# BEFORE THE
# PENNSYLVANIA PUBLIC UTILITY COMMISSION

| | | |
|---|---|---|
| Petition of PPL Electric Utilities Corporation for Approval of Tariff Modifications and Waivers of Regulations Necessary to Implement its Distributed Energy Resources Management Plan | : : : : : | Docket No. P-2019-3010128 |

## REBUTTAL TESTIMONY OF
## MATTHEW WALLACE

## PPL Electric Statement No. 6-R

**March 4, 2020**

**Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.**

A. My name is Matthew Wallace, and my business address is 2 North Ninth Street, WNDOB, Allentown, PA 18101.

**Q. BY WHOM ARE YOU EMPLOYED AND IN WHAT CAPACITY?**

A. I am employed by PPL Electric Utilities Corporation ("PPL Electric" or the "Company") as Senior Engineer.

**Q. WHAT ARE YOUR DUTIES AS SENIOR ENGINEER?**

A. I am primarily responsible for developing distributed energy resources ("DERs") interoperability systems.

**Q. WHAT IS YOUR EDUCATIONAL BACKGROUND?**

A. I hold a Bachelor of Science degree in Civil Engineering Technology from the State University of New York ("SUNY") Institute of Technology and an Associate of Applied Science degree in Civil Engineering Technology from Mohawk Valley Community College.

**Q. PLEASE DESCRIBE YOUR PROFESSIONAL EXPERIENCE.**

A. I have worked at PPL Electric for almost three years, working as a Senior Engineer in Distribution Standards (April 2017 – January 2019), Distribution Planning (January 2019 – September 2019), and Distribution Operations Engineering (September 2019 – present).

While working in these roles, I performed work on PPL Electric's Keystone Solar Future Project as the Company's DER interoperability lead.

Prior to working for PPL Electric, I worked for the New York State Department of Public Service as a Utility Engineer (first as a Junior Engineer, then Utility Engineer I, then Utility Engineer II), advising the state's utility regulatory commission on matters related to electric distribution systems and DERs.

Prior to that, I worked for the New York State Department of Transportation as a field engineer performing construction inspection.

**Q. HAVE YOU PREVIOUSLY TESTIFIED AS A WITNESS BEFORE THE PENNSYLVANIA PUBLIC UTILITY COMMISSION ("COMMISSION")?**

A. No.

**Q. WOULD YOU PLEASE DESCRIBE THE SUBJECT MATTER OF YOUR REBUTTAL TESTIMONY?**

A. My rebuttal testimony will respond to certain allegations made in NRDC Statement No. 1, the Direct Testimony of Harry Warren submitted on behalf of the Natural Resources Defense Council ("NRDC") and in SEF Statement No. 2, the Direct Testimony of Ron Celentano submitted on behalf of the Sustainable Energy Fund. In particular, my rebuttal testimony is focused on responding to their questions about the ConnectDER LLC ("ConnectDER") DER Management device that will be used under the Company's DER Management proposal.

**Q. ARE YOU SPONSORING ANY EXHIBITS WITH YOUR TESTIMONY?**

A. Yes, I am sponsoring the following exhibits:

- PPL Electric Exhibit MW-1R – A document detailing the cost benefits of PPL Electric's use of the ConnectDER DER Management device and how that compares to common solar inverter installations.
- PPL Electric Exhibit MW-2R – A copy of Underwriters Laboratories ("UL") certification for ConnectDER's meter collar in the DER Management device.
- PPL Electric Exhibit MW-3R – A letter dated February 28, 2020, showing that MET Laboratories, Inc. ("MET"), an independent third party, evaluated and determined that ConnectDER's DER Management device is compliant with the applicable UL safety standard, *i.e.*, UL 62368-1:2014.
- PPL Electric Exhibit MW-4R – A copy of the installation instructions for the meter collar from ConnectDER's product manual.
- PPL Electric Exhibit MW-5R – A copy of the installation instructions for the "dongle" from ConnectDER's product manual.

## I. <u>DETAILS ON THE CONNECTDER DER MANAGEMENT DEVICE</u>

### A. OVERVIEW OF THE CONNECTDER DER MANAGEMENT DEVICE

**Q. NRDC WITNESS WARREN AND SEF WITNESS CELENTANO HAVE ASSERTED THAT THERE IS A LACK OF DETAILS ABOUT THE DER MANAGEMENT DEVICE THAT WOULD BE USED AS PART OF THE DER MANAGEMENT PLAN. (NRDC ST. NO. 1, PP. 8, 25-26; SEF ST. NO. 2, PP. 11, 14.) BEFORE PROVIDING THOSE DETAILS, COULD YOU PLEASE**

**PROVIDE SOME BACKGROUND ON CONNECTDER AS WELL AS THE COMPANY'S DEVELOPMENT OF THE DEVICE WITH CONNECTDER?**

A. ConnectDER is headquartered in Arlington, Virginia with their Design and Build Shop located in Philadelphia, Pennsylvania. The company was formed in 2012 to produce an innovative meter collar design allowing DERs to be installed without having the burden and high cost of connecting the inverter electrically to the customer's electrical panel. This is the Simple ConnectDER. Expanding on this novel idea, ConnectDER later added metering functions and communication capabilities to its meter collar after utilities expressed interest in these abilities. In working with PPL Electric, ConnectDER has expanded this device to include DER Management. All models of the ConnectDER devices are approved to be installed on PPL Electric's system as well as on the systems of other major electric utilities, including Green Mountain Power, Consolidated Edison, Inc., and Arizona Public Service. There are currently over 8,000 devices in operation.

PPL Electric's work with ConnectDER originated from a desire to find a more cost-effective DER Management device, which would benefit both the customers and PPL Electric. In the Keystone Solar Future Project, PPL Electric developed a DER Management device that featured a weatherproof cabinet containing a Radio Frequency ("RF") Mesh network radio or cellular modem. For purposes of this testimony, I will refer to that device as the "Keystone Solution."

By comparison, the ConnectDER DER Management device is a quicker installation and provides substantial cost savings to DER customers. The Keystone Solution uses more expensive components and is more labor intensive, whereas the ConnectDER DER Management device is cheaper, reduces the DER's installation costs,

and can be installed in a matter of minutes. The ConnectDER DER Management device also is smaller, more aesthetically pleasing, and less complicated than the Keystone Solution.

**Q. COULD YOU PLEASE PROVIDE A DETAILED BREAKDOWN OF THE COMPONENTS COMPRISING THE CONNECTDER DER MANAGEMENT DEVICE?**

A. The ConnectDER DER Management device is a two-part system consisting of: (1) the meter collar; and (2) the dongle.

In the meter collar there are three main components: (1) an electrical breaker; (2) a Wi-Fi board for communicating with the dongle; and (3) the main communication board, which enables the device to communicate with PPL Electric over the Company's RF Mesh network. The meter collar plugs into the customer's meter base, thereby positioning it between the customer-owned meter base and the Company-owned meter. In other words, it is located on the "high side" or the utility side of the meter base, which is the general point of separation of PPL Electric and customer ownership and responsibility. A picture of the meter collar, as installed between the meter and the meter base is shown in PPL Electric Exhibit MW-4R and is reproduced below:

**Picture of ConnectDER Meter Collar from PPL Electric Exhibit MW-4R**

On the meter collar, there are terminals where the power cable from the smart inverter can be connected, providing an easier and less costly way to connect the DER to the customer's electrical system. Without the meter collar, the customer would need to install cable and conduit from the smart inverter to the electrical panel in the customer's building, usually located in the basement. Figure 1 of PPL Electric Exhibit MW-1R shows how an inverter connects to the customer's property without the meter collar, while Figure 2 of that exhibit shows how the inverter can directly connect to the meter collar when the nameplate capacity of the DER is under 15 kW. Those Figures are reproduced below:

