

## Planning an Enphase Energy System

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## Overview

This document provides site surveyors and design engineers with the information required to evaluate a site and plan the installation of the Enphase Energy System. The information provided in this document supplements the information in the data sheets, quick install guides, and product manuals. Diagrams and information in this document are illustrative of example system configurations and installations. However, they may not include all requirements from additional local codes and standards and Authorities Having Jurisdiction (AHJs) applicable to a site.

**NOTE:** This guide describes an Enphase Energy System with IQ-Series or M-Series Microinverters. Please pay particular attention to the equipment requirement for each type of Microinverter.

## Enphase Energy System Overview

With Enphase Energy System, homeowners have power when the grid goes down and can save money when the grid is up. Enphase Energy System includes a combination of the following Enphase products:

**IQ8™ Series Microinverters and Accessories:** The Enphase Energy System is fully compatible with IQ 8 Microinverters and makes retrofit upgrades as simple as new installations.

- **IQ 6™ / IQ 7™ Series Microinverters and accessories:** The Enphase Energy System is compatible with IQ 7 and IQ 6 Series Microinverters and makes retrofit upgrades as simple as new installations.

**Warning:** The Enphase Energy System does not support mixing of IQ6/IQ7 Series Microinverters with IQ8 Series Microinverters.

- **Enphase M-Series Microinverters and Accessories:** The Enphase Energy System is compatible with Enphase M215 and M250 Microinverters and makes retrofit upgrades simple.

**NOTE:** The Enphase Energy System upgrade is only compatible with M215 and M250 Series Microinverters. Other legacy Microinverters are not supported.

**Warning:** Enphase system does not support mixing of M-Series microinverters with IQ8 Series microinverters or IQ6/7 Series Microinverters.

- **Enphase IQ Battery** is an all-in-one AC coupled storage system that includes embedded, grid forming multimode Microinverters. You can connect multiple IQ Batteries to maximize potential backup for homes. The IQ Battery 3/3T/10/10T storage system provides flexibility to customers to start small and add capacity incrementally.
- **IQ™ Combiner Series** consolidates interconnection equipment into a single enclosure and streamlines PV and storage installations by providing a consistent, pre-wired solution for residential applications. It includes the Enphase IQ Gateway. Install the new communication kit in any IQ Combiner to enable wireless communication with IQ Battery and IQ System Controller.
  - **IQ™ Combiner 4/4C** consolidates interconnection equipment into a single enclosure and streamlines PV and storage installations by providing a consistent, pre-wired solution for residential applications. IQ™ Combiner 4/4C includes Enphase IQ Gateway with the latest software needed to support IQ8™. Install the new communication kit COMMS-CELLMODEM-M1-06 with IQ™ Combiner 4/4C to enable wireless communication with IQ Battery and IQ System Controller.
- **IQ Gateway™**, a communications gateway that can communicate with IQ-Series Microinverters, IQ batteries, and the IQ System Controller. It collects system performance information and transmits that information over the internet to Enphase Cloud. An IQ Gateway is required for Enphase Energy Systems with IQ-Series Microinverters. Note the IQ Gateway is included in an Enphase IQ Combiner. For retrofit sites, an IQ Gateway may already be present.
 

**NOTE:** IQ Gateway will not communicate with M-Series Microinverters.
- **Envoy-S Metered** is a communications gateway that can communicate with M-Series Microinverters, IQ batteries and the IQ System Controller. It collects system performance information and transmits that information over the internet to Enphase Cloud. An Envoy-S Metered is required for every Enphase Energy System with M-Series Microinverters.

**NOTE:** Legacy Gateway/EMU SKUs (ENV-120-01 or ENV-120-02, IEMU-03 or IEMU-01 or IEMU02) will not work with an Enphase Energy System. You must replace these legacy SKUs with an Envoy-S Metered during the Enphase Energy System installation.

- **Enphase IQ System Controller** connects the home to grid power, the IQ Battery, and PV. It provides microgrid interconnect device (MID) functionality by automatically detecting and seamlessly transitioning the system from grid power to backup power in the event of a grid failure. It allows IQ Battery and/or an IQ6/7 Series PV array to form an intentional island (per IEEE 1547.4 definition) and contains a neutral-forming transformer (NFT) to enable 120/240 V operation in backup mode.
- **Enphase IQ System Controller 2** forms the intentional microgrid for systems with IQ8™ Series Microinverters. This smart switch will be fully backward compatible and will support Enphase Energy systems with IQ6™/IQ7™/M-Series Microinverters as well.
- **Enphase System Shutdown Device** is the only rapid shutdown device per 2017 NEC 690.12 for an IQ8 grid agnostic system.

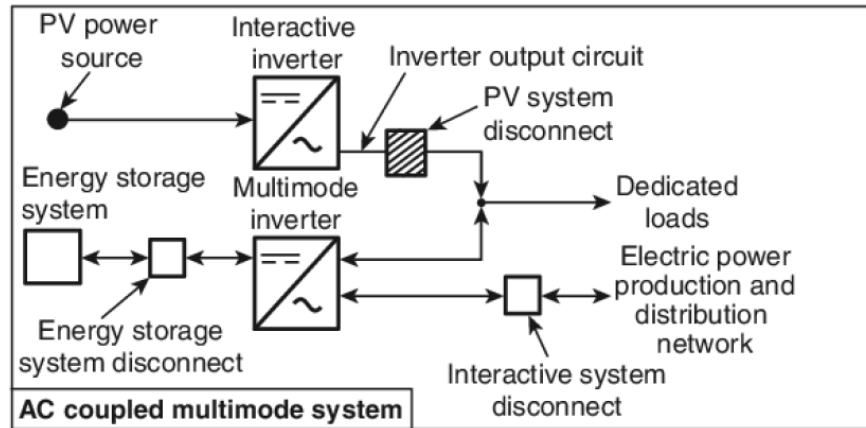
**NOTE:** Enphase System Shutdown device is not needed in an Enphase Energy System with IQ6/7-Series or M-Series Microinverters.

- **IQ Load Controller** Each IQ Load Controller unit can enable fine-grained, circuit-level control for 2x 240V loads or 4x 120V loads. Dedicated loads up to 36A resistive/25A inductive or branch circuits with multiple loads up to 32A resistive/25A inductive are supported by the IQ Load Controller.
- **Enphase Wireless communication kit** enables direct communication between IQ Battery, IQ System Controller, and the IQ Gateway using 2.4 GHz frequency. The kit is connected to one of the USB ports on the IQ Gateway.
- An **Enphase Mobile Connect™** cellular modem is required unless already present to ensure the best performance of your system. The cellular modem connects to a USB port on the IQ Gateway.
- **Enphase Consumption CTs** enable home energy consumption monitoring and are required for Enphase Energy System to operate correctly.

## Enphase Energy Systems Common Configurations

### Regulatory Background – National Electrical Code

Grid-tied only PV inverters are required to shut down in the event of a utility grid power outage. They cannot form an un-intentional island, and their anti-islanding technology prevents the formation unintentional islands. Enphase Energy Systems could provide backup to some or all of the load circuits in a home by forming an intentional island according to 2017 NEC sections 690 and 705. The IQ System Controller with MID function in conjunction with the multimode inverters in the IQ Battery and/or IQ8 PV Microinverters comprise a microgrid system that forms an intentional island entirely within the bounds of the local electric power system (EPS). Figure 1 below shows a drawing of an AC coupled multimode system based on 2017 NEC section 690 and 705.



## Backup Configurations

Enphase Energy System enables many backup configurations for different customer goals and needs. Below are the common configurations that allow the Enphase Energy System to provide power to customer loads independent of the grid. IQ System Controller 1 or IQ System Controller 2 can be used in these configurations to form the intentional microgrid.

1. **Solar Only:** The system does not provide any backup. It offers economic savings by using the power produced to supply customer loads and exports excess power back to the grid when allowed. This document will not cover Solar Only configuration.
2. **Sunlight Backup:** In addition to the benefits offered by the Solar Only use case, the system provides backup when the sun is shining for up to four essential loads. Only IQ8-Series Microinverters support this configuration.
3. **Home Essentials Backup:** In addition to the benefits offered by the Sunlight Backup solution, the system provides backup during day or night for essential loads.
4. **Full Energy Independence:** In addition to the benefits offered by the Home Essentials Backup use case, the system provides backup during day or night for the whole home.

**NOTE:** When IQ System Controller 2 is used with IQ6, IQ7 or M-Series Microinverters, the Enphase Energy System Shutdown switch (EP200G-NA-02-RSD) should not be used as a rapid shutdown initiator. The installers need to short the RSD auxiliary contacts of IQ System Controller 2 to make the system operational. Refer Installer memo – [Wiring the Rapid Shutdown Switch with IQ System Controller 2](#)

### Sunlight Backup Configuration

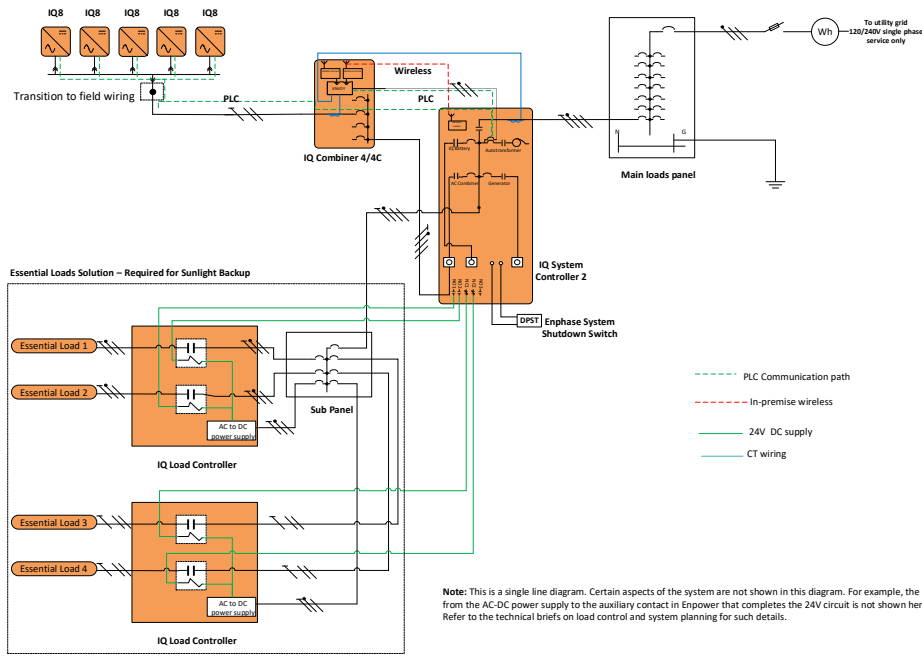
Only IQ8 Series Microinverters support this configuration. In this configuration, the Enphase Energy System provides backup when the sun is shining. The system does not include any IQ Batteries. The system can support PV branch circuits rated for up to 64A continuous current output.

