# Illinois Distributed Generation Rebate Application

| | | |
|---|---|---|
| **Name:** | | |
| **Account Number:** | | |
| **Service Address:** | | |
| **City:** | **State:** | **Zip Code:** |
| **Mailing Address:** | | |
| **City:** | **State:** | **Zip Code:** |
| **Telephone (Daytime):** | **(Evening):** | |
| **Email Address:** | | |
| **Inverter Manufacturer:** | **Model:** | **AC Rating:** |
| **Energy Source:** | | |
| **Inverter Meets all Ameren Illinois Smart Inverter Specifications:** | **Yes ___** | **No ___** |
| **Generation Facility Nameplate (DC) Rating:** | **(kW)** | **(kVA)** **(AC Volts)** |

Along with the application above please make sure the following is included.

- Inverter Specification Sheet (for installed firmware version)
- Picture of the Illinois Volt-Var Set points properly configured on the inverter display
- Verification of Communications Requirements:
  - Protocol Requirements: If not included on the Inverter Spec Sheet, include documentation from the manufacturer or appropriate certifying organization that the inverter installed supports one of the three protocols defined on page 3
  - Transport Layer Requirements: If not included on the Inverter Spec Sheet, include documentation from the manufacturer that the inverter installed supports the TCP/IP transport/network layer functionality
  - Physical Layer Requirements: If not included on the Inverter Spec Sheet, include a picture of the Ethernet or RS 485 Serial Port on the installed Inverter

Ameren Illinois Company d/b/a Ameren Illinois
Smart Inverter Specifications

Original Informational Sheet Supplemental to Rider CGR – Customer Generation Rebate,
Sheet Nos. 59 – 59.005 of Electric Service Schedule Ill. C. C. No. 1

Effective November 6, 2018

## 1. SCOPE OF WORK

### 1.1 Purpose

This document is formulated to provide guidance to SMART inverter installers in Illinois. The document provides the minimum specification for inverters that interconnect with Ameren Illinois' (Company) electric service territory according to the Distributed Generation Rebate (Sec. 16-107.6).

## 2. SUMMARY

### 2.1 Safety

Ameren Illinois is committed to both the safety of the public and their employees and to the reliable operation of their distribution system.

### 2.2 Inverters

"SMART inverter" means a device that converts direct current into alternating current and can autonomously contribute to grid support during excursions from normal operating voltage and frequency conditions by providing each of the following: dynamic reactive and real power support, voltage and frequency ride-through, ramp rate controls, communication systems with ability to accept external commands, and other functions from the electric utility. (**Sec. 16-107.6)**

SMART inverters are distinguished from regular inverters in three ways:

(1) They can modify their real power (Watt) and reactive power (VAR) output to provide grid support;

(2) They can respond autonomously to voltage/frequency changes, and

(3) They can respond to communication signals.

### 2.3 General Capabilities Requirements

SMART inverter installations connected to the Company's system shall meet the minimum specifications listed in Table 1.

*Table 1: Summary of Inverter Standards/Guidelines*

| References | Description |
|---|---|
| IEEE 1547-2003 & IEEE 1547a | SMART Inverters connected to the Company's system shall be rated as IEEE 1547 compliant with the allowance of smart capabilities extended by IEEE 1547a, and when applicable shall comply with the upcoming IEEE 1547 full revision and with final conformance test procedures contained in IEEE standard 1547.1, which is not expected to be published until Q3 or Q4 of 2019. |
| UL 1741 | SMART inverters connected to the Company's system shall be rated as UL 1741 safety compliant |
| UL 1741 SA | SMART Inverters connected to the Company's system shall pass UL 1741 SA[1] as Grid Support Utility Interactive Inverter |
| California Rule 21 | SMART Inverters connected to the Company's system shall be compliant with California Rule 21 Phase 1 functions (Section Hh. of the Rule 21) |

[1] UL 1741 and UL 1741SA certification should be from a Nationally Recognized Testing Laboratory (NRTL) whose OSHA Scope of Recognition includes UL 1741

Additional details of these standards/guidelines are provided in Appendix A

**2.4 Interconnection Applications**

Customers or certified installers will still need to apply for interconnection. Ameren Illinois' Interconnection application forms can be found at Distributed Generation.

**2.5 Ownership & Control**

The Customer shall be financially responsible for the smart inverter. The Company shall have the ability to operate and control the SMART inverter directly or through aggregators. Moreover, the Company will either own the communication device and be responsible for communication costs incurred during operation, or approve an appropriately secure third party owned communication device to communicate with Ameren's system.

**2.6 Aggregate Device Control**

If a customer owns multiple inverters on site, the Company will need access to each SMART inverter or appropriate aggregating controllers.