**Figure 1 of PPL Electric Exhibit MW-1R – Typical Connection Diagram**

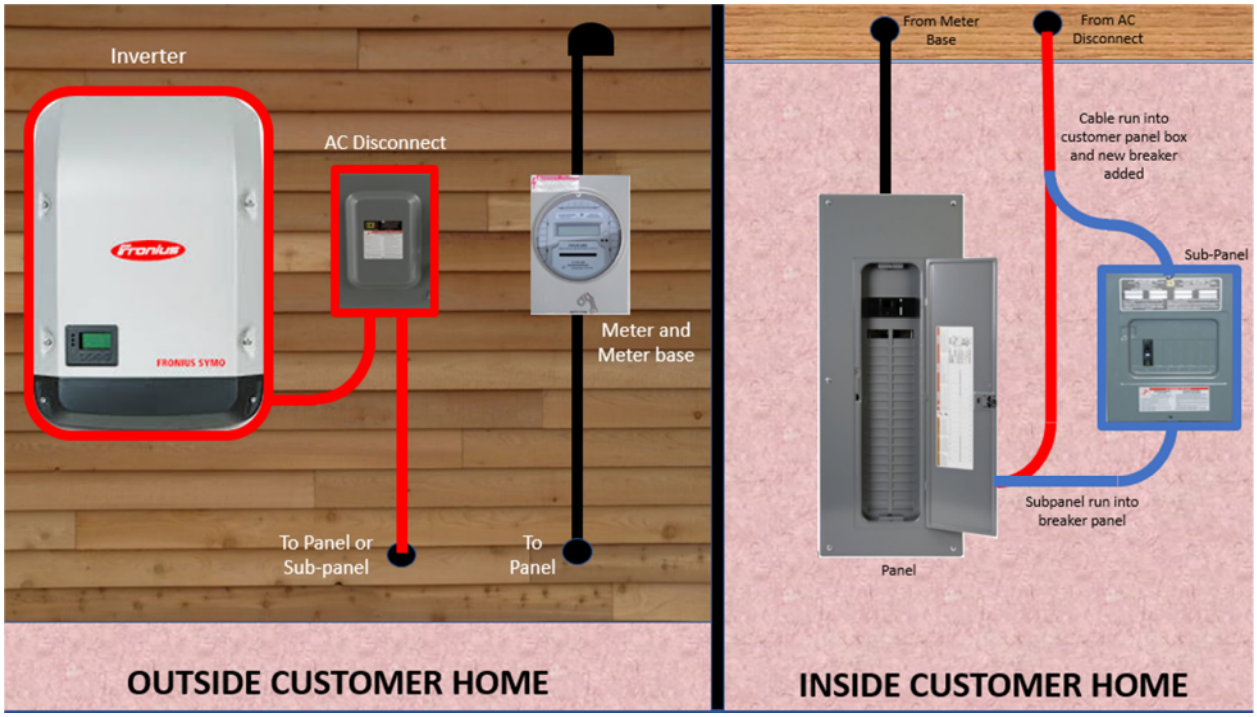
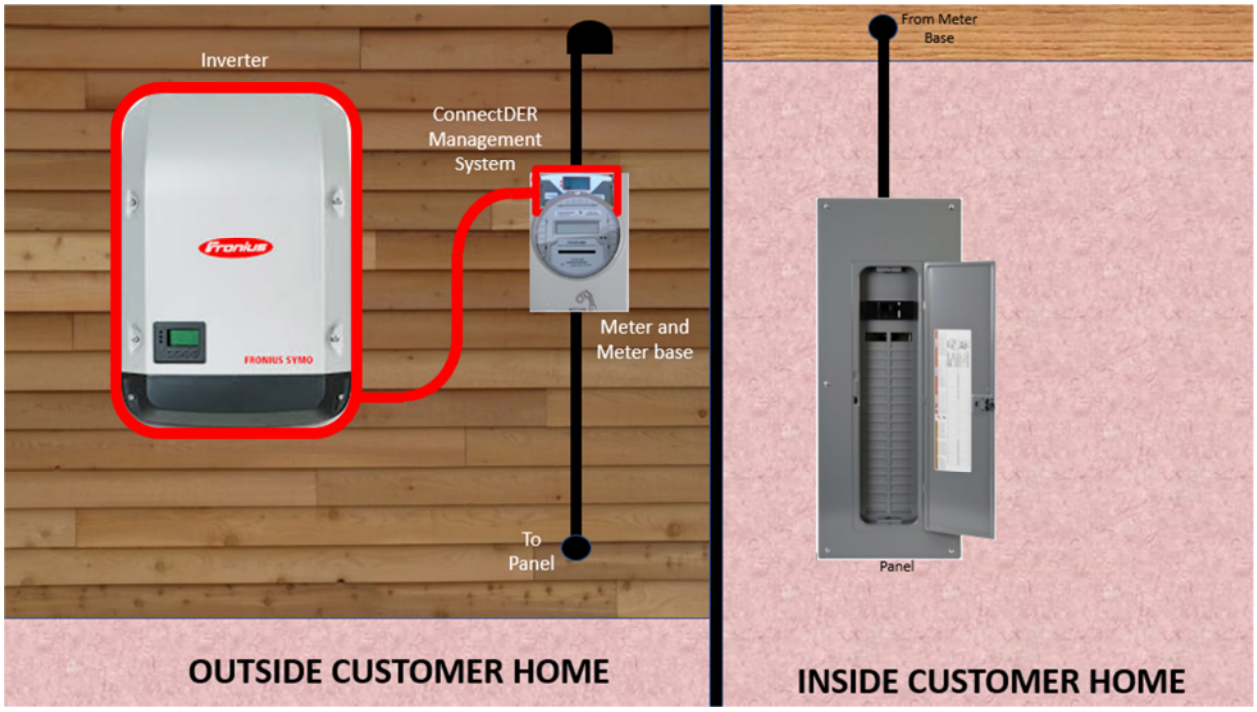



**Figure 2 of PPL Electric Exhibit MW-1R – Connection Diagram When Connecting the Inverter Directly to the Meter Collar**



The dongle is a small device that is physically connected to the smart inverter. The dongle houses a Wi-Fi communication board that communicates with the smart inverter via Modbus over RS485 and transmits the data to the meter collar. In turn, the meter collar relays the information to and from PPL Electric through the Company's RF Mesh network. As an analogy, this set-up is similar to a Bluetooth mouse for a laptop computer, where the Bluetooth receiver (here, the dongle) plugs into the computer's Universal Serial Bus ("USB") port and wirelessly connects to the wireless mouse (here, the meter collar). A picture of the dongle from PPL Electric Exhibit MW-5R is shown below:

**Picture of the ConnectDER "Dongle" from PPL Electric Exhibit MW-5R**


**Q. HOW MUCH WILL IT COST FOR PPL ELECTRIC TO PURCHASE AND INSTALL ONE OF THESE CONNECTDER DER MANAGEMENT DEVICES?**

A. Although final pricing is still being determined, the final total unit cost for the device will be no more than $700. The estimated installation cost is $55, which consists of $36 for

materials and $19 for 15 minutes of labor. In comparison, the Keystone Solution's installation cost is $250.

**Q. WOULD YOU PLEASE EXPLAIN HOW THE DER MANAGEMENT DEVICE IS INSTALLED?**

A. The installation of the ConnectDER device is fast, simple, and easy to learn. Fully installing the meter collar and dongle should take no longer than 15 minutes for an electrician.

To install the meter collar, the meter will be removed from the customer's meter base. The meter collar will be placed into the meter base, and the meter will then be installed into the meter collar. Conduit will then be installed connecting the inverter to the meter collar. The AC power cables (Line 1, Line 2, Neutral, and Ground) from the inverter are then ran through the conduit and connected to the meter collar. Step-by-step instructions on installing the ConnectDER meter collar can be found in PPL Electric Exhibit MW-4R, which is attached to my rebuttal testimony.

As for the dongle, it is designed to fit inside the enclosure of many inverters, as seen in the picture of the dongle provided above. It is connected to the inverter using three small wires that plug into the inverter's RS485 interface. This process takes only a few minutes and simply requires a small flat head screw driver. If the dongle does not fit inside the inverter compartment, the dongle will be installed in a water-proof enclosure that will be connected to the inverter with a close-nipple conduit connection. The additional work to install this enclosure will add approximately five minutes and will require a pair of channel locks and flat head screw driver. In either installation scenario,

the process is quick and simple for an electrician. Step-by-step instructions on installing the dongle are set forth in PPL Electric Exhibit MW-5R, which is attached to my rebuttal testimony.

**Q. WILL THE COMPANY'S INSTALLATION OF THE CONNECTDER DER MANAGEMENT DEVICE SUBSTANTIALLY REDUCE THE INSTALLATION COSTS FOR MOST NEW DERS?**

A. Absolutely. The ConnectDER DER management devices will reduce the installation costs for DER installations that are: (1) less than 8 kW by approximately $393 to $600; and (2) less than 15 kW by approximately $476 to $700. The installation cost is reduced because the need to install equipment, such as AC disconnect and potential breaker panel changes, can be eliminated through the use of the ConnectDER DER Management device, as seen in PPL Electric Exhibit MW-1R. Moreover, if an electrical panel upgrade would have been needed to interconnect the DER, the installation of this device will produce an additional $1,000 to $1,600 in cost savings.

Therefore, PPL Electric's DER Management proposal will reduce the total cost of DER installations under 15 kW by approximately $393 to $2,300. Notably, on an annual average basis, approximately 80% of the DERs interconnected to PPL Electric's distribution system are less than 15 kW. Compared to the average cost for a residential 6.2 kW solar PV system of approximately $16,740 provided by NRDC witness Warren (NRDC Statement No. 1, p. 20, lines 16-18), the Company's proposal will reduce the total cost of that system by approximately 2.3% to 13.7%.

**Q. WOULD THE COMPANY'S DER MANAGEMENT PETITION AND ITS USE OF THE DER MANAGEMENT DEVICE MAKE IT BURDENSOME FOR SOLAR CONTRACTORS TO INSTALL AND SERVICE DER INSTALLATIONS, AS ALLEGED BY SEF WITNESS CELENTANO (SEF ST. NO. 2, P. 11)?**

A. No. The ConnectDER device will reduce both the cost and time to install DERs. As explained previously, it is much easier and less costly to physically connect the inverter output to the ConnectDER device, rather than forcing the customer to connect the DER to, and possibly upgrade, the customer's electrical panel/system.

Additionally, although the dongle could have to be disconnected when the DER is being serviced, disconnecting and reconnecting the dongle adds only a few minutes to the overall service time.

## B. TESTING AND UL LISTING OF THE CONNECTDER DER MANAGEMENT DEVICE

**Q. SEF WITNESS CELENTANO ARGUES THAT THE DER MANAGEMENT DEVICE "WILL NEED TO BE THOROUGHLY TESTED TO ASSURE THAT IT IS WORKING AS EXPECTED" AND "WILL NEED ITS OWN UL LISTING." (SEF ST. NO. 2, P. 14.) COULD YOU PLEASE PROVIDE DETAILS ON THE TESTING OF THE DEVICE AND THE STATUS OF ITS LISTING WITH UNDERWRITERS LABORATORIES ("UL")?**

A. The meter collar and dongle have been tested and are operational on PPL Electric's RF Mesh network. Today, the tested devices are communicating with the Company's back-end systems in both directions, and PPL Electric is reading data from the inverters as well as managing their set points. Through this testing, PPL Electric has confirmed that the

ConnectDER DER Management devices work as well as, if not better than, the Keystone Solution.

As for independent testing, the meter collar used in the ConnectDER device has carried a UL listing demonstrating that it meets UL Standards 414 and 2745 since 2014. A copy of the current UL certification for the meter collar is attached as PPL Electric Exhibit MW-2R. Further, MET performed third party testing of the ConnectDER DER Management device, which confirmed that the dongle complies with UL Standard 62368 for safety. Attached as PPL Electric Exhibit MW-3R is a letter from MET to ConnectDER providing this confirmation.