IQ System Controller 2 is installed on the load side of an existing main load panel. This configuration must be used with an [Essential Loads Solution](#). An Essential Loads Solution consists of:

- An off-the-shelf panel with a maximum of 4 pre-selected, essential load circuits that are backed up by the system.
- Up to 2 IQ Load Controllers, each enabling fine-grained, circuit-level control for 2x 240V or 4x 120V essential load circuits. Sunlight backup needs at least one IQ Load Controller to be installed on site.

Enphase Energy System does not support using this configuration for backing up an entire home as this will lead to a poor customer experience.

Figure 2: Enphase Energy System in Sunlight Backup configuration with IQ8-Series Microinverters & System Controller 2.



**Home Essentials Configuration**

M-Series, IQ6, IQ7 and IQ8-Series Microinverters support this configuration. The Enphase Energy System provides backup during the day or night for essential loads. The system has at least one IQ Battery 3/3T. IQ System Controller is installed on the load side of an existing main load panel or service equipment. This use case can be used when the Enphase Energy system is configured to provide backup to a few pre-selected, essential load circuits. Up to 2 IQ Load Controllers are strongly recommended to reject high power loads.

Figure 3 *Enphase Energy System in Home Essentials configuration with IQ8-Series Microinverters & System Controller 2.*

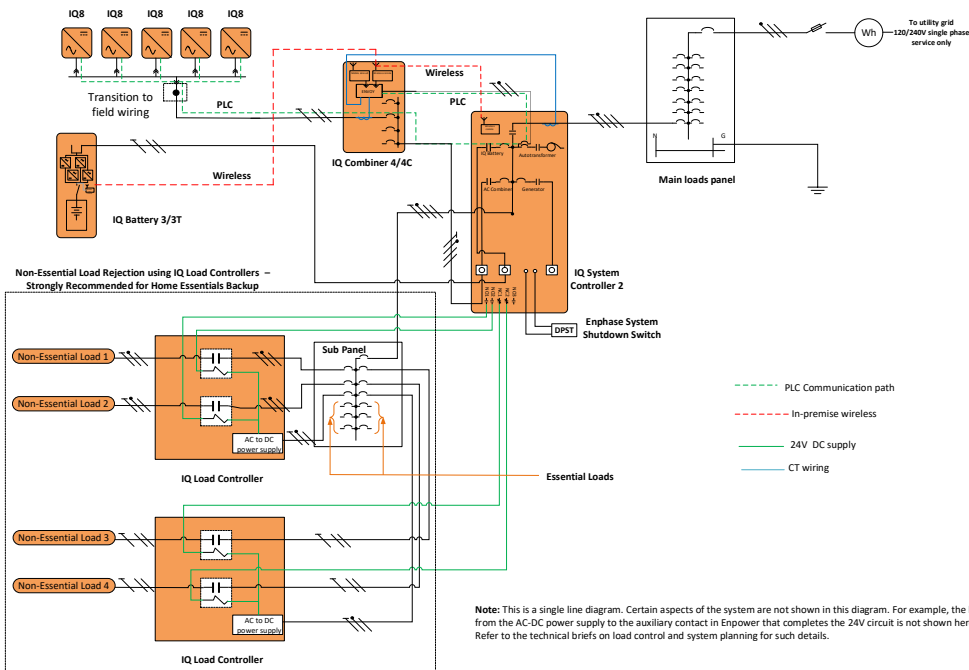


Figure 4: *Enphase Energy System in Home Essentials configuration with IQ-Series Microinverters & System Controller 1.*

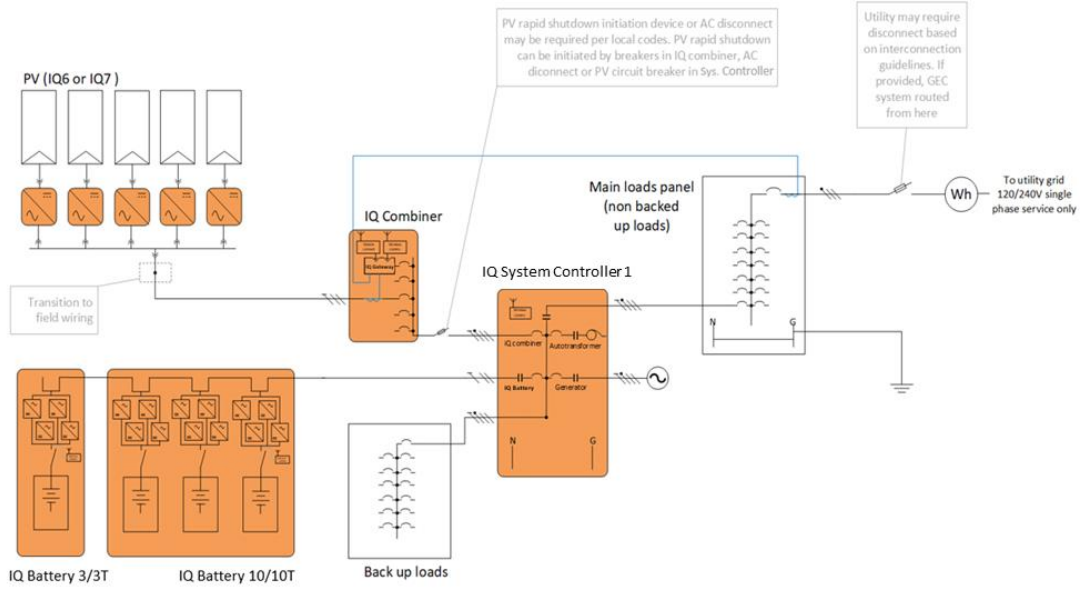


Figure 5: Enphase Energy System in Home Essentials configuration with IQ-Series Microinverters & System Controller 2.

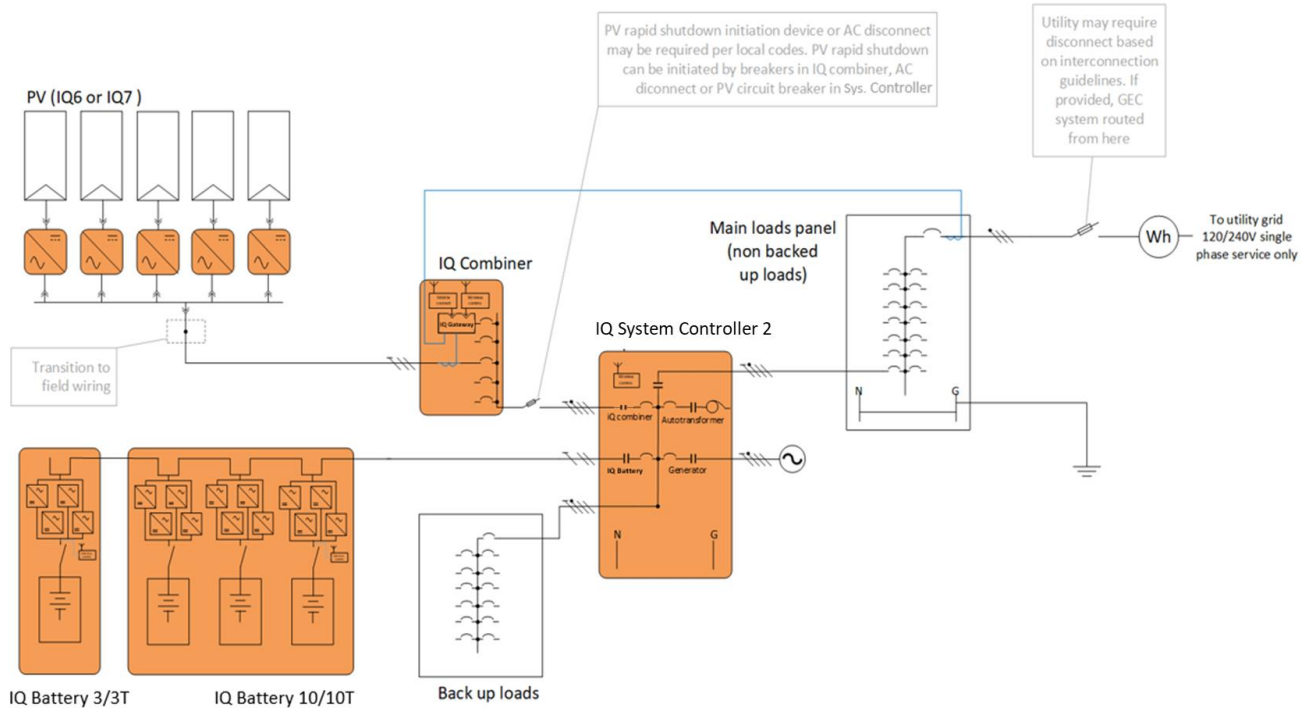


Figure 6: Enphase Energy System in Home Essentials configuration with M-Series Microinverters & System Controller 1.

