentary basis, with the TEP Distribution System. By definition, the TEP Distribution System includes all circuits of primary voltage 46kV line-to-line and less. Generating Facilities include distributed generation, energy storage, and co-generation.

3.2 Not Covered

This document does not apply to the following:

- a. Generating Facilities that request to interconnect at voltages higher than the highest distribution voltage offered by TEP (46kV line-to-line).

- b. Generating Facilities that are large enough in capacity that they cannot be accommodated by the TEP distribution circuit.
- c. Back-up generation, or separate systems, that will never operate in parallel with the TEP Distribution System. Such systems will require a double-throw open-transition switch (break-before-make) to transfer customer load from TEP to the back-up generator/separate system or from the back-up generator/separate system to TEP. This requirement applies to both emergency operation and for routine testing of the Generating Facility. See the TEP Electric Service Requirements for further information.

4. DEFINITIONS

Advanced Inverter: A grid interactive static inverter with functions to allow for more elaborate monitoring and communication of the grid status, the ability to receive operation instructions from a centralized location, and the capability to make autonomous decisions to improve grid stability, support power quality, and provide ancillary services such as voltage regulation, power factor control, and reactive power control.

Advanced Metering Infrastructure (AMI): The TEP-owned metering system whereby electrical meters transmit electric usage and other data via a radio and/or cell phone communication system to a central data collection system.

Application: The standard form or format for an applicant to apply to TEP for Interconnection of a Generating Facility with the Distribution System.

Arizona Corporation Commission (ACC): The regulatory agency of the State of Arizona having jurisdiction over public service corporations operating in Arizona.

Authority Having Jurisdiction (AHJ): The governmental authority having jurisdiction to inspect and approve the installation of a Generating Facility.

Backfeed: To energize a section of the TEP electric system with a Generating Facility.

Bi-directional Meter: A meter having two separate metering registers, one to record electricity delivered to a Customer and the other to record electricity received from that Customer.

Certified Equipment: Specific generating and protective equipment system or systems certified as meeting the requirements in Section 8 relating to testing, operation, safety, and reliability by a Nationally Recognized Testing Laboratory (NRTL).

Clearance: A statement by one having complete authority over all parts of a circuit or piece of electrical equipment that said circuit or electrical equipment is disconnected from all known sources of power. It is assurance that all proper precautionary measures have been taken and workers may proceed to inspect, test, and install grounds on the circuit.

Clearance Point: The physical location on a section of circuit or equipment that is to be visibly disconnected from all known sources of power.

Customer: An electric consumer applying to connect a Generating Facility on the consumer's side of the TEP revenue meter.

Disconnect Switch: A means to disconnect the Generating Facility from TEP that is:

- a. Installed and maintained for a Generating Facility by the Customer;
- b. A visible-open, manual, gang-operated, load break disconnect device;
- c. Capable of being locked in a visible-open position by a standard Utility padlock that will completely isolate the Generating Facility from the Distribution System.
- d. Capable of being grounded on the Utility side if the Generating Facility operating voltage is over 500 volts.

Distributed Generation (DG): Any type of electric generator, static inverter, or Generating Facility interconnected with the TEP Distribution System that (1) has the capability of operating in electrical parallel with the TEP system, or (2) can feed a Customer load that can also be fed by the TEP system.

Distribution System: The infrastructure constructed, maintained, and operated by TEP to deliver electric service at the distribution level to retail customers.

Energy Storage: The capture of energy produced at one time for use at a later time. A device that stores energy with the potential to Backfeed the Distribution System.

Exporting System: Any type of Generating Facility that is designed to regularly Backfeed the Distribution System.

Fault Current: The level of current that can flow if a short circuit is applied to a voltage source.

Generating Facility: All or part of a Customer's electrical generator(s) and/or energy storage system(s) together with all inverter(s) and protective, safety, and associated equipment necessary to produce electric power at the Customer's facility.

Generator: A rotating machine or static inverter used to produce electric power.

Good Utility Practice: Any of the practices, methods, and acts engaged in or approved by a significant portion of the electric industry during the relevant time period, or any of the practices, methods, and acts which, in the exercise of reasonable judgment in light of the facts known at the time the decision was made, could have been expected to accomplish the desired result at a reasonable cost consistent with good business practices, reliability, safety, and expedition. Good Utility Practice is not intended to be limited to the optimum practice,

method, or act to the exclusion of all others, but rather to be acceptable practices, methods, or acts generally accepted in the region at the relative time.

Inadvertent Export: The unplanned, uncompensated transfer of electrical energy from a Generating Facility to the Distribution System across the Point of Interconnection.

Interconnection: The physical connection of a Generating Facility to the Distribution System.

Interconnection Agreement: An agreement signed between TEP and the Customer, covering the terms and conditions governing the Interconnection and operation of the Generating Facility with TEP, including any appendices to the agreement.

Interconnection Facilities: The electrical wires, switches, and related equipment that are required, in addition to the facilities required to provide electric distribution service to a Customer, to allow Interconnection. Interconnection Facilities may be located on either side of the Point of Interconnection as appropriate to their purpose and design.

Interconnection Manual: A separate document developed and maintained by TEP as required by the ACC Interconnection of Distributed Generation Facilities regulation, Section R14-2-2628. The manual contains technical, safety, and protection requirements necessary to interconnect a Generating Facility to the TEP Distribution System.

Interconnection Study: A study that may be undertaken by TEP (or a TEP-designated third party) in response to TEP's receipt of a completed Application. An Interconnection Study may include:

- a. a Feasibility Study
- b. a System Impact Study
- c. a Facilities Study
- d. additional analysis required by TEP.

Islanding: A condition in which a portion of the TEP electric power system is energized solely by one or more local electric power systems throughout the associated Point of Interconnection while that portion of the electric power system is electrically separated from the rest of the TEP electric power system. Islands can be intentional (planned) or unintentional (unplanned).

Maximum Capacity: The nameplate kilovolt-ampere, alternating current (AC) capacity of a Generating Facility or, if the Operating Characteristics of the Generating Facility limit the power transferred across the Point of Interconnection to the Distribution System, only the power transferred across that Point of Interconnection, not including Inadvertent Export.

Metering: The function related to measuring the transfer of electric power and/or energy.

Meter Socket Adapter (MSA): A device installed at the Customer-owned electrical panel between the meter socket and the TEP revenue meter to facilitate connection of Customer-owned technology.

Momentary Parallel Closed Transition Switching: The transfer of electrical load between two power sources that occurs by electrically paralleling the power sources for a brief period of time in order to affect a rapid transfer of load between the power sources.

Non-Exporting System: A system in which there is no designed, regular export of power from the Generating Facility to the Distribution System.

Operating Characteristics: The mode of operation of a Generating Facility (Exporting System, Non-Exporting System, or Inadvertent Exporting System) that controls the amount of power delivered across the Point of Interconnection to the Distribution System.

Parallel System: A Generating Facility that can be electrically interconnected to a bus common with the TEP electric power system, and can operate in electrical parallel either on a momentary or continuous basis.

Point of Interconnection: The physical location where the TEP service conductors are connected to a Customer's service conductors, bus, and/or service equipment to allow parallel operation of the Customer's Generating Facility with the TEP Distribution System.

Readily Accessible: Capable of being reached quickly and conveniently on a 24-hour basis without climbing over or removing obstacles, obtaining special permission, keys or security clearances.

Reclosing: The act of automatically re-energizing a utility power line in an attempt to restore power following a fault on the line.

Relay: An electric device that is designed to interpret input conditions in a prescribed manner and after specified conditions are met to respond to cause operation or similar abrupt change in associated electric control circuits.

Representative: An agent of the Customer who is designated by the Customer and is acting on the Customer's behalf.

Rotating Machine: An induction or synchronous machine used to generate alternating current (AC) electric power.

Service Entrance Section (SES): The Customer-owned main electrical panel or equipment located at its premises to which TEP delivers electric energy via a service drop or service lateral.

Static Inverter: An electronic device used to convert direct current (DC) power into alternating current (AC) power.

Transfer Switch: Source transfer equipment which may be designed to be automatically or manually operated for the purpose of transferring electrical load from one power source to another.

Transfer Trip Scheme: A form of remote trip in which a communication channel is used to transmit a trip signal from the relay location (e.g. TEP substation) to a remote location (e.g. Customer Generating Facility).

Unsafe Operating Conditions: Conditions that if left uncorrected may result in (1) harm to personnel, (2) damage to equipment, (3) adverse effect to the safe operation of the Distribution System, and/or (4) operation of the Generating Facility outside pre-established parameters required by the Interconnection Agreement.

Utility: An electric distribution company (for the purposes of this document, Tucson Electric Power Co.) that constructs, operates, and maintains the electrical Distribution System for the receipt and delivery of electric power.

5. APPLICABLE STANDARDS

Customer Generating Facilities shall comply with the codes, guides, and standards listed below. If there is any conflict between the below documents and this Interconnection Manual, the Interconnection Manual shall govern.

- a. ANSI C84.1-2016, Electric Power Systems and Equipment – Voltage Ratings (60 Hertz)
- b. IEEE 519-2014, IEEE Recommended Practice and Requirements for Harmonic Control in Electrical Power Systems
- c. IEEE 1453-2015, IEEE Recommended Practice for the Analysis of Fluctuating Installations on Power Systems
- d. IEEE 1547-2018, IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces
- e. IEEE 1547.1-2020, IEEE Approved Draft Standard Conformance Test Procedures for Equipment Interconnecting Distributed Energy Resources with Electric Power Systems and Associated Interfaces
- f. IEEE C37.90-2005 (R2011), IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus
- g. IEEE C37.90.1-2012, IEEE Standard for Surge Withstand Capability Tests for Relay and Relay Systems Associated with Electric Power Apparatus
- h. IEEE C37.90.2-2004, IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
- i. NFPA 70-2017, National Electrical Code (NEC)
- j. UL 1741-2010, Standard for Inverters, Converters, Controllers, and Interconnection Equipment for Use with Distributed Energy Resources

- k. UL 1741 SA-2016, Standard for Inverters, Converters, Controllers, and Interconnection Equipment for Use with Distributed Energy Resources, Supplement A

6. GENERATOR FACILITY PARALLEL OPERATION MODES

A Parallel System is any type of Generating Facility that can electrically parallel with, or potentially Backfeed the TEP system. This includes any Generating Facility using a closed-transition transfer switch or transfer scheme to transfer Customer load from TEP to Generating Facility and vice-versa. Also included is any Static Inverter that can be configured or programmed to operate in “utility interactive” mode.

Several Generating Facility parallel operation modes are defined in the ACC rule for Interconnection of Distributed Generation Facilities. They are Exporting, Non-Exporting, and Inadvertent Exporting.

6.1 Exporting System

An Exporting System is designed to operate in electrical parallel with the Utility Distribution System and may Backfeed (i.e. export power to) the Distribution System at any time.

6.2 Non-Exporting System

A Non-Exporting System is designed to operate in electric parallel with the Utility Distribution System, but never export power across the Point of Interconnection. This is accomplished by either sizing the Generating Facility such that exporting power is not possible or by inclusion of control functions to prevent the export of power. Non-Exporting operation is subject to TEP confirmation and other TEP interconnection requirements detailed in this manual still apply.

6.3 Inadvertent Exporting System

An inadvertent Exporting System is designed to operate in electrical parallel with the Utility Distribution System and may momentarily export power on an infrequent basis, such as times during an abrupt increase or decrease of Customer load. The two types of Inadvertent Exporting Systems and their momentary power export limits are as follows:

6.3.1 Generating Facility Using UL 1741 or UL 1741 SA Inverter(s)

- a. Utilize control functions that limit the export of electrical power to the Distribution System
- b. Have a Maximum Capacity of 500kVA or less
- c. Have a magnitude of Inadvertent Export of no more than 100kVA
- d. Have a duration of Inadvertent Export of power of less than 30 seconds for any single event
- e. Monitor that its total energy export per month is maintained to be no more than its Maximum Capacity multiplied by 0.1 hours per day over a rolling 30-day

period (e.g. a 100kVA gross nameplate capacity Generating Facility would have a maximum energy export per 30-day month of 300kWh)

- f. Disconnect the Generating Facility from the Distribution System in the event of an Inadvertent Export, ceasing to energize the Distribution System or halting energy production, within two seconds after the period of uninterrupted export exceeds 30 seconds or the magnitude of export exceeds 100kVA
- g. Enter a safe operation mode, where Inadvertent Export events cannot occur, upon failure of the control or inverter system for more than 30 seconds, whether from loss of control signal, loss of control power, or a single component failure or related control sensing of the control circuitry

6.3.2 Generator Facility Not Using UL 1741 or UL 1741 SA Inverter(s)

- a. The amount of Inadvertent Export to the Distribution System shall be limited to the lesser of (1) 50% of the Generating Facility's Maximum Capacity, (2) 10% of the continuous conductor rating in watts at 0.9 power factor for the lowest rated feeder conductor up-line of the Generating Facility, or (3) 500kW.
- b. The frequency of Inadvertent Export events shall be less than two occurrences per 24-hour period.

7. GENERATOR TYPES AND SIZE CLASSES

TEP protection requirements for Customer Generator Facilities are based on the size and characteristics of the parallel Generator. In addition, location of the Generating Facility interconnection to the Distribution System can impact protection requirements as TEP facility operating characteristics are not uniform throughout the Distribution System. The following describes the types and sizes of most DG and their relative impacts to TEP.

7.1 Rotating Machines

A Generator that is a rotating machine produces electricity using an electro-mechanical energy conversion process. Part of the mechanical system includes a rotor which is a rotational mass of considerable inertia. That inertia can delay Generator response to abnormal Distribution System events. The two rotating machine Generator types are synchronous generators and induction generators.

7.1.1 Synchronous Generators

Synchronous generators are generally capable of supplying sustained current for faults on the TEP system. These units can also operate independently from TEP and supply isolated TEP load if the load is within the unit's output capability. Therefore, synchronous generators are of particular concern because their significant fault current contribution can negatively affect TEP protection schemes and because they are capable of energizing a de-energized TEP circuit. Synchronous generators are also vulnerable to damage for out-of-sync paralleling should they be operating when TEP attempts to re-

energize the circuit from the Utility source. Therefore, synchronous generators must be designed to automatically separate from TEP upon loss of Utility voltage.

7.1.2 Induction Generators

Induction generators are basically induction motors that are mechanically driven above synchronous speed to produce electric power. These units do not have a separate excitation system and require their output terminals be energized with alternating current (AC) voltage and supplied with reactive power to develop the magnetic flux. For this reason, induction generators are normally not capable of supplying sustained fault current into faults on the TEP system. Such units are generally not capable of supplying isolated load when separated from the TEP system; however, it is possible for an induction generator to become self-excited if a sufficient amount of capacitance exists at its output terminals. Under conditions of self-excitation, an induction generator will be capable of supplying isolated load, provided the load is within the unit's output capability. In most cases, when self-excitation occurs it will be accompanied by a sudden increase in terminal voltage. TEP and its other customers must be protected from out-of-sync closing and over-voltages that can occur whenever an induction generator becomes self-excited. Therefore, induction generators shall be designed to automatically separate from the TEP system upon loss of Utility voltage and prior to reclosing of the TEP feeder.

7.2 Static Inverters

Static inverters convert direct current (DC) power to alternating current (AC) power by means of electronic switching. Switching can be controlled by the AC voltage of the Utility supply system (line-commutated) or by internal electronic circuitry (forced-commutated).

Line-commutated inverters are generally not capable of operating independently of the Utility AC supply system, cannot normally supply any appreciable fault current, or continue to energize isolated loads provided proper protective functions are in place. To accommodate such protective functions, any line-commutated inverter that is electrically paralleled with the TEP system shall be tested and certified to UL 1741 or UL 1741 SA by a Nationally Recognized Testing Laboratory (NRTL).

Forced-commutated, or self-commutated, inverters are capable of energizing load independently of the Utility system. Any forced-commutated inverter, the output of which is to be directly interconnected with TEP, needs to be specifically designed for that purpose. It would need to be designed to accommodate parallel interfacing and operation. However, it is not anticipated at this time that any forced-commutated inverters will be interconnected to the TEP system. TEP will consider this type of interconnection on a case-by-case basis. Under no circumstances shall the self-commutated output of a "battery backup" type inverter, which is normally designed to energize a subpanel independently of the Utility, be connected to the TEP system.