### C. SUPPLY CHAIN AND AVAILABILITY OF CONNECTDER'S DER MANAGEMENT DEVICE

**Q. NRDC WITNESS WARREN ASSERTS THAT THERE IS INSUFFICIENT INFORMATION ABOUT THE AVAILABILITY AND "SUPPLY CHAIN" FOR THE DER MANAGEMENT DEVICES. (NRDC ST. NO. 1, P. 8.) PLEASE RESPOND.**

A. The current supply chain plan is to have 200 ConnectDER DER Management devices ready and in stock at PPL Electric in the coming months, so that PPL Electric is ready to implement its DER Management Plan upon Commission approval. ConnectDER would have another 200 units on hand at any given time, bringing the total "in-stock" units to 400 units, which is approximately one quarter of supply needed for a year in PPL Electric's territory.

The current manufacturer and assembler for the ConnectDER DER Management devices is Allen Integrated out of Macungie, Pennsylvania, with ConnectDER completing

the final setup of the devices. ConnectDER and its manufacturer can produce approximately 200 units per month with their current manpower. ConnectDER and its manufacturer can double their production rate with minimal additions to their manpower. Therefore, ConnectDER and its manufacturer can produce more than enough units to meet the Company's demand under the DER Management Plan.

Further, the major communication components are made by Landis+Gyr and Lantronics. Both of these large companies are capable of keeping up with the demand for these units into the future. Indeed, I note that Landis+Gyr is the manufacturer of the Company's RF Mesh meters, which have been deployed for over 1.2 million residential customers in PPL Electric's service territory.

### D. WHETHER MULTIPLE DER MANAGEMENT DEVICES ARE NEEDED WHEN THERE ARE MULTIPLE DERS

**Q. NRDC WITNESS WARREN STATES THAT "SOME SOLAR SYSTEMS USE MULTIPLE INVERTERS," SO IT IS UNCLEAR WHETHER PPL'S PROPOSAL WOULD REQUIRE MULTIPLE DER MANAGEMENT DEVICES OR OTHER EQUIPMENT BE INSTALLED. (NRDC ST. NO. 1, P. 20.) WOULD YOU PLEASE RESPOND?**

A. A single ConnectDER DER Management device can communicate with a DER that features multiple networked inverters by utilizing the Modbus broadcast function. This has been demonstrated in a DER featuring multiple Fronius inverters. Therefore, a DER with multiple inverters would not require multiple ConnectDER DER Management devices.

## II. STATEWIDE STANDARDS ARE NOT NEEDED TO "MINIMIZE DER INSTALLATION COSTS" AND TO "HELP ASSURE THAT INVERTERS ARE PROPERLY CONFIGURED AT THE TIME OF INSTALLATION"

**Q. NRDC WITNESS WARREN ALSO AVERS THAT "CONSISTENCY IN STANDARDS ACROSS PENNSYLVANIA" HELPS "MINIMIZE DER INSTALLATION COSTS" AND "HELPS ASSURE THAT INVERTERS ARE PROPERLY CONFIGURED AT THE TIME OF INSTALLATION." (NRDC ST. NO. 1, P. 16.) WOULD YOU PLEASE RESPOND?**

A. PPL Electric's DER Management proposal will substantially reduce DER installation costs for most new DER installations, as explained in Section I, *supra*. It is unclear to me how a statewide proceeding would be able to "minimize DER installation costs" as much as the use of the ConnectDER DER management device. Further, the installation, commissioning, and troubleshooting of the ConnectDER DER Management device will be the responsibility of PPL Electric, adding no additional burden to the customer.

Regarding inverter configuration, the combination of the ConnectDER DER Management device and inverters certified to meet the requirements of IEEE 1547-2018 will allow PPL Electric to remotely verify that the appropriate grid support settings have been implemented. Further, if the inverter's grid support settings are incorrect, PPL Electric will have the ability to remotely adjust them.

**Q. DOES THIS CONCLUDE YOUR REBUTTAL TESTIMONY AT THIS TIME?**

A. Yes, although I reserve the right to supplement my rebuttal testimony.

# PPL Electric Exhibit MW-1R

# Current DER Electrical Interconnection Process

The following standard method of inverter based DER interconnection is the method that is commonly used by electricians and solar installers to connect inverter based DER systems to the grid. PPL Electric conducted a study of average costs based on this connection methodology through input of a local electrician who constructs solar inverters for customers. Through this review, the standard interconnection costs for customers range between $393 - $700 depending on varying structural and electrical conditions and National Electric Code (NEC) requirements. In addition to this cost range, PPL Electric identified that in certain situations, an electrician may require the installation of a new sub panel or replacement of the customer's existing breaker panel. If these are requirements identified by an electrician for an inverter system connection, an additional $1,000 or $1,600 of combined equipment and labor costs can be expected respectively. None of these estimates include the costs associated with the inverter(s) or DER source (batteries, solar, etc.).

# Connection Diagram

The following diagram shows the required connections and equipment that are installed by the customer's electrician. Items highlighted in red represent the standard wire path and equipment installed. In some cases, based on the customer's electrical design, the contractor may have to install a sub-panel (highlighted in blue) or an upgrade to the customer's existing meter panel. The costs associated to each item as provided by an experienced local electrician are documented in the Estimated Cost section.

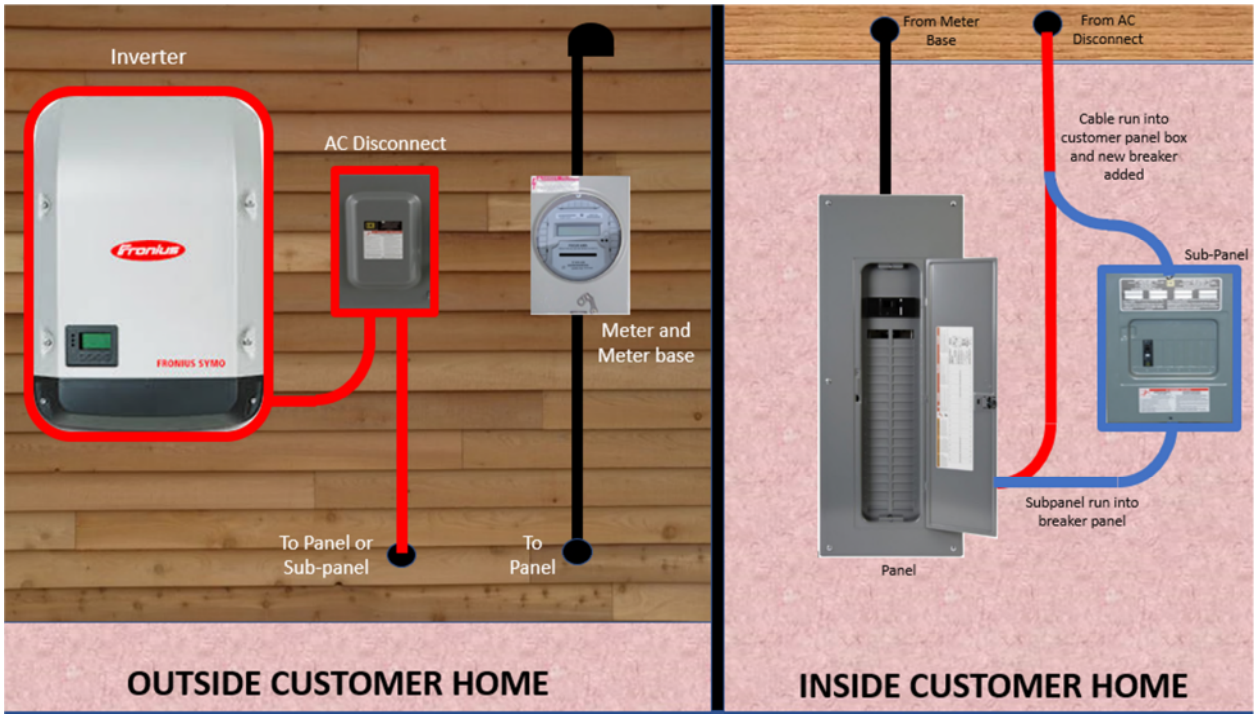



**Figure 1:** Standard Electrical Interconnection of Inverter Based DER Systems

# Estimated Cost

## Inverter Systems (< 8kW)

When using the current standard approach for systems ranging from 0-8kW, electrically connecting a customer's solar inverter system would cost a customer between $393 and $600. This range depends a lot on the customer's residence and existing equipment.

### Table 1: Standard Installation Approach, Vinyl/Wood Exterior (Simplest Situation)

| Description | Detail | Costs |
|---|---|---|
| AC Disconnect Switch | D222NRBCP 60-Amp 240-Volt Two-Pole Outdoor General Duty Fusible Safety Switch with Neutral | $185 |
| Panel Box Breaker | Eaton Circuit Breaker, 40 Amps, Number of Poles: 2, 240VAC AC | $13 |
| Labor ($75/hour)** | Installing cabling between inverter and panel with the need to drill through a vinyl or wood siding. | $75 |
| Wire Run between Inverter and Internal House Panel | 20 feet to get from the disconnect switch to the main service panel inside the house. | $120 |
| **TOTAL** | | $393 |

** Estimated of electrician labor costs ranged between $50 and $100. PPL Electric used the average of these numbers ($75/hr) for estimates shown above.

### Table 2: Standard Installation Approach, Masonry Exterior (More Complex Situation)

| Description | Detail | Costs |
|---|---|---|
| AC Disconnect Switch | D222NRBCP 60-Amp 240-Volt Two-Pole Outdoor General Duty Fusible Safety Switch with Neutral | $185 |
| Panel Box Breaker | Eaton Circuit Breaker, 40 Amps, Number of Poles: 2, 240VAC AC | $13 |
| Labor ($75/hour)** | Installing cabling between inverter and panel with the need to drill through a masonry wall. | $300 |
| Wire Run between Inverter and Internal House Panel | 20 feet to get from the inverter to the main service panel inside the house. | $120 |
| Circuit Breaker Panel Upgrade | Replace existing breaker panel with upgraded panel (100A – 200A) | $1600 |
| **TOTAL** | | $600 |

** Estimated of electrician labor costs ranged between $50 and $100. PPL Electric used the average of these numbers ($75/hr) for estimates shown above.

## Inverter Systems (8kW – 15kW)

When using the current standard approach for systems ranging from 8-15kW, electrically connecting a customer's solar inverter system would cost a customer between $476 and $700. This range depends a lot on the customer's residence and existing equipment.