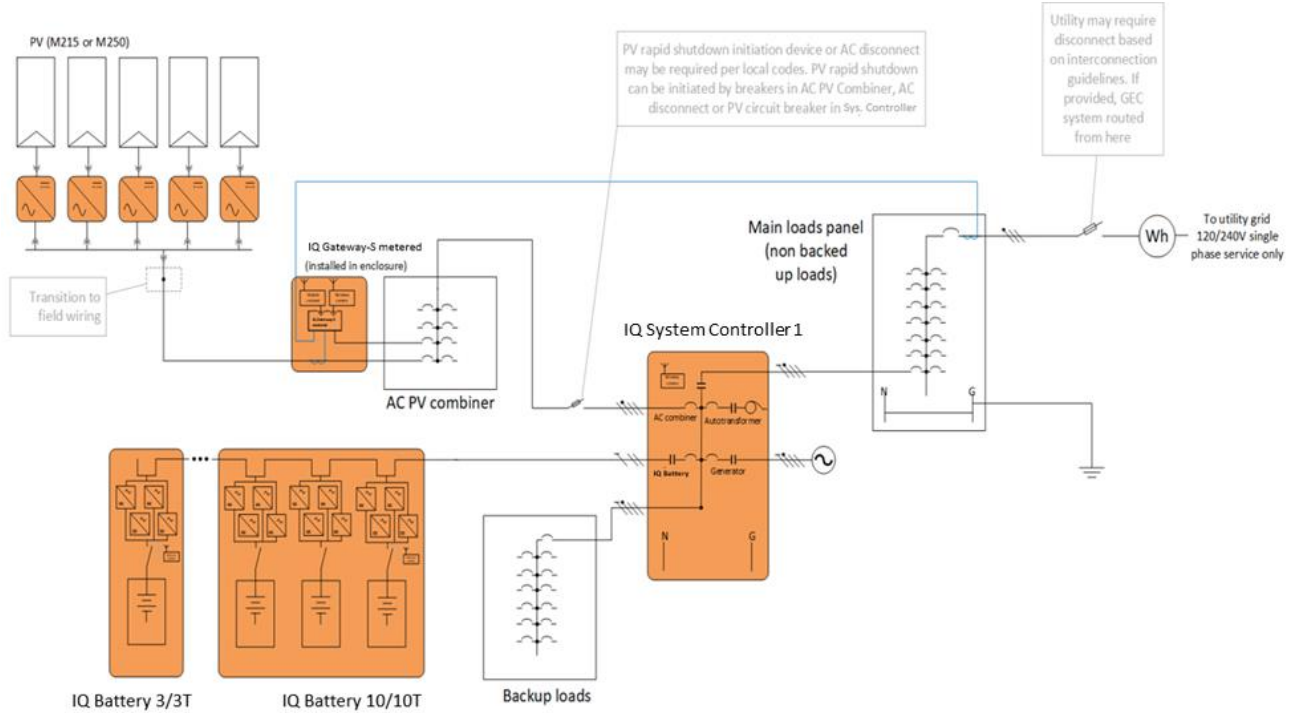
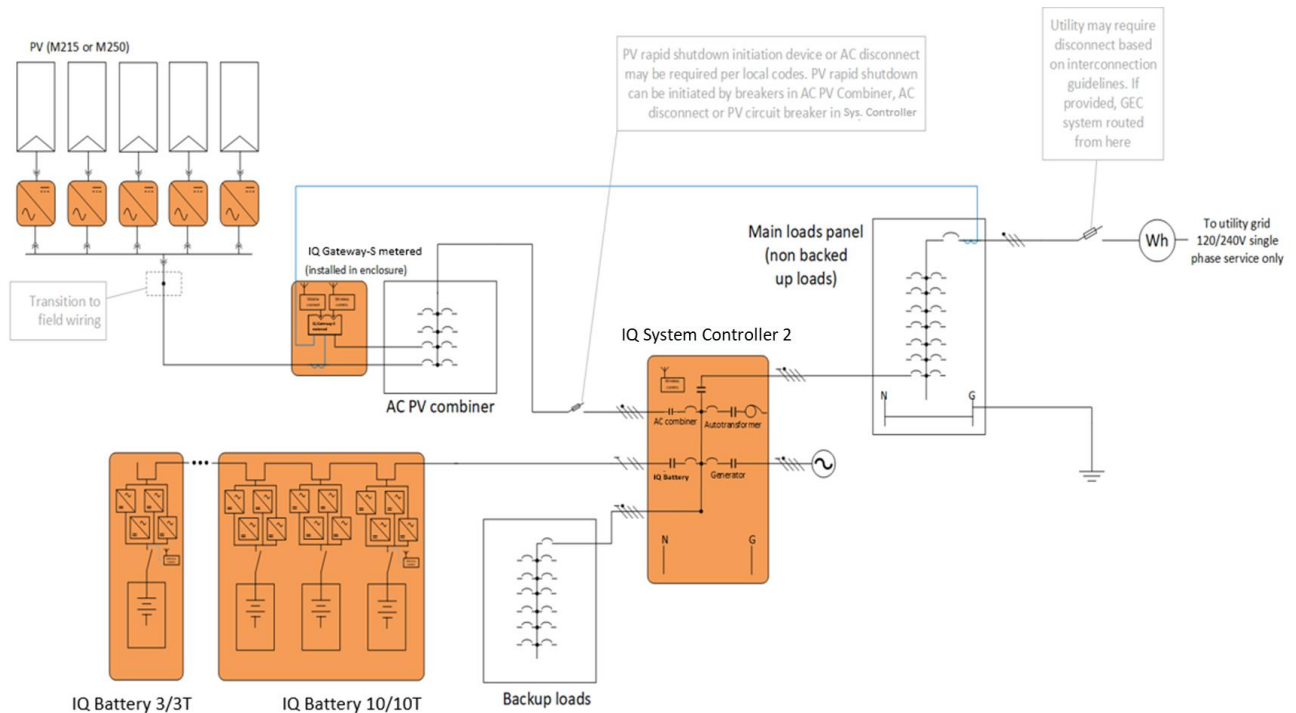


Figure 7: Enphase Energy System in Home Essentials configuration with M-Series Microinverters & System Controller 2.



**Full Energy Independence Configuration**

M-Series, IQ6, IQ7 and IQ8-Series Microinverters support this configuration. The Enphase Energy System provides backup during day or night. The system must have at least 10 kWh of IQ Batteries installed i.e., at least an IQ Battery 10/10T. Depending on the IQ Battery sizing, the system will be able to sustain off grid operation for extended periods of time. This use case supports whole home backup i.e., backing up all the loads in the home. Note that the batteries



must be sized correctly to supply the loads. Up to 2 IQ Load Controllers can be used to enable fine-grained control of backed-up loads.

Figure 8 *Enphase Energy System in Full Energy Independence configuration with IQ8 Microinverters & System Controller 2.*

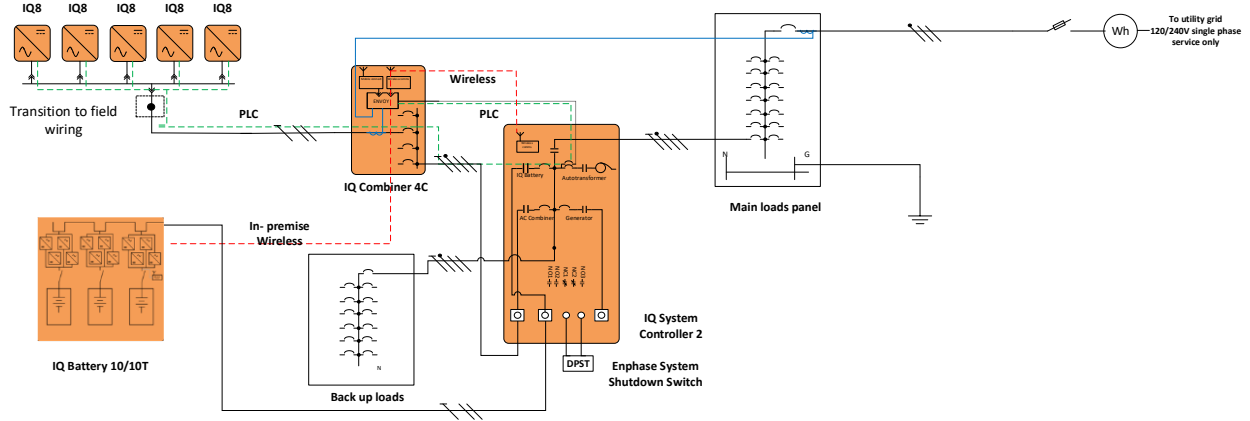


Figure 9 *Enphase Energy System in Full Energy Independence configuration with IQ6 or IQ7 Microinverters & System Controller 1*

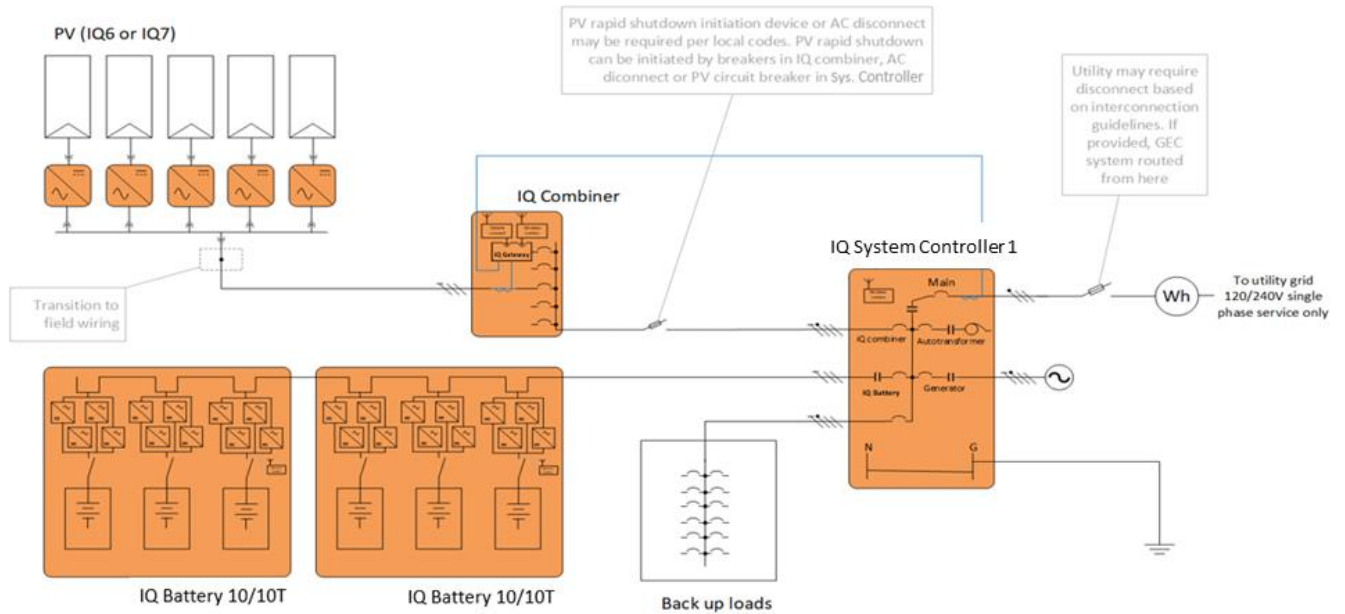


Figure 10: *Enphase Energy System in Full Energy Independence configuration with IQ6 or IQ7 Microinverters & System Controller 2.*

