

*Customer Guide for Retail Interconnection of
Electric Power Producing and Storage Facilities
Residential / Small Commercial – Single Phase
Inverter Based – 167 kWac or Less*

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1.0 Introduction

This guide is published to provide pertinent information that will assist customers and their engineers, builders, and contractors in planning for and obtaining a safe and prompt interconnection of Customer owned electric power-producing and storage facilities that run in parallel with the FirstEnergy Operating Company (Company) distribution system. These facilities shall be referred to in this document as Distributed Energy Resources (DER).

The guide conveys general knowledge and does not provide every detail or every requirement. Furthermore, the information is supplementary to, and does not intentionally conflict with the National Electrical Code (NEC), the National Electrical Safety Code (NESC), the Company's current applicable Tariffs, or such state and municipal laws and ordinances as may be in force and applicable within the cities, towns, or communities in which the Company furnishes electric service. It is always necessary for customers and contractors to comply with state statutes, local ordinances, and the Company's Tariffs on file with the State in which they reside. To the extent that any information included in this Guide contradicts any terms in the Company's current applicable Tariff, the Tariff provisions shall govern.

Mandatory rules of this document are those that identify actions that are specifically required or prohibited and are characterized by the terms **shall** or **shall not**. This Guide is subject to amendment from time to time and will be re-issued on an as needed basis. It is the responsibility of the user to obtain the current version.

The current edition of this Guide supersedes all previous editions or versions. The current edition of this Guide is available at <https://www.firstenergycorp.com/feconnect.html>

2.0 Definitions

area electric power system (Area EPS): An EPS that serves Local EPSs. An area EPS is usually owned and operated by the Company

authority having jurisdiction: Authority having the rights to inspection and approval of the design and construction of Local EPS premise electrical systems

clearing time: The time between the start of an abnormal condition and the DER ceasing to energize the *Area EPS*. It is the sum of the detection time, any adjustable time delay, the operating time plus arcing time for any interposing devices (if used), and the operating time plus arcing time for the interrupting device (used to interconnect the DER with the *Area EPS*).

distributed energy resource (DER): A source of electric power that is not directly connected to a bulk power system. DER includes both generators and energy storage technologies capable of exporting active power to an EPS. An interconnection system

or a supplemental DER device that is necessary for compliance with IEEE-1547 is part of a DER. Controllable loads used for demand response are not included in the definition of DER

electric power system (EPS): Facilities that deliver electric power to a load. Includes the area EPS and the local EPS

flicker: The subjective impression of fluctuating luminance caused by voltage fluctuations. NOTE—Above a certain threshold, flicker becomes annoying. The annoyance grows very rapidly with the amplitude of the fluctuation. At certain repetition rates even very small amplitudes can be annoying (IEEE Std 1453).

interconnection: The result of the process of adding DER to an Area EPS, whether directly or via intermediate Local EPS facilities.

interconnection equipment: Individual or multiple devices used in an interconnection system.

interconnection system: The collection of all interconnection and interoperability equipment and functions, taken as a group, used to interconnect a DER to an Area EPS.

Island: A condition in which a portion of an Area EPS is energized solely by one or more Local EPSs through the associated PCCs while that portion of the Area EPS is electrically separated from the rest of the Area EPS on all phases to which the DER is connected. When an island exists, the DER energizing the island may be said to be “islanding”.

local electric power system (Local EPS): An EPS contained entirely within a single premises or group of premises. The local EPS is usually owned and operated by the Customer

nameplate ratings: Nominal voltage (V), current (A), maximum active power (kW), apparent power (kVA), and reactive power (kvar) at which a DER is capable of sustained operation.

point of common coupling (PCC): The point of connection between the Area EPS and the Local EPS. Equivalent, in most cases, to “service point” as specified in the National Electrical Code® (NEC®) and the National Electrical Safety Code® (NESC®)

point of distributed energy resources connection (point of DER connection–PoC): The point where a DER unit is electrically connected in a Local EPS and meets the requirements of this standard exclusive of any load present in the respective part of the Local EPS

3.0 State Interconnection Rules and Regulations

Retail interconnections, which primarily include net energy metered customers, are subject to State interconnection rules and regulations. State rules define the interconnection review procedure and provide details such as allowable fees and assignment of construction costs. They also impose processing deadlines and reporting requirements for utilities. The state-specific interconnection rules and standards are shown in Table 1 below. These standards may be revised from time-to-time. These documents are available via the State Commission's website