### Table 3: Standard Installation Approach, Vinyl/Wood Exterior (Simplest Situation)

| Description | Detail | Costs |
|---|---|---|
| AC Disconnect Switch | D223NRB SquareD, Safety Switch,Switch Fusible GD240V, 100A, 2P NEMA 3R | $235 |
| Panel Box Breaker | Eaton Circuit Breaker, 80 Amps, Number of Poles: 2, 240VAC AC | $46 |
| Labor ($75/hour)** | Installing cabling between inverter and panel with the need to drill through a masonry wall. | $75 |
| Wire Run between Inverter and Internal House Panel | 20 feet to get from the inverter to the main service panel inside the house. | $120 |
| **TOTAL** | | $476 |

** Estimated of electrician labor costs ranged between $50 and $100. PPL Electric used the average of these numbers ($75/hr) for estimates shown above.

### Table 4: Standard Installation Approach, Masonry Exterior (More Complex Situation)

| Description | Detail | Costs |
|---|---|---|
| AC Disconnect Switch | D223NRB SquareD, Safety Switch, Switch Fusible GD240V, 100A, 2P NEMA 3R | $235 |
| Panel Box Breaker | Eaton Circuit Breaker, 80 Amps, Number of Poles: 2, 240VAC AC | $46 |
| Labor ($75/hour)** | Installing cabling between inverter and panel with the need to drill through a masonry wall. | $300 |
| Wire Run between Inverter and Internal House Panel | 20 feet to get from the inverter to the main service panel inside the house. | $120 |
| **TOTAL** | | $700 |

** Estimated of electrician labor costs ranged between $50 and $100. PPL Electric used the average of these numbers ($75/hr) for estimates shown above.

## Estimate for an additional cost associated to a required upgrade to existing breaker panel or installation of a new sub-panel

In some cases, due to space in a customer's main panel, a customer will be required to have an electrician install a sub-panel (illustrated in blue in the diagram) or upgrade the existing breaker panel. If one of these are requirements to install an inverter system connection, an additional $1,000 or $1,600 can be expected to be paid by the customer on top of the ranges specified above. For example, if a panel upgrade is required for a 0-8kW systems the cost range would increase from $393-$600 to $1,993-$2,200 (i.e. $393+1600=$1993).

# Proposed PPL DER Management Solution

The following method of inverter interconnection is the method that is being proposed for use pursuant to the Company's DER Management Plan. Through this method, the standard interconnection costs would be approximately $55. Since the ConnectDER Management device would be provided and installed by PPL Electric, the Company would incur those installation costs, not the customer.

# Connection Diagram

The following diagram shows the required connections and equipment that are installed by the customer electrician as part of PPL Electric's DER Management Solution. Items highlighted in red represent the standard wire path and equipment installed.

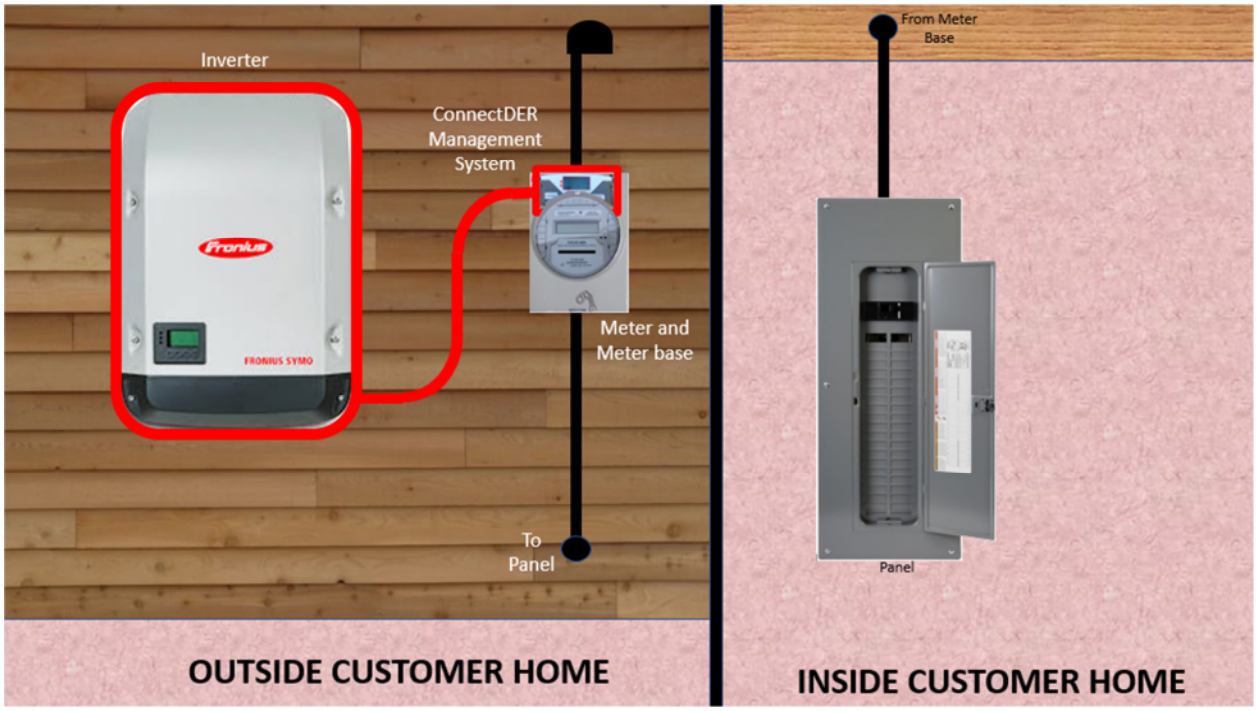



**Figure 2:** PPL Electric's DER Management Solution of Inverter Based DER Systems

# Estimated Cost

## Inverter Systems (0-15kW)

When using the ConnectDER DER Management device for systems ranging from 0-15kW, electrically connecting a customer's solar inverter system would cost approximately $55.

| Description | Detail | Costs |
|---|---|---|
| Labor ($75/hour) | Installing cabling between inverter and the ConnectDER DER Management Device. | $19 |
| Wiring Costs | 6 feet to get from the inverter to the ConnectDER DER Management Device. | $36 |
| **TOTAL** | | $55 |

# PPL Electric Exhibit MW-2R

# CERTIFICATE OF COMPLIANCE

| | |
|---|---|
| **Certificate Number** | 20170403-E468258 |
| **Report Reference** | E468258-20170331 |
| **Issue Date** | 2017-APRIL-03 |
| **Issued to:** | ConnectDER Inc<br>2001 Jefferson Davis Hwy, Suite 403<br>Arlington VA 22202 |
| **This is to certify that representative samples of** | METER-SOCKET ADAPTERS FOR COMMUNICATIONS EQUIPMENT<br>Smart Meter Socket Adapter with alternate energy source connection and communications, “Smart ConnectDER V3” Product Line, Models S; followed by B or T; followed by 5; followed by 02 or 12; followed by JC; followed by 10; followed by 15A, 20A, 25A, 30A, 35A, 40A, 45A, 50A, 60A, 70A, or 80A; may be followed by NR<br><br>Have been investigated by UL in accordance with the Standard(s) indicated on this Certificate. |
| **Standard(s) for Safety:** | UL 2745, Outline for Meter Socket Adapters for Communications Equipment |
| **Additional Information:** | See the UL Online Certifications Directory at www.ul.com/database for additional information |

Only those products bearing the UL Certification Mark should be considered as being covered by UL's Certification and Follow-Up Service.

Look for the UL Certification Mark on the product.

Bruce Mahrenholz, Director North American Certification Program

UL LLC

# PPL Electric Exhibit MW-3R

eurofins | MET Labs

HEADQUARTERS: 914 WEST PATAPSCO AVENUE • BALTIMORE, MARYLAND 21230 • PHONE (410) 354-3300 • FAX (410) 354-3313

February 28, 2020

Mr. Jonathan Knauer
ConnectDER, Inc.
2001 Jefferson Davis Highway, Suite 403
Arlington, VA 22202
USA

Subject: Smart ConnectDER with Wi-Fi Dongle
Listing Number E115038; MET Project Number 107130
Safety Standards: • UL 62368-1:2014
Audio/video, information and communication technology equipment – Part 1: Safety requirements

Dear Mr. Knauer:

MET has determined the evaluated product, the Smart ConnectDER with Wi-Fi Dongle to be compliant with the above referenced standards. Upon completion of a satisfactory Pre-Certification Factory Inspection, NRTL certification may be granted. If not already done so, someone from our Follow-up Services department will contact you to schedule your Pre-Certification Factory Inspection.

Thank you for the opportunity to perform this service for ConnectDER, Inc. We look forward to future opportunities with your company.

*Sincerely,*
MET LABORATORIES, INC.

Jim Krzmarzick
Project Engineer,
Safety Laboratory

# PPL Electric Exhibit MW-4R

# INSTALLATION

## PACKAGE INSPECTION

1. Verify the ConnectDER is undamaged shipping.

2. Verify the ConnectDER is configured with the proper line or load-side interconnection.
3. Verify the ConnectDER is equipped with the proper circuit breaker for the application.
4. Verify the screws for the junction box base are furnished.

5. Verify the screws for the junction box cover are furnished.

Verify the neutral pigtail (copper wire w/white insulation) is furnished.

## ITEMS REQUIRED FOR INSTALLATION

NOTE

The following tools are needed to install the ConnectDER:

1. A torque wrench and/or torque screwdriver to cover a range from 2 to 50 in/lbs.
2. A #2 Philips screwdriver bit for use with torque wrench/screwdriver.
3. A ¼" flat screwdriver bit for use with the torque wrench/screwdriver.
4. A pair of wire cutters.
5. A wire stripper.
6. Suitable metering equipment such as a digital volt-ohmmeter.

Other items needed:

- Tools to attach the raceway to ConnectDER junction box and terminate field wiring.
- An approved wiring connector to terminate the neutral pigtail inside the meter socket, if applicable.
- An additional meter locking ring (for ring-type meter sockets).
- Additional utility tamper-prevention seals.