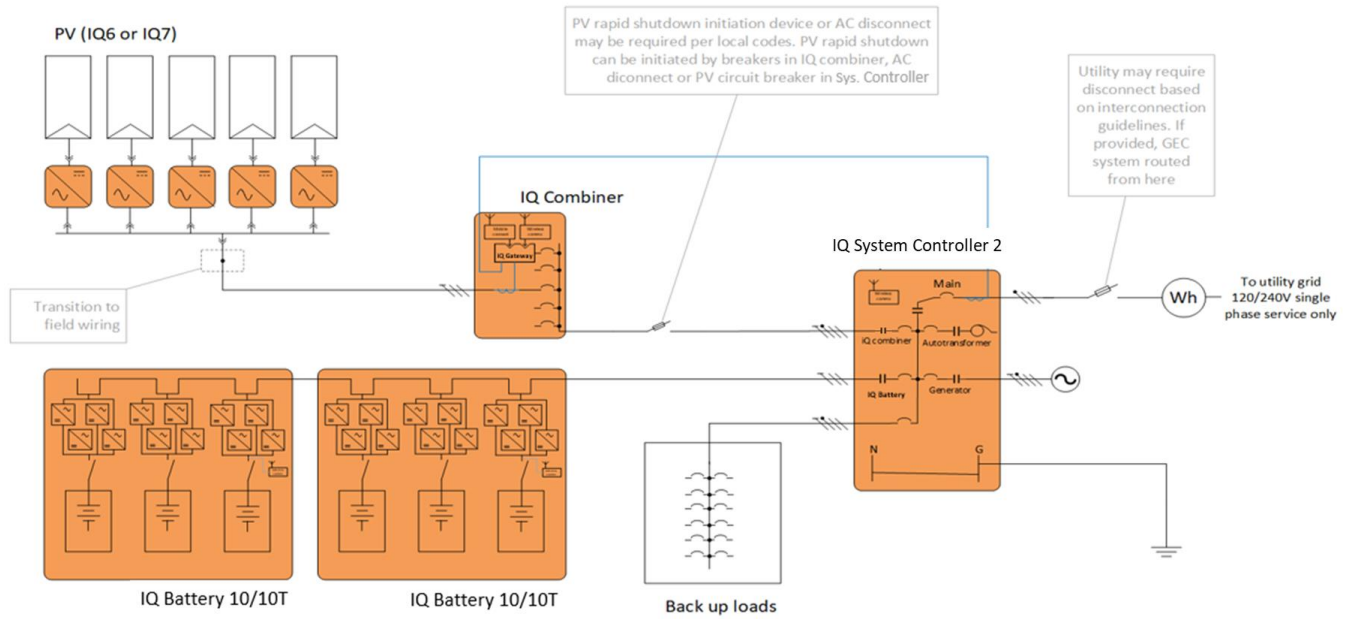


Figure 11: Enphase Energy System in Full Energy Independence configuration with M-Series Microinverters & System Controller 1.

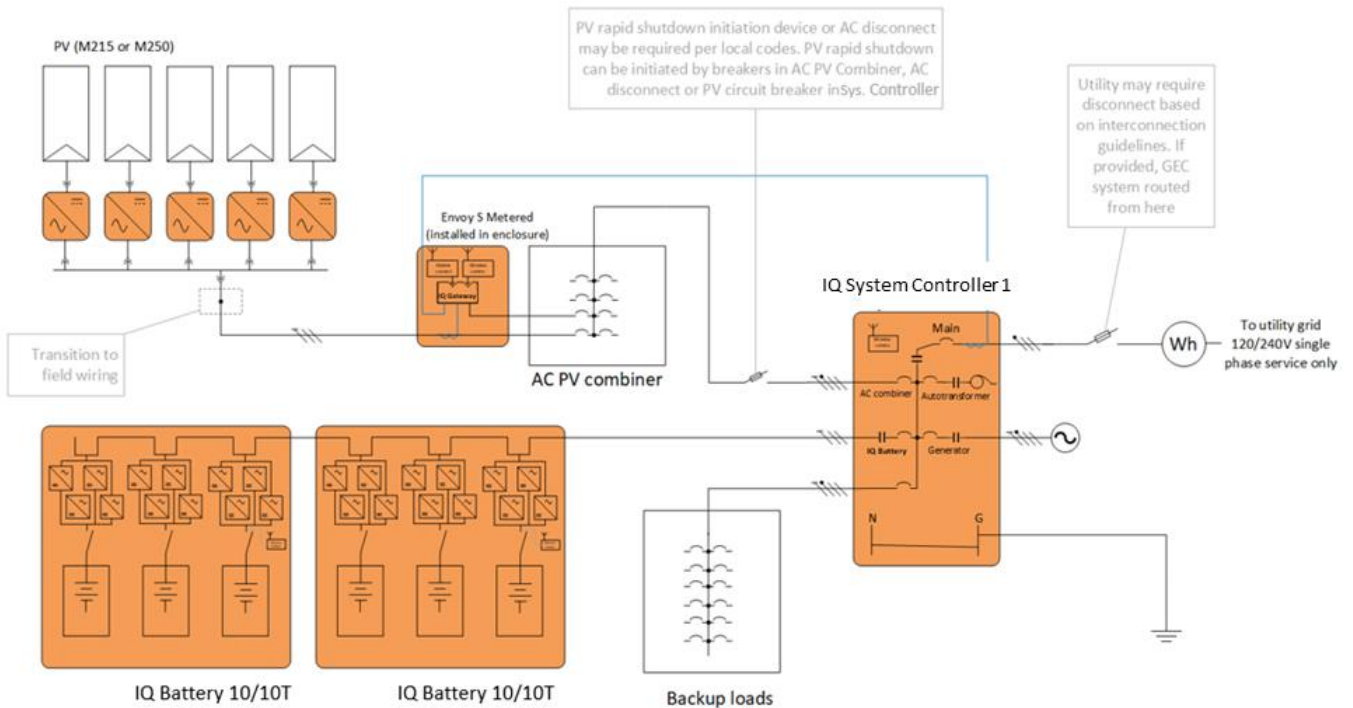
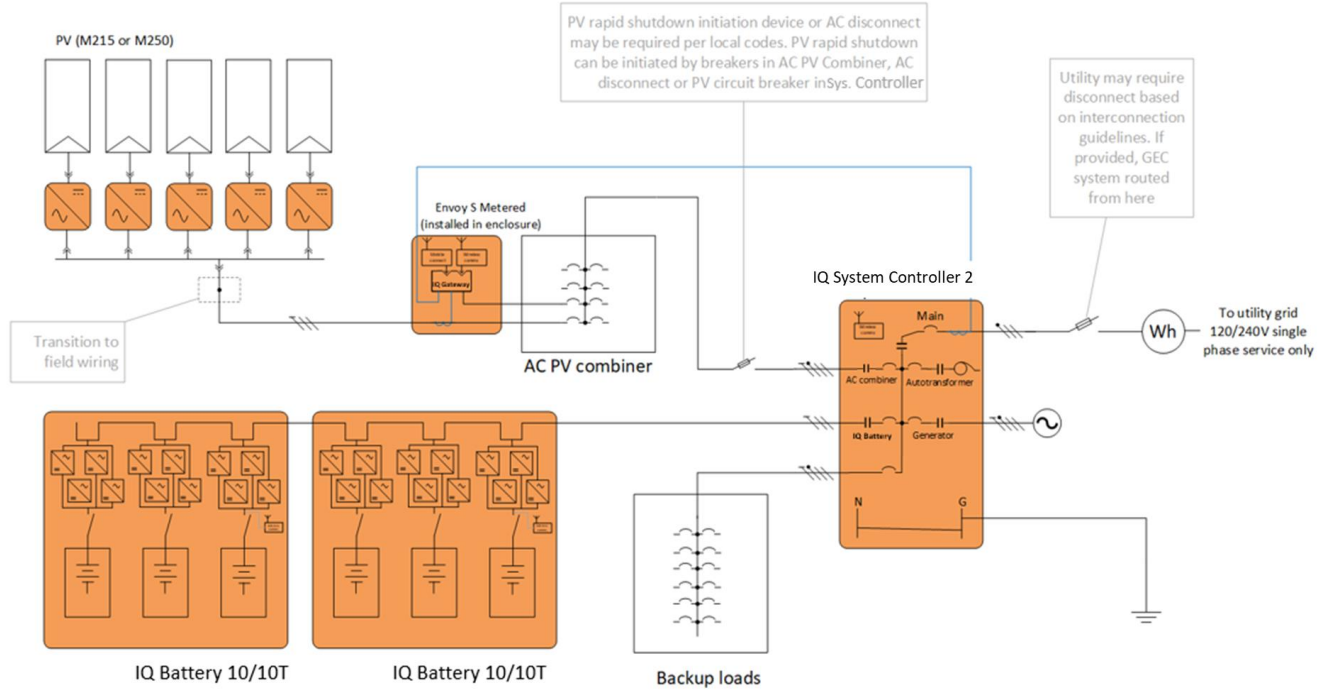


Figure 12: Enphase Energy System in Full Energy Independence configuration with M-Series Microinverters & System Controller 2



## Component List for IQ6/7 or M-Series backup systems

The following table lists the required components for installation of new systems and retrofitting an existing Enphase system:

### Energy Essentials/Full Energy Independence configuration

Component	Name (Model Number)	New System (Quantity)	Retrofit IQ System (Quantity)	Retrofit M215/M250 System (Quantity)	Retrofit Enphase Non-IQ6/7 and Non-M215/M250 System (Quantity)
<b>Energy Storage System (ESS)</b>	<b>IQ Battery:</b> Encharge-3-1P-NA Encharge-3T-1P-NA Encharge-10-1P-NA Encharge-10T-1P-NA	IQ Battery 3/3T and IQ Battery 10/10T units (See pairing chart for minimums)	IQ Battery 3/3T and IQ Battery 10/10T units (See pairing chart for minimums)	IQ Battery 3/3T and IQ Battery 10/10T units (See pairing chart for minimums)	IQ Battery 3/3T and IQ Battery 10/10T units (See pairing chart for minimums)
<b>Smart switch with Microgrid Interconnection Device (MID)</b>	<b>IQ System Controller 1:</b> EP200G101-M240US00	1	1	1	1
	<b>IQ System Controller 2:</b> EP200G101-M240US01	1	1	1	1
<b>Load control</b>	<b>IQ Load Controller</b> EP-NA-LK02-040	0,1 or 2	0,1 or 2	0,1 or 2	0,1 or 2
<b>IQ System Controller Switch Main Breaker and/or Load Breaker</b>	<b>IQ System Controller Main Breakers:</b> BRK-200A-2P-240V BRK-175A-2P-240V BRK-150A-2P-240V BRK-125A-2P-240V BRK-100A-2P-240V	0, 1 or 2	0, 1 or 2	0, 1 or 2	0, 1 or 2
<b>IQ System Controller Switch Circuit Breakers for PV and IQ Battery Circuits</b>	<b>IQ System Controller Circuit Breakers:</b> BRK-20A-2P-240V-B BRK-30A-2P-240V BRK-40A-2P-240V BRK-50A-2P-240V BRK-60A-2P-240V BRK-80A-2P-240V	2	2	2	2
<b>Enphase Energy System Communications (between ESS, MID and Combiner)</b>	<b>Enphase Communications Kit:</b> COMMS-CELLMODEM-M1 OR COMMS-KIT-01 (if system already has cellular modem or if using an IQ Combiner SKU that already has a cellular modem)	1	1	1	1
<b>IQ Combiner</b>	<b>IQ Combiner:</b> X-IQ-AM1-240-3-ES OR X-IQ-AM1-240-3C-ES	1	0	0	1
<b>Standalone Gateway</b>	<b>IQ Gateway for IQ Series</b> ENV-IQ-AM1-240	1 (If not using IQ Combiner)	0	1 (If not already present on site)	0
	<b>Envoy-S Metered for M-Series</b> ENV-S-AM1-120	0	0	1 (If not already present on site)	0
<b>Consumption CTs</b>	<b>Current Transformers:</b> CT-200-SPLIT	2 (If not using a new IQ Combiner that ships with consumption CTs)	2 (one for each phase) (If system doesn't already have CTs)	2 (one for each phase) (If system doesn't already have CTs)	2 (one for each phase) If system doesn't already have CTs

Component	Name (Model Number)	New System (Quantity)	Retrofit IQ System (Quantity)	Retrofit M215/M250 System (Quantity)	Retrofit Enphase Non-IQ6/7 and Non-M215/M250 System (Quantity)
<b>Microinverters</b>	<b>IQ7 Series or IQ6 Series</b>	As needed per system design	None needed unless expanding or replacing existing Microinverters (comply with pairing ratio)	N/A	<b>Upgrade to IQ7 or IQ 6 Series</b> Microinverters needed (comply w/ pairing ratio)
	<b>M215/M250 M-Series RMA SKUs:</b> M215240-IQ7-S22-US M215240-IQ7-S25-US M250240-IQ7-S22-US M250240-IQ7-S25-US	N/A	N/A	None needed unless expanding or replacing existing Microinverters (Comply with pairing ratio)	<b>N/A</b>
<b>PV Modules</b>	<b>Any</b>	As needed per system design	None needed unless expanding	None needed unless expanding	Existing or new panels

### Component list for IQ8-Series backup systems

Component Type	Product Name and Model Number	Solar Only	Sunlight Backup	Home Essentials Backup	Full Energy Independence
<b>Microinverters</b>	<b>IQ8 Series</b> IQ8-60-2-US IQ8PLUS-72-2-US IQ8M-72-2-US IQ8A-72-2-US IQ8H-240-72-2-US	As needed per system design	As needed per system design (Up to 64A continuous)	As needed per system design (Up to 64A continuous)	As needed per system design (Up to 64A continuous)
<b>Batteries</b>	<b>IQ Batteries</b> ENCHARGE-3-1P-NA ENCHARGE-10-1P-NA ENCHARGE-3T-1P-NA ENCHARGE-10T-1P-NA	0	0	At least one ENCHARGE-3-1P-NA or ENCHARGE-3T-1P-NA	At least one ENCHARGE-10-1P-NA or ENCHARGE-10T-1P-NA
	<b>IQ8 Series</b> IQ8H-208 -72-2-US	As needed per system design	Not supported	Not Supported	Not supported
<b>AC Combiner</b>	<b>IQ Combiner 4/4C</b> X-IQ-AM1-240-4 OR X-IQ-AM1-240-4C-ES (Includes IQ Gateway and 2 consumption CTs)	1	1	1	1
<b>Gateway</b>	<b>IQ Gateway for IQ Series</b> ENV-IQ-AM1-240	1 (If not using IQ Combiner)	0	0	0
<b>Smart Switch with Microgrid Interconnection Device (MID)</b>	<b>IQ System Controller 2</b> EP200G101-M240US01	0	1	1	1
<b>Load Control</b>	<b>IQ Load Controller:</b> EP-NA-LK02-040	0	1 or 2	0, 1 or 2	0, 1 or 2
<b>Enphase System Shutdown switch</b>	<b>For use with IQ System Controller 2 for IQ8 PV rapid shutdown and system shutdown</b> EP200G-NA-02-RSD	0	1	1	1
<b>Enphase Energy System Communications (between IQ Batteries, IQ System Controller 2 and IQ Gateway)</b>	<b>Enphase Communications Kit</b> COMMS-CELLMODEM-M1-06 (COMMS-KIT-01 and CELLMODEM-M1-06-SP-05) OR	0	1	1	1

	COMMS-KIT-01 (if system already has cellular modem or if using an IQ Combiner SKU that already has a cellular modem)				
Component Type	Product Name and Model Number	Solar Only	Sunlight Backup	Home Essentials Backup	Full Energy Independence
<b>Mobile Connect</b>	<b>Enphase Mobile Connect</b> CELLMODEM-M1-06-SP-05 (T Mobile/Sprint 5yr data plan) CELLMODEM-M1-06-AT-05 (AT&T 5yr data plan)	0 or 1 (If not using a Combiner with cell modem built-in)	0 (Part of COMMS-CELLMODEM-M1-06)	0 (Part of COMMS-CELLMODEM-M1-06)	0 (Part of COMMS-CELLMODEM-M1-06)
<b>Consumption CTs</b>	<b>Current Transformers</b> CT-200-SPLIT	2 (If not using a new IQ Combiner that ships with consumption CTs)	0	0	0
<b>Main Breaker and/or Load Breaker for IQ System Controller 2</b>	<b>IQ System Controller Main Breakers</b> BRK-200A-2P-240V (Eaton SKU: CSR2200N) BRK-175A-2P-240V (Eaton SKU: CSR2175N) BRK-150A-2P-240V (Eaton SKU: CSR2150N) BRK-125A-2P-240V (Eaton SKU: CSR2125N) BRK-100A-2P-240V (Eaton SKU: CSR2100)	0	0,1 or 2	0,1 or 2	0,1 or 2
<b>Circuit Breakers for IQ8 PV, IQ Battery, and generator Circuits in IQ System Controller 2</b>	<b>IQ System Controller 2 Circuit Breakers</b> BRK-20A-2P-240V-B (Eaton SKU: BR220B) BRK-30A-2P-240V (Eaton SKU: BR230B) BRK-40A-2P-240V (Eaton SKU: BR240B) BRK-60A-2P-240V (Eaton SKU: BR260) BRK-80A-2P-240V (Eaton SKU: BR280)	0	1 or 2 (For PV and generator)	2 or 3 (For PV, batteries, and generator)	2 or 3 (For PV, batteries, and generator)
<b>Circuit Breakers for PV in IQ Combiner 4/4C</b>	<b>IQ Combiner 4/4C Circuit Breakers<sup>1</sup></b> BRK-20A-2P-240V-B (Eaton SKU: BR220B) BRK-15A-2P-240V-B (Eaton SKU: BR215B)	1, 2, 3 or 4	1, 2, 3 or 4	1, 2, 3 or 4	1, 2, 3 or 4
<b>Hold down kits</b>	<b>For IQ Combiner 4/4C</b> X-IQ-NA-HD-125A	0	1 or 2	1 or 2	1 or 2
	<b>For IQ System Controller 2</b> EP200G-NA-HD-200A	0	1	2	2
<b>Off-the shelf panel</b>	For essential loads backup	No	Yes (Up to 4 essential loads)	Yes	No
<b>PV Modules</b>	Any	As needed per system design	As needed per system design	As needed per system design	As needed per system design

<sup>1</sup> Enphase recommends using breakers compatible with hold down kits in IQ Combiner 4/4C for IQ8 solar only use case to enable an easy upgrade to a backup use case when the homeowner decides to add backup.

## Split Enphase Systems on a Single Site

It is necessary to “split” the PV systems into a microgrid, and a non-microgrid PV system, each with their own IQ Gateway in the following scenarios:

1. **Prevent mixing of multiple microinverter Series** – Due to technical limitations, M-Series Microinverters cannot be installed in the same system as IQ6/IQ7 Series Microinverters. Similarly, IQ6/IQ7 Series Microinverters cannot be installed with IQ8 Series Microinverters.
2. **IQ8 Series microinverter output exceeding 64A continuous at site** – IQ System Controller 2 supports only 64A continuous PV at the AC combiner port. If the IQ8 PV array exceeds 64A continuous output, the installer can configure an additional grid tied system with an IQ Gateway/IQ Combiner 4/4C. Splitting the Microinverters across two grid forming systems is NOT supported for IQ8 Microinverters.

**NOTE:** The Grid-tied system MUST be commissioned and switched off prior to commissioning microinverters connected to IQ System Controller 2.

**NOTE:** We no longer recommend splitting the system if the total PV system size exceeds what can be supported by the total IQ Battery system size. PV shedding shall be used to address this scenario. For guidance PV system size pairing with an IQ Battery, see the sections: *IQ Microinverter PV System to IQ Battery Pairing* and *M-Series Microinverter PV System to IQ Battery Pairing*

This configuration does not support power export limiting.

The following items are needed to create a split system.

1. Two Gateways:
  - Multiple IQ-Gateways are required for split systems, because the microgrid and non-microgrid PV Microinverters operate with different grid profiles and parameters.
2. Installation of a power line filter:
  - When multiple IQ Gateways exist on site, a power line filter must be installed to prevent cross domain communication.
  - The [Q-LCF-064-1P](#) is a tested solution that is compatible with Enphase IQ6/7 Microinverters and IQ Gateway at up to 64A of continuous current.
  - Similarly, the [RP220](#), [RP225](#), [RP230](#), or [RP240](#) Series from Radius Power can be used with M215/M250 Microinverters and the Envoy-S Metered.
  - For systems with IQ6, IQ7 and M-Series Microinverters, Enphase recommends installing the power line filter with the microgrid IQ Gateway and all microgrid PV Microinverters on the “Load” input of the filter and the IQ System Controller 1 or IQ System Controller 2 source on the “Line” input of the filter. (See figures Figure 13, Figure 15, Figure 16.)
  - For systems with IQ8 Microinverters install Q-LCF-064-1P between the main panel and the non-microgrid Envoy (see Figure 14).
3. Installation of additional Consumption CTs:
  - Depending on the configuration of the split system, an additional pair of Consumption CTs may need to be added. See the following for details.