7.3 Definition of Generator Size Classes

The protection requirements detailed in Section 9 of this manual vary based on Generating Facility size and type. (Facilities that are Non-Exporting, Inadvertent Exporting, or qualify for review under Level 1 Super Fast Track or Level 2 Fast Track are not subject to all of the protection requirements listed in Section 9.) TEP defines the various Generating Facility size classes as follows:

Class I	100kW or less single-phase, 50kW or less three-phase
Class II	51kW to 300kW three-phase
Class III	301kW to 2500kW, three-phase
Class IV	Greater than 2500kW, three-phase

8. APPLICATION REVIEW CONSIDERATIONS

8.1 Declaration of Generating Facility Type, Maximum Capacity, and Parallel Operating Mode

When applying to interconnect a Generating Facility to the TEP Distribution System, the Customer must declare Generator type (rotating machine or inverter-based), Maximum Capacity (kVA or kW), and mode of parallel operation (Exporting, Non-Exporting, or Inadvertent Exporting).

To qualify for Interconnection as a Non-Exporting Generating Facility, Customer must either furnish data showing that their minimum load in kVA over the previous 12-month period was greater than the Generating Facility AC nameplate capacity, or show proof that the Generating Facility control/protection scheme will prevent the export of power under all conditions.

To qualify for Interconnection as an Inadvertent Exporting Generating Facility, Customer must furnish information and data to demonstrate conformance to the restrictions listed in Section 6.3 of this document.

8.2 Certified Equipment

Certified Equipment includes Generating Facility and Interconnection Facility equipment, furnished separately or packaged together as an interconnection system, that meet the requirements set forth in this Interconnection Manual. Certified Equipment, in conjunction with adherence to other requirements in this Interconnection Manual, means that the Customer will not have to install additional controls or perform or pay for additional tests in order to obtain approval to interconnect.

To qualify as Certified Equipment, Generating Facility equipment proposed for use separately or packaged with other equipment for the Interconnection shall:

- a. Comply with all applicable codes and standards listed in Section 5 of this document.
- b. Comply with all applicable codes and standards used by a Nationally Recognized Testing Laboratory (NRTL) to test and certify Interconnection Equipment.
- c. Be labeled and publicly listed as certified by the NRTL at the time of application submission.

If Certified Equipment includes only interface components (switchgear, inverters, or other interface devices), a Customer shall show, upon request from TEP, that the Generating Facility is compatible with the interface components and consistent with the testing and listing specified for the Interconnection equipment. A Customer is not required to ensure that equipment provided by the Utility is Certified Equipment.

8.3 Review Screens

Generating Facility interconnection applications will be reviewed against some or all of the below screens depending on system size. The screens are used to determine which application process applies to each project.

Screens

- A. For interconnection of a proposed Generating Facility to a distribution circuit, the aggregated generation on the circuit, including the Proposed Generating Facility, shall not exceed 15% of the total circuit annual peak load as most recently measured at the substation or on the line section (if available), or the circuit hosting capacity limit, whichever is greater. Non-Exporting Systems, regardless of system size, and Inadvertent Export systems with a Maximum Capacity of 20kW and under shall not be subject to this subsection.
- B. A proposed Generating Facility shall not contribute more than 10% to a distribution circuit's maximum fault current at any point on the Distribution System, including during normal contingency conditions that may occur due to reconfiguration of the feeder or the distribution substation.
- C. The proposed Maximum Capacity of a Generating Facility, in aggregate with the Maximum Capacity of other generation on a distribution circuit, shall not cause any distribution protective devices and equipment (including, but not limited to, substation breakers, fuse cutouts, and line reclosers), or consumer equipment on the system, to exceed 90% of the short circuit interrupting capability. Interconnection shall not be proposed for a circuit that already exceeds 90% of the short circuit interrupting capability.
- D. TEP employs a three-phase, four-wire, primary Distribution System. Interconnection to TEP shall be line-to-neutral for both three-phase and single-phase Generating Facilities.
- E. If a proposed Generating Facility is to be interconnected on a single-phase shared secondary, the aggregate generation capacity on the shared secondary, including the Maximum Capacity of the Generating Facility, shall not exceed 75% of the service transformer rating. Non-Exporting Systems and Inadvertent Export systems shall not be subject to this subsection.

- F. If a proposed Generating Facility is single-phase and is to be interconnected on a transformer 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.
- G. A proposed Generating Facility, in aggregate with other generation interconnected to the distribution low-voltage side of a substation transformer feeding the distribution circuit where the Generating Facility would interconnect, shall not exceed 10MW 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 transmission voltage level busses from the Point of Interconnection). Non-Exporting Systems, regardless of system size, and Inadvertent Export Systems with a Maximum Capacity of 20kW and under, shall not be subject to this subsection.
- H. A proposed Generating Facility's Point of Interconnection shall not be on a transmission line.
- I. A proposed Generating Facility shall not exceed the capacity of the Customer's existing electrical service unless there is a simultaneous request for an upgrade to the Customer's electrical service or the Generating Facility is configured never to inject on to the feeder power that exceeds the capacity of the electrical service.
- J. If a proposed Generating Facility is non-inverter based, the Generating Facility must comply with the Protective Function requirements and any additional TEP Interconnection requirements, which are specified in this document.

8.4 Expedited Review

For project applications declaring to be Non-Exporting inverter-based energy storage Generating Facilities or Inadvertent Exporting Generating Facilities with a Maximum Capacity of 20kW or less, the screens of Section 8.3 may be bypassed and the facility evaluated against the conditions listed below. If all conditions are met, the application will be approved as submitted and, upon execution of an Interconnection Agreement, the Generating Facility will be approved for parallel operation.

An Expedited Review process flow chart is shown in Appendix A.5.

8.4.1 Non-Exporting Inverter-Based Energy Storage Generating Facility

To qualify for expedited processing, the following conditions must be met:

- a. The Generating Facility shall utilize only UL 1741 and UL 1741SA listed equipment.
- b. The Generating Facility shall meet all applicable codes and standards required by this by and referenced in this document.
- c. The Generating Facility shall comply with TEP Interconnection and contractual requirements.
- d. The Generating Facility shall be Non-Exporting inverter-based energy storage device with an aggregate maximum nameplate rating no greater than 500kW.
- e. No other Generating Facilities, other than isolated backup Generating Facilities, may be at the same Point of Interconnection as the Generating Facility.
- f. The Generating Facility shall comply with Section 8.3(F) of this document.

- g. The Generating Facility shall comply with one of the following:
 - The system capacity shall be less than 25% of the electrical service entrance ampere rating, and less than 50% of the service transformer rating, or
 - The system output rating shall be less than 50% of the verifiable Customer minimum load as measured over the past 12 months.

8.4.2 Inadvertent Exporting Generating Facility 20kW or Less

To qualify for expedited processing, the following conditions must be met:

- a. The Generating Facility shall utilize only UL 1741 and UL 1741SA listed equipment.
- b. The Generating Facility shall meet all applicable codes and standards required by and referenced in this document.
- c. The Generating Facility shall comply with TEP Interconnection and contractual requirements.
- d. The Generating Facility shall utilize control functions that limit the export of electrical power to the Distribution System.
- e. The Generating Facility shall have a duration of Inadvertent Export of power of less than 30 seconds for any single event.
- f. The Generating Facility shall monitor that its total energy export per month is maintained to be no more than its Maximum Capacity multiplied by 0.1 hours per day over a rolling 30-day period (e.g. a 100kVA gross nameplate capacity Generating Facility would have a maximum energy export per 30-day month of 300kWh).
- g. The Generating Facility shall disconnect from the Distribution System in the event of an Inadvertent Export, ceasing to energize the Distribution System or halting energy production, within two seconds after the period of uninterrupted export exceeds 30 seconds or the magnitude of export exceeds 100kVA.
- h. The Generating Facility shall enter a safe operation mode, where Inadvertent Export events cannot occur, upon failure of the control or inverter system for more than 30 seconds, whether from loss of control signal, loss of control power, or a single component failure or related control sensing of the control circuitry.
- i. No other Generating Facilities, other than isolated backup Generating Facilities or Generating Facilities that are already subject to an executed Interconnection Agreement, may be at the same Point of Interconnection as the Generating Facility.
- j. The Generating Facility shall comply with Section 8.3(E) and (F) of this document.

8.5 Level 1 Super Fast Track

Generating Facilities of Maximum Capacity 20kW or less that are inverter-based, that use equipment conforming to the standards listed in Section 5, and comply with Screens A, E, and F in Section 8.3 qualify for the Level 1 Super Fast Track application process. In this process, the Customer must complete the required application form and submit information detailing the manufacturer and model of the inverter(s) proposed for installation, a facility site plan, a one-line electrical drawing, and a three-line wiring diagram.

TEP will review the application against the aforementioned screens, along with the drawings and inverter data. If the Generating Facility passes TEP review, the application will be approved and an Interconnection Agreement will be executed.

If the Generating Facility does not meet one or more of the requirements for Level 1 Super Fast Track, the Customer will be notified. The Customer may then choose to (1) modify the Generating Facility design in order to meet the requirements of and continue processing under Level 1 Super Fast Track, (2) request that TEP perform a Supplemental Review described in Section 8.8, or (3) withdraw the application.

A Level 1 Super Fast Track application process flow chart is shown in Appendix A.1.

8.6 Level 2 Fast Track

A Customer requesting to interconnect a Generating Facility of Maximum Capacity 21kW to 2000kW, complying with all applicable standards listed in Section 5 along with Screens A through J in Section 8.3, qualifies for the Level 2 Fast Track application process. In this process, the Customer must complete the required application form and submit required technical data for proposed Generating Facility equipment, a facility site plan, a one-line electrical drawing, and a three-line wiring diagram. Also, depending on Generating Facility size and type, TEP may require the Customer to furnish and install additional protection and metering equipment. That equipment is described elsewhere in this manual.

Following application submission, TEP will review the project against the aforementioned screens, along with the drawings and equipment data. If the Generating Facility passes TEP review, the application will be approved and an Interconnection Agreement will be executed.

If the Generating Facility does not meet one or more of the requirements for Level 2 Fast Track, the Customer will be notified. The Customer may then choose to (1) modify the Generating Facility design in order to meet the requirements of and continue processing under Level 2 Fast Track, (2) request that TEP perform a Supplemental Review described in Section 8.8, (3) request that TEP process the application under Level 3 Study Track described in Section 8.7, or (4) withdraw the application.

A Level 2 Fast Track application process flow chart is shown in Appendix A.2.

8.7 Level 3 Study Track

Generating Facilities of Maximum Capacity greater than 2000kW or those that do not meet one or more of the requirements for the Level 1 Super Fast Track, Level 2 Fast Track, or Supplemental Review application processes will have their applications processed under Level 3 Study Track. The components of this process are listed below and elaborated upon thereafter.

a. Pre-application Meeting

- b. Application Submittal
- c. Application Review
- d. Scoping Meeting
- e. Feasibility Study
- f. System Impact Study
- g. Facilities Study
- h. Interconnection Agreement

The pre-application meeting is optional and is an opportunity for the Customer to discuss the proposed project with TEP and ask any questions.

For TEP review, the application for Level 3 Study Track includes an application form, electrical one-line and three-line diagrams, AC and DC control schematics, a location map, a site plan, and Generating Facility equipment information (e.g. data sheets, product bulletins, etc.).

If, after TEP review, the Generating Facility meets all requirements and no additional equipment or system modifications are necessary, the application will be approved for Interconnection. If the Generating Facility does not meet one or more of the Interconnection requirements, and TEP determines that more study is necessary, the Customer may request an optional Scoping Meeting. The Scoping Meeting purpose is for TEP to explain the studies needed and the costs and timelines associated with each.

Following the Scoping Meeting, the Customer may request a Feasibility Study or proceed directly to the System Impact Study. The Feasibility Study evaluates short circuit currents and existing circuit protection equipment in an effort to determine whether further studies are necessary. Often TEP will know beforehand that a System Impact Study cannot be avoided and, in such cases, will inform the Customer. This benefits the Customer by reducing the overall review process timeline.

The System Impact Study, if required, involves modeling the TEP circuit to which the Generating Facility will interconnect in Distribution System modeling software and evaluating the impact of the Generating Facility based on the following studies:

- a. Load Flow Study
- b. Short Circuit Study
- c. Voltage Regulation Study
- d. Circuit Protection and Coordination Study
- e. Islanded Operation Potential

If the outcome of the System Impact Study determines the need for additional TEP facilities to accommodate the Interconnection, a Facilities Study will be required. The Facilities Study identifies all TEP work necessary prior to Generating Facility Interconnection. It includes a list of tasks, cost estimates, and a schedule for construction completion.

A Level 3 Study Track application process flow chart is shown in Appendix A.3.

8.8 Supplemental Review

For Generating Facility applications that do not meet all of the requirements for Level 1 Super Fast Track or Level 2 Fast Track processing, the Customer may elect to request a Supplemental Review. The Supplemental Review measures the proposed Generating Facility against several additional screens and is used to determine if the application presents issues significant enough to warrant processing under Level 3 Study Track. The Supplemental Review has a minimum feeder load screen, a voltage and power quality screen, and a safety and reliability screen. If the Generating Facility passes all the Supplemental Review screens, the application can continue being processed under either Level 1 Super Fast Track or Level 2 Fast Track.

A Supplemental Review process flow chart is shown in Appendix A.4.

9. INTERCONNECTION TECHNICAL REQUIREMENTS

The requirements and specifications outlined in this section are applicable to Generating Facilities interconnected for parallel operation with the TEP Distribution System. The protection and safety devices and other requirements specified are intended to provide protection for the TEP system, TEP workers, other TEP customers, and the general public. They are not intended to provide protection for the Customer's generation equipment or personnel; this is the sole responsibility of the Customer.

With respect to the above protection objectives, it is necessary to disconnect the parallel generator when trouble occurs. This is to:

- a. Ensure if a fault on the TEP system persists, the fault current supplied by the Customer's Generating Facilities is interrupted.
- b. Prevent the possibility of reclosing into an out-of-sync isolated system composed of the TEP Distribution System, or section thereof, and the Customer's Generating Facilities.
- c. Prevent reclosing into the Customer's Generating Facilities that may be out of synchronization or stalled.
- d. Prevent unintentional islanding.

Protection requirements are minimal for smaller Generating Facilities, but expand with increasing Generating Facility size. Small Generating Facilities typically have much less generating capacity than the load it needs to support when TEP protective devices operate and isolate the system from a fault or other abnormal operating condition. This load/generation imbalance will quickly cause voltage collapse and automatically shut down the Generator(s).

For larger installations, the probability of isolated operation is higher because the available generation may be sufficient to carry the entire load, or part thereof, of its associated TEP circuit. In cases where the TEP Distribution System arrangement is such that it is possible that the Generator(s) can continue to serve isolated load, additional protection and generator shutdown schemes are required. Please note that this does not preclude the Customer from using their Generating Facilities to serve only their own load during a TEP outage as long as measures are taken to ensure that Generator(s) are not in electrical parallel with the TEP system during that time.

Special Note on TEP Automatic Circuit Reclosing Practices

TEP applies automatic reclosing to overhead distribution circuits. When the TEP source breaker trips, the Customer must ensure that their Generator(s) is/are disconnected from the TEP circuit prior to automatic reclosing. TEP applies instantaneous reclosing at the substation circuit breaker, where the distribution circuit can be re-energized in less than 18 cycles (0.3 sec) after a protective relay trip. Automatic reclosing out-of-sync with the Customer's Generator(s) may cause severe damage to Customer equipment and could also pose a serious hazard to Customer or TEP personnel.

9.1 General Technical Requirements

9.1.1 Compliance

Customer is responsible for obtaining and maintaining all required permits and inspections indicating that the Customer's Generating Facilities comply with all applicable codes, ordinances, and statutes relating to safety, construction, and operation.

9.1.2 Customer Equipment

Customer is responsible for the design, installation, operation, and maintenance of equipment on the Customer's side of the Point of Interconnection. Customer shall submit specifications and detailed plans for their proposed equipment as required by the application instructions and elsewhere in this manual for TEP review. TEP review does not indicate acceptance or approval by TEP or other authorities.

9.1.3 Multiple Generators

Multiple Generator connections on the same TEP service are allowed. Disconnect Switches shall be located near the Point of Interconnection for each system. If TEP approves more than one Disconnect Switch behind a service, then each Disconnect Switch shall be labeled as per Section 9.4.3. If the Disconnect Switch(es) is/are located remotely from the SES, placard maps shall be furnished at each Disconnect Switch showing the relative location of each Switch to the SES.

9.1.4 DG Metering

If TEP is required to install electric meter(s) to record the output of Customer's Generator(s), Customer shall ensure that the design is such that the meter(s) is/are located on the Utility side of any Generator breaker on a normally energized bus. Electronic meters are not designed to be de-energized for any length of time.