At a minimum, the installer should use the following safety personal protective equipment (PPE):

1. A flash shield.
2. Safety glasses.
3. A pair of rubber gloves.
4. A pair of leather gloves.
5. Calorie rated clothing.

Other equipment may be required by utility procedures. These requirements will be communicated to the installer by their employer during the training process.

## METER REMOVAL

WARNING

**In most service territories, meter removal will be a utility function**. Contact your utility for specific information on their standard practices and/or to schedule a visit by utility or utility approved personnel to remove the meter. If power is not removed from the equipment prior to working inside the meter socket, electric shock, arc flash hazards, fire, serious injury or death may result.

## REMOVE THE METER AND METER SOCKET COVER

WARNING

Contact the utility for specific information on their standard practices and/or to schedule a visit by utility or utility-authorized personnel to remove the meter.

**FIGURE 5**

Remove the utility tamper-prevention seal(s).

1. Remove the locking ring (for ring-type meter sockets).
2. Remove the electric meter as shown in **FIGURE 5.**
3. Inspect the meter socket terminals for damage such as loose or broken wires, damaged jaws, etc.

The ConnectDER may be installed in meter sockets of **any age**, provided:

- The meter socket and service entrance conductors are in good condition and comply with utility requirements and local codes.
- The minimum work space clearances (as specified by the serving utility) are maintained after the ConnectDER is installed.
- The 5th jaw has sufficient ampacity or there is satisfactory means to terminate the neutral pigtail. A neutral pigtail is required for all 4-jaw meter sockets.

ConnectDER use in shallow "button" type meter sockets is not recommended.

Temporarily block off all energized parts with appropriate insulating material or insulating device. Set the ConnectDER circuit breaker to the OFF position. This ensures the field wiring terminals will be de-energized after inserting the ConnectDER into a live meter socket.

## INSTALL THE NEUTRAL LEAD

### 4-JAW METER SOCKET

WARNING

**All 4-jaw meter sockets require a neutral conductor pigtail** to be attached from the rear of the ConnectDER to a neutral point inside of the meter socket.

Before beginning, make sure that the ConnectDER circuit breaker is open (OFF).

**FIGURE 6** below depicts the inside of a typical 4 jaw meter socket.

This model has a single accessory position, circled in red. Many sockets have a second accessory position, depicted below as a blue dot. If these accessory positions are not in use (such as for a grounding electrode conductor), they are the preferred option for securing the neutral connection. These accessory positions may contain pressure terminal(s) or hardware for the connection of compression (ring) terminals. Terminate in accordance with the marked torque values or per the terminal manufacturers specifications. Potential alternatives are suggested on the next page if these are not available.

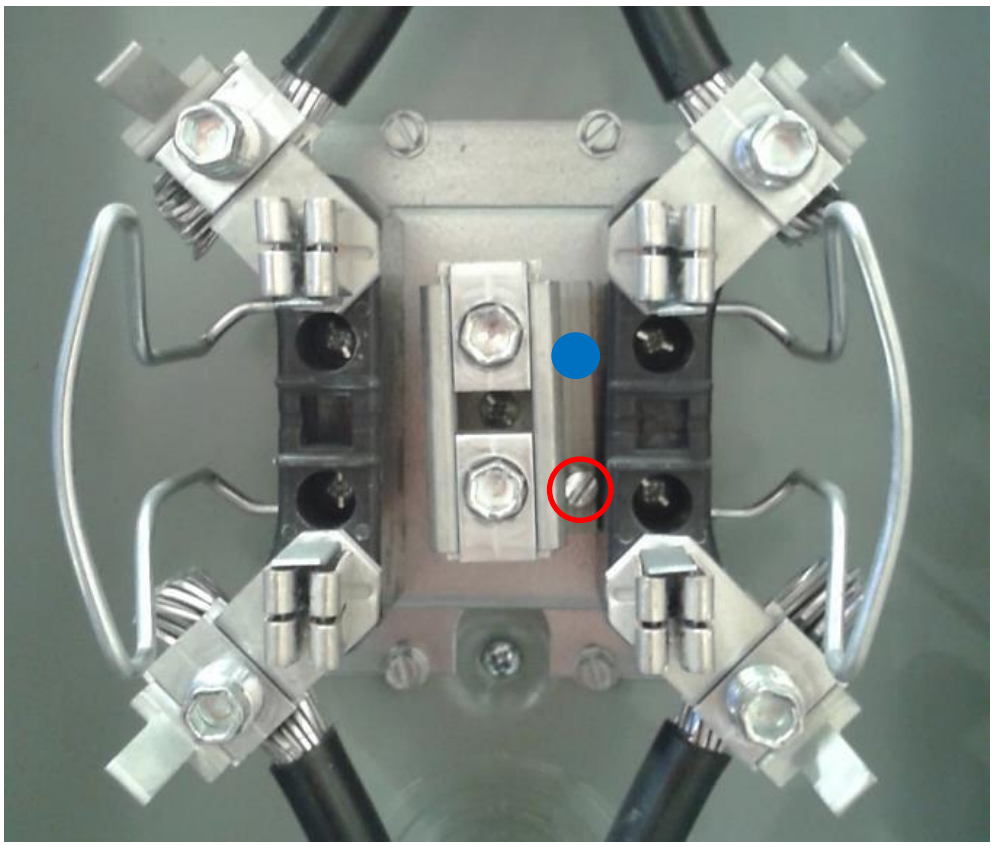


**FIGURE 6**

Possible options for connecting the neutral pigtail to the meter socket, in case there is no spare terminal as shown in **FIGURE 6** (previous page):

Connect the end of the neutral wire pigtail lead to the load side grounded neutral conductor. Use a suitable Listed pressure connector such as a gutter tap, split bolt connector, or parallel groove clamp. More detail about each is provided below.

These suggestions are not intended to be a full listing of options, and ConnectDER does not endorse one particular method over another. Consideration should be given to routing and securing the wiring in such a way that it is protected from non-insulated live parts.

**If a neutral pigtail other than the furnished AWG size is required, it must be furnished by the installer.** Wire terminations at the ConnectDER must be made with copper conductors only.

WARNING Install this and other neutral termination options in accordance with the manufacturer's instructions.

**FIGURE 7** depicts a "Parallel Tap Connector" or "Gutter Tap Connector". Multiple manufacturers offer equivalent products.


**FIGURE 7**

1. Removable component for the "main" or "run" conductor, referring to the existing load side service entrance neutral conductor within the meter socket. Often there is no need to disconnect the existing wire provided there is enough slack to manipulate the conductor.
2. Termination point for the "tap" conductor, in this case the ConnectDER neutral pigtail.

Check to see that the connector you select is

- available in sizes to accommodate the correct range of run and tap conductors
- suitable for use for either copper or aluminum conductors
- available with an insulating cover if required
- UL listed or otherwise approved by the utility and AHJ.

**FIGURE 8** depicts a "Split-Bolt Connector" or "Split-Bolt Bug". Multiple manufacturers offer equivalent products.

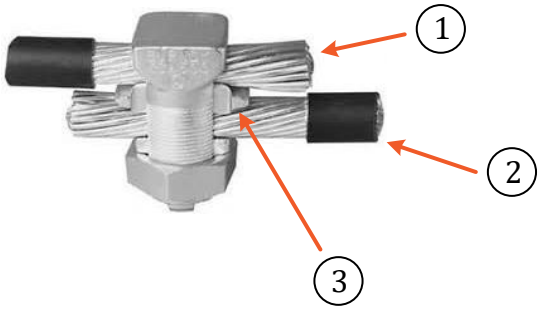



**FIGURE 8**

1. "Main" or "run" conductor, referring to the existing load side service entrance neutral conductor within the meter socket. Often there is no need to disconnect the existing wire provided there is enough slack to manipulate the conductor.
2. Tap conductor, in this case the ConnectDER neutral pigtail would be terminated here.
3. Pressure bar that separates the run and tap conductors. This makes it possible to splice aluminum (often the residential service entrance cable is aluminum) to copper.

Check to see that the connector you select is

- available in sizes to accommodate the correct range of run and tap conductors
- suitable for use for either copper or aluminum conductors
- UL listed or otherwise approved by the utility and AHJ.

**If a neutral pigtail other than the furnished AWG size is required, it must be furnished by the installer.** Wire terminations at the ConnectDER must be made with copper conductors only.


WARNING Install this and other neutral termination options in accordance with the manufacturer's instructions.

**FIGURE 9** depicts a "Parallel Groove Clamp" or "Parallel Groove Connector". Multiple manufacturers offer equivalent products.

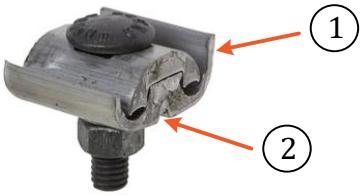



**FIGURE 9**

1. One side of the clamp may be larger for the "main" or "run" conductor, referring to the existing load side service entrance neutral conductor within the meter socket. Often there is no need to disconnect the existing wire provided there is enough slack to manipulate the conductor.
2. Termination point for the "tap" conductor, in this case the ConnectDER neutral pigtail.

Check to see that the connector you select is

- available in sizes to accommodate the correct range of run and tap conductors
- suitable for use for either copper or aluminum conductors

UL listed or otherwise approved by the utility and AHJ.

**If a neutral pigtail other than the furnished AWG size is required, it must be furnished by the installer.** Wire terminations at the ConnectDER must be made with copper conductors only.

WARNING Install this and other neutral termination options in accordance with the manufacturer's instructions.

WARNING

**The approaches to ground and neutral connections have numerous variables. The connection method can vary based on utility and authority having jurisdiction requirements, accessory components chosen, meter socket type, and overall system configuration.**

**Coordinate with your utility and authority having jurisdiction to establish acceptable methods in cases where methods recommended below cannot be employed.**

**Due to the wide variety of meter socket styles and locations where a neutral could be terminated, a given site may require a longer neutral than the one provided in the box, or a different type of wire.** ***It is the responsibility of the installer to make certain the neutral is terminated in an approved manner.***

Possible options for connecting the neutral pigtail to the meter socket:

If a grounded terminal is available, attach the end of the neutral wire pigtail lead. This option is depicted in **FIGURE 10** below. Torque to manufacturers specified value.