Table 1 – Rules & Regulations for Retail Interconnections

Maryland	Code of Maryland Regulations (COMAR), Title 20 PSC, Subtitle 50, Chapter 9 Small Generator Interconnection Standards, Chapter 10 Net Metering
Ohio	Ohio Administrative Code, Chapter 4901:1-22, Interconnection Services, Chapter 4901:1-10-28
Pennsylvania	Pennsylvania 52 PA Code Chapter 75, Subchapter C Interconnection Standards , Subchapter B Net Metering
New Jersey	New Jersey Administrative Code, N.J.A.C. 14:8-4, Net Metering for Class 1 Renewable Energy Systems, N.J.A.C. 14:8-5, Intetrcnection of Class 1 Renewable Energy Systems
West Verginia	West Virginia PSC, Title 150, Series 33, Rules Governing Electric Utility Net Metering Arrangements and Interconnections

4.0 Applicability

The interconnection requirements set forth in this document describe the minimum operating characteristics, metering, and protective equipment the individual Company requires for operation of its electric distribution system in parallel with DER owned by a Customer. This guide was developed for those Customers with a single-phase service at voltages of up to 240 volts and interconnecting inverter based DER of up to 167 kWac rated capacity for retail interconnection purposes.

Customers utilizing power producing resources that do not operate in parallel with the area EPS, such as emergency back-up generation, or storage batteries used only for back-up purposes, are not subject to the requirements of this document. However, their installation shall meet the requirements of the NEC. Transfer switches or other methods that assure separation of the Company area EPS from the Customer owned local EPS must be utilized. Permits, inspections and approvals by the authority having jurisdiction shall be obtained for electrical system modifications related to back-up power systems as described and defined in the NEC.

5.0 Application Procedure

The Customer shall submit an application, prior to installing, operating, or making significant changes to a DER utilizing application forms and instructions available at <https://www.firstenergycorp.com/feconnect.html>. A capacity increase, or decrease, exceeding 5% is a significant change requiring a modified application. In the case of multiple Customer accounts being impacted by a single project, the Customer shall submit a specific application for each account. However, the Customer is permitted to utilize a common site plan and single-line drawing. The Customer will need to click on the link for the appropriate FirstEnergy Operating Company and follow the instructions specific to each State jurisdiction. If assistance is required during the application process, local Company contact information is provided at the web address listed above.

6.0 Design Requirements

6.1 The Customer DER shall be UL 1741 / UL1741SA certified as a “Grid Support Interactive Inverter”, or a “Grid Support Utility Interactive Inverter” utilizing IEEE 1547-2003, or IEEE 1547a-2014 compliant settings with all grid support functions disabled.

Table 2

Function (1547-2018 term**)	UL 1741 SA Term and section	SA Testing Required*	Function Enabled?
Low/High Voltage Ride-Through	Low/High Voltage Ride-Through, SA9	Yes	N/A
Low/High Frequency Ride-Through	Low/High Frequency Ride-Through, SA10	Yes	N/A
Enter service ramp rate	Soft-Start Ramp Rate, SA11	Yes	N/A
Constant power factor mode	Specified Power Factor, SA12	Yes	NO
Voltage-reactive power mode	Volt-var, SA13	Yes	NO
Frequency-droop operation /	Frequency-Watt, SA14	Yes	NO
Voltage-active power mode	Volt-Watt, SA15	Yes	NO

**UL 1741SA testing requires testing to IEEE 1547.1-2005 or IEEE 1547.1a-2015. The grid support functionality testing contained in UL 1741SA will be incorporated in IEEE*

1547.1 and referenced by UL 1741 once revised and published. Once published, the revised IEEE 1547.1 may be used in lieu of UL 1741SA.

***Not all IEEE 1547-2018 functions are included in this table*

6.2 An equipment package shall be considered certified as complying with the above-referenced standards if it has been submitted by a manufacturer to a nationally recognized testing and certification laboratory and has been tested and listed by the laboratory for continuous interactive operation with an area EPS in compliance with the standards listed above. The DER shall conform to all applicable local, state and federal building codes, national standards and any other requirements of authorities having jurisdiction.

6.3 The DER shall provide appropriate protection and control equipment, including an interrupting device (commonly a listed inverter) that will automatically disconnect the DER from the area EPS in the event the area EPS becomes de-energized or for a fault on the local/area EPS. This automatic device shall operate within the trip setting requirements identified in IEEE Standard 1547. Unless specifically required by and approved by the Company in writing, the settings for automatic operation shall conform to the following Table 3. No setting shall be changed by the Customer after initial commissioning unless specifically authorized by the Company in writing.

