Dunn Energy Cooperative
"Energy Through Excellence"
A Touchstone Energy® Cooperative

# Inverter-Based DER Commissioning Testing Procedure

## A. Pre-Commissioning Tests:

| | NA | No | Yes |
|---|---|---|---|
| Electrical inspection certification by local Authority having jurisdiction? | ☐ | ☐ | ☐ |
| Are the PV / Utility AC Disconnect Switch, Utility Billing Meter and Production Meter (if used) installed with appropriate labeling? | ☐ | ☐ | ☐ |
| Does the PV System Step-Up transformer nameplate match the interconnection application. (i.e., voltage, winding ratio, winding configuration, base rating)? | ☐ | ☐ | ☐ |
| Do the inverter specifications match interconnection application? | ☐ | ☐ | ☐ |
| Is the UL 1741 certification for inverter equipment provided? | ☐ | ☐ | ☐ |
| Has protection coordination has been completed for the site? Verifying documentation is to be provided by owner. | ☐ | ☐ | ☐ |
| Is the inverter firmware version the same that was used for UL 1741 certification? Verifying documentation is to be provided by owner. | ☐ | ☐ | ☐ |
| If default IEEE 1547 inverter settings were specified, are the inverter settings the same that were used during UL 1741 certification? Verifying documentation is to be provided by owner. | ☐ | ☐ | ☐ |
| If inverter settings are different from IEEE 1547 default settings, have the program settings been pre-approved by Utility? Verifying documentation is to be provided by owner. | ☐ | ☐ | ☐ |
| Are placards installed at site indicating device locations? | ☐ | ☐ | ☐ |
| Is gate signage installed with 24/7 emergency contact information, site name, and address? | ☐ | ☐ | ☐ |
| If a power factor has been specified by the Utility, has the inverter been adjusted to this fixed power factor? Provide print out of settings document, if applicable. | ☐ | ☐ | ☐ |

## B. Commissioning Testing

1. Pre-Energization: The following tests are required to be completed on a DER system prior to energization by the Cooperative (also referred to as the Utility). Some of these tests may be completed in the factory if no additional wiring or connections were made to that component. These tests are marked with a "*". Other sections may be marked as NA, for example if a grounding transformer is not required at the site, that section may be marked NA.

i. Grounding Verification

| | NA | No | Yes |
|---|---|---|---|
| Is a grounding transformer required? | ☐ | ☐ | ☐ |
| Does the grounding transformer nameplate match the interconnection application? | ☐ | ☐ | ☐ |
| Was the grounding transformer sized and specified by a licensed engineer? Verifying documentation is to be provided by owner. | ☐ | ☐ | ☐ |
| Does the grounding transformer protection comply with interconnection and operating agreement? Verifying documentation is to be provided by owner. | ☐ | ☐ | ☐ |
| Does the grounding transformer trip the main breaker when disconnected? | ☐ | ☐ | ☐ |

ii. *CTs & VTs Verification

| | NA | No | Yes |
|---|---|---|---|
| Are the VTs & CTs installed per design? Verifying documentation is to be provided by owner. | ☐ | ☐ | ☐ |
| Instrument transformer disconnects and shorting switches are installed per design? Verifying documentation is to be provided by owner. | ☐ | ☐ | ☐ |

iii. Breaker/Switch Verification

| | NA | No | Yes |
|---|---|---|---|
| Do all breakers, switches, and associated controls function properly? Verifying documentation is to be provide by owner. | ☐ | ☐ | ☐ |

iv. *Relay Test

| | NA | No | Yes |
|---|---|---|---|
| Has relay calibration & testing been completed? Verifying documentation is to be provided by owner. | ☐ | ☐ | ☐ |

v. Remote Control, SCADA, and Remote Monitoring Tests

| | NA | No | Yes |
|---|---|---|---|
| Does the communication network that provides remote monitoring function properly? | ☐ | ☐ | ☐ |

vi. Trip, Phase, Synchronizing Tests

| | NA | No | Yes |
|---|---|---|---|
| Has proof of UL 1741 certification for inverter equipment been provided? | ☐ | ☐ | ☐ |

**C. Energization Commissioning Tests:**

Prior to scheduling the energization commissioning tests, the Interconnection Customer shall submit all pre-testing results, as-built drawings, inverter settings, relay/protective device settings, grounding transformer calculations and any other applicable information. Necessary measurements shall be verified by qualified personnel.