### ***Split systems that DO require additional Consumption CTs***

If the non-microgrid PV system is interconnected on the load side of the primary microgrid IQ Gateway’s Consumption CT, a second set of Consumption CTs must be added around the non-microgrid PV conductors and connected in parallel with the primary microgrid Consumption CT wiring to the microgrid IQ Gateway. Please refer to Figure 13 for more details and the orientation of the CTs. Only the line filter position changes for IQ8 Series Microinverters, the CT placement and orientation remains the same. Refer Figure 14 for details on line-filter placement in IQ8 PV systems.

Figure 13: “Split” PV system that requires an additional set of Consumption CTs

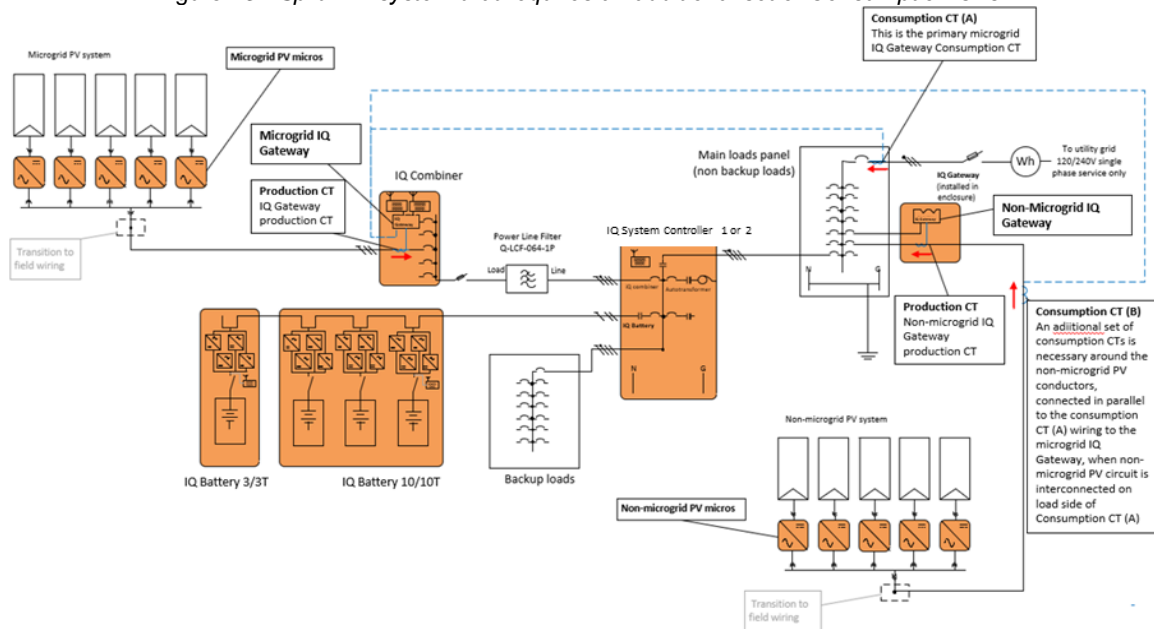
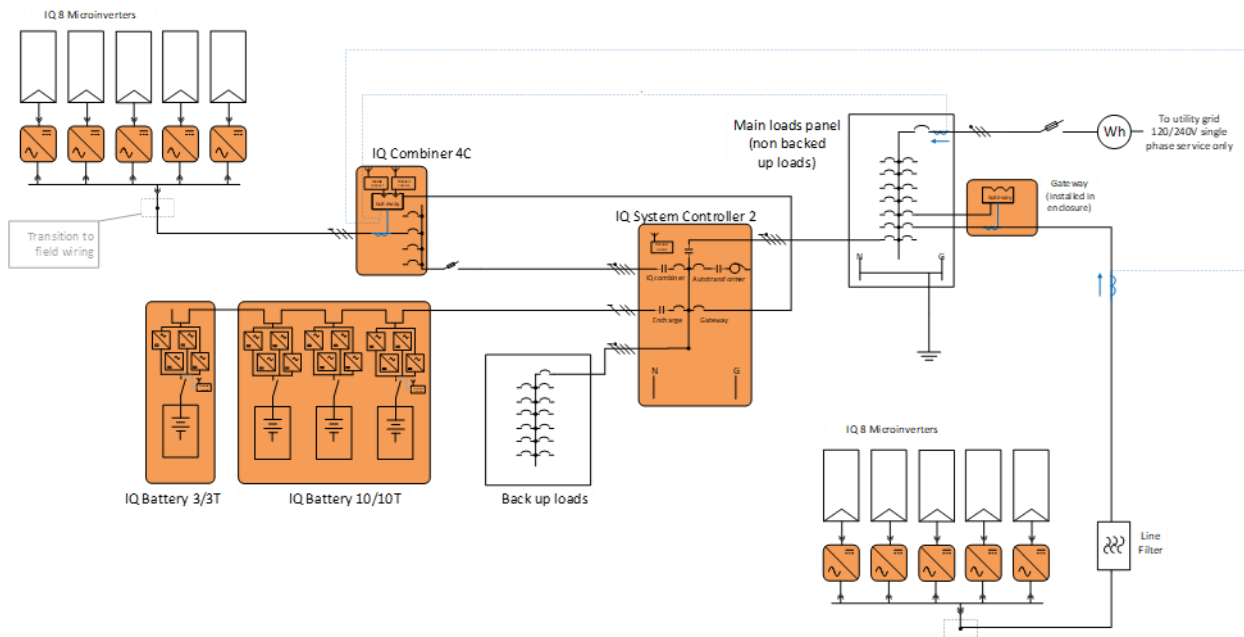


Figure 14 Line filter placement in Split System with IQ8 Series Microinverters – between non-microgrid IQ Gateway and Main loads panel

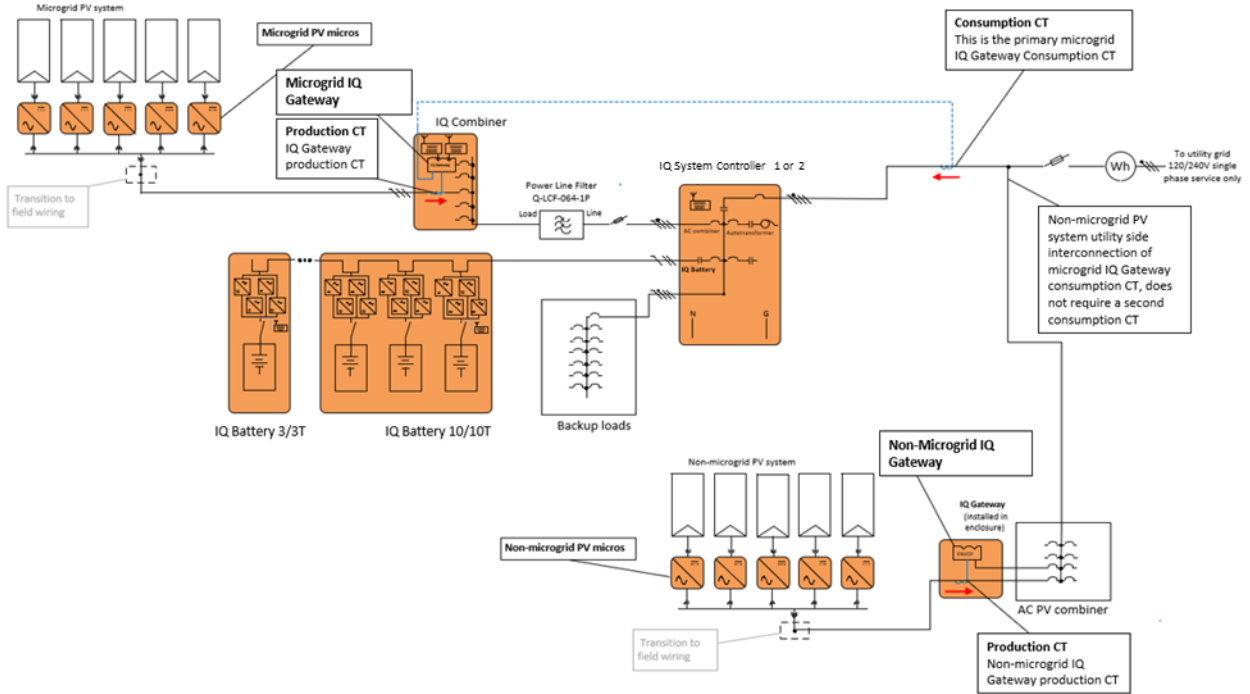


**Split systems that DO NOT require additional Consumption CTs**

For Enphase Energy systems with IQ6, IQ7 Microinverters in the microgrid, where the non-microgrid PV system is interconnected on the utility side of the primary microgrid Gateway’s Consumption CTs, NO additional Consumption CTs are needed. See Figure 15 for this configuration.

