

Document Requirements for Engineering Review- PV Systems

v1.1 12/6/2018

Outlined below are the engineering documents and their associated minimum detail requirements for a Distributed Energy Resource (DER) interconnection application to be deemed complete. The requirements apply to Section 9 and 10 Interconnection Requests, incentive program applications, and non-incentive applications. The Section 10 Tariff and Xcel Energy Standard for Electric Installation and Use provide additional detail on interconnection requirements. Interconnections using Energy Storage Systems must also follow the Xcel Energy Storage Interconnection Guidelines in addition to the below requirements. In the context of this document, “Dedicated Power Production Plant” refers to interconnections that connect directly to the Distribution System for the sole purpose of exporting energy to the distribution system and are not associated with serving a customer load or premise.

One Line Diagram

One-Line diagram, also known as a single-line diagram, showing the installation of the DER system and associated equipment is required. The following information shall be clearly depicted on the one-line diagram:

1. Name of Customer who owns/will own service, the Xcel Energy “customer of record” for existing services
2. Installation premise address
 - 2.1. Installation address shall match application address
 - 2.2. Address shall match the premise address for existing customer/services.
 - 2.3. For dedicate power production plant applications: GPS Coordinates in WGS 94 decimal degrees, with municipality and county are acceptable in place of an address when one has not yet been established by the county
3. Installer name & contact information
4. Application OID or SRC number assigned to the project
5. Label and show the electrical layout of all equipment which is in-line from the main service meter to the DER system
 - 5.1. The equipment listed shall include, at a minimum, switches, breakers, fuses, junction boxes, combiner boxes, protective devices, etc. Include distances between equipment
 - 5.2. All customer equipment shall be located on the customer-side of the main service meter
 - 5.3. Xcel Energy infrastructure is not required to be shown on the customer one-line. Any Xcel Energy equipment shown is subject to change and should not be used for planning/design purposes by the customer
6. Main service meter and main service panel
7. Main service protection is required.
 - 7.1. The DER system shall have a protective device between itself and the utility.
 - 7.1.1. Note: For DER being installed on existing buildings, the main service breaker will typically be sufficient.
 - 7.2. Protective device shall be provided immediately after the main service meter.
8. When present, the circuit for auxiliary equipment power necessary to the operation of the DER shall be shown.
9. Production meter, if applicable, with ownership noted (utility or customer).

- 9.1. For single-phase installations, the meter shall be specified as 1-phase, 3-wire
- 9.2. For three-phase installations, the meter shall be specified as 3-phase, 4-wire.
- 9.3. No loads or energy storage systems are allowed between the Production Meter and the inverters.
- 9.4. All Xcel-owned production meters shall be installed at an Xcel Energy standard voltage.
 - 9.4.1. Note: Xcel Energy standard service voltages can be found on Pg. 24, section 3.1.1 of the [Electric Standard For Electric Installation and Use](#).
 - 9.4.2. The inverter side of a step-up transformer may be a non-standard Xcel Energy voltage, provided that no Xcel Energy metering is located between the step-up transformer and the inverter.
- 9.5. The production meter shall be wired such that the DER system is the source.
 - 9.5.1. Polarity should be shown on the drawing as facing the PV, i.e. H1 of the CT faces the inverter such that DER is seen by the production meter as kWh *delivered*.
- 9.6. When present, customer owned “check meters” shall be clearly noted as “provided by customer”
 - 9.6.1. Customer owned check meters cannot be located on the inverter side of the Xcel Energy production meter.
- 9.7. Refer to applicable state interconnection tariffs and program rules to determine if production meters are applicable.
10. Any Xcel-owned metering requiring PTs shall show the PTs as unfused.
11. A visible, lockable and readily accessible AC disconnect labeled “Utility AC Disconnect,” “Photovoltaic Utility AC Disconnect,” or similar.
 - 11.1. Other AC Disconnects shall not be labeled or identified as a “Utility” AC Disconnect.
 - 11.2. If the AC disconnect is not located within 10 feet of the main service meter, a label meeting all requirements of the “Label Details” section should be placed at the main service meter clearly showing the location of the AC Disconnect.
 - 11.2.1. This will be evaluated as an “exception,” which may or may not be approved based on the accessibility of the AC Disconnect or the clarity of the placard.
 - 11.3. For installations that require a Production Meter, the Utility AC Disconnect shall be located between the inverters and production meter.
 - 11.4. For installations not requiring a Production Meter, the Utility AC Disconnect shall be located between the inverter and main service.
12. Show all DER systems, both proposed and existing
13. Clearly provide electrical ratings of all equipment including, but not limited to, Volts, Amps, number of phases, kW, kVA, winding configurations
14. Clearly note the aggregate inverter AC capacity of each system
15. The electrical ratings of the inverter(s) shall be provided
 - 15.1. Voltage
 - 15.2. Power Output (KVA or kW)
 - 15.3. Phases (single or three-phase inverters)
16. Clearly note if inverter(s) are UL1741 certified
17. If the system size is greater than 100 kW:
 - 17.1.1. Ground referencing equipment shall be installed between the main service meter and production meter to provide a ground reference for the system.
 - 17.1.1.1. Note: See the “PV and Inverter-based DER Ground Referencing Requirements and Sample Calculations” document for ground reference requirements.
 - 17.1.2. Details of the ground reference equipment required on the one-line:

- 17.1.2.1. Type/winding configuration of ground referencing equipment
- 17.1.2.2. X0 value
- 17.1.2.3. X0/R0 ratio
- 17.1.2.4. Neutral current rating
- 17.1.2.5. Fault withstand rating
- 17.1.2.6. Calculations that show the specifications of the ground referencing equipment will meet Xcel Energy ground referencing requirements.
- 17.1.3. Loss of ground referencing equipment shall immediately trip the DER system offline
 - 17.1.3.1. The method of monitoring and tripping shall be shown on the one-line
- 18. A note indicating that the design shall meet National Electric Code (NEC codes) requirements
- 19. For energy storage systems, the mode of operation being applied for shall be clearly indicated on the one-line.
 - 19.1. Reference the [Xcel Energy Guidelines for Interconnection of Electric Energy Storage](#) found on Xcel Energy's website for the full requirements of Energy Storage applications.

Site Plan

Site Plan or location plan identifying location of equipment noted on the one line shall show the following information:

1. Name of Customer who owns/will own the service, the Xcel Energy "customer of record" for existing services
2. Installation premise address
 - 2.1. Installation address shall match application address
 - 2.2. Address shall match the premise address for existing customer/services.
 - 2.3. For stand-alone interconnection applications: GPS Coordinates in WGS 94 decimal degrees, with municipality and county are acceptable in place of an address when one has not yet been established by the county
3. Installer name & contact information
4. Application OID or SRC number assigned to the project
5. Building and streets shall be labelled
 - 5.1. A minimum of one street shall be included on the site plan, with the name, distance, and direction to the nearest cross street, if the nearest cross street is not shown.
6. Compass direction (indicate North)
7. Main service entrance, all meter locations, disconnects, transformers, utility poles (if applicable), proposed and existing DER systems
 - 7.1. Distance shall be noted between this equipment
 - 7.2. For dedicated power production plants with overhead primary service interconnections, the customer pole shall be no less than 25' from the Xcel Energy meter pole. Typical acceptable distance from the Xcel Energy meter pole to the customer pole is 40'.
 - 7.3. For dedicated power production plants with co-located overhead primary service interconnections, each primary meter pole will typically require two Xcel Energy poles (at minimum, 25' apart) to make transitions to additional, co-located services. This is typically a pole line on the property with individual services to each primary meter pole. The customer pole should be no less than 25' from the Xcel Energy meter pole. Typical acceptable distance from the Xcel Energy meter pole to the customer pole is 40'.