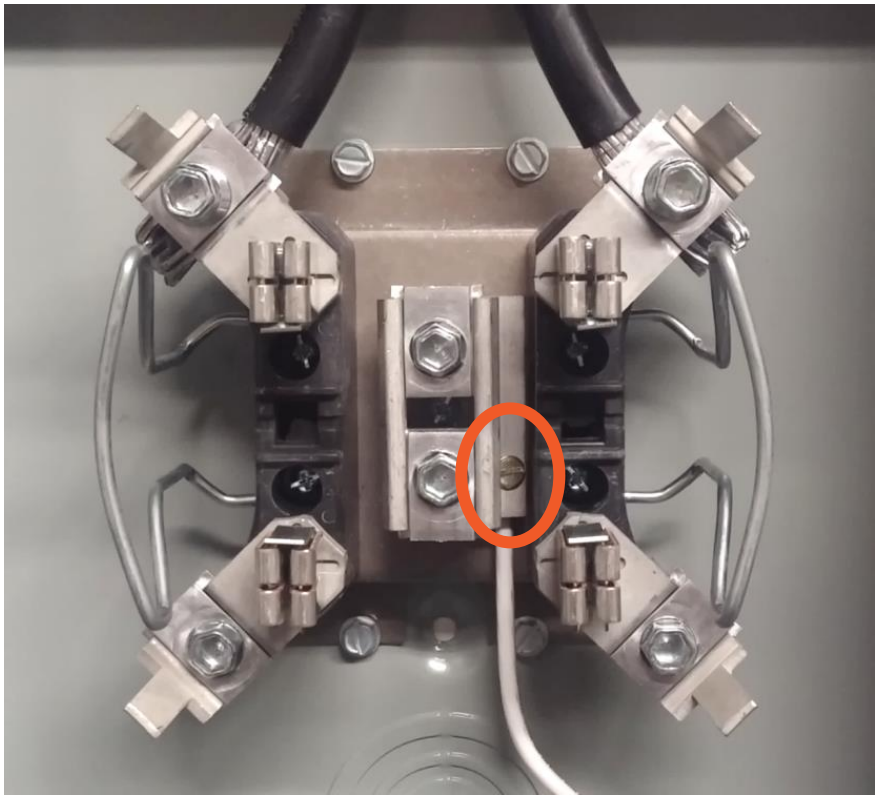


**FIGURE 10**

For ring-type meters, reinstall the meter cover while routing the neutral lead through the cover opening.

Bend the other end of the neutral lead 90 degrees before terminating it at the ConnectDER. This will help it avoid contact with non-insulated live parts when inserting the ConnectDER into the meter socket. See **FIGURE 11.**

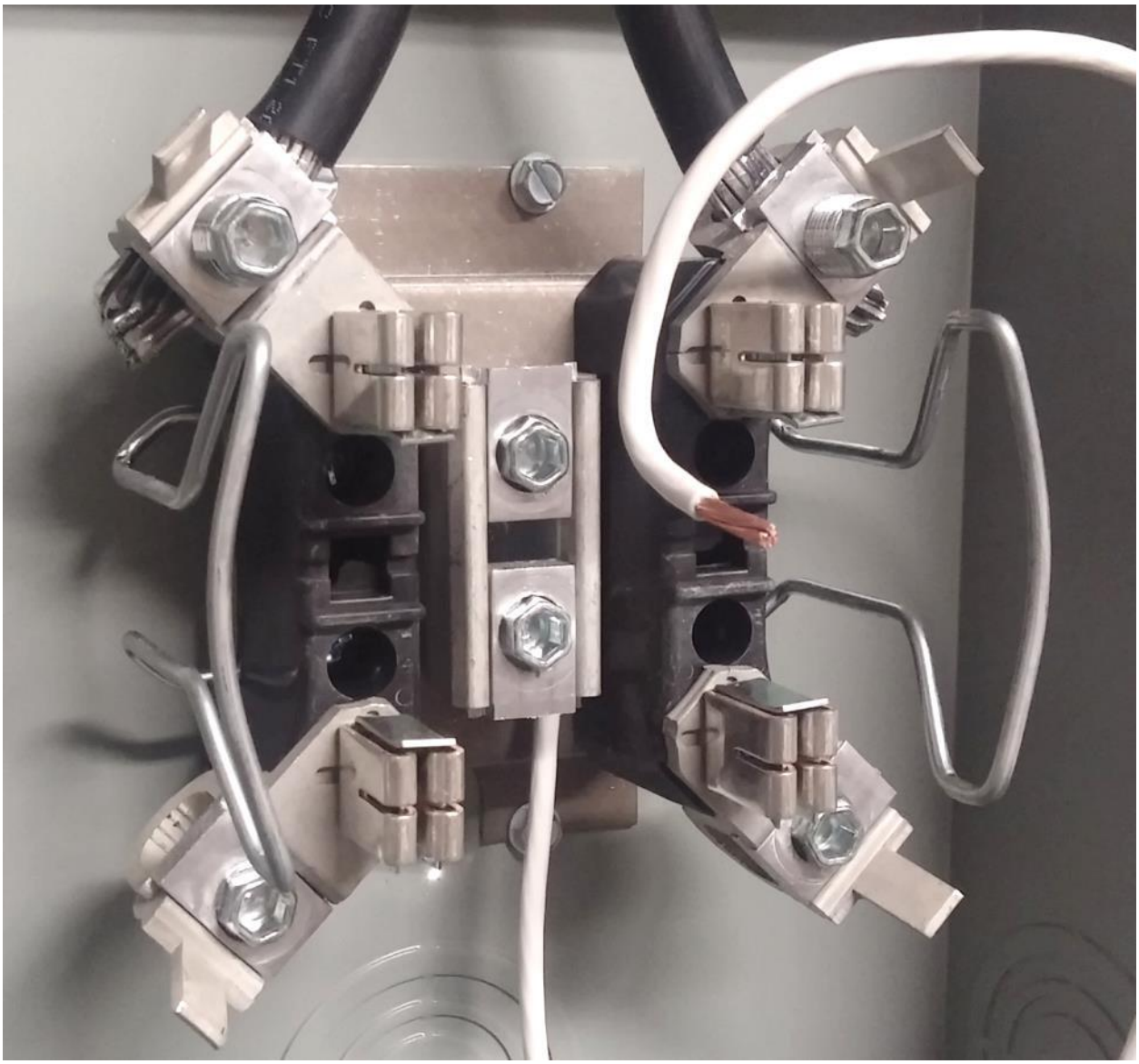


**FIGURE 11**

Terminate the neutral lead to the ConnectDER using a screwdriver as shown below in **FIGURE 12**. Torque the connection to the values shown in **TABLE 2** below. (NOTE: Ringless type meter socket shown below).

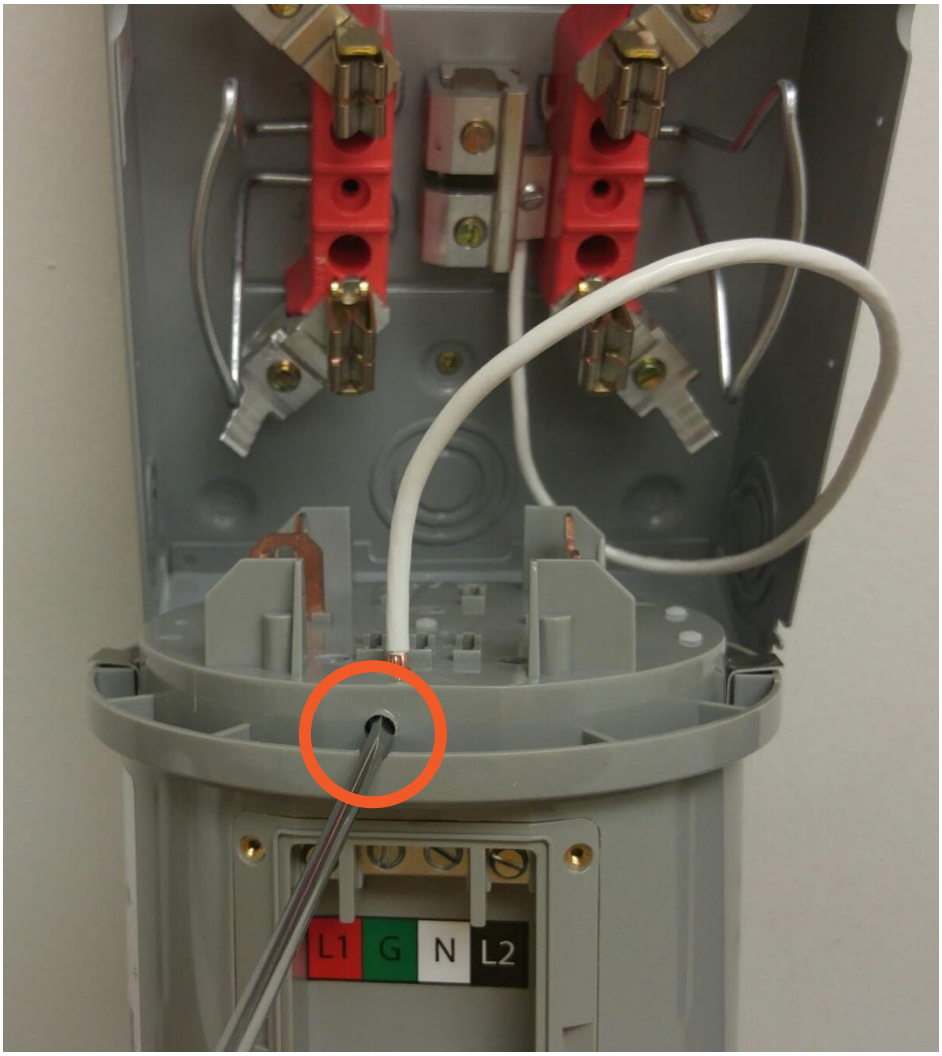



**FIGURE 12**

**TABLE 2**

| NEUTRAL PIGTAIL WIRING TORQUE VALUES | |
|---|---|
| **Wire size (AWG)** | **Torque value** |
| 14-12 | 15 in/lbs. |
| 10-6 | 40 in/lbs. |
| 2-4 | 50 in/lbs. |