Table 3 Company Voltage and Frequency Settings Requirements

Voltage Range (% of base)	Maximum Total Clearing Time (S)	Frequency (Hz)	Maximum Total Clearing Time (S)
V<45	0.16	<57	0.16
45≤V<60	1	<59.5	2
60≤V<88	2	>60.5	2
110<V<120	1	>62	0.16
V≥120	0.16		

Note: Power Factor shall be set to 1.0

6.4 Following a disconnect of the DER due to voltage or frequency excursion, the electric power-producing facility shall remain disconnected until the utility service voltage has recovered to acceptable voltage and frequency limits for a minimum of five minutes

6.5 DER installed at a single phase electric service location utilizing a self-contained company meter (usually 400A service size, or less), shall have a disconnect switch meeting the requirements of the NEC between the Company meter and the DER PoC. The switch shall be clearly marked, "Generator Disconnect Switch", with permanent 3/8 inch or larger letters. The preferred location of the switch is outside the building in the immediate vicinity of the electric meter to facilitate access by Company personnel.

6.6 DER installed at a single phase electric service location utilizing an instrument transformer cabinet for company metering (usually greater than a 400 A service size), shall be capable of being isolated from the utility system by means of a manual, visible open, lockable, load break disconnect switch conforming with the NEC. The switch shall be installed outdoors in the immediate vicinity of the electric meter, or service entrance to facilitate access by Company personnel. The switch shall be clearly marked, "Generator Disconnect Switch," with permanent 3/8 inch or larger letters.

6.7 If the Customer has a previously approved indoor meter location, a consultation with the Company regional engineering department is required prior to submitting plans. Depending on the details of the situation, unique requirements may be needed. These requirements may include relocation of the meter, relocation of instrument transformers and/or special signage requirements.

6.8 No attachments by the customer or the customer's agent are permitted to Company-owned meters, meter circuits, or ancillary meter devices. The following are considered un-authorized connections when not made, installed, or performed by a Company employee or an authorized representative of the Company:

- Any adapter placed between the revenue meter and meter socket.
- Attachments or connections to the potential or current circuits of transformer rated revenue meters.
- Any connection inside the meter socket.

6.9 The use of power storage facilities, like batteries, or other non-renewable resources, connected in tandem with renewable energy generation sources, such as inverter based solar PV systems, is permitted under the Company Tariff for Electric Service. Charge and discharge of a storage device, or operation of nonrenewable generation is permitted while operating in parallel with the area EPS, but only when power is not being exported as measured at the PCC. The storage device, or non-renewable generation, shall be located on the Customer side of the DER automatic protective device. (See Design Requirements 4.0) The Customer shall provide the Company with control system specifications, acceptable to the Company, that indicate the mode of operation will not permit export while operating in parallel with the area EPS. Alternatively, the storage device, or other non-renewable resource may be installed on the Customer side of an automatic, or manual, transfer switch meeting the requirements of the NEC.

7.0 Power Quality

The requirements for acceptable flicker levels shall be in accordance with the latest version of IEEE Std 1453, Recommended Practice for the Analysis of Fluctuating Installations on Power Systems. Short and long-term perception of flicker shall be within the planning and compatibility levels identified in this standard. Mitigation measures necessary to comply with these requirements shall be at the Customer's expense. The DER shall not be a source of excessive harmonic voltage or current distortion and/or voltage flicker. Limits for harmonic distortion will be as published in the latest issue of IEEE 519, "Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems."

8.0 Verification Testing

Verification testing confirms that the system as designed, delivered, and installed meets the interconnection and interoperability requirements of this document and IEEE-1547. The Company, at its sole discretion, may require verification testing of interface equipment by a qualified technician during initial installation in accordance with the manufacturer's documented procedures and IEEE-1547. The Company reserves the right to witness verification testing or require written certification that the testing was successfully performed.

9.0 Company Preliminary Approval Process

The Company will perform a review of the application documents submitted and evaluate the need for any upgrades to Company facilities due to the DER installation. If the application does not meet approval requirements, or upgrades to Company facilities will be required, the Customer will be notified. If the application meets the approval requirements, an "Approval to Install" notification shall be issued. This notice serves as:

- Notification that the Company has received the Customer's application
- Notification that the Company has not found any deficiencies with the application
- Notification that the application has been preliminarily approved for interconnection

The Approval to Install is a preliminary approval and is for operational purposes only. It is the Customer's responsibility to ensure compliance with any requirements documented in the Approval to Install, all local, state and federal ordinances, statutes, regulations or other legal requirements.