9.1.5 Dedicated Transformer/Transformer Upgrade

Maximum Capacity of a Generating Facility or the aggregate Maximum Capacities of multiple Generating Facilities served from a shared TEP distribution transformer shall not exceed 100% of the continuous duty rating of the transformer. In situations where the 100% continuous rating would be exceeded, the Customer may request to be served from a dedicated transformer or request an upgrade of the existing transformer. Costs for dedicated transformers or transformer upgrades shall be borne by the Customer.

9.1.6 Voltage Requirements

Customer generating equipment must be rated at 60 Hertz and be either a single or three-phase system connected at a standard TEP voltage. For three-phase systems, to meet TEP effectively grounded system requirements, interconnection must be made via a 4-wire grounded wye system. Customer-furnished isolation or step-up/down transformers may be installed for this purpose as long as the transformer connection is either (1) delta-wye ground with the wye ground connection on the Utility side or (2) wye ground-wye ground with a neutral conductor(s) run from the SES to the Generator(s) neutral terminal. The Generating Facilities shall follow, and not attempt to oppose or regulate changes in the voltage at the Point of Interconnection, unless mutually agreed upon by the Customer and TEP.

9.1.7 Transfer Trip

A Transfer Trip Scheme will be required if Customer's Generating Facilities (1) are of sufficient capacity to carry the minimum load of the TEP distribution feeder to which it is interconnected, or (2) are of sufficient capacity and physically located such that it can support an islanded (isolated) section of the feeder. Refer to Section 9.6.3 of this Manual for additional details. (Note: Generating Facility applications qualifying for Level 1 Super Fast Track or Level 2 Fast Track review and all Non-Exporting and Inadvertent Exporting Generating Facilities will not be subject to transfer trip requirements.)

9.1.8 Potential Open Point(s)

Whenever a Generator is configured to operate in electrical parallel with the TEP grid, Customer shall ensure that any potential open point(s) located in the circuit between the Generator output and the TEP service is/are suitably interlocked to prevent an out-of-sync closure between the power sources. A potential open point can be any circuit breaker, switch, or other device that can be open and/or closed and is not equipped with either a sync check or synchronizing function. A potential open point(s) may be interlocked as follows:

- a. A keyed or other suitable mechanical interlock that will prevent the potential open point from being opened unless a circuit breaker in the circuit, equipped with a sync check or synchronizing function is first opened. Conversely, if the potential open point is open, the keyed or mechanical interlock will also prevent closing if the aforementioned circuit breaker is not also open. The circuit breaker, when opened, shall immediately break the electrical path between the two power sources.
- b. An electrical interlock consisting of a set of electrical contacts that interface with the potential open point device and are directly wired to instantaneously trip open a circuit breaker (such as a Generator breaker) when said device is opened. The circuit breaker shall be equipped with synchronizing means and serve as the equipment to re-establish parallel operation between the Generator and TEP. As such, the potential open point also shall be electrically interlocked to prevent closing if the circuit breaker is not open. The circuit breaker, when opened, shall immediately break the electrical path between the power sources.

An exception to the above interlocking requirements can be made for a Generator(s) with built-in anti-islanding protection that cannot be bypassed, circumvented, and/or disabled.

9.1.9 Generating Facility Maximum Capacity

The Generating Facilities Maximum Capacity as defined in Section 4 of this document shall not exceed the 100% continuous duty rating of the Utility transformer and/or any Utility service conductors.

9.2 DG Output Circuit Point of Connection

A Generating Facility is permitted by the NEC to be connected, or tapped, on either the supply (Utility) side or the load side of the SES service disconnecting means. Requirements for each are as follows:

9.2.1 Supply Side Connection

A supply side connection, often referred to as a “line side tap”, is performed by connecting the DG output circuit between the Utility revenue meter and the main service disconnecting means. The location of the tap ensures that the revenue meter registers net energy flow. This installation is subject to all applicable NEC requirements along with any other criteria specified by the AHJ. In addition, TEP specifies the following requirements for supply side connections:

- a. Any supply side connection shall be made without modifications to any factory installed and/or UL listed equipment or components, unless expressly authorized by the panel manufacturer and/or listing agency. Any authorized modification must be performed in strict accordance with the panel manufacturer’s directions and specifications. If panel manufacturer authorization is granted to perform a supply side connection, proof of such authorization and AHJ approval shall be provided to TEP as part of the Interconnection Application process.

- i. No drilling, tapping, or replacing of factory installed bus bars or conductors is allowed unless performed by the manufacturer or its designated representative.
 - ii. If lugs are replaced to accommodate additional conductors, the panel manufacturer must specify a UL (or other NRTL) listed kit or provide written approval of the parts to be used. Appropriate torque specs shall be provided.
 - iii. When connecting to a field-installed conductor, a UL listed tap should be used. Breaking the conductor should be avoided – using a lay-in lug is preferred. Alternatively, an insulated mechanical lug is also acceptable. The connector’s manufacturer and model number should be provided.
 - iv. Fused and unfused conductors shall not occupy the same raceway.
 - v. Bonding jumpers per NEC 250.92(B) shall be installed around reducing washers and any eccentric or concentric fitting knockouts remaining.
 - vi. If panel manufacturer does not grant permission and/or have a kit to perform the tap required, a field evaluation is required in order to perform the supply side interconnection. In this case, the Customer shall provide TEP with a Letter of Compliance issued by the NRTL certified by OSHA to perform the evaluation as well as a photograph of the approval sticker affixed to the SES at the time the work is completed in the field.
- b. Rigid metal conduit (RMC) shall be used between the supply side connection in the SES and an external fused service disconnect (which may also be the DG disconnect) for the DG output circuit. (Exception: A short length of flexible conduit may be used to connect a meter socket adapter (MSA) to the remaining run of RMC. See paragraph 9.2.1 (i) of this Manual for additional details.)
 - c. The minimum rating of the fused service disconnect shall be 60 amp as per NEC Article 230.79(D). Tapped DG output circuit conductors shall be sized according to NEC requirements.
 - d. The supply side connection fused service disconnect shall be mounted within 10’, and in the line of sight, of the SES as per NEC Article 705.31. The circuit shall not be routed through any other enclosures between the SES and the fused service disconnect. Workspace and elevation shall be in accordance with Section 9.3.3 of this document. If necessary to go beyond the 10-foot maximum requirement, there is an allowance under NEC Article 705.31 for current limited circuit breakers or cable limiters to be installed at the tap point.
 - e. A neutral to ground (N-G) bond must be established in the supply side connection fused service disconnect. Note however, that if the supply side connection is made via a protective device located within the SES (i.e. not an external fused service disconnect), then the existing N-G bond in the SES will suffice. Such bonding shall conform to NEC requirements.
 - f. Per NEC Article 230.70(A)(1), the fused service disconnect shall be Readily Accessible.

- g. No Customer connections or equipment are permitted in the TEP sealed metering compartment or pull section of the SES. (Exception: An MSA with UL 414 listing is allowed. See paragraph 9.2.1 (i) of this Manual for additional details.)
- h. TEP secondary electrical service conductors are not fused and can only be de-energized by TEP personnel. Customer will need to make arrangements with TEP to de-energize the electrical service prior to performing a supply side connection. Customer will also have to coordinate such work with the AHJ as TEP requires a clearance from the AHJ before re-energizing the service following completion of work.
- i. A customer-owned meter collar for the purpose of interconnecting power production or whole home electric isolation, shall be allowed where that device does not impede access to the sealed meter socket compartment or pull section of the SES. The meter collar shall be UL 414 Certified and rated adequately for the connected equipment.

9.2.2 Load Side Connection

A load side connection is performed by connecting the DG output circuit on the load side of the main service disconnecting means. *(Note: TEP prefers this type of connection over the supply side connection because it allows the Customer to complete their work without requiring TEP to de-energize the service and, correspondingly, the AHJ to subsequently issue an electrical clearance prior to re-energization. An additional benefit is that the main service disconnecting means usually also provides overcurrent protection. Thus, for faults at the tap point, a Customer-owned protection device will open to clear the fault. For supply side connections, faults at the tap are cleared by the TEP distribution transformer fuse or other TEP-owned overcurrent protection device.)*

Load side connections are subject to all applicable NEC requirements along with any other criteria specified by the AHJ.

9.3 DG Disconnect Switch

Customer shall install and maintain a visual-open, manually operated, load break Disconnect Switch that will completely open and isolate all ungrounded conductors of the Customer's Generating Facilities from the TEP system. For multi-phase systems, the switch shall be gang-operated. The Disconnect Switch shall comply with the additional requirements listed below.

Interconnection System Equipment

Interconnection equipment such as a customer-owned meter collar for the purpose of interconnecting power production or whole home electric isolation and (intentional or unintentional) islanding of a Generating Facility shall be allowed where that device does not impede access to the sealed meter socket compartment or pull section of the Sealed Electric Section (SES). The meter collar shall be UL 414 Certified and rated adequately for the connected equipment.

9.3.1 Visible Open and Lockable Requirements

The Disconnect Switch shall be visible-open such that the switch blades, jaws, and the air-gap between them are clearly visible when the switch is in the “open” position and the front cover of the switch box is opened. The switch handle shall be capable of being locked in the “open” position by a standard TEP padlock with a 3/8” shank. The switch front cover shall be kept locked at all times by a TEP-furnished padlock. The front cover hasp shall be capable of accepting a 3/8” shank padlock, and shall not be field modified in any way.

9.3.2 Switch Connection

The Disconnect Switch shall be connected so that the blades (and any fuses present) are de-energized when the switch is in the “open” position in accordance with NEC Article 404.6(C). For a typical DG Disconnect Switch arrangement, this means that the switch blades will connect to the Customer Generating Facilities while the switch jaws will connect to the DG output circuit tap in the SES. The Disconnect Switch shall be located on the utility source side of any meter installed to measure the output of the Generating Facilities (i.e. the DG Meter).

9.3.3 Switch Location

The Disconnect Switch shall be installed in a Readily Accessible location to provide safe, easy, unrestricted, and unimpeded access for TEP personnel at all times. It shall be installed within 10 feet of the Customer SES, unless TEP has been contacted and approved a Customer variance request to install it elsewhere. Any variance granted does not alter the requirement that the Disconnect Switch be Readily Accessible.

The Disconnect Switch shall be installed securely on a rigid operating surface such as the side of a building, wall, or Unistrut rack so that operation of the switch handle does not cause movement or flexing of the switch enclosure. Mounting height shall be such that the center-line of the switch handle is between 42 inches and 75 inches above final grade. Working space requirements are as per the NEC.

9.3.4 Electrical Ratings

The Disconnect Switch must be rated for the voltage and current requirements of the Generating Facility, and must be listed and conform to all applicable UL, ANSI, and IEEE standards. The switch shall be rated to withstand the available fault current duty.

9.3.5 Switch Grounding

The switch enclosure shall be properly grounded via an equipment ground wire attached to a factory provided grounding lug or an appropriately UL listed grounding lug or terminal. If the Disconnect Switch will be installed on a line operating above 500V, the switch shall have provisions to allow grounding on the Utility side.

9.3.6 Switch Conductors

Electrical conductors and/or cables entering into and exiting from the Disconnect Switch enclosure shall be physically separated and shall not share a common raceway or enclosure (other than the switch enclosure itself). Under no circumstances shall the Disconnect Switch enclosure be used as conduit or raceway for any conductors other than those phase conductors being switched, the neutral (grounded conductor) and equipment ground (grounding conductor).

9.3.7 Operational Jurisdiction

The Disconnect Switch will be placed under the operational jurisdiction of TEP for systems with a line voltage of 600V or less, and the cover of such switch will be locked closed with a standard 3/8" shank TEP-furnished padlock following satisfactory completion of the TEP site inspection.

TEP shall have the right to lock open, or cause to be locked open, the Disconnect Switch without notice to Customer when interconnected operation of the Customer's Generating Facilities with the TEP system could adversely affect the TEP system or endanger life or property, or upon termination of the Interconnection Agreement.

9.3.8 NEC Rapid Shutdown of Photovoltaic Systems

For systems to be equipped with rapid shutdown:

- a. The DG Disconnect Switch shall not be designated as the rapid shutdown initiation device.
- b. Rapid shutdown initiation shall not depend on the DG Disconnect Switch.

9.4 Labeling Requirements

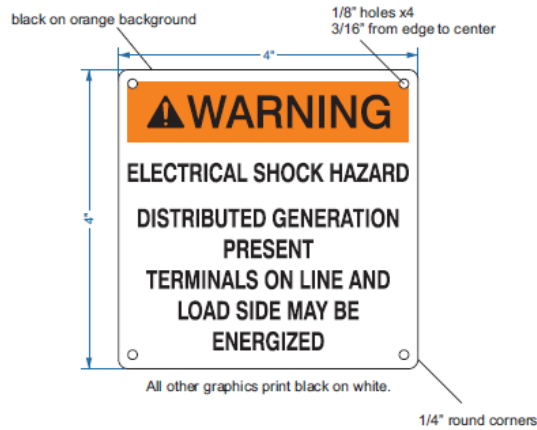
9.4.1 General Labeling Requirements

Customer is responsible for furnishing and installing necessary labeling on Generating Facilities and Interconnection Facilities in accordance with the NEC and any other applicable safety regulations. In addition, TEP requires specific warning labels to be affixed to the Customer SES, DG Disconnect Switch, and DG meter. Required warning labels are available for purchase from Border States Electric, a TEP-preferred supplier. Customer may also furnish their own warning labels if they identically match those approved by TEP. The required warning labels are shown in the subsections below. All TEP-required warning labels shall be permanently affixed to the fronts of their respective equipment enclosures using rivets or screws. Use of glue or other adhesives is not permitted.

9.4.2 Customer SES Labeling

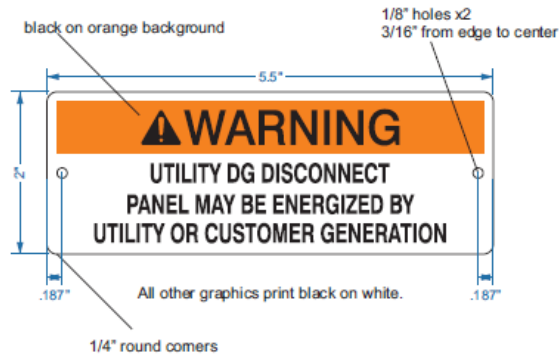
The TEP-required Customer SES warning label is shown below. In the case where a variance has been granted and the DG Disconnect Switch is not located in close proximity to the SES, a permanent plaque depicting the plan view of the Generating Facilities and Interconnection Facilities and denoting the location of the SES and DG

Disconnect Switch is required to be installed on the SES. The plaque shall be submitted to TEP for approval.



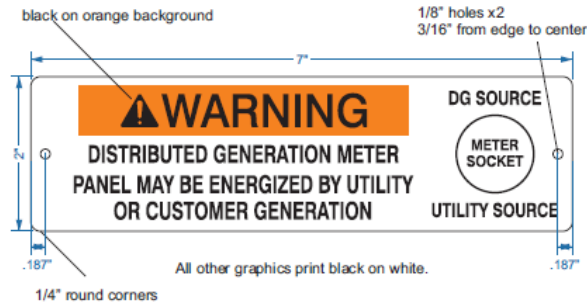
9.4.3 DG Disconnect Switch Labeling

The TEP-required DG Disconnect Switch warning label is shown below. In the case where a variance has been granted and the DG Disconnect Switch is not located in close proximity to the SES, a permanent plaque depicting the plan view of the Generating Facilities and Interconnection Facilities and denoting the location of the SES and DG Disconnect Switch is required to be installed on the DG Disconnect Switch. The plaque shall be submitted to TEP for approval.



9.4.4 DG Metering Labeling

The TEP-required DG Meter warning label is shown below.



9.5 Power Quality

Customer shall ensure that the electrical characteristics of its load and Generating Facilities will not interfere with normal power quality standards expected of TEP service. The specific requirements listed in the subsections below are intended to protect TEP and other customers from any negative impacts that may arise from operation of the Customer's Generating Facilities.

9.5.1 Power Factor

When the Generating Facilities function as a net load to the TEP System, the power factor of the net load shall not be less than 90% lagging (absorbing reactive power) as measured at the Point of Interconnection, and shall not be leading (exporting reactive power), unless agreed to by TEP.

When the Generating Facilities, in conjunction with any Customer load, export electric power to the TEP system, the power factor of the net generation shall not be less than 90% leading (absorbing reactive power) as measured at the Point of Interconnection, and shall not be lagging (exporting reactive power), unless agreed to by TEP.