1. **Three-Phase Anti-islanding Test:** A Three-Phase Anti-islanding test shall be conducted to verify that the PV System ceases to energize within 2 seconds of an island and does not reenergize until 5 minutes after applicable voltage from the Utility is restored. Ensure readings at each of the inverters reveal nominal grid voltage.

   i. The PV System shall be energized and operating in parallel with the Utility.
      1. Close the Utility PV AC Disconnect Switch.
      2. Close AC inverter circuit breakers in switchboard if applicable.
      3. Close disconnect on DC Combiner Boxes as applicable.
      4. Verify each inverter completed start-up sequence. Confirm L-L and/or L-G voltage readings.

| | NA | No | Yes |
|---|---|---|---|
| All switches are in the closed position and the inverter's displays indicate that nominal grid voltage is present? | ☐ | ☐ | ☐ |

   ii. Verify that inverters are energized and operating:
      1. Place a meter with CTs and PTs at an accessible location on the conductors or bus on the PV System side of the Utility PV AC Disconnect.
      2. Record the measured current and voltage below and the time when taken.

| | | | | | | |
|---|---|---|---|---|---|---|
| Inverter AC rated Current - Nominal | Amperes: | A-Phase | B-Phase | C-Phase | | Initials: |
| AC Current Measured | Amperes: | A-Phase | B-Phase | C-Phase | Time (hh:mm:ss): | Initials: |
| Inverter L-L rated Voltage - Nominal | Voltage: | AB-Phase | BC-Phase | AC-Phase | | Initials: |
| L-L Voltage Measured | Voltage: | AB-Phase | BC-Phase | AC-Phase | Time (hh:mm:ss): | Initials: |

| | NA | No | Yes |
|---|---|---|---|
| Are all inverters producing current (not less than 15% of the total aggregated output of the PV System)? | ☐ | ☐ | ☐ |

   iii. Three-phase anti-island simulation – Open properly rated three-phase switch to disconnect the PV System from the Utility.
      1. Place the same meter that was used above at an accessible location on the conductors or bus on the PV System side of the Utility PV AC Disconnect.
      2. The Utility PV AC Disconnect shall be turned to the "OFF" or "OPEN" position and the time shall be recorded below.
      3. Record the time it takes for the inverters to shut-down after being disconnected from the Utility.
      4. It shall be verified that the PV System ceased to generate within 2 seconds of simulated loss of Utility.
      5. Verify that the Utility meter registers loss of generation.

| Measurements after disconnecting from Utility | | | | Time (hh:mm:ss): | Initials: |
|---|---|---|---|---|---|
| Time it takes for inverters to shut-down after being disconnected from Utility? | | | | | |
| AC Current Measured: | A-Phase | B-Phase | C-Phase | | |
| L-L Voltage Measured: | AB-Phase | BC-Phase | AC-Phase | | |

| | NA | No | Yes |
|---|---|---|---|
| Did all inverters cease producing current within 2 seconds after the grid power was removed from PV System? | ☐ | ☐ | ☐ |

iv. Reconnecting PV System after Utility voltage returns – Close properly rated three-phase switch reconnecting PV System with the Utility.

1. Place the same meter above at an accessible location on the conductors or bus on the PV System side of the Utility PV AC Disconnect. The meter shall show NO current injected to the grid for at least 5 minutes from the moment the disconnect is turned "ON".
2. The Utility PV AC Disconnect shall be turned to the "ON" or "CLOSED" position and time shall be recorded below.
3. During the 5-minute period, no alternating current being injected into the grid should be observed at any point.
4. Verify that the PV System delays production for at least 5 minutes.

| Measurement 5 minutes after reconnection | | | | Time (hh:mm:ss): | Initials: |
|---|---|---|---|---|---|
| Time AC Disconnect Closed: | | | | | |
| AC Current Measured: | A-Phase | B-Phase | C-Phase | | |
| L-L Voltage Measured: | AB-Phase | BC-Phase | AC-Phase | | |

| | NA | No | Yes |
|---|---|---|---|
| Has a minimum of 5 minutes passed with no production of voltage or current from PV System? | ☐ | ☐ | ☐ |

| | NA | No | Yes |
|---|---|---|---|
| Three phase anti-islanding test pass? | ☐ | ☐ | ☐ |