**2.7 Location of SMART inverter**

The SMART inverter utility interface connection shall be placed at a location that is safely accessible by the Company and capable of maintaining reliable communication as measured on an hourly basis. Additional costs for connecting from the Company's communication device to a reliable antennae site location will be paid by the customer.

**2.8 List of Approved SMART inverters**

For a list of approved SMART inverters, please refer to Go Solar California's approved list. On the listing, the inverter must be labelled as a 'Grid Support Utility Interactive Inverter' [NOTE: 'Utility Interactive' is NOT the same as 'Grid Support Utility Interactive Inverter']. Go Solar California's link has an extensive list of SMART Inverters, Illinois' customers are encouraged and advised to double check each SMART Inverter with the minimum requirements set forth in this document.

## 3. COMMUNICATION REQUIREMENT

All SMART inverters must meet the communication requirements outlined below. Table 2 presents the Company's acceptable communication and transport protocols, as well as the required interface layer. SMART inverter must be capable of providing one of the protocols, transport, and physical interface in Table 2. [NOTE: All SMART inverters connected to the Company system MUST be capable of communications, additionally, any firmware or software updates shall be updateable via communications remotely].

*Table 2: Minimum Requirement for communication and interface*

| Protocol | Transport | Physical Interface/Layer |
|---|---|---|
| IEEE 1815 (DNP3)/ SunSpec Modbus/ IEEE 2030.5 (Sep 2.0) | TCP/IP | Ethernet/ RS 485 |

The Company will install, at an appropriate time, a communication module/device to communicate with the SMART inverter. The Company shall own the communication module, and shall be responsible for the communication module/device installation and operating costs. As noted above, the customer is responsible for any costs required to connect the communication device to a reliable antenna site.

[NOTE: The Company may choose not to install the communication device at the time of SMART Inverter inspection / commissioning and will make appropriate arrangements to install the device at a later date].

## 4. OPERATING MODES AND CONTROL SETTINGS

Default Operating Modes and Control Settings are presented in Section 4. The Company shall reserve the right to change or modify it when required.

### 4.1 Operating Modes

Modes of operations are presented in Table 3.

*Table 3: Modes of Operations*

| Mode of Operation | Required/Optional | Description | Default Activation Status |
|---|---|---|---|
| Anti-Islanding | Required | Refers to the ability of a DER to detect loss of utility source and cease to energize | Activated |
| Adjustable constant power factor (SPF) | Required | Power Factor set to a fixed value. Some manufactures refer to this as 'Specified Power Factor (SPF)' | Deactivated |
| Voltage – Reactive (Volt/Var) | Required | Refers to active control of reactive power output as a function of voltage | Activated |
| Ramp Rates | Required | Refers to ability to have an adjustable entry service ramp rate when a DER restores output of active power or changes output levels over the normal course of operation. | Activated |
| Voltage Ride through (L/HVRT) | Required | Refers to ability of SMART Inverter to ride through a certain range of voltages before tripping off | Activated |
| Frequency Ride through (L/HFRT) | Required | Refers to ability of SMART Inverter to ride through a certain range of frequencies before tripping off | Activated |
| Voltage – Active Power (Volt/Watt) | Required as available | Refers to active control of real power output as a function of voltage | If capable, deactivated |
| Adjustable Constant Reactive Power | Required as available | Reactive Power set to a fixed value | If capable, deactivated |
| Frequency - Watt | Required as available | Refers to control of real power as a function of frequency | If capable, deactivated |

## 4.2 Control Settings

Control settings are presented in Tables 4-7.

*Table 4: Response to Islanding faults and open phase conditions*

| Condition | Trip Time (s) |
|---|---|
| Open Phase/Faults | 2 |

*Table 5: Low/High Voltage Ride Through (L/HVRT) minimum requirement – ACTIVATED*

| Region | Voltage range (% of nominal voltage) | Operating Mode/Response | Min. ride-through time (s) | Max. Trip Time (s) |
|---|---|---|---|---|
| *HIGH VOLTAGE 2 (HV2)* | V ≥ 120 | Cease to Energize | N/A | 0.16 |
| *HIGH VOLTAGE 1 (HV1)* | 110 < V < 120 | Momentary Cessation | 12 | 13 |
| *NEAR NOMINAL VOLTAGE (NN)* | 88 ≤ V ≤ 110 | Continuous Operation | Infinite | N/A |
| *LOW VOLTAGE 1 (LV1)* | 70 ≤ V < 88 | Mandatory Operation | 20 | 21 |
| *LOW VOLTAGE 2 (LV2)* | 50 ≤ V < 70 | Mandatory Operation | 10 | 11 |
| *LOW VOLTAGE 3 (LV3)* | V < 50 | Momentary Cessation | 1 | 1.5 |