9.5.2 Current Imbalance

The phase current imbalance for a three-phase system as measured at the Point of Interconnection shall not be greater than 10% at any time. Current imbalance on the ungrounded conductors for a 120/240V single-phase system shall not exceed 20%.

9.5.3 Harmonics

The electrical output of Customer's Generating Facilities shall not contain harmonic content that may cause disturbances on or damage to the TEP system, or other Customer's systems, not limited to computer, telephone, communication, and other sensitive electronic or control systems. Harmonics, as measured at the Point of Interconnection, shall not exceed the limits promulgated in IEEE 519-2014.

9.5.4 Power Fluctuations

Customer must exercise reasonable care to assure that the electrical characteristics of its load and generating equipment do not result in a voltage deviation from sine wave form or cause unusual short interval fluctuations; nor shall it result in impairment of

Customer's service or service to other customers, interference with operation of computer, telephone, television, or other communication systems or facilities.

9.5.5 Voltage Flicker

The voltage flicker level, as measured at the Point of Interconnection, shall not exceed values outlined in IEEE 519-2014 and IEEE 1453-2015.

9.5.6 Service Voltage Ranges

Customer shall ensure its Generating Facilities do not cause RMS voltage at the Point of Interconnection to vary beyond the Voltage Service Range A of +/- 5% as specified in ANSI C84.1-2016. TEP may require the Customer to remedy any voltage excursion caused by the Generating Facilities at the Point of Interconnection, any point along the TEP system and/or a neighboring customer's Point of Interconnection that is outside of this Range A.

9.6 Protective Relaying Requirements

9.6.1 General Requirements

- a. Customer shall be solely responsible for properly protecting and electrically paralleling its Generator(s) and/or Static Inverter(s) with the TEP system.
- b. Generating Facilities capable of fault current contribution exceeding 200% of rated nameplate current shall include an automatic interrupting device, such as a generator breaker, that is rated to interrupt that specific available fault current and is certified to applicable UL standards. The interrupting device shall be directly tripped, at a minimum, by all protective devices required herein. Any control component wired in series with the trip and/or close circuit shall not impede or bypass any required protective devices, or affect the ability to trip/close the automatic interrupting device.
- c. Inherent characteristics of induction disk type voltage and frequency relays render their use unsuitable for some generator interface protection applications. Therefore, relays with definite level and timing characteristics (e.g. solid-state type or microprocessor based relays) will be necessary to meet the minimum requirements herein.
- d. For Generating Facilities comprised of Rotating Machines greater than 50kW that require voltage and frequency relay protection, separate and independent voltage and frequency relays and associated trip paths to the automatic interrupting device are required. This is to ensure a redundant trip function in case of single relay failure or out-of-tolerance condition.

It is acceptable for the over/under voltage functions to be integrated into a single over/under-voltage relay and the over/under frequency functions to be integrated into a single over/under-frequency relay. Also, the frequency and voltage functions may be incorporated into a single microprocessor-based protective relay provided that the relay incorporates relay failure alarm contacts, and such output is wired to

- trip the automatic interrupting device upon (1) relay failure or (2) loss of power to the relay.
- e. With the addition of generation at a Customer site, the ground fault current magnitude may increase to a level where the grounding grid is insufficient to protect personnel from step or touch potentials. Therefore, the Customer is required to ensure the adequacy of the Customer's grounding grid to keep the step and touch potentials at a safe level in the vicinity of equipment accessible by TEP personnel or the general public.
 - f. The Customer shall ensure that the Generating Facility protective relaying and controls are adequately protected from electrical surges that may result from lightning, TEP switching, or electrical faults.
 - g. Addition of the Customer's Generating Facility may require additional control, metering, and protective devices at TEP facilities. The Customer will be responsible for labor and material costs as determined by the Facilities Study.

9.6.2 Generator Class Protection Requirements

The following are minimum protection requirements by Generator classes. Facilities that are Non-Exporting, Inadvertent Exporting, or qualify for review under Level 1 Super Fast Track or Level 2 Fast Track are not subject to all of the protection requirements listed below. Specifically, the requirements listed for Class III Generating Facilities below are only applicable to those that fail to qualify for approval under Level 1 Super Fast Track or Level 2 Fast Track status.

9.6.2.1 Class I (Single-Phase 100kW or less, Three-Phase 50kW or less)

- a. The minimum required protection for synchronous and induction generators is an under-voltage relay.
- b. Synchronous generators require a synchronizing scheme, either manual with a synch check relay, or an automatic synchronizer.
- c. Static Inverters shall be Certified Equipment, tested and certified to UL 1741-2010 and UL 1741 SA-2016 by a NRTL certified by OSHA to perform the UL test standards.

9.6.2.2 Class II (Three-Phase 51kW – 300kW)

- a. The minimum required protection for synchronous and induction generators is under-voltage, over-voltage, under-frequency, and over-frequency relaying.
- b. Synchronous generators require a synchronizing scheme, either manual with a synch check relay, or an automatic synchronizer.
- c. Static Inverters shall be Certified Equipment, tested and certified to UL 1741-2010 and UL 1741 SA-2016 by a NRTL certified by OSHA to perform the UL test standards.
- d. Overload tripping shall be required for any Generator capable of sustained operation above its nameplate current rating.

9.6.2.3 Class III (Three-Phase 301kW – 2500kW)

- a. For this class of installation, utility grade protection devices and equipment are required.
- b. The minimum required protection for synchronous and induction generators is under-voltage, over-voltage, under-frequency, over-frequency, negative sequence time overcurrent, and ground time and instantaneous overcurrent relaying.
- c. Synchronous generators require a synchronizing scheme, either manual with a synch check relay, or an automatic synchronizer.
- d. Static Inverters shall be Certified Equipment, tested and certified to UL 1741-2010 and UL 1741 SA-2016 by a NRTL certified by OSHA to perform the UL test standards.
- e. Overload tripping shall be required for any Generator capable of sustained operation above its nameplate current rating.
- f. Other equipment such as supervisory control and alarms, telemetering, and associated communications channel may be necessary. TEP will advise Customer of any requirements after completion of a Facilities Study for the proposed installation.
- g. Synchronous generators 500kW and greater will require transfer trip protection. See Subsection 9.6.3 below for more details.
- h. For Level 3 Study Track applications, transfer trip protection may be required of any Generating Facility of this size class. Determination will be based on whether the Generating Facility or aggregation of Generating Facilities is/are of sufficient size relative to the minimum load on a distribution circuit, or sectionalized portion thereof, to serve the entire load. See Subsection 9.6.3 below for more details.

9.6.2.4 Class IV (Three-Phase Greater than 2500kW)

Note: Induction generators and line commutated inverters in this size range are not anticipated. Generating Facilities comprised of multiple smaller Static Inverters that aggregate to this size class are possible.

- a. For this class of installation, utility grade protection devices and equipment are required.
- b. All Generating Facilities in this size class will require transfer trip protection. See Subsection 9.6.3 below for more details.
- c. Synchronous generators shall have the following relay protection:
 - Over/under-voltage
 - Over/under-frequency
 - Ground time overcurrent
 - Ground instantaneous overcurrent
 - Voltage-controlled/restrained time overcurrent
 - Negative sequence time overcurrent
 - Overexcitation

- Loss of excitation
 - Phase sequence voltage
- d. Synchronous generators require a synchronizing scheme, either manual with a synch check relay, or an automatic synchronizer.
 - e. Overload tripping shall be required for any Generator capable of sustained operation above its nameplate current rating.
 - f. Static Inverters shall be Certified Equipment, tested and certified to UL 1741-2010 and UL 1741 SA-2016 by a NRTL certified by OSHA to perform the UL test standards.
 - g. For Generating Facilities using Static Inverters with an aggregate rated AC output greater than 2500kW, redundant over/under-voltage and over/under frequency protection will be required. Such protection shall be applied to one or more breakers external to the inverters (e.g. the main Generating Facility breaker).

9.6.3 Transfer Trip Requirements

This subsection covers requirements for Generating Facilities that are subject to transfer trip relaying provisions. A Transfer Trip Scheme will normally be comprised of a relay located at the TEP substation feeder breaker that communicates via fiber optic cable or wireless connection with a relay located at the Generating Facility. Whenever the TEP substation feeder breaker opens, a trip signal is sent to the relay at the Generating Facility to automatically trip the generation off line. Necessary relay and communication equipment located at the both the TEP substation and at the Customer Generating Facility will be furnished and installed by TEP. Customer expenses associated with implementation of the Transfer Trip Scheme shall be as determined by the Facilities Study.

9.6.3.1 Requirements for Transfer Trip of all Generating Facilities

- a. Customer shall provide real estate and easement for all required TEP equipment. Such equipment shall be determined by the Facilities Study. All equipment must be installed in a location Readily Accessible to TEP personnel.
- b. Equipment and means of completing the communication path will be determined by TEP and communicated to the Customer during the Facilities Study.
- c. If the communications are to be by wireless means, Customer shall provide a location and easement to install antennas tall enough to provide line-of-sight to TEP communications towers in the area.
- d. TEP uses mirrored bits communication between the TEP substation relay and the Generating Facility relay. In the event there is a loss of mirrored bit communication, the Generating Facility breaker shall trip open via the Generating Facility relay. A five minute delay for loss of mirrored bits will be

programmed into the Generating Facility relay settings to avoid nuisance trips.

10. DG METERING REQUIREMENTS

10.1 General Requirements

- a. Customer shall install, at Customer expense, a DG meter socket, and any necessary metering cabinets to house TEP metering equipment required for measuring and recording the AC energy production of the Generating Facilities. If such metering is not required, TEP will inform the Customer.
- b. TEP will furnish, own, install, and maintain any meters and instrument transformers necessary to meter the Generator Facilities production.
- c. TEP-furnished meters shall be in sealed compartments with no other wiring, other than the metered Generating Facilities output conductors, allowed in the sealed compartments. Electrical conductors and/or cables entering into and exiting from the DG meter base or transformer-rated metering cabinet shall be physically separated and shall not share a common raceway or enclosure. Under no circumstances shall any metering enclosure be used as a junction box, raceway, or wireway.
- d. DG metering equipment shall be installed in a Readily Accessible location so as to provide safe, easy, unrestricted, and unimpeded access for TEP personnel. It shall be installed within 10 feet of the Customer SES, unless TEP has been contacted and approved a Customer variance to install it elsewhere. Any variance granted does not alter the requirement that the DG metering equipment be Readily Accessible.
- e. Customer-furnished DG metering sockets and cabinets shall be selected and installed in accordance with the TEP Electric Service Requirements.
- f. If Customer installs third-party metering equipment, Customer shall ensure that no wiring, or other Customer-owned equipment enters into any TEP sealed compartment or enclosure. Customer-installed meters and associated equipment used to measure Generating Facility output shall be located on the Generator side of the TEP DG meter. Third party metering equipment must be clearly labeled to distinguish it from TEP DG metering equipment. Any connections made on the Generator side of the DG meter in order to accommodate third-party metering or monitoring equipment shall be of negligible load so as not to affect the Generating Facility output measured by the DG meter.
- g. For Generating Facilities comprised of synchronous generators, Customer shall furnish and install a meter disconnect switch that is gang-operated with a visible-open on the Generator side of the DG metering equipment in order to isolate that equipment from the Generator.
- h. DG metering shall occur at the voltage at the Point of Interconnection unless a variance is granted by TEP. For example, it is permissible to install a 480Y/277V – 208Y/120V step-down transformer to convert a Generator voltage of 480V three-phase to a service voltage of 208V three-phase, but the DG metered output shall be at 208V three-phase.

10.2 Single-Phase Generating Facilities

For single-phase Generating Facilities 200A or less, Customer shall furnish and install an appropriately rated, TEP-approved, self-contained ringed DG meter socket (e.g. 100A, 125A, 200A). Meter sockets with test/bypass capability are not required for either residential or commercial DG installations. Wiring into and out of the meter socket shall be such that connections to the line terminals shall be for the Generator source circuit and connections to the load terminals shall be for the circuit feeding back to the SES. Meter socket wiring shall include all required grounding and bonding. *(Note: TEP anticipates the vast majority of single-phase Generating Facilities will be 200A or less. Based on NEC requirements, a 240V_{ac} Generating Facility with a continuous output current rating of 160A can be metered with a 200A self-contained meter socket. This corresponds to an AC system size of 38kW.)*

For single-phase Generating Facilities larger than 200A (i.e. with a continuous output current rating more than 160A), Customer shall furnish and install a TEP-approved current transformer (CT) cabinet along with a transformer-rated meter socket with test switch and conduit connecting the cabinet to the socket. Customer shall install and terminate all Generating Facility output circuit wiring, both line and load sides, inside the CT cabinet along with all required grounding and bonding. TEP will furnish and install current transformers and the transformer rated meter. TEP will also furnish and install all meter wiring between the CT cabinet and the transformer rated meter socket.

10.3 Three-Phase Generating Facilities 200A and Less

For three-phase Generating Facilities 200A or less (i.e. rated continuous output current 160A or less), Customer shall furnish and install an appropriately rated, TEP-approved, self-contained, ringed DG meter socket. Wiring into and out of the meter socket shall be such that connections to the line terminals shall be from the Generator output circuit and connections to the load side shall be from the SES interconnection circuit. Meter socket wiring shall include all required grounding and bonding.

10.4 Three-Phase Generating Facilities Greater than 200A but 300kW and Less

Three-phase Generating Facilities greater than 200A (continuous output current rating greater than 160A) will require a Customer furnished and installed TEP-approved CT cabinet and transformer-rated meter socket with test switch. Customer shall also furnish and install a conduit to connect the CT cabinet to the meter socket. Customer shall install and terminate Generator Facility output circuit wiring, both line and load sides, inside the CT cabinet along with all required grounding and bonding. TEP will furnish and install current transformers, the transformer-rated meter, and all meter wire between the cabinet and the socket.

10.5 Three-Phase Generating Facilities Greater than 300kW

All three-phase Generating Facilities greater than 300kW are required to have remote monitoring capability. The TEP Operations Center needs to have visibility of all Customer loads and generation in excess of 300kW to make operating decisions. TEP uses an ION

meter for this purpose. The ION meter, in conjunction with a communications channel, provides instantaneous watt, var, volt, and cumulative kWh readings.

To accommodate instantaneous metering, Customer shall furnish necessary enclosures to house the required metering equipment. Options include providing dedicated space in the interconnecting switchgear or furnishing and installing separate enclosures to include a CT cabinet, a potential transformer cabinet, a modem cabinet, and a meter base for the ION meter. Customer shall also furnish and install all power circuit wiring into and out of the interconnecting switchgear or the CT cabinet, whichever applies. TEP will furnish and install the ION meter, modem, instrument transformers, and all instrument transformer wiring. All costs to implement remote metering for Generating Facilities qualifying for review under Level 2 Fast Track will be borne by TEP.

10.6 Generating Facilities Interconnecting at Primary Voltages

Generating Facilities interconnecting at primary voltages must be metered using medium-voltage switchgear. DG primary metering requirements are identical to revenue metering at primary voltage. The Customer shall furnish and install the required switchgear and TEP shall furnish and install, at Customer expense, all instrument transformers and meters. Refer to the TEP Electric Service Requirements for information regarding TEP-approved primary metering switchgear.

11.ADVANCED GRID SUPPORT FEATURES

Inverter-based Generating Facilities shall use inverters that comply with the requirements set forth in national standards IEEE 1547-2018, UL 1741-2010, and UL 1741 SA-2016. As required by A.A.C. R14-2-2625, inverters shall be capable of the advanced grid support features listed below. Advanced grid support features shall not be activated without mutual agreement of the Customer and TEP. (Note: Inverter functions detailed in IEEE 1547-2018 that have not yet been incorporated by the manufacturers will not be required.)

Advanced Grid Support Features

1. Volt/VAR Mode – Provide voltage/VAR control through dynamic reactive power injection through autonomous responses to local voltage measurement.
2. Volt/Watt Mode - Provide voltage/Watt control through dynamic reactive power injection through autonomous responses to local voltage measurement.
3. Fixed Power Factor – Provide reactive power by a fixed power factor.
4. Anti-Islanding – Support anti-islanding to trip off under extended anomalous conditions.
5. Low/High Voltage Ride-through – Provide ride-through of low/high voltage excursions beyond normal limits.
6. Low/High Frequency Ride-through - Provide ride-through of low/high frequency excursions beyond normal limits.