## 5-JAW METER SOCKET

 **WARNING** *Some PV inverter manufacturers specify a full-sized neutral conductor (i.e. the same size as the line conductors) as part of the inverter output wiring.* ***The 5th jaw inside a form 12S meter socket may have only nominal ampacity, intended to be sufficient for the utility meter to calculate kW usage on 120/208v systems.***

*In 4-jaw meter sockets, and* ***in cases where the 5th jaw in the meter socket has insufficient ampacity to support the PV inverter or other DER:***

- *Attach a copper wire pigtail from the rear of the ConnectDER to a neutral point inside of the meter socket.* ***The conductor must have a minimum ampacity as the line conductors protected by the circuit breaker inside the ConnectDER unit.***
- *Use a method approved by the utility and authority having jurisdiction (AHJ).*

***It is the responsibility of the installer to ensure the neutral pigtail or the 5th jaw (where present) in the meter socket provides equal or greater ampacity as permitted to be protected by the integrated circuit breaker.***

*Follow the instructions in the "4-JAW METER SOCKET" section to install a neutral pigtail.*

## PLACE THE CONNECTDER IN THE METER SOCKET

1. Confirm the ConnectDER circuit breaker is in the open (OFF) position.

2. Be certain to install the ConnectDER in the proper orientation. The field wiring terminals are at the top of the device and the circuit breaker is at the bottom.

3. Insert the ConnectDER into the meter socket ensuring any wire or added terminations are prevented from contacting non-insulated live parts within the existing meter socket as shown in **FIGURE 13.**

4. Make sure that all contacts are seated in the meter socket jaws. This is especially of concern in older meter sockets with loose and slightly misaligned jaws.


**FIGURE 13**

1. There is limited clearance to slide a ringless cover over both the breaker switch and terminal pocket.

2. Once the device is set in the meter socket, slip the cover on.

3. Slowly work the cover over both the breaker switch and terminal pocket, taking care not to gouge or damage them. To clear the breaker switch, it may be necessary to tip the ConnectDER DOWN, and angle the top edge of the meter socket cover towards the meter socket.

4. Then, slip the upper edge of the meter socket cover under the top lip of the meter socket housing, and latch the cover. See **FIGURE 14**.


**FIGURE 14**

## RE-INSTALL THE METER

1. For ring-type sockets, install a locking ring to secure the ConnectDER to the meter socket cover. (Ringless cover shown in **FIGURE 15**).
2. Install a lock ring and tamper-prevention seal to secure the utility billing meter to the ConnectDER.
3. Install a tamper-prevention seal in the latch to secure the meter socket cover.


**FIGURE 15**

## CHECK THE CIRCUIT BREAKER AND COVER

1. Confirm the circuit breaker is in the OFF position as shown in **FIGURE 16**.


**FIGURE 16**

2. Confirm the cover is aligned properly and securely shut as shown in **FIGURE 17**.

**FIGURE 17**

3. Install a lockout device until the ConnectDER field wiring is terminated.

## INSTALL THE JUNCTION BOX AND CONNECT THE RACEWAY

NOTE If the raceway will be attached at a later time, install the junction box according to steps 4 and 5, then install the junction box cover as directed in step 4, "TERMINATE THE FIELD WIRING"). The junction box may remain in place when installing the raceway.

1. Drill the conduit hole for the power raceway as shown in **FIGURE 18.** The conduit entry be used on either side of the junction box. A ¼" pilot bit at the top of the power groove locates the center of a ½", ¾" or 1" trade size conduit opening. Confirm the field wiring terminals are de-energized using an appropriate meter.

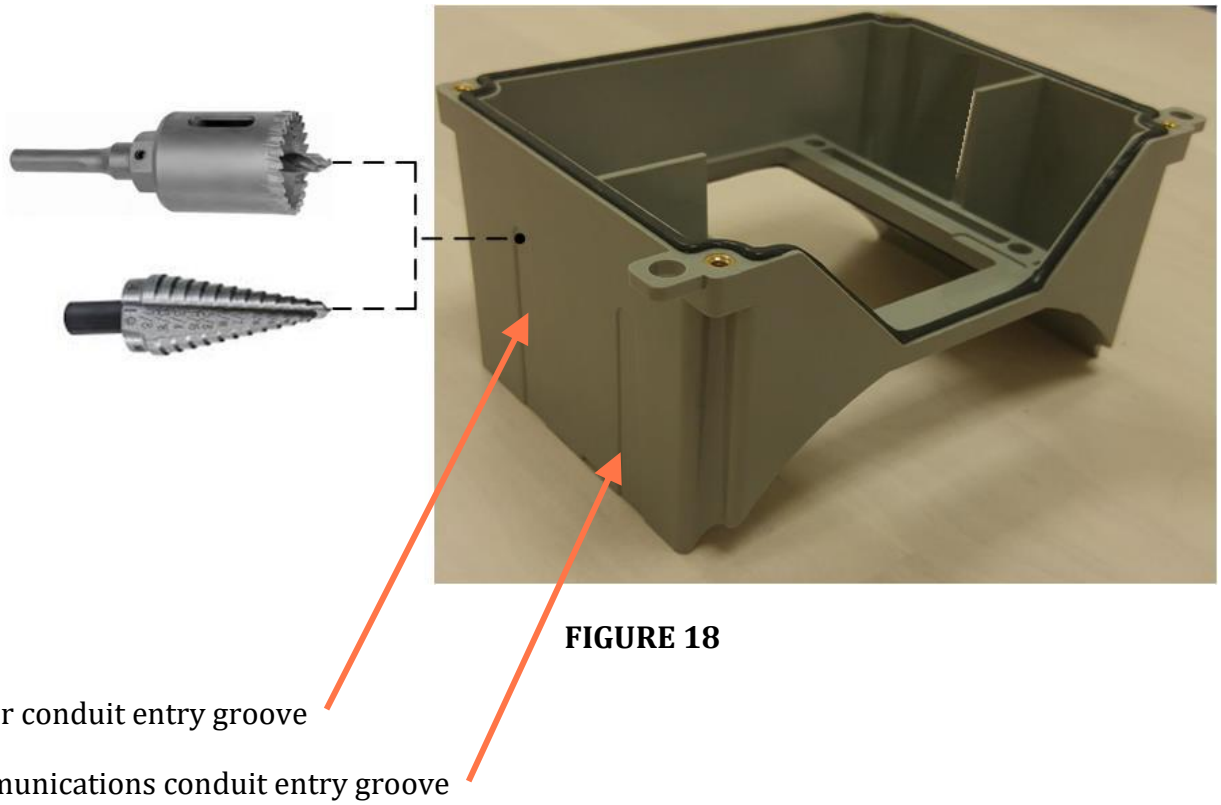



**FIGURE 18**

2. Drill the raceway hole using the appropriate sized hole saw. Remove any shavings from the interior of the junction box.

NOTE **DO NOT USE A KNOCKOUT PUNCH – IT MAY CRACK OR BREAK THE JUNCTION BOX.**

3. Install a Listed wet location-rated raceway connector.

4. Confirm the field wiring terminals are de-energized using an appropriate meter.

5. Install the junction box to the top of the ConnectDER™ unit using the Philips screws furnished with the unit. **Tighten the screws to 5 in/lbs. using a #2 Philips bit.** Make sure the seal is fully compressed and the box makes contact with the body of the terminal pocket. See **FIGURE 19**.

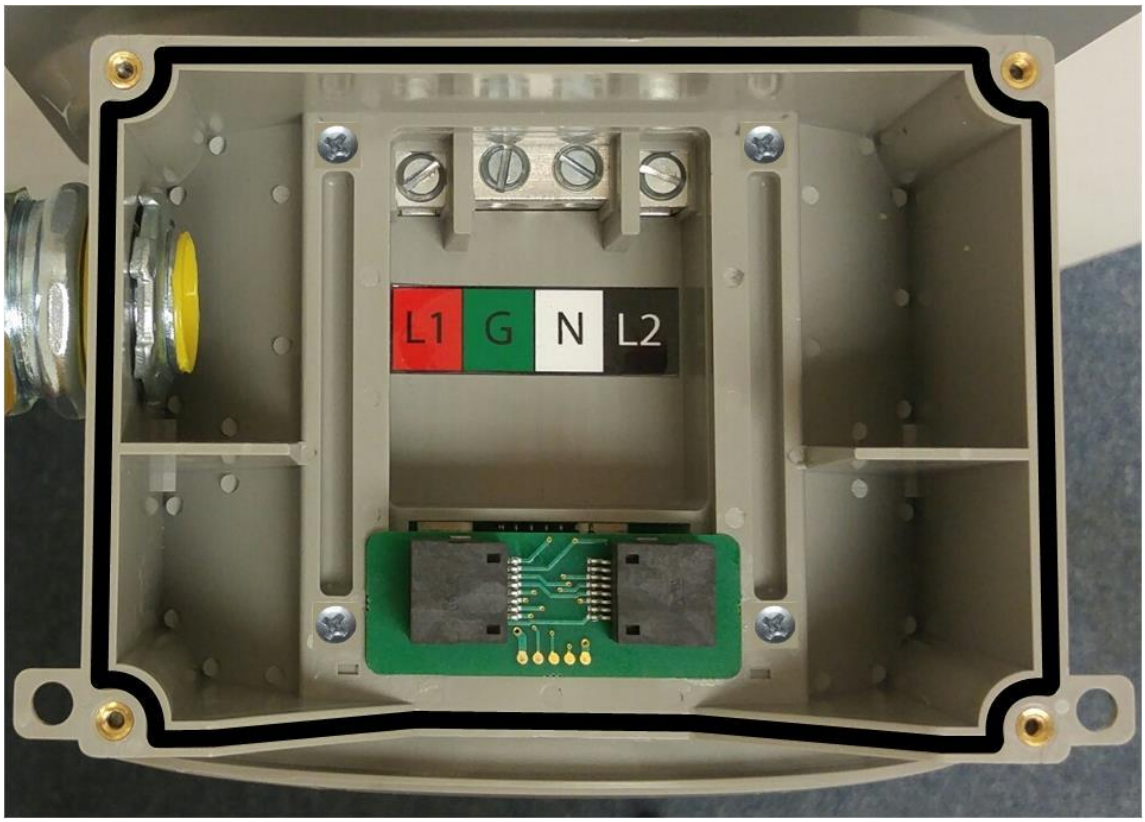



**FIGURE 19**

NOTE **USE A TORQUE DRIVER TO TIGHTEN THE SCREWS TO 5 IN/LBS.**

6. Attach the field wiring raceway approved by the AHJ and the utility.

7. Provide some extra length of raceway when using flexible liquidtight conduit. This allows easier access to the inside of the meter socket in the future.