*Table 6: Low/High Frequency Ride Through (L/HFRT) minimum requirement – ACTIVATED*

| Region | System Frequency Default Settings | Minimum Range of Adjustability | Ride-Through Until | Ride-Through Operational Mode | Maximum Trip Time |
|---|---|---|---|---|---|
| HIGH FREQ 2 (HF2) | f > 62 | 62.0 – 64.0 Hz | No Ride-Through | NA | 0.16s |
| HIGH FREQ 1 (HF1) | 60.5 < f ≤ 62 | 60.1 – 62.0 Hz | 299 | Man. Operation | 300s |
| NEAR NOMINAL (NN) | 58.5 ≤ f ≤ 60.5 | NA | Indefinite | Con. Operation | NA |
| LOW FREQ 1 (LF1) | 57.0 ≤ f ≤ 58.5 | 57.0 – 59.9 Hz | 299 | Man. Operation | 300s |
| LOW FREQ 2 (LF2) | f < 57.0 | 53.0 – 57.0 Hz | No Ride-Through | NA | 0.16s |

*Table 7: Volt-VAR Settings for DER – ACTIVATED*

| Volt-VAR parameters | Definitions | Default Values (% of Nominal Voltage |
|---|---|---|
| V2 | Dead band lower voltage limit | 96.7% |
| Q2 | Reactive power injection or absorption at voltage V2 | 0 |
| V3 | Dead band upper voltage limit | 103.3% |
| Q3 | Reactive power injection or absorption at voltage V3 | 0 |
| V1 | Voltage at which DER shall inject Q1 reactive power | 92.0% |
| Q1 | Reactive power injection at voltage V1 | 30% |
| V4 | Voltage at which DER shall absorb Q4 reactive power | 107.0% |
| Q4 | Reactive power absorption at voltage V4 | 30% |
| Open loop response time | Time to 90% of the reactive power change in response to the change in voltage | 5 seconds |

Note: The SMART inverter shall operate with a reactive power priority, and shall be capable of producing or absorbing reactive power to the ranges specified in Table 7 irrespective of active power production.

**Ramp Rate Settings:**

- Normal ramp-up rate: For transitions between energy output levels over the normal course of operation. The default value is 100% of maximum current output per second with a range of adjustment between 1% to 100%.
- Connect/Reconnect Ramp-up rate: Upon starting power into the grid, following a period of inactivity or a disconnection, the inverter shall wait for 300 seconds before reconnecting and shall be able to control its rate of increase of power from 1 to 100% maximum current per second. The default value is 2% of maximum current output per second.

**Note:** The maximum active power steps during restoring output is 20%.

## Appendix A – Summary of Inverter Standards / Guidelines

**1. UL 1741**

UL 1741SA is the latest revision to UL 1741, which was announced in September 2016. Compared to UL 1741, the UL 1741 SA has new grid support functions. California and Hawaii are the first states to mandate that inverter manufactures meet the UL 1741 SA requirements of the UL 1741 standard, with compliance required in September 2017 (which is a year after the release of 1741 SA). The following are the features in UL 1741 SA:

- Anti-islanding protection
- Low and High voltage ride through
- Low and High Frequency ride through
- Must Trip Test
- Normal Ramp Rate and Soft Start Ramp Rate
- Specified Power Factor
- Volt-Var Mode
- Frequency-Watt – Optional
- Volt-Watt – Optional

**2. IEEE 1547**

IEEE 1547 is the standard for interconnecting DER with electric power systems. The standard was approved in 2003 and reconfirmed in 2008. The standard had stated that DER:

- Shall trip in response to abnormal V/F conditions, and
- Shall not actively regulate voltage and frequency

In 2014, an amendment, known as IEEE 1547a was released. The amendment stated that DER:

- May ride through abnormal V/F
- May actively regulate voltage by changing real/reactive power
- May change real power in response to frequency deviations

IEEE 1547 is currently going through a full revision that is expected to be released sometime in 2018. As of Jan 2017, the IEEE 1547rev had the following in its draft 6 version:

- Shall ride through abnormal V/F
- Shall be capable of actively regulating voltage by changing real/reactive power
- Shall be capable of changing real power in response to frequency deviations
- Shall have communication interface

**3. IEEE 1547.1**

IEEE 1547.1 is the standard that lists the conformance test procedure for equipment interconnecting DER with electric power systems. The standard was approved in 2005. In 2015 an amendment known as IEEE 1547.1a was approved. A full revision process began in 2016, and the final IEEE 1547.1 standard containing conformance test procedures for smart inverters is not expected to be published until Q3 or Q4 of 2019.

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Effective November 6, 2018

**4. California Rule 21 – Phase 1 Functions**

The following functions are California Rule 21 Phase 1 requirements:

- Anti-Islanding
- Low/High Voltage Ride-Through
- Low/High Frequency Ride-Through
- Dynamic Volt/Var operations
- Ramp rates
- Fixed power factor
- Reconnect by “soft-start” methods
- Frequency-Watt (Optional)
- Volt/Watt (Optional)