7. Soft-Start Reconnection – Reconnect after grid power is restored.
8. Frequency/Watt Mode – Provide Frequency/Watt control to counteract frequency excursions beyond normal limits by decreasing or increasing real power.

12. TESTING AND START-UP REQUIREMENTS

The information detailed in this section covers the general requirements that must be met in order to place a Generating Facility in service. Also included are specific requirements that are based on Generating Facility size, type, and interconnection method.

12.1 General Requirements

- a. Upon completion of Generating Facilities construction, Customer shall contact TEP with a Notice of Installation Complete (NIC).
- b. Customer is required to have a signed Interconnection Agreement with TEP along with documentation from the AHJ that the Generating and Interconnection Facilities have been inspected and approved.
- c. Prior to setting the DG meter and replacing the revenue meter with a Bi-Directional Meter, TEP reserves the right to inspect the Interconnection Facilities to verify conformance to interconnection requirements. If TEP finds any items that do not meet requirements, the Customer will be notified and given the opportunity to remedy any problems.
- d. After setting the meters, TEP reserves the right to perform commissioning tests on the Generating Facilities and associated Interconnection Facilities. After passing any required commissioning tests, the Customer will be given a Permission to Operate (PTO) Letter for the Generating Facilities. Should the system, in part or whole, fail any aspect of the commissioning tests, the Customer will be given the opportunity to remedy any problems.
- e. Customer shall not commence interconnected operation of the Generating Facilities with the TEP system before receiving a PTO Letter from TEP. TEP will allow the Customer to temporarily interconnect a Generating Facility in order to perform pre-commissioning checks and tests. Customer shall notify TEP before operating the Generating Facility in parallel with the TEP Distribution System. Customer assumes all liability for any damage or hazardous conditions caused by their Generating Facilities during the temporary interconnection.

12.2 Specific Requirements for Single-Phase and Three-Phase Inverter-Based Generating Facilities, 50kW and Less

- a. Generating Facilities using only Certified Equipment will not be required to undergo commissioning tests.
- b. If the Generating Facilities interconnect to the TEP system via a load side connection, a pre-meter set inspection is not required. (Please note that TEP metering technicians perform a series of checks before setting the meters and may reject the job if they find anything contrary to TEP requirements.)

- c. TEP reserves the right to conduct a pre-meter set inspection on Generating Facilities employing a supply side connection or any unconventional interconnection method that was previously approved during application review.

12.3 Specific Requirements for Single-Phase Inverter-Based Generating Facilities, 51kW to 100kW, and Three-Phase Inverter-Based Generating Facilities, 51kW to 300kW

Generating Facilities in this category must pass both a pre-meter set inspection and a commissioning test. The pre-meter set inspection consists of a physical review of the Interconnection Facilities installation to ensure conformance to TEP requirements and to verify that construction matches the approved design drawings. The Customer will be notified of any necessary corrections and be given the opportunity to remedy the situation. The commissioning test involves energizing the system to check that the inverter(s) is/are functional followed by a simulated utility outage to verify inverter shutdown and restart are in accordance with anti-islanding requirements. Verification of any required advanced inverter settings may also be performed as part of the commissioning test.

12.4 Specific Requirements for Three-Phase Inverter-Based Generating Facilities, 301 kW to 2500kW, Non-Transfer-Trip

Generating Facilities in this category have the same pre-meter set inspection and commissioning test requirements as for those in the category detailed in the above Section 12.3.

12.5 Specific Requirements for Rotating Machine Generating Facilities, 50kW and Less

- a. Generating Facilities are subject to a pre-meter set inspection (at the discretion of TEP) to verify if the installation includes the required relaying, synchronizing scheme, and disconnect switches.
- b. The Generating Facility must pass a commissioning test prior to receiving a PTO Letter. The commissioning test involves a simulated utility outage via opening of the DG Disconnect Switch to confirm correct tripping of the Generator(s) breaker.

12.6 Specific Requirements for Rotating Machine Generating Facilities, 51kW to 500kW, Non-Transfer-Trip

- a. Customer shall submit relay settings sheets and test reports to TEP confirming that appropriate settings have been established and that tests have been performed to verify correct relay calibration.
- b. Upon receipt and confirmation of correct relay setting and test data, TEP will conduct a pre-meter set inspection to check on the system physical installation. Customer will be notified of any necessary corrections and be given an opportunity to remedy the situation.
- c. Following meter set, a commissioning test is required. Customer or Representative shall have personnel on-site that are capable of interrogating the relay(s) to allow viewing of the entered settings.

- d. A simulated utility outage via opening of the DG Disconnect Switch will be performed to verify correct tripping of the Generator(s) breaker.
- e. A simulated loss of control power to the relay shall also be performed to demonstrate that this event will cause the Generator(s) breaker to open.

12.7 Specific Requirements for Generating Facilities with Transfer-Trip Relay Protection

- a. The Customer and TEP will coordinate a day to test the transfer trip functionality.
- b. TEP will switch all load off the customer's normal feeder to an adjacent circuit. The normal feeder breaker will be racked into 'test' position.
- c. TEP will test to ensure the Customer generation interconnection breaker trips when the TEP feeder breaker is open. TEP will also verify that the Customer generation interconnection breaker cannot be closed or trips freely as long as the TEP feeder breaker remains open.
- d. Further tests of SCADA status points and telemetry will be performed and confirmed before placing the generation in service.
- e. Immediately after generation is placed in service, TEP will measure currents and voltages at test points inside the Utility Equipment Enclosure to verify the instrumentation.

13. OPERATING AND MAINTENANCE REQUIREMENTS

- a. Customer will be responsible for operating and maintaining the Generating Facilities in accordance with the requirements of all applicable safety and electrical codes, laws, and governmental agencies having jurisdiction.
- b. Customer shall protect, operate, and maintain the Generating Facilities in accordance with prudent engineering and utility practices and methods. Additionally, Customer shall operate and maintain the Generating Facilities in a safe manner and in a non-hazardous condition.
- c. Customer will allow TEP and its authorized agents access to the protective relaying and control facilities to conduct startup or periodic tests deemed necessary by TEP. TEP will provide Customer with advance notice of such tests so that the Customer's representatives may be in attendance when tests are performed.
- d. In the event TEP or its authorized agents lock open the DG Disconnect Switch, Customer shall not remove or tamper with such lock.
- e. TEP will be allowed to install on Customer's premises any instrumentation equipment for research purposes. Such equipment will be owned, furnished, installed, and maintained by TEP.
- f. TEP, including its employees, agents, and representatives, shall have the right to enter Customer's premises to:
 - Inspect Customer's Generating Facilities, protective devices, and to read or test instrumentation equipment that TEP may install, provided that reasonable notice is given to Customer prior to entering its premises.

- Maintain, replace, or repair TEP equipment, which may require TEP personnel to open the DG Disconnect Switch without notice.
 - Immediately and without prior notice disconnect, or cause Customer to immediately disconnect, the Generating Facilities, or otherwise render the Generating Facilities disconnected from the TEP system, if in TEP's opinion, a hazardous condition exists and such immediate action is necessary to protect persons, TEP facilities, or other customers' or third parties' property and facilities from damage or interference. This includes any situation where, in TEP's opinion, any of the protective devices or switching apparatus is not or does not appear to be operating properly.
- g. Open the DG Disconnect Switch without notice if an operating Clearance is required by TEP personnel.
- h. Close the DG Disconnect Switch upon completion of TEP work performed under an operating Clearance.

14. REQUIREMENTS FOR MOMENTARY PARALLEL CLOSED TRANSITION SWITCHING OF BACKUP GENERATORS

As previously stated, this document applies to all Generating Facilities that operate either continuously or momentarily in parallel with the TEP Distribution System. However, TEP recognizes the difference in purpose of employing Generating Facilities as backup capacity during a TEP outage versus applications where the Generating Facilities supply normal Customer load. TEP also understands the Customer inconvenience of enduring a second outage when returning to TEP service following outage restoration. (Note: TEP normally requires an open transition switching scheme, i.e. break-before-make, of switch contacts when transitioning from TEP supply to backup Generator and vice-versa.) Therefore, if the proposed backup Generator(s) meet the application and technical requirements of this section, review will be conducted via a separate process that does not involve the standard criteria detailed in previous sections of this document.

14.1 Interconnection Application

For TEP review, the interconnection application for momentary parallel closed transition switching of backup Generators includes an application form, electrical one-line and three-line diagrams, AC and DC control schematics, a location map, a site plan, and Generating Facility equipment information (e.g. data sheets, product bulletins, etc.). Generating Facility equipment includes both Generator(s) and Transfer Switch(es).

14.2 Interconnection Technical Requirements

To qualify for consideration under this section, Generating Facilities must meet the following technical requirements:

- a. Total Generating Facility capacity shall not exceed 2.0 MW.
- b. Customer shall furnish and install a Generator Disconnect Switch complying with the requirements of Section 9.3 of this document.

- c. Customer shall furnish and install, at the Point of Interconnection, over/under voltage, over/under frequency, phase sequence, synchronization, and directional relaying that will trip either the Generator breaker or an Interconnection breaker when programmed relay setpoints are exceeded. Directional relaying shall trip if it senses current flowing from the Generator(s) into the TEP Distribution System for a time exceeding a maximum closed transition period of 0.15 seconds.
- d. Customer shall set the transfer-to-normal time delay to not less than 15 minutes after TEP power has been continuously re-established.

14.3 Customer Responsibilities

- a. Customer shall complete and sign an Emergency-Standby Generator Interconnection Agreement provided by TEP.
- b. Customer shall be responsible for all costs associated with any equipment or facilities that need to be installed on TEP's system to accommodate the Generating Facility Interconnection.
- c. Customer shall own and be responsible for the costs of designing, installing, operating, and maintaining Generating Facility equipment including Generator(s), necessary control and protective devices, and the Disconnect Switch specified in Section 14.2(b) above.
- d. Customer shall maintain its Generating Facility, its associated facilities on the Customer side of the Point of Interconnection, and all other required materials in good and safe operating condition.
- e. Customer shall pay for the ongoing maintenance costs for all facilities required to be installed on TEP's system solely to interconnect the Customer's Generating Facility to the TEP system.
- f. The electrical output of the Customer Generating Facility shall not contain harmonic content, or impose any other power quality issue, which may cause disturbances on, or damage to, the TEP electrical system or other customers' electrical systems.

15. INTERCONNECTION STUDIES AND DRAWING APPROVAL

As part of the Application review, various Interconnection Studies and drawing approvals may be required. Descriptions of each are articulated below.

15.1 Feasibility Study

The Feasibility Study is a preliminary review of the potential impacts on the Distribution System that will result from a proposed Interconnection. The Feasibility Study will include a review of short circuit currents, including contribution from the proposed generator, as well as coordination of and potential overloading of distribution circuit protection devices. It will also provide initial details and ideas on the complexity and likely costs to interconnect prior to commitment of a more costly engineering review.

15.2 System Impact Study

The System Impact Study is a full engineering review of the impact on the Distribution System from a Generating Facility. The study will reveal all areas where the Distribution System will need to be upgraded to allow the Generating Facility to be built and interconnected as designed and may include discussions with the Customer about potential alterations to generator design, including downsizing to limit grid impacts, as well as operational limits that would limit grid impacts if implements.

Components of a System Impact Study may include some, or all, of the following:

- a. Load Flow Study – a study based on distribution analysis software modeling of the affected TEP distribution circuit, with and without the proposed Generating Facility, to evaluate if the Interconnection of the Generating Facility will cause any voltage regulation problems or cause any distribution circuit equipment to exceed their thermal ratings.
- b. Short-Circuit Study – a study based on distribution analysis software modeling of the affected TEP distribution circuit, with and without the proposed Generating Facility, to evaluate if the Interconnection of the Generating Facility will contribute sufficient additional fault current so that TEP distribution circuit equipment ratings are exceeded.
- c. Circuit Protection and Coordination Study: - a study of TEP protective devices and settings and the impact of the proposed Generating Facility on TEP protective device coordination.
- d. Impact on System Operation: - a review of any impacts caused by the Interconnection of the Generating Facility to TEP operations, including to any TEP distribution circuit switching or other TEP distribution circuit reconfiguration operation. Also is an evaluation of the potential for the proposed Generating Facility, in conjunction with existing Distributed Generation hosted on the affected TEP distribution circuit, to operate as an island following separation from the TEP grid.
- e. Transient Stability Study – a study to determine if momentary power fluctuations associated with Generating Facility operation are sufficient to cause voltage and/or frequency deviations exceeding industry-standard limits. It is anticipated that this study will only be required of proposed Generating Facilities exceeding 5 MW in total nameplate rating.

15.3 Facilities Study

The Facilities Study is a comprehensive analysis of the actual construction needed to take place based on the outcome of the System Impact Study. It shall delineate the detailed costs and milestones of construction. Construction may include new circuit breakers, relocation of reclosers, new TEP grid extensions, reconductoring lines, new transformers, protection requirements and any related communications equipment.

15.4 Drawing Review

TEP requires the Customer to submit drawings of the proposed Generating and Interconnecting Facilities for review and approval. Required drawings and other necessary

detailed information vary based on size and type of the proposed facility. Specific requirements are listed with the Application instructions. For illustrative purposes, several sample drawings for simple residential solar photovoltaic systems are included in Appendix B. Appendix C includes concept diagrams for various energy storage system arrangements.

15.5 Study Fees

Customer shall be responsible for all costs associated with the performance of any necessary studies. Prior to beginning any study, the Customer shall be provided with a study agreement that will outline the scope of the study and provide a non-binding, good faith estimate of the cost of materials and labor needed to perform the study. TEP requires the Customer to execute the study agreement and pay a deposit in the amount of the estimated study cost prior to commencing with the study. Funds in excess of those necessary to complete the study will be refunded to the customer. Customer shall be invoiced for any additional funds that are required to complete the study that exceed the original good faith cost estimate.

16. OTHER CONSIDERATIONS

16.1 Interconnection Completion Deadline

A.A.C R14-2-2621(G) requires a Customer Generating Facility to interconnect with the Utility within 180 days after Application approval. A.A.C. R14-2-2604(A)(7) allows the customer a 90-day extension to the 180-day deadline. TEP will approve extensions to the A.A.C defined deadlines if the customer can demonstrate that any of the following has occurred:

- permits have been acquired
- equipment has been purchased
- construction has commenced
- additional funds in reliance on the interconnection agreement have been spent.