2. **A-Phase, Single-Phase, Anti-islanding Test:** A single-phase anti-islanding test shall be conducted to verify that the generation ceases to energize within 2 seconds of an island and does not re-energize until 5 minutes after applicable voltage from the Utility is restored. This test shall be repeated for each phase.

   i. The PV System shall be energized and operating in parallel with the Utility.
      1. Place a meter with CTs and PTs at an accessible location on the conductors or bus on the PV System side of the Utility PV AC Disconnect and record the measured current below and the time when taken.

| | NA | No | Yes |
|---|---|---|---|
| Are all switches in the closed position and PV System indicates nominal grid voltage is present? | ☐ | ☐ | ☐ |

   ii. Verify that PV System is energized and operating:

| | | | | | |
|---|---|---|---|---|---|
| AC Current Measured | A-Phase | B-Phase | C-Phase | Time (hh:mm:ss): | Initials: |
| L-L Voltage Measured | AB-Phase | BC-Phase | AC-Phase | Time (hh:mm:ss): | Initials: |

| | NA | No | Yes |
|---|---|---|---|
| Are all inverters producing current (not less than 15% of the total aggregated output of PV System)? | ☐ | ☐ | ☐ |

   iii. A-phase, single-phase anti-island simulation. Follow the steps below.

      1. Verify that the PV System is producing at an output level of at least 15% of the total system output.
      2. Open Phase A Disconnect (can be a temporarily installed disconnect).
      3. Inverter must cease delivery of power within 2 seconds of loss of single phase.

| **Measurement 2 seconds after Utility disconnection** | | | | **Time (hh:mm:ss):** | **Initials:** |
|---|---|---|---|---|---|
| Time Phase A Disconnect Opened: | | | | | |
| AC Current Measured: | A-Phase | B-Phase | C-Phase | | |
| L-L Voltage Measured: | AB-Phase | BC-Phase | AC-Phase | | |

| | NA | No | Yes |
|---|---|---|---|
| Did the inverters cease to energize within 2 seconds after grid power was removed from PV System? | ☐ | ☐ | ☐ |

iv. Reconnecting PV System after Utility voltage returns – Close properly rated A-phase switch reconnecting PV System with the Utility. Follow the steps below.

1. The Phase A Disconnect Switch shall be closed back in and the time shall be recorded below. Alternating-current readings shall be continuously observed for at least 5 minutes extending from the moment the disconnect is closed back in.
2. During the 5-minute period, no alternating-current injected to the grid should be observed at any point.
3. Verify the PV System delays production for at least 5 minutes.

| **Measurement 5 minutes after reconnection** | | | | **Time (hh:mm:ss):** | **Initials:** |
|---|---|---|---|---|---|
| Time Phase A Disconnect Closed: | | | | | |
| AC Current Measured | A-Phase | B-Phase | C-Phase | | |
| Observed L-L Voltage Measured | AB-Phase | BC-Phase | AC-Phase | | |

| | **NA** | **No** | **Yes** |
|---|---|---|---|
| Has a minimum of 5 minutes passed with no production of voltage or current from PV System? | ☐ | ☐ | ☐ |

| | **NA** | **No** | **Yes** |
|---|---|---|---|
| A-phase, single-phase, anti-islanding simulation test pass? | ☐ | ☐ | ☐ |

3. **B-Phase, Single-Phase, Anti-islanding Test:** A single-phase anti-islanding test shall be conducted to verify that the generation ceases to energize within 2 seconds of an island and does not re-energize until 5 minutes after applicable voltage from the Utility is restored.

i. The PV System shall be energized and operating in parallel with the Utility.

| | NA | No | Yes |
|---|---|---|---|
| Are all switches in the closed position and PV System indicates nominal grid voltage is present? | ☐ | ☐ | ☐ |

ii. Verify that PV System is energized and operating:

| | | | | | |
|---|---|---|---|---|---|
| AC Current Measured | A-Phase | B-Phase | C-Phase | Time (hh:mm:ss): | Initials: |
| L-L Voltage | AB-Phase | BC-Phase | AC-Phase | Time (hh:mm:ss): | Initials: |

| | NA | No | Yes |
|---|---|---|---|
| Are all inverters producing current (not less than 15% of the total aggregated output of PV System)? | ☐ | ☐ | ☐ |

iii. B-phase, single-phase anti-island simulation – Open B Phase disconnect switch disconnecting PV System from the Utility (can be a temporarily installed disconnect)..