8. The Production Meter and AC Disconnect should be located together in a readily accessible location within 10' of the main service meter.
9. 24/7 unescorted keyless access shall be provided for the meters and AC Disconnect.
10. For all interconnections not located on rooftops:
 - 10.1. An access road is required to all Xcel Energy equipment, including production metering and AC disconnects. The width of this road shall be indicated and cannot be less than 12' wide. It shall show the route from a public road to the Xcel Energy equipment.
 - 10.2. Property boundaries shall be clearly shown.
11. Position, distance and clearance concerns of overhead electric service lines and/or other utilities in relation to the PV panels shall be noted.
 - 11.1. If there are no clearance issues, state this.
12. A separate Detail View or Plan View may be required to clearly show location of meters, main service and AC disconnect, when the site layout is unclear or illegible when printed on an 11"x17" sheet.

Label Details

1. Labels shall be weatherproof, durable and permanently mounted.
2. Demonstrate or state compliance with NEC 690.
3. Include label on Main Service Meter, "Generation System Connected", or similar.
4. Include label "Utility AC Disconnect", or similar
5. Where multiple DER systems are present, equipment for each system shall uniquely identified through labelling.

Test procedure

A test procedure that will be used to verify the protection and operation of the system shall be submitted to Xcel Energy for approval. The procedure includes an open-phase test (for three phase systems) and an anti-islanding test (for all systems) to verify the system ceases generating in parallel with the Xcel Energy distribution system when the Utility source is lost. Each system is unique and will require a custom test procedure based on the inverter manufacturer's recommendations for commissioning and anti-islanding. In addition to the manufacturer's recommendations, the following steps or notes shall be included:

1. Name of Customer who owns service, the Xcel Energy "customer of record" for existing services
2. Installation premise address shall match application address
 - 2.1. Address shall match the premise address for existing customer/services.
3. Installer name & contact information
4. Application OID or SRC number assigned to the project
5. A note stating "All testing shall be performed by qualified personnel."
6. Steps that verify PV system is ready to be energized
7. Steps to verify labeling for the Main Service Panel, PV System Circuit Breaker, DC Disconnect, AC disconnect, Utility AC disconnect, Production Meter (when applicable) and other relevant labelling and signage.
8. Steps to energize the PV system.
9. While in normal operation, steps to verify the voltages at the inverter AC output are within 5% of the combined inverted AC voltage ratings and all inverter LED's, alarms, and/or LCD codes are "normal."
10. While in normal operation, steps to verify that all inverters are operational and producing power.

11. Steps to simulate the loss of utility source for the anti-islanding test. This typically involves opening an AC disconnect. Clearly identify the disconnection device being used to simulate this utility power outage.
12. Using a voltmeter, verify the voltage at the inverter side of the AC disconnect has dropped to zero
 - 12.1. Only customer-owned equipment shall be used for this verification. Xcel Energy will not provide special equipment for this verification. Xcel Energy provided meters shall not be used for this verification.
13. Using an ammeter or the inverter's display, verify the DER output of the inverter has ceased within two seconds. For three phase systems, three phase monitoring may be required.
14. For three-phase systems: Steps to simulate the loss of a single-phase from the utility. The device used should be clearly identified.
 - 14.1. If ground referencing equipment is present, the open point must occur upstream of this device (upstream meaning in the direction of the utility source).
 - 14.2. If the protection scheme used to detect the open phase uses devices other than the inverter (for instance, separate relaying to trip a VFI or breaker), the installer must demonstrate that a non-detection zone exists in the open-phase detection schemes. Installers using negative sequence, zero sequence, or other imbalance detection methods to detect the open phase typically have large non-detection zones that do not detect open phase conditions to the degree required for compliance with IEEE 1547. A step will be required to disable this setting during testing so as to avoid false-positives of the test results if this non-detection zone exists.
15. Steps to verify voltage and current are to be listed for the open-phase test.
16. Verify inverter LED's, alarms, and/or LCD codes are appropriate for loss of Utility Source
17. Steps to restore the lost utility source shall be listed.
18. A step to verify that the inverter system delays 5 minutes before resuming power output after the Utility Source is restored
19. Verify fixed power factor settings for each inverter meet the project requirements