16.2 TEP Distributed Generation Points of Contact

For Generating Facilities of Maximum Capacity of 20kW and less, the TEP contact is:

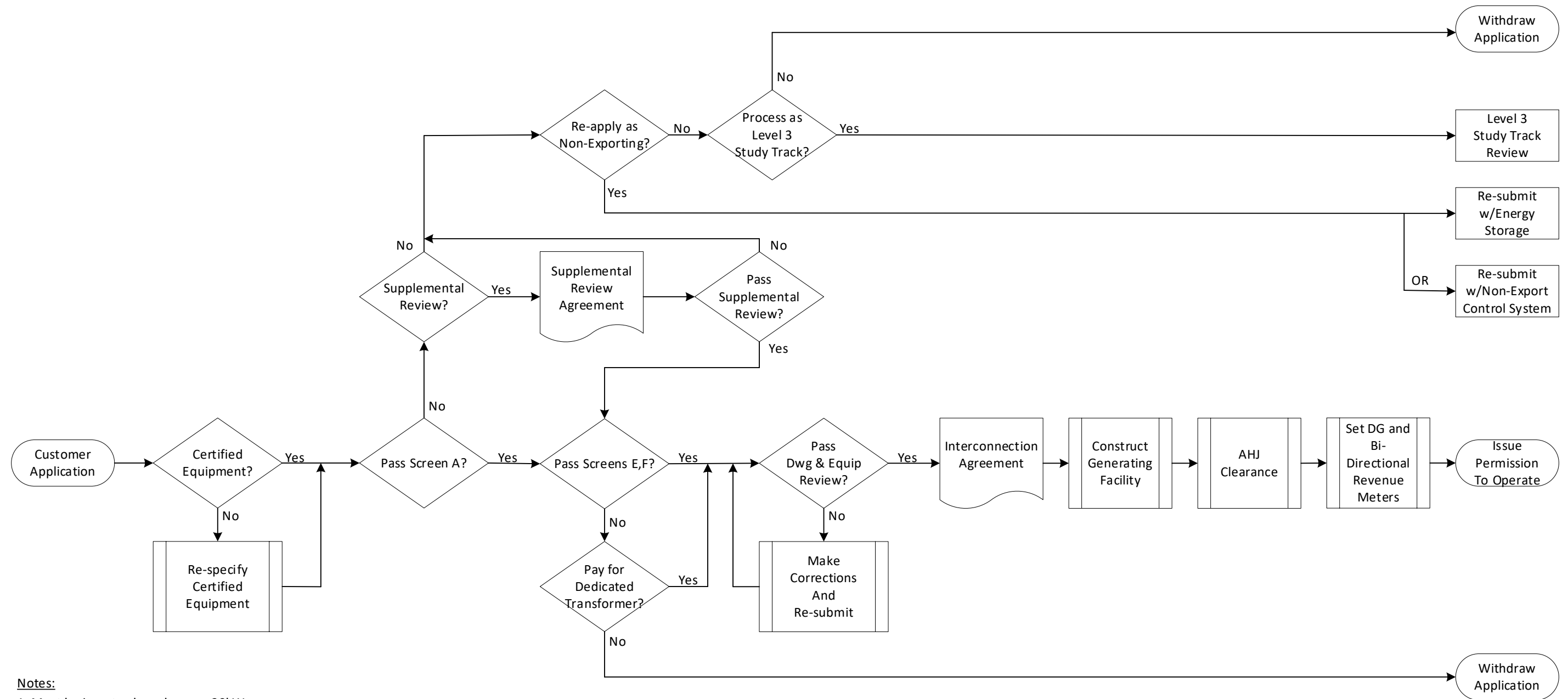
Blanka Anderson
Senior Program Coordinator
Tucson Electric Power Co.
P.O. Box 711, HQE502
Tucson, AZ 85702
(520) 918-8361
Renewables@tep.com

For Generating Facilities of Maximum Capacity greater than 20kW, the TEP contact is:

Patricia Duran

Program Coordinator
Tucson Electric Power Co.
P.O. Box 711, HQE502
Tucson, AZ 85702
(520) 918-8307
CommRenewables@tep.com

LEVEL 1 SUPER FAST TRACK APPLICATION PROCESS

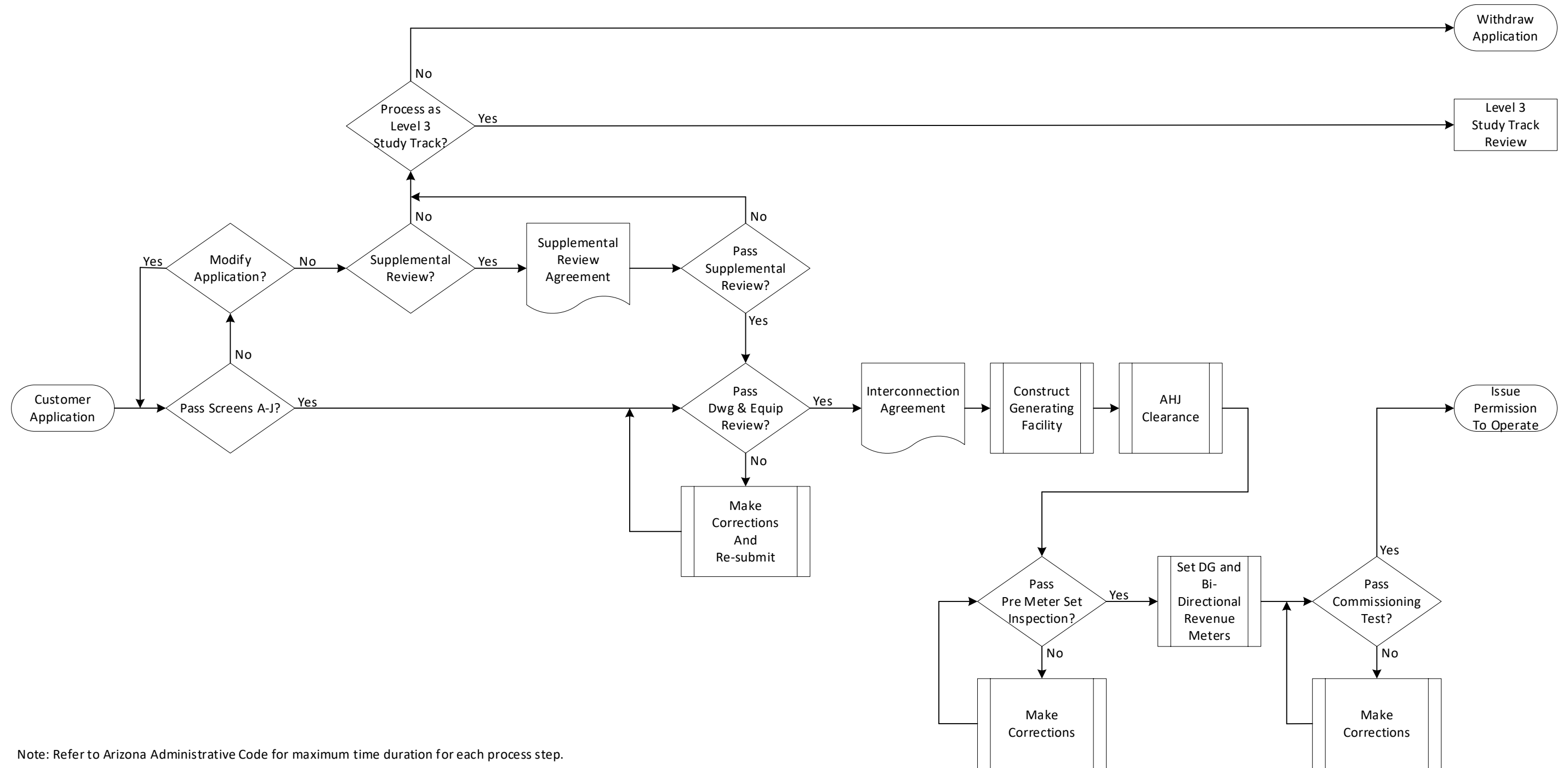


Notes:

1. Must be inverter-based, < or = 20kW
2. Must use only Certified Equipment
3. Refer to Arizona Administrative Code for maximum time duration for each process step.

APPENDIX A.1

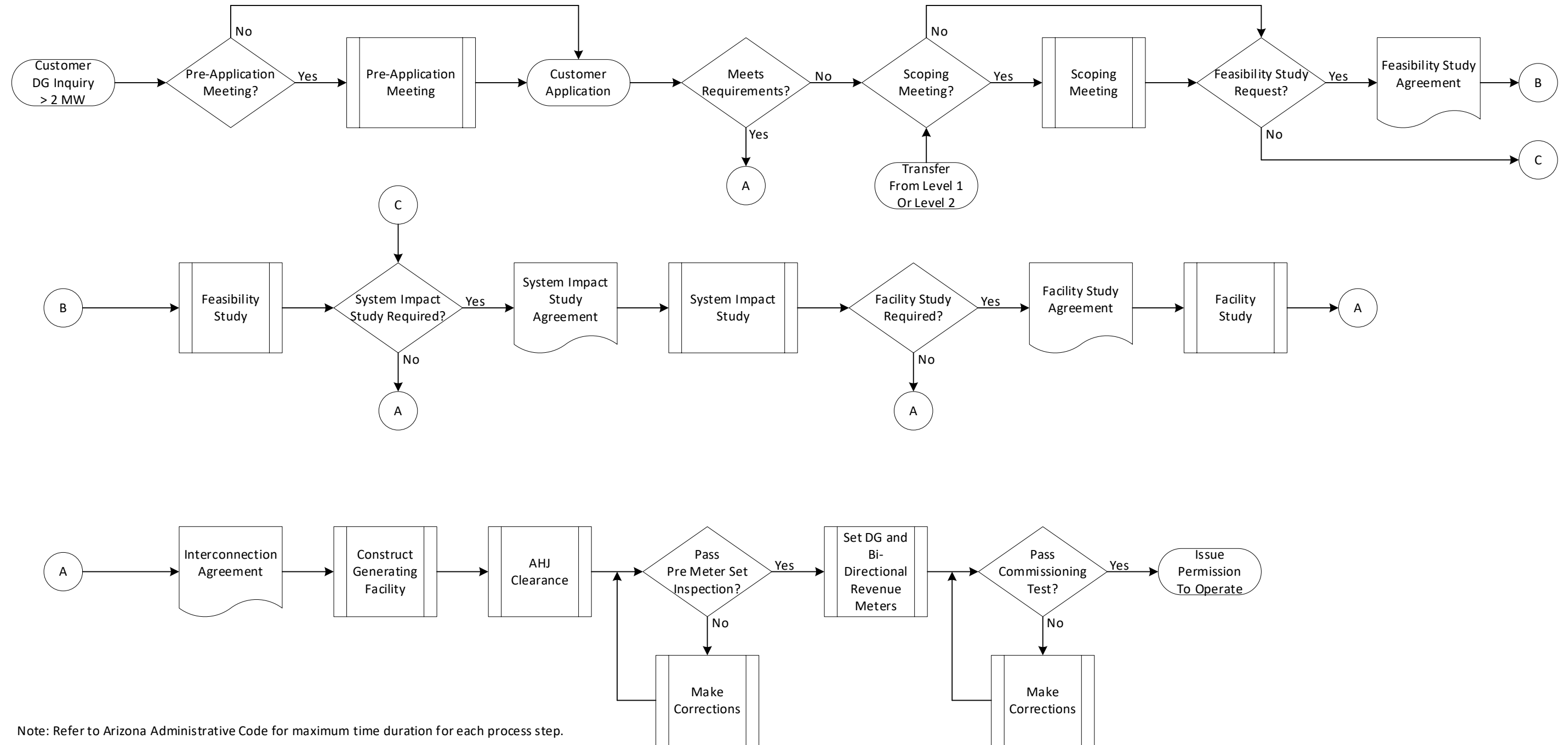
LEVEL 2 FAST TRACK APPLICATION PROCESS



Note: Refer to Arizona Administrative Code for maximum time duration for each process step.

APPENDIX A.2

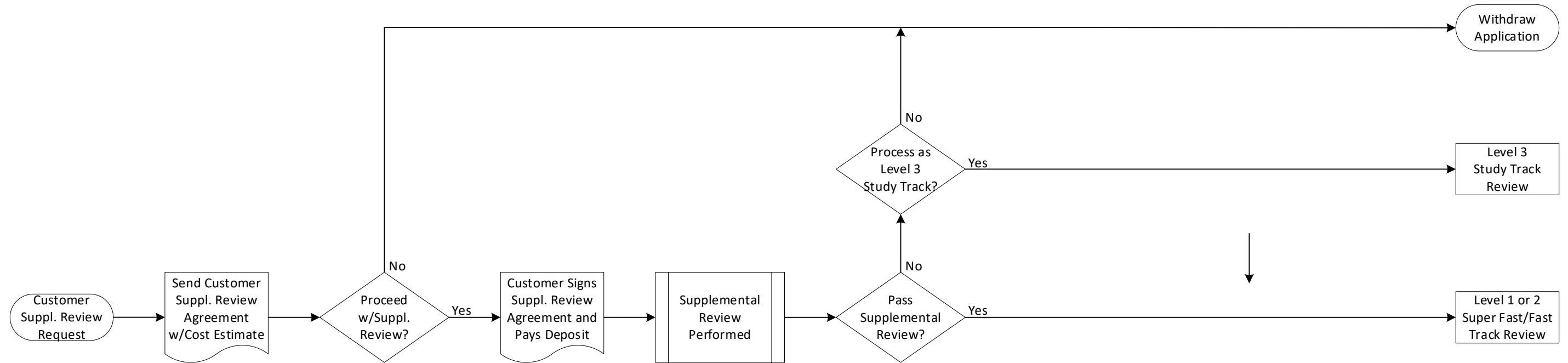
LEVEL 3 STUDY TRACK APPLICATION PROCESS



Note: Refer to Arizona Administrative Code for maximum time duration for each process step.

APPENDIX A.3

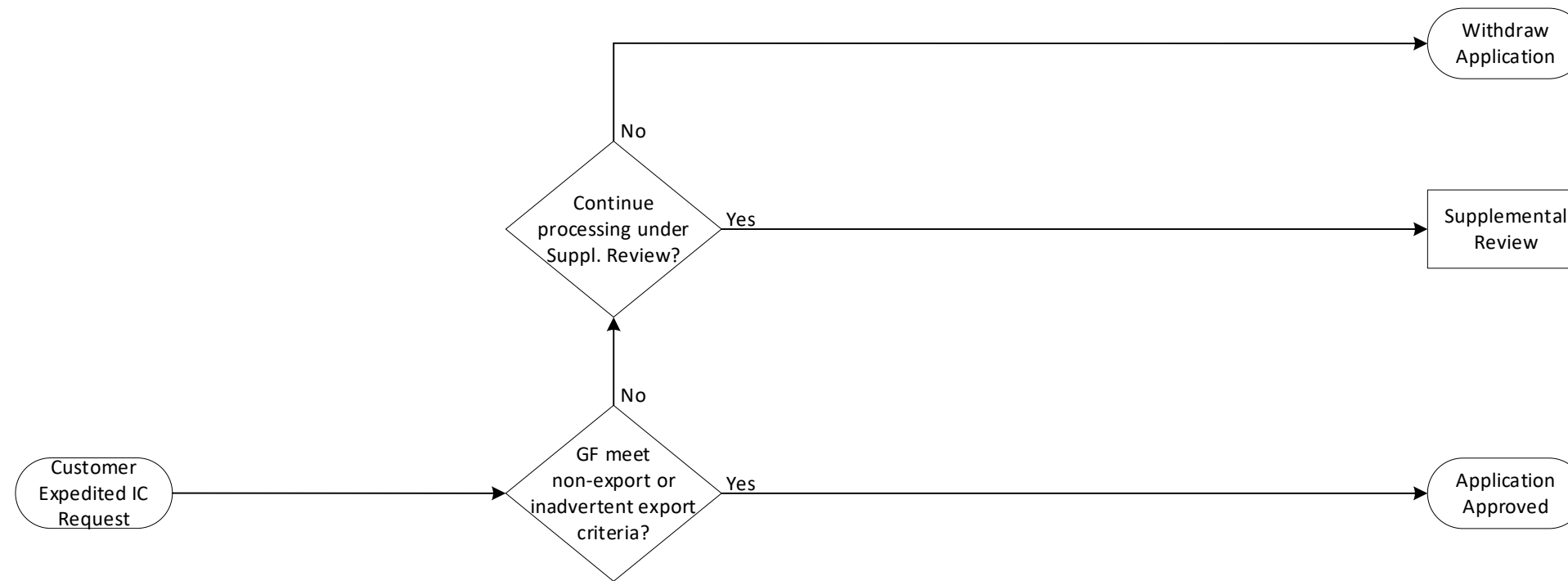
SUPPLEMENTAL REVIEW PROCESS



Note: Refer to Arizona Administrative Code for maximum time duration for each process step.