10.0 Upgrades to Company Facilities

Depending on the rated capacity and location of a proposed DER, the Company may determine that an upgrade is required to its facilities to safely and reliably interconnect with the Company area EPS. In such cases, the Customer will be informed of the

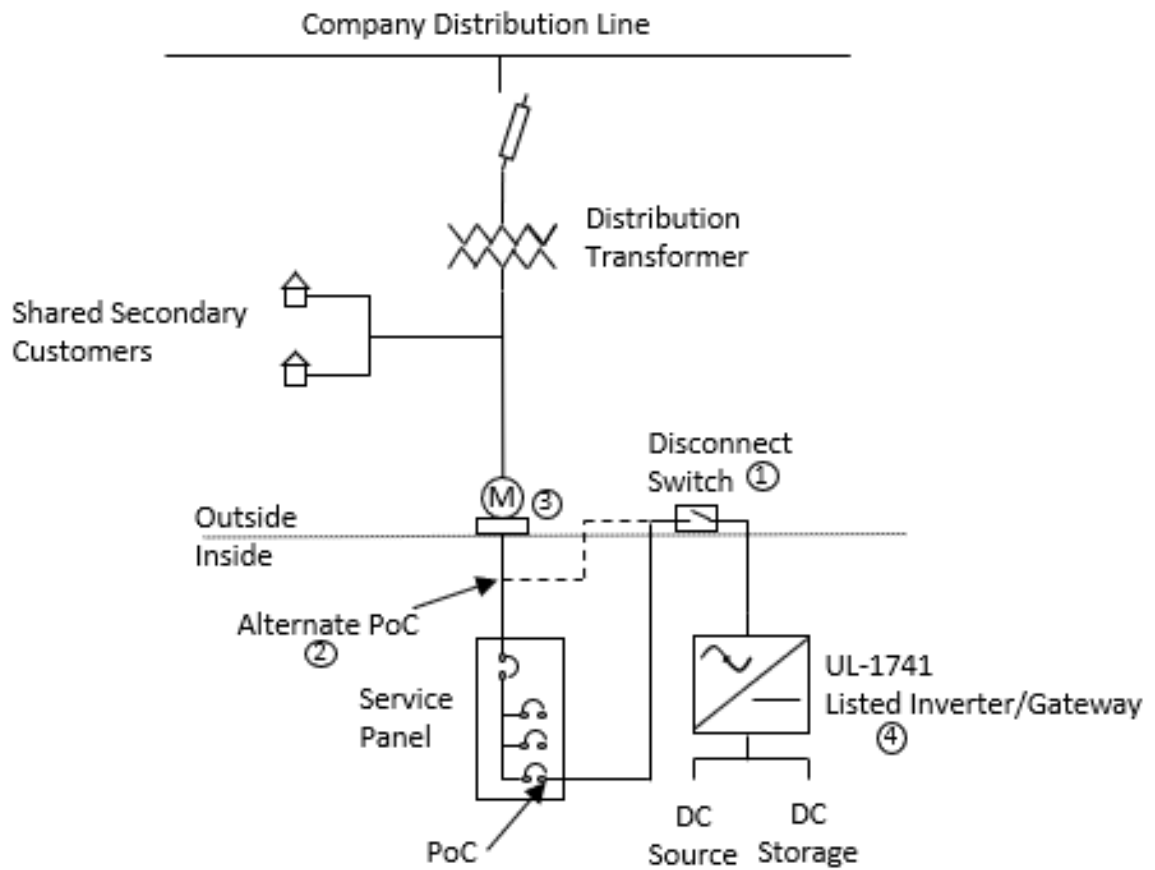
estimated cost of the upgrades to Company facilities needed to accommodate the DER. All costs associated with DER related facility upgrades will be the responsibility of the Customer. If the Customer desires to proceed with upgrades, the Customer will be given instructions on how to open a work request with the Company. The work request process will result in a Fixed Cost Billing Agreement being generated by the Company. Execution of the Billing Agreement, payment and completion of the work request is required prior to the Company issuing an Approval to Operate (See section 11.0).

11.0 Company Final Approval Process

After the Customer has received an Approval to Install from the Company, completed the installation, obtained all required approvals from State and local authorities having jurisdiction, and paid the Company for any required facility upgrades, the Customer shall submit the Part 2 (final application) documents. These documents can be obtained at <https://www.firstenergycorp.com/feconnect.html> and are unique to each Company location / State. The Customer shall note any as-built changes to the original application documents. The Company shall perform a review of the application documents, assess if the Company has completed any required facility upgrades, and determine if final approval is warranted. The Company may require a witness test as part of its final review. If final approval is granted, an Approval to Operate notice will be issued by the Company. This notice shall serve as the Company's final communication regarding the DER application process.

It is often necessary for the Company to change the type of meter installed at the Customer location to properly bill net-meter accounts. If required, meter change-out orders are automatically issued by the Company at the same time an Approval to Operate notice is issued.

Figure 1 - Typical Configuration - 1 Phase 120/240V – DER Less Than 100 kWac



Notes:

1. Disconnect switch required. See section 6.5 and 6.6 of this document.
2. When using a supply side connection as per the NEC, the disconnect switch shall be listed as suitable for use as service equipment.
3. No Customer connections are permitted in the meter pan
4. UL-1741 certified inverter meeting the requirements of IEEE-1547. See Section 6.1 of this document.