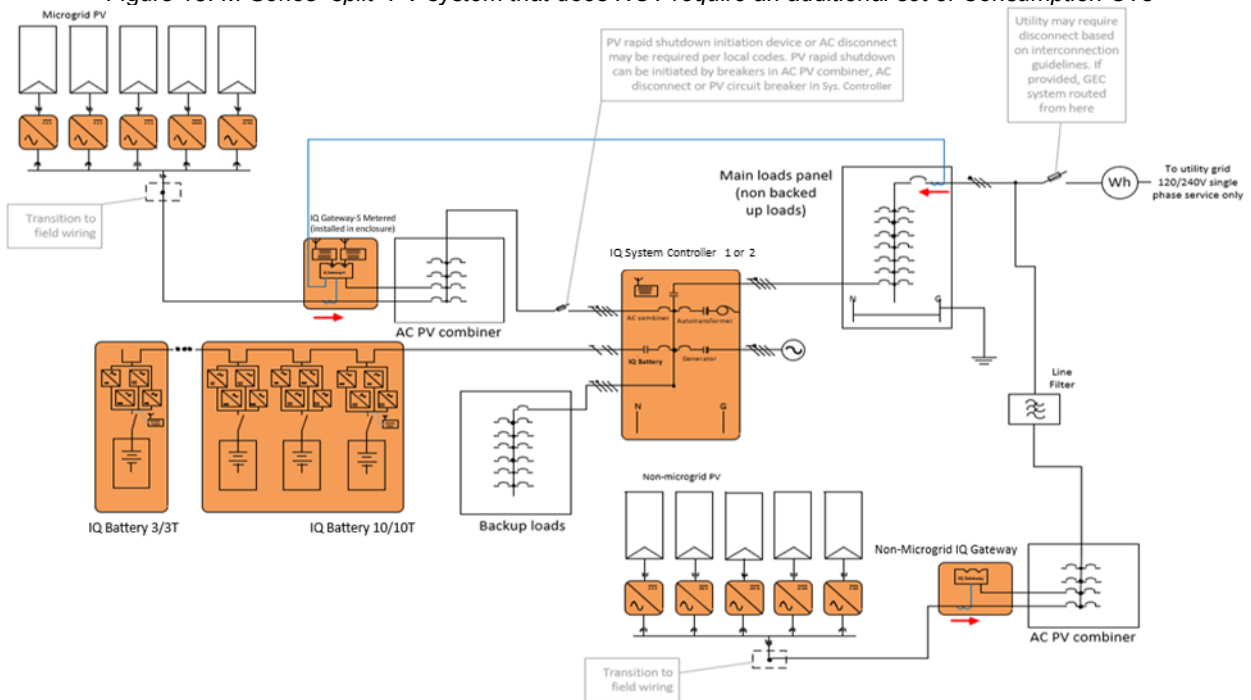


Figure 15: “Split” PV system that does NOT require an additional set of Consumption CTs



M-Series Microinverter systems support similar configurations for “split” PV systems. An example where non-microgrid PV system is interconnected on the utility side of the microgrid IQ Gateway’s Consumption CTs is shown below. No additional consumption CTs are needed.

Figure 16: M-Series “split” PV system that does NOT require an additional set of Consumption CTs



## Non-backup Configuration - Installing Enphase Energy System without IQ System Controller

The IQ Battery can be added to an existing system without using an IQ System Controller, however, it will not provide backup power. When installed in this configuration, the IQ Battery is treated as a distributed energy resource (DER), equivalent to a PV system, and cannot form an intentional island. It may be connected in the IQ Combiner or on a user-provided distribution point in compliance with the NEC. Ensure that the consumption CTs are installed on the line-side of IQ Battery interconnection point and that IQ Battery circuits are not included in the production CT. Figure 17 and Figure 18 show this configuration for IQ6/7/8 and M215/250 Microinverters, respectively.

Figure 17: Grid interactive IQ Battery installation with no backup on IQ6/7/8 Microinverter sites

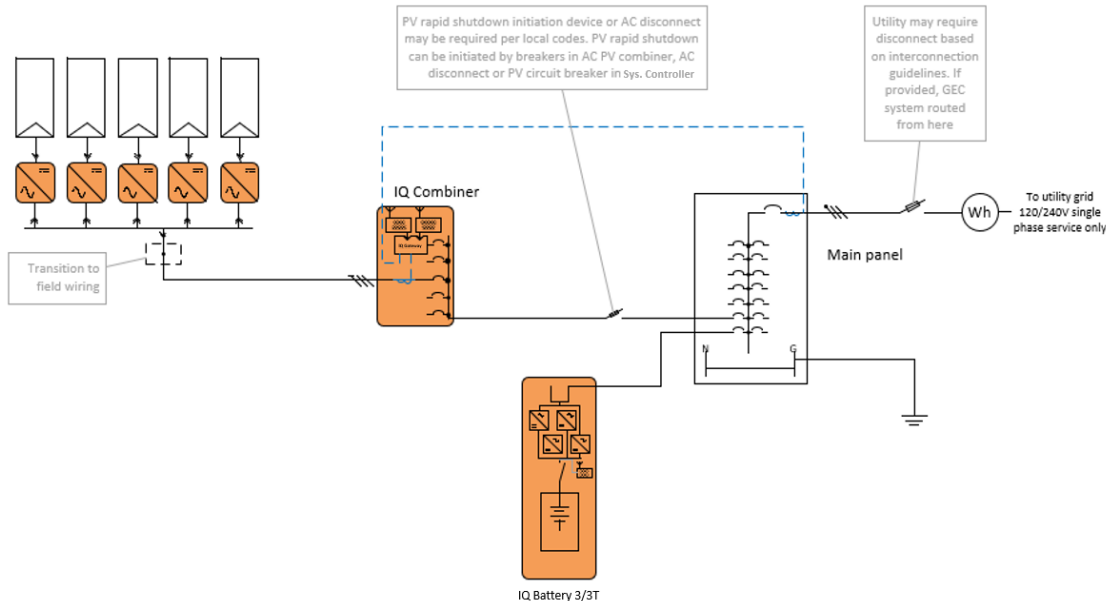
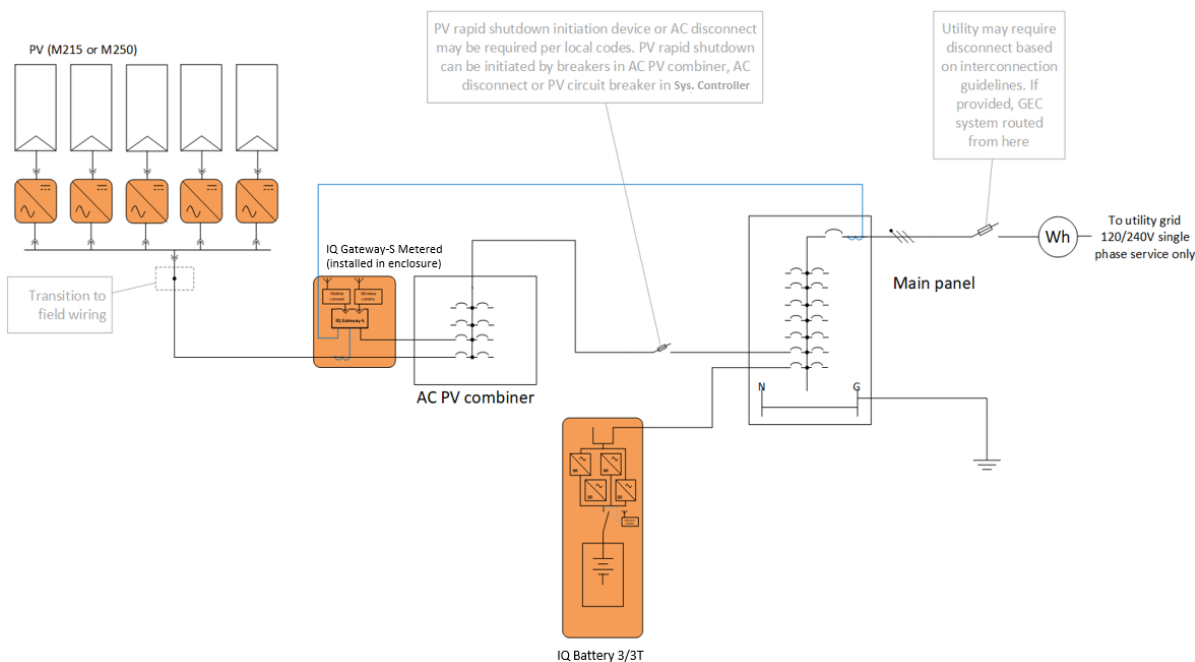


Figure 18: Grid interactive IQ Battery installation with no backup on M-Series Microinverter sites



## System Sizing for different configurations

### Load Analysis

The first step in correctly sizing a system is a proper load analysis. If an IQ Gateway with correctly configured consumption CTs is already installed at a site, you can use data from Enphase Cloud to properly size the system. A site survey, electric bills, and third-party consumption meters can also provide useful load data for system sizing. Also, review the *Enphase Energy System Project Survey* document and System Planner at [estimator.enphaseenergy.com](https://estimator.enphaseenergy.com).

### IQ Battery and PV System Sizing

A backup system provides power to loads when the grid is down.

It is important to differentiate the terms **power** and **energy**. **Power** is a measure of the instantaneous electricity used and is expressed in units of watts (W) or kilowatts (kW). **Energy** is the accumulated or integrated power used over time and is expressed in units of watt-hours (Wh) or kilowatt-hours (kWh). When running in the backup operation, any power capacity shortages or energy capacity shortages will result in a loss of power to loads and should be avoided. Therefore, it is important to properly size the system for both power and energy capacities in each installation.

Sufficiently size the total IQ Battery **power** rating to **power** loads and charge from PV power generation. You can increase the power rating by adding additional IQ Battery units, which also provide additional energy, improving the customer user experience.

The standalone or micro-grid power sources must be sufficient to meet the **2017 NEC 690.10 / 2020 NEC 710.15(A)** requirements.

- **2017 NEC 690.10 -> 710.15 (A) Supply Output.** Power supply to premises wiring systems shall be permitted to have less capacity than the calculated load. The capacity of the stand-alone supply shall be equal to or greater than the load posed by the largest single utilization equipment connected to the system. Calculated general lighting loads shall not be considered as a single load.
- **Power** (kW) capacity from IQ Battery system *must* exceed the largest single load.
- **Energy** storage (kWh) capacity should be sized to supply to the estimated backup loads for a user-defined period.

#### ***Sizing IQ8-Series Microinverters for Sunlight Backup configuration***

Identify the largest maximum single load power rating (kW) that you want to backup and select the absolute minimum number of IQ Battery units required to meet the **2017 NEC 690.10 / 2020 NEC 710.15(A)** requirements, after factoring in 30% of the PV AC apparent power as standalone supply. In an IQ8 PV system, the IQ8 PV capacity can be added to the stand-alone supply of the system to meet **2017 NEC 690.10 / 2020 NEC 710.15(A)**. However, since the solar resource is highly variable, Enphase recommends a safety margin to improve customer experience. 30% of the PV AC apparent power is suggested as a starting point for design. For example, with a 6 kVA AC PV system, Enphase suggests that the largest single load not exceed 2 kVA.

#### ***Sizing IQ Battery Storage System for Full Energy Independence configuration***

Identify the largest maximum single load power rating (kW) that you want to backup and select the absolute minimum number of IQ Battery units required to meet the **2017 NEC 690.10 / 2020 NEC 710.15(A)** requirements.