APPENDIX A.4

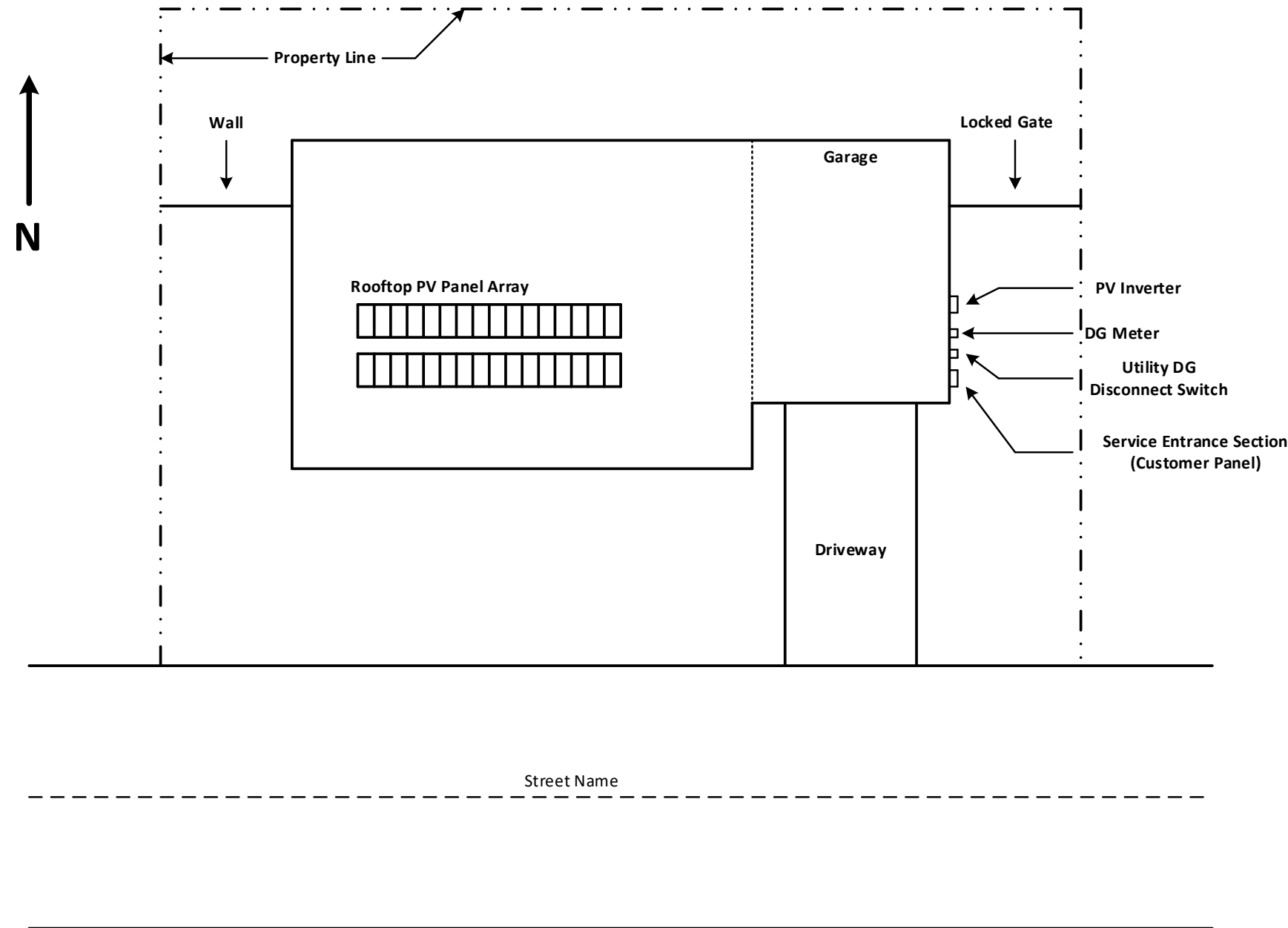
EXPEDITED REVIEW PROCESS



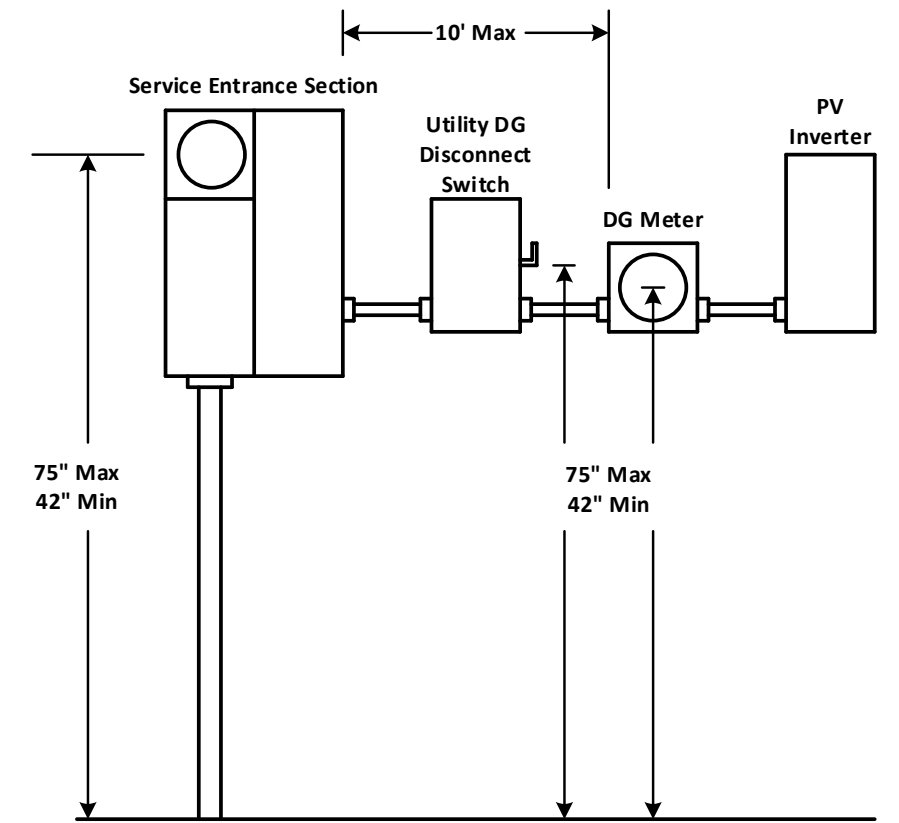
Note: Refer to Arizona Administrative Code for maximum time duration for each process step.

APPENDIX A.5

SAMPLE RESIDENTIAL SITE PLAN

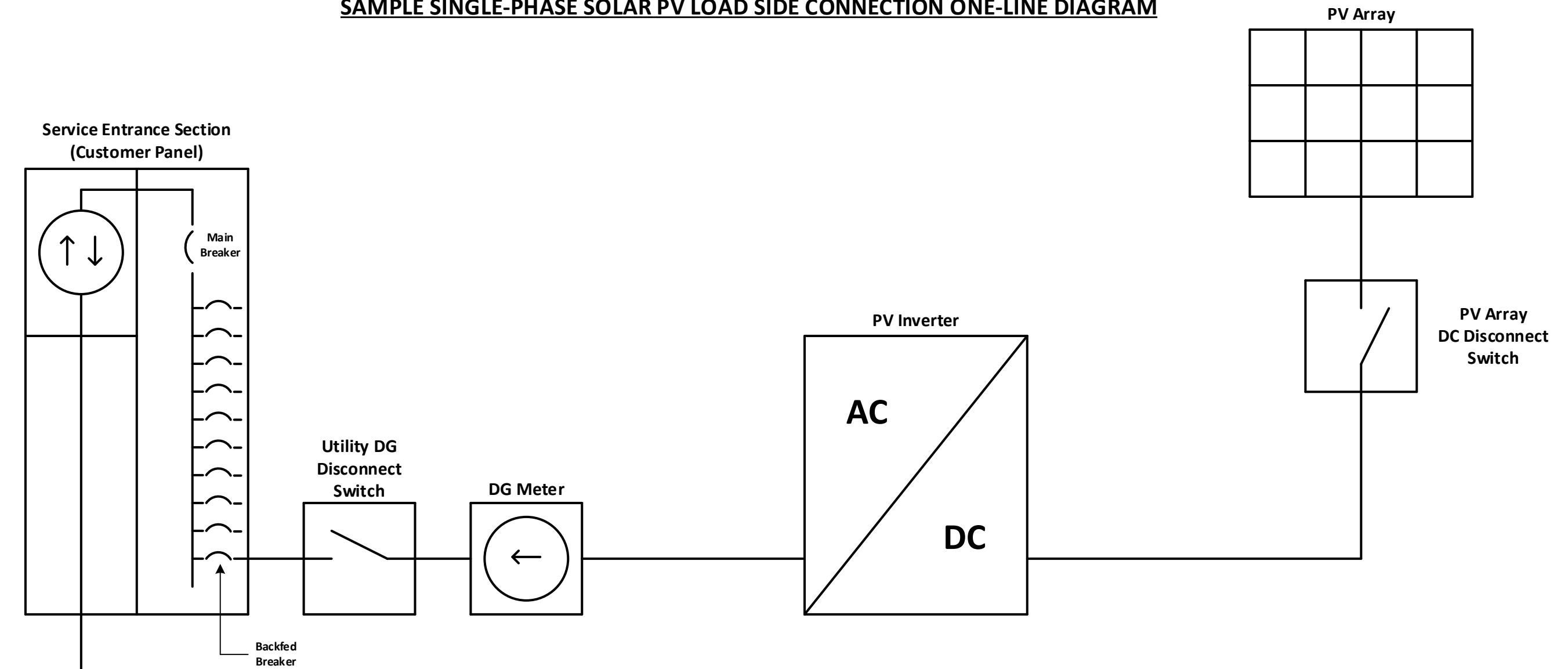


SAMPLE EQUIPMENT ELEVATION VIEW



APPENDIX B.1

SAMPLE SINGLE-PHASE SOLAR PV LOAD SIDE CONNECTION ONE-LINE DIAGRAM

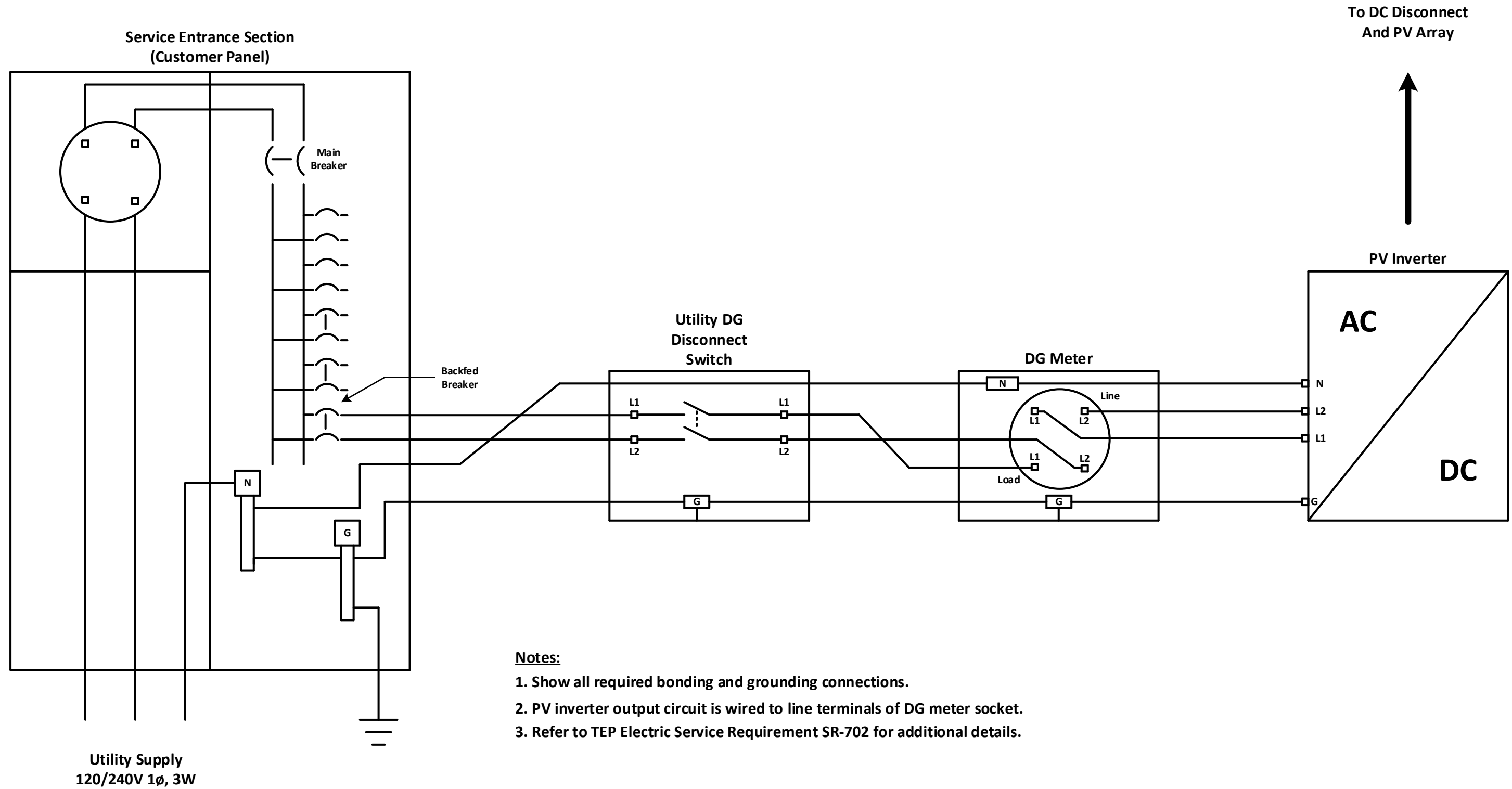


Notes:

1. Specify manufacturer and model of Utility DG Disconnect Switch.
2. Specify manufacturer and model of DG meter socket.
3. Specify PV inverter manufacturer, model, and kW_{ac} rating.
4. Identify main breaker and PV backfed breaker sizes.
5. Identify conduit and wire size for all wiring between PV inverter AC output and SES.
6. Identify all required safety labeling.