| **Measurement 2 seconds after Utility disconnection** | | | | **Time (hh:mm:ss):** | **Initials:** |
|---|---|---|---|---|---|
| Time B-Phase Disconnect Opened: | | | | | |
| AC Current Measured: | A-Phase | B-Phase | C-Phase | | |
| L-L Voltage Measured: | AB-Phase | BC-Phase | AC-Phase | | |

| | NA | No | Yes |
|---|---|---|---|
| Did the inverters cease to energize within 2 seconds after grid power was removed from PV System? | ☐ | ☐ | ☐ |

iv. Reconnecting PV System after Utility voltage returns – Close B-phase switch reconnecting PV System with the Utility.

| **Measurement 5 minutes after reconnection** | | | | **Time (hh:mm:ss):** | **Initials:** |
|---|---|---|---|---|---|
| Time B-Phase Disconnect Closed: | | | | | |
| AC Current Measured | A-Phase | B-Phase | C-Phase | | |
| Observed L-L Voltage Measured | AB-Phase | BC-Phase | AC-Phase | | |

| | NA | No | Yes |
|---|---|---|---|
| Has a minimum of 5 minutes passed with no production of voltage or current from PV System? | ☐ | ☐ | ☐ |

| | NA | No | Yes |
|---|---|---|---|
| B-phase, single-phase, anti-islanding simulation test pass? | ☐ | ☐ | ☐ |

4. **C-Phase, Single-Phase, Anti-islanding Test:** A single-phase anti-islanding test shall be conducted to verify that the generation ceases to energize within 2 seconds of an island and does not re-energize until 5 minutes after applicable voltage from the Utility is restored.

i. The PV System shall be energized and operating in parallel with the Utility.

| | NA | No | Yes |
|---|---|---|---|
| Are all switches in the closed position and PV System indicates nominal grid voltage is present. | ☐ | ☐ | ☐ |

ii. Verify that PV System is energized and operating:

| | | | | | |
|---|---|---|---|---|---|
| AC Current Measured | A-Phase | B-Phase | C-Phase | Time (hh:mm:ss): | Initials: |
| L-L Voltage Measured | AB-Phase | BC-Phase | AC-Phase | Time (hh:mm:ss): | Initials: |

| | NA | No | Yes |
|---|---|---|---|
| Are all inverters producing current (not less than 15% of the total aggregated output of PV System)? | ☐ | ☐ | ☐ |

iii. C-phase, single-phase anti-island simulation – Open C-phase disconnect switch disconnecting PV System from the Utility (can be a temporarily installed disconnect).

| **Measurement 2 seconds after Utility disconnection** | | | | **Time (hh:mm:ss):** | **Initials:** |
|---|---|---|---|---|---|
| Time C-Phase Disconnect Opened | | | | | |
| AC Current Measured: | A-Phase | B-Phase | C-Phase | | |
| L-L Voltage Measured: | AB-Phase | BC-Phase | AC-Phase | | |

| | NA | No | Yes |
|---|---|---|---|
| Did the inverters cease to energize within 2 seconds after grid power was removed from PV System? | ☐ | ☐ | ☐ |

iv. Reconnecting PV System after Utility voltage returns – Close C-phase disconnect switch reconnecting PV System with the Utility.

| **Measurement 5 minutes after reconnection** | | | | **Time (hh:mm:ss):** | **Initials:** |
|---|---|---|---|---|---|
| Time C-Phase Disconnect Closed | | | | | |
| AC Current Measured | A-Phase | B-Phase | C-Phase | | |
| Observed L-L Voltage Measured | AB-Phase | BC-Phase | AC-Phase | | |

| | NA | No | Yes |
|---|---|---|---|
| Has a minimum of 5 minutes passed with no production of voltage or current from PV System? | ☐ | ☐ | ☐ |

| | NA | No | Yes |
|---|---|---|---|
| C-phase, single-phase, anti-islanding simulation test pass? | ☐ | ☐ | ☐ |

**D. Testing reference and Notes:**

**E. Final System sign-off:**

Has a Professional Engineer provided a statement certifying that the DER system has been designed and installed to operate as per IEEE-1547 and in accordance with the technical requirements as per the interconnection and operating agreement with Dunn Energy Cooperative?

Yes___ No___