8. Use 90-degree connectors on the ends of the raceway where practical. Strap the raceway securely to the mounting surface as shown in **FIGURE 20** to minimize inadvertent or intentional contact with the raceway.

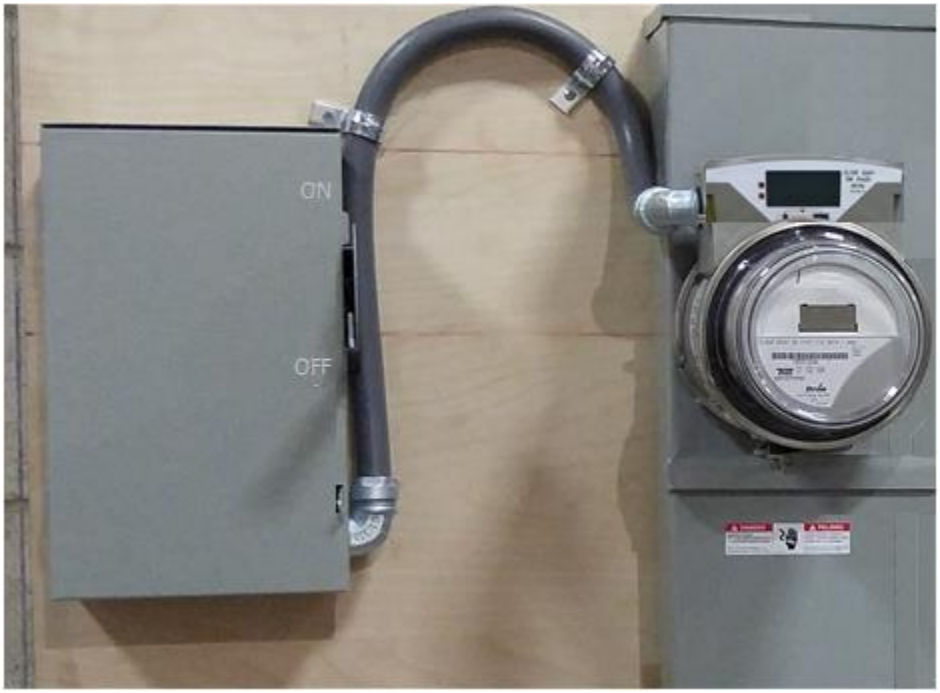



**FIGURE 20**

## TERMINATE THE FIELD WIRING

1. Verify the wiring is clear of faults using suitable metering equipment.
2. Pull the wiring into the junction box.
3. Connect the field wiring to the terminals as shown in **FIGURE 21** and tighten to the values shown in **TABLE 3** below.

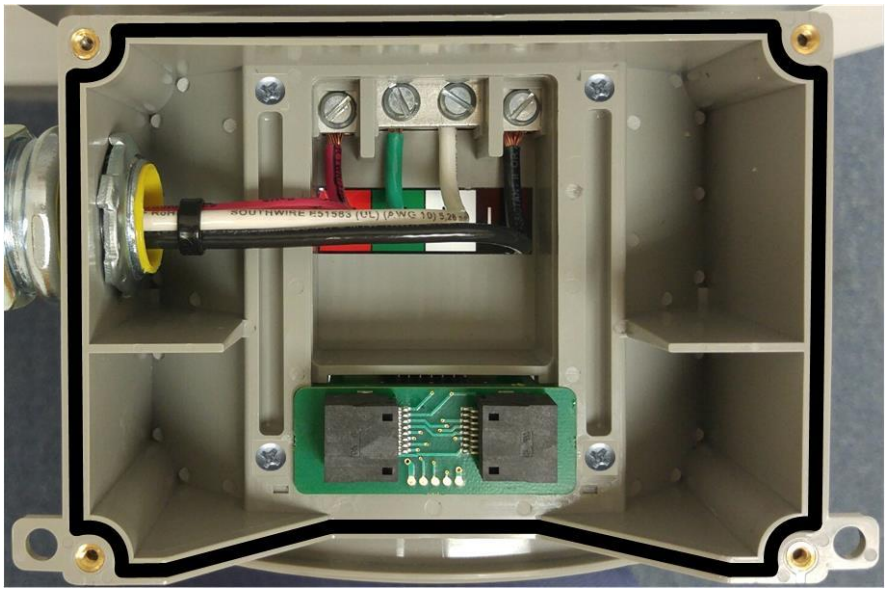


**FIGURE 21**

**TABLE 3**

| FIELD WIRING TORQUE VALUES | |
|---|---|
| **Wire size (AWG)** | **Torque value** |
| 14-10 | 35 in/lbs. |
| 8 | 40 in/lbs. |
| 6-4 | 45 in/lbs. |
| 3 | 50 in/lbs. |

4. Attach the junction box cover using the Philips screws provided. Tighten until the lid bottoms out on the base so the gasket is fully compressed. **Torque to 5 in/lbs.**

NOTE **USE A TORQUE DRIVER TO TIGHTEN THE SCREWS TO 5 IN/LBS.**

## PREPARE THE SYSTEM FOR PROVISIONING

1. Install one or more tamper-prevention seals on the junction box cover (optional, such as the green seal shown in **FIGURE 22**).

2. Confirm the PV or other DER system passed inspections by the AHJ and the utility where applicable.

3. Remove the lockout on the circuit breaker cover, open the cover and switch the breaker to the "ON" position.

4. Close the breaker cover using the thumbscrew.

5. Install tamper-prevention seal on the breaker cover (optional).


**FIGURE 22**

# PPL Electric Exhibit MW-5R

## PROVISION THE SYSTEM USING "ADMIN" CREDENTIALS

1. Ensure the ConnectDER is properly installed, energized and indicating "b4 EnA" is displayed on the LCD as shown previously in **FIGURE 25.**
2. Log in to the URL provided by the ConnectDER Service Center on your Smartphone, laptop or tablet.
3. Select the "Table" view.
4. Select the desired unit by clicking on its "Unit S/N" hyperlink.
5. Select "Edit Unit" and enter the Address, City, State, and Zip Code. The Premises ID, Location Notes, and DER Type are optional.
6. Select "Update Unit", then click "OK".
7. Select the "Provision" button. The status will change to "Provisioning", then to "Operational" once provisioning is completed.

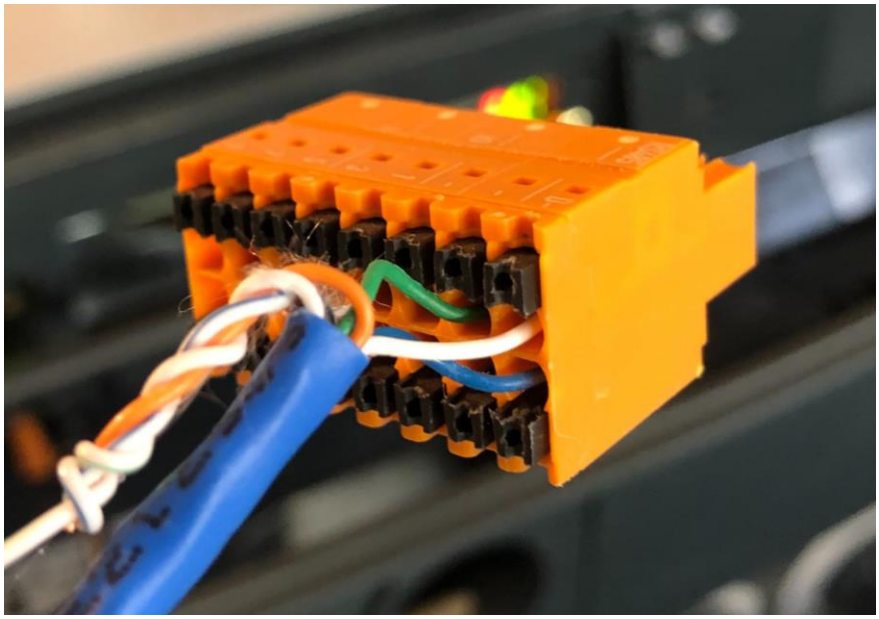
## INSTALL THE DONGLE

The Wi-Fi Dongle is a small module that gets installed in the communications chassis of a solar inverter.

Installation of the Dongle is very simple (photos/instructions assume a Fronius inverter).

1. Use the toggle switch adjacent to the RJ11 jack to select between RS232 and RS485. For RS232, set the toggle to the position closest to the RJ11 jack, for RS485, set the toggle to the position furthest from the jack.

2. Connect the Dongle to the serial port on the inverter. Connect:
    a. Solid orange (D+) to D+ terminal
    b. Striped blue (D-) to D- terminal
    c. Solid green (GND) to "-" terminal



3. Power the Dongle by connecting it to the USB port on the inverter. Once energized, it pairs automatically with the collar, and installation is complete.

## VERIFICATION

I, MATTHEW WALLACE, being a Senior Engineer at PPL Electric Utilities Corporation, hereby state that the facts above set forth are true and correct to the best of my knowledge, information and belief and that I expect PPL Electric Utilities Corporation to be able to prove the same at a hearing held in this matter. I understand that the statements herein are made subject to the penalties of 18 Pa.C.S. § 4904 relating to unsworn falsification to authorities.

Date: 3/4/2020

Matthew Wallace