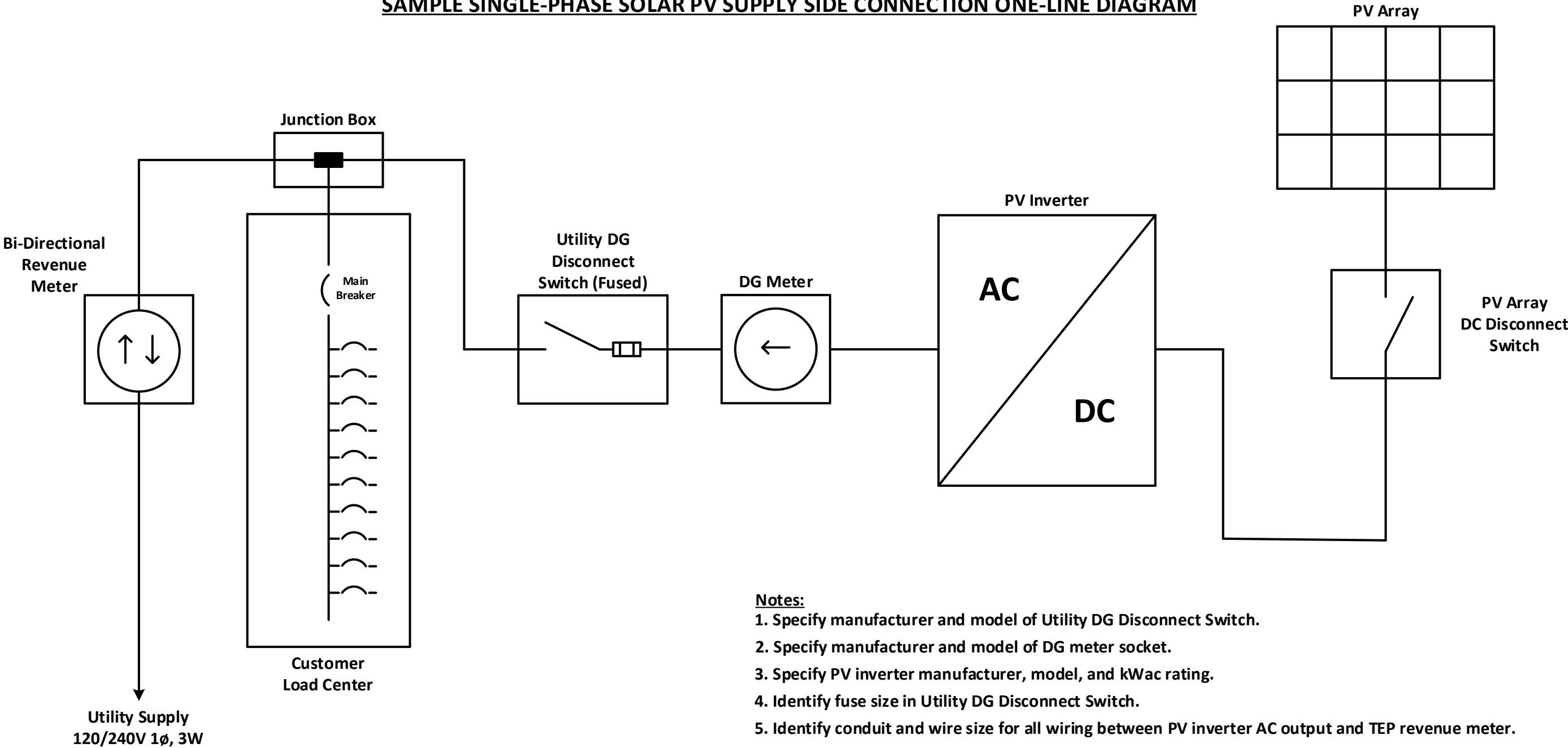
APPENDIX B.2

SAMPLE SINGLE-PHASE SOLAR PV LOAD SIDE CONNECTION THREE-LINE DIAGRAM



APPENDIX B.3

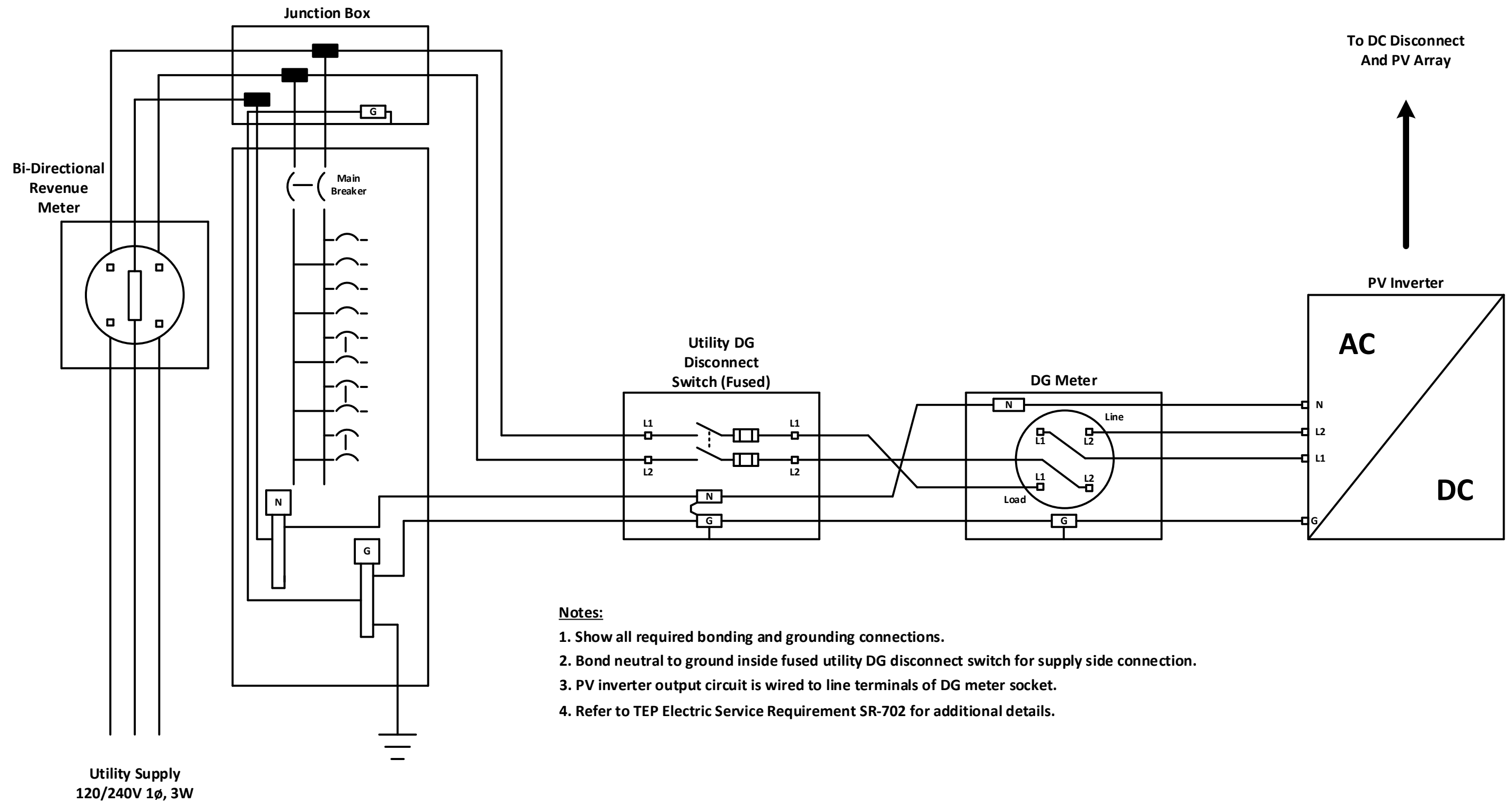
SAMPLE SINGLE-PHASE SOLAR PV SUPPLY SIDE CONNECTION ONE-LINE DIAGRAM



- Notes:**
1. Specify manufacturer and model of Utility DG Disconnect Switch.
 2. Specify manufacturer and model of DG meter socket.
 3. Specify PV inverter manufacturer, model, and kWac rating.
 4. Identify fuse size in Utility DG Disconnect Switch.
 5. Identify conduit and wire size for all wiring between PV inverter AC output and TEP revenue meter.
 6. Identify all required safety labeling.
 7. Specify manufacturer and model of tap connectors inside junction box.

APPENDIX B.4

SAMPLE SINGLE-PHASE SOLAR PV SUPPLY SIDE CONNECTION THREE-LINE DIAGRAM

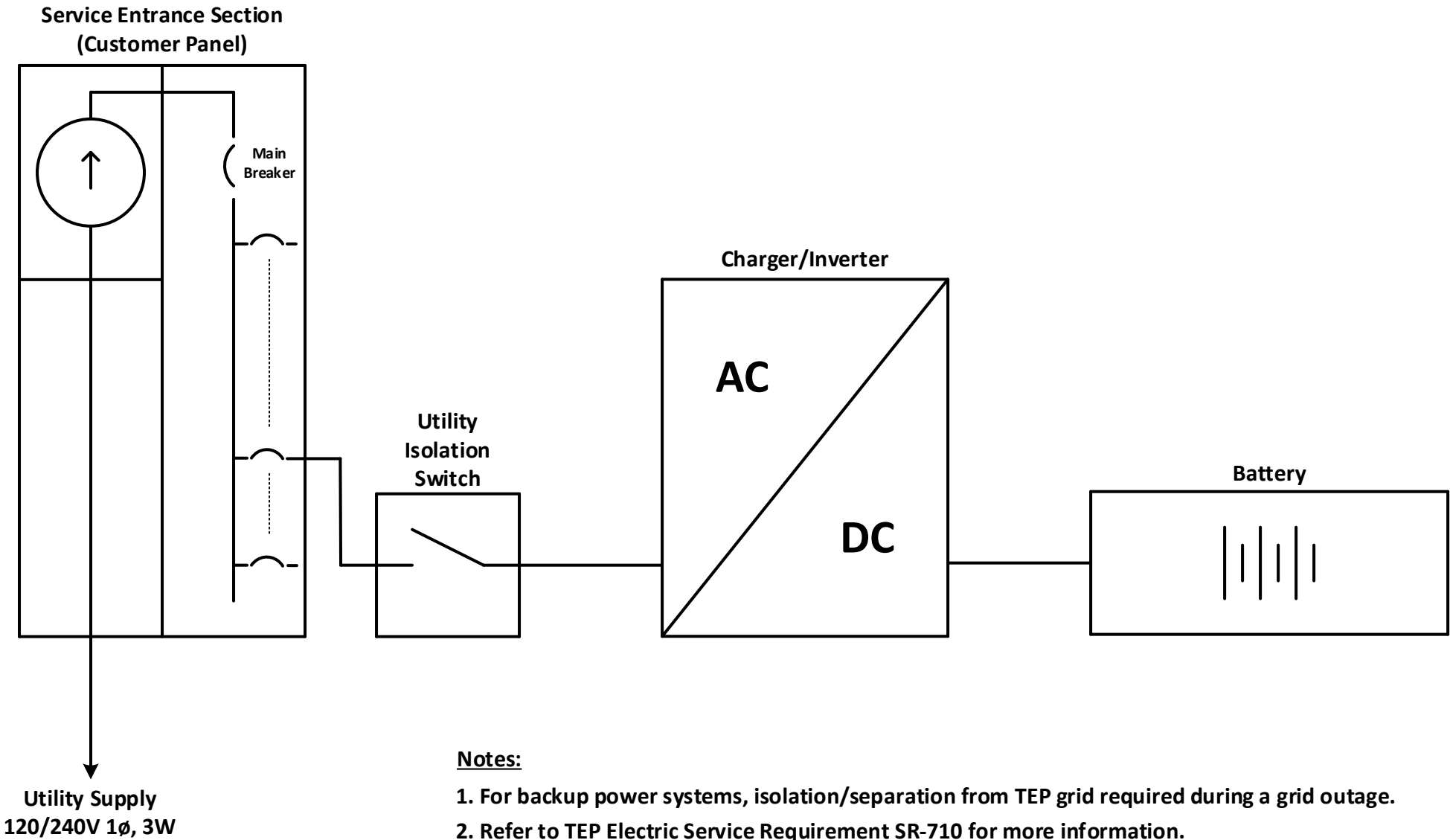


Notes:

1. Show all required bonding and grounding connections.
2. Bond neutral to ground inside fused utility DG disconnect switch for supply side connection.
3. PV inverter output circuit is wired to line terminals of DG meter socket.
4. Refer to TEP Electric Service Requirement SR-702 for additional details.

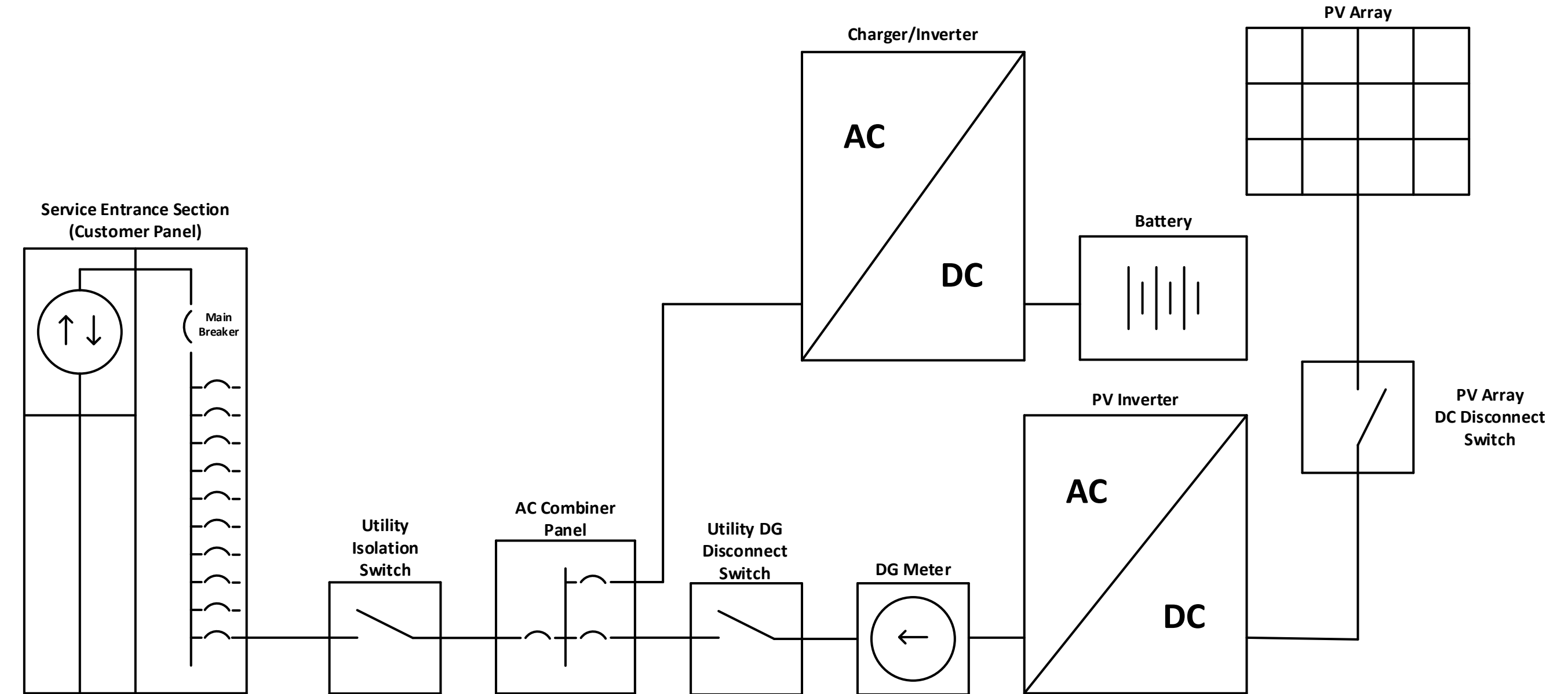
APPENDIX B.5

ENERGY STORAGE CONFIGURATION DIAGRAM – BATTERY STORAGE ONLY



APPENDIX C.1

ENERGY STORAGE CONFIGURATION DIAGRAM – SOLAR + STORAGE AC-COUPLED

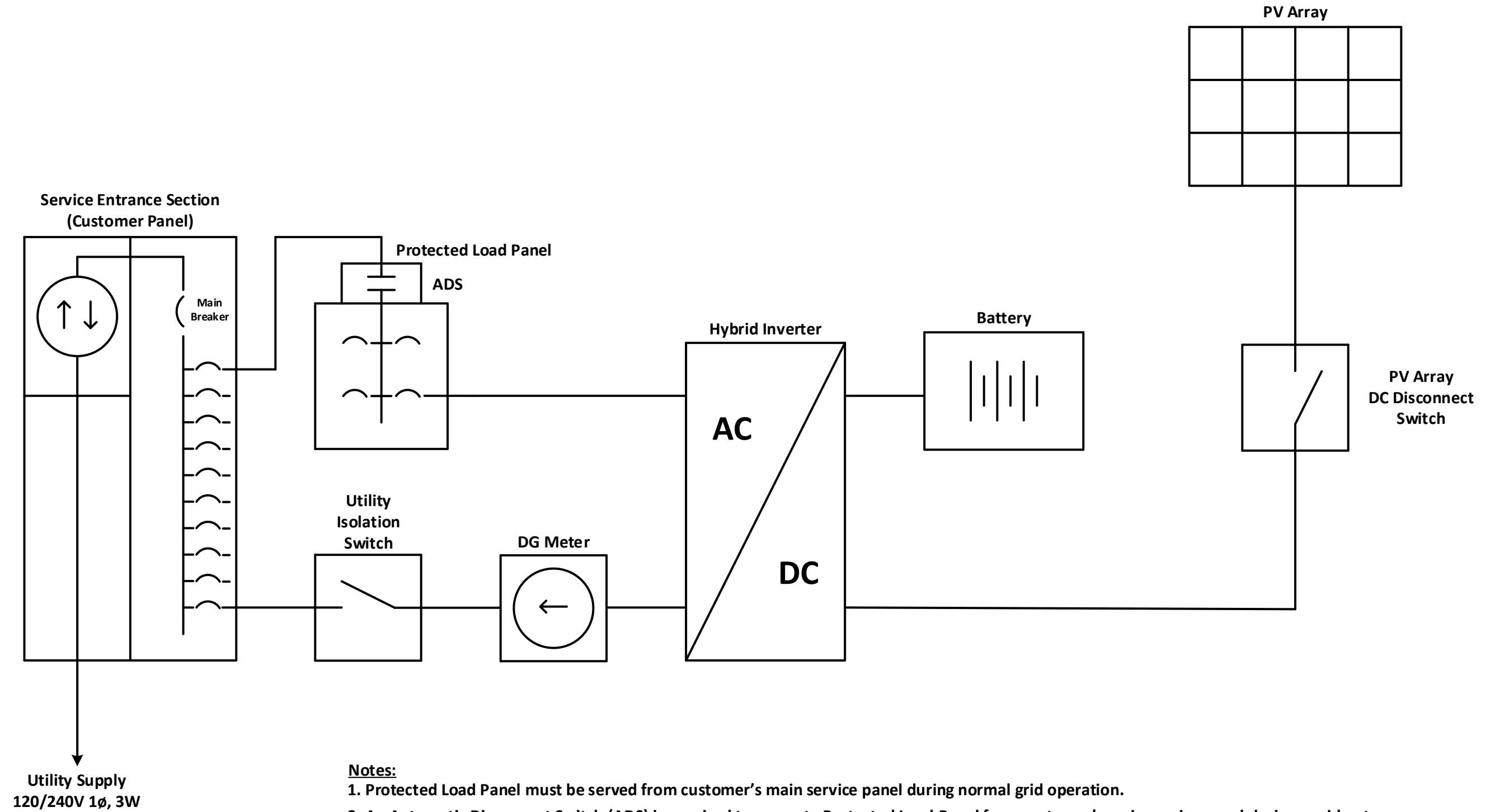


Notes:

1. For backup power systems, isolation/separation from TEP grid required during a grid outage.
2. Refer to TEP Electric Service Requirement SR-710 for more information.

APPENDIX C.2

ENERGY STORAGE CONFIGURATION DIAGRAM – SOLAR + STORAGE DC-COUPLED



Notes:

1. Protected Load Panel must be served from customer's main service panel during normal grid operation.
2. An Automatic Disconnect Switch (ADS) is required to separate Protected Load Panel from customer's main service panel during a grid outage.
3. Refer to TEP Electric Service Requirement SR-710 for more information.

APPENDIX C.3