For Enphase Energy systems with M-Series, IQ6 or IQ7 Series Microinverters in **Full Energy Independence configuration**, at minimum, the larger of a) two IQ battery 10/10T units or b) number of IQ Battery 3/3T units to meet the IQ Microinverter PV System to IQ battery Pairing (see below) or c) the absolute minimum number of IQ Battery units required to meet the **2017 NEC 690.10 / 2020 NEC 710.15(A)** requirements, is recommended.

For Enphase Energy systems with IQ8 Series Microinverters in **Full Energy Independence configuration**, at a minimum two IQ battery 10/10T units is recommended.

1. Identify the largest single load power rating (kW) that you want to backup and select the absolute minimum number of IQ Battery units required to meet the **2017 NEC 690.10 / 2020 NEC 710.15(A)** requirements.
2. This step applies only to M-Series, IQ6 and IQ7 Series Microinverters. **If using IQ8 Microinverters, skip step 2 and go to step 3.**  
Select the minimum number of IQ Battery storage units required so that the total PV system AC power output is not greater than 150% of the total IQ Battery storage system power capacity. If the system's PV

System output pushes the ratio above 150%, use auxiliary contact in IQ System Controller to shed certain PV circuits to maintain the ratio to below 150% when the system transitions to off-grid. Refer [Load and Solar Circuit Control using IQ System Controller Auxiliary Contacts](#) for more details.

3. IQ8 Series microinverter systems don't have any PV output to IQ Battery power capacity ratio limitation. If you are using only one IQ Battery 3/3T, then the number of IQ8 Series Microinverters permitted in the PV array is limited to 48, irrespective of the microinverter type. Use a higher rated panel and microinverter in case 48 Microinverters do not maximize the PV array size. For example, a PV array with 48 IQ8 Microinverters has a maximum continuous current rating of 48 A. Since the AC Combiner port in IQ System Controller 2 is rated for 64 A continuous current input, use 40 IQ8H instead.
4. For Full Energy Independence configuration, a minimum of two IQ battery 10/10T units is recommended.
5. Based on the estimated backup loads for the user-defined period, calculate the required energy storage (kWh) capacity and the minimum number of IQ Battery required.
6. Based on a site's load analysis of both power (kW) and energy capacity (kWh) needed, determine the total number of IQ Battery units required for the storage system.
  - a. The minimum number of IQ Battery units required is the largest of the calculated values in steps 1,2,3 and 4.
  - b. The desired number of IQ Battery units is the value calculated in step 5.  
The maximum allowed number of IQ Battery 3/3T units that can be connected to a single IQ System Controller is 12 (four IQ Battery 10/10T).

### ***Sizing IQ Battery System for Energy Essentials configuration***

For **Energy Essential configuration**, follow these steps to size an IQ Battery system:

7. Identify the largest single load power rating (kW) that you want to backup and select the absolute minimum number of IQ Battery units required to meet the **2017 NEC 690.10 / 2020 NEC 710.15(A)** requirements.
8. This step applies only to M-Series, IQ6 and IQ7 Series Microinverters. **If using IQ8 Microinverters, skip step 2 and go to step 3.**  
Select the minimum number of IQ Battery storage units required so that the total PV system AC power output is not greater than 150% of the total IQ Battery storage system power capacity. If the system's PV System output pushes the ratio above 150%, use auxiliary contact in IQ System Controller to shed certain PV circuits to maintain the ratio to below 150% when the system transitions to off-grid. Refer [Load and Solar Circuit Control using IQ System Controller Auxiliary Contacts](#) for more details.
9. IQ8 Series microinverter systems don't have any PV output to IQ Battery power capacity ratio limitation. If you are using only one IQ Battery 3/3T, then the number of IQ8 Series Microinverters permitted in the PV array is limited to 48, irrespective of the microinverter type. Use a higher rated panel and microinverter in case 48 Microinverters do not maximize the PV array size. For example, a PV array with 48 IQ8 Microinverters has a maximum continuous current rating of 48 A. Since the AC Combiner port in IQ System Controller 2 is rate for 64 A continuous current input, use 40 IQ8H instead.
10. Based on the estimated backup loads for the user-defined period, calculate the required energy storage (kWh) capacity and the minimum number of IQ Battery required.
11. Based on a site's load analysis of both power (kW) and energy capacity (kWh) needed, determine the total number of IQ Battery units required for the storage system.
  - a. The minimum number of IQ Battery units required is the largest of the calculated values in steps 1,2 and 3.
  - b. The desired number of IQ Battery units is the value calculated in step 4.  
The maximum allowed number of IQ Battery 3/3T units that can be connected to a single IQ System Controller is 12 (four IQ Battery 10/10T).

## **IQ8 Microinverter PV System to IQ Battery Pairing**

IQ8 Series microinverter systems don't have any PV output to IQ Battery power capacity ratio limitation. If you are using only one IQ Battery 3/3T, then the number of IQ8 Series Microinverters permitted in the PV array is limited to 48, irrespective of the microinverter type. Use a higher rated panel and microinverter in case 48 Microinverters do not maximize the PV array size. For example, a PV array with 48 IQ8 Microinverters has a maximum continuous current rating of 48 A. Since the AC Combiner port in IQ System Controller 2 is rate for 64 A continuous current input, use 40 IQ8H instead.

## IQ Microinverter PV System to IQ Battery Pairing

The following table identifies the maximum number of Microinverters that can be connected to a given IQ Battery size. Maximum PV system output power cannot be greater than 150% of the total IQ Battery power capacity to ensure stable system operation.

Table 1: Maximum number of IQ Microinverters for IQ Battery for backup operation

IQ Battery 3/3T units	Equivalent IQ Battery 10/10T units	IQ Battery energy capacity (kWh)	IQ Battery power capacity (kWAC)	Max PV system power (kWAC)	Maximum number of Microinverters					
					IQ6	IQ6+	IQ7	IQ7+	IQ7X	IQ7A
1		3.36	1.28	1.92	8	6	8	6	6	5
2		6.72	2.56	3.84	16	13	16	13	12	11
3	(1x IQ Battery 10/10T)	10.08	3.84	5.76	25	20	24	19	18	16
4		13.44	5.12	7.68	33	27	32	26	24	22
5		16.8	6.4	9.6	41	34	40	33	30	27
6	(2 x IQ Battery 10/10T)	20.16	7.68	11.52	50	41	48	39	36	33
7		23.52	8.96	13.44	58	48	56	46	42	38
8		26.88	10.24	15.36	66	54	64	52	48	44
9	(3 x IQ Battery 10/10T)	30.24	11.52	17.28	75	61	72	59	54	49
10		33.6	12.8	19.2	83	68	80	66	60	54
11		36.96	14.08	21.12	91	75	88	72	67	60
12	(4 x IQ Battery 10/10T)	40.32	15.36	23.04	100	82	96	79	73	66

**WARNING:** Undersizing power and energy capacity of the storage system may lead to a poor user experience. User education and setting reasonable expectations of system performance is essential with systems involving backup storage.

## M-Series Microinverter PV System to IQ Battery Pairing

The following table identifies the maximum number of Microinverters that can be connected to a given IQ battery size.

Table 2: Maximum number of M-Series Microinverters for IQ battery for backup operation

IQ Battery 3/3T units	Equivalent IQ Battery 10/10T units	IQ Battery energy capacity (kWh)	IQ Battery continuous power (kWAC)	Max PV system power (kWAC)	# of Microinverters	
					M215	M250
1		3.26	1.28	1.92	8	8
2		6.52	2.56	3.84	17	16
3	(1x IQ Battery 10/10T)	9.78	3.84	5.76	26	24
4		13.04	5.12	7.68	35	32
5		16.30	6.40	9.6	44	40
6	(2 x IQ Battery 10/10T)	19.56	7.68	11.52	53	48
7		22.81	8.96	13.44	62	56
8		26.07	10.24	15.36	71	64
9	(3 x IQ Battery 10/10T)	29.33	11.52	17.28	80	72
10		32.59	12.80	19.2	89	80
11		35.85	14.08	21.12	98	88
12	(4 x IQ Battery 10/10T)	39.11	15.36	23.04	107	96

**Warning:** Under sizing power and energy capacity of the storage system may lead to a poor user experience. User education and setting reasonable expectations of system performance are essential with systems involving backup storage.

## Battery Storage Modes

1. **Battery storage mode is “Self-Consumption”** with a reserve State of Charge (SoC) limit for backup (set by customer or 0 if not set). When system is connected to the utility grid:
  - A. During the day:
    - i. When the battery SoC is greater than the reserve SoC limit -
      - a) If house loads exceed photovoltaic power, batteries discharge to service loads, based on the location of the consumption CTs, until SoC reaches the reserve SoC limit. Battery power is not exported to the grid.
      - b) If house loads exceed photovoltaic and battery discharge power, utility power is imported to service excess loads.
      - c) If photovoltaic power exceeds house loads, photovoltaic power may be export to grid depending on the interconnection agreement.
    - ii. When the battery SoC is less than or equal to the reserve SoC limit -
      - a) Batteries do not discharge to serve house loads. Photovoltaic power is used to charge batteries at the maximum rate supported by the batteries till the batteries reach reserve SoC limit.
      - b) Any photovoltaic power not consumed by the batteries is used to service loads. If photovoltaic power exceeds the loads, then the excess photovoltaic power may be exported to grid depending on the interconnection agreement.
      - c) If house loads exceed the photovoltaic power, utility power is imported to service excess loads.
  - B. At night:
    - i. When the battery SoC is greater than the reserve SoC limit -
      - a) Photovoltaic power is not available, and batteries discharge to service loads, based on the location of the consumption CTs, until SoC reaches the reserve SoC limit. Battery power is not exported to the grid.
      - b) If house loads exceed the battery discharge power, utility power is imported to service excess loads.
    - ii. When the battery SoC is less than or equal to the reserve SoC limit -
      - a) Batteries do not discharge, and utility power is imported to service all loads.
2. **Battery storage mode is “Savings”** with a Time of Use tariff and reserve State of Charge (SoC) limit for backup (set by customer or 0 if not set). When the system is connected to the utility grid:
  - A. During peak rates:
    - i. When the battery SoC is greater than the reserve SoC limit -
      - a) If house loads are less than battery discharge power, batteries discharge to service loads until SoC reaches the reserve SoC limit and photovoltaic power is exported to the grid to maximize economic benefit. Battery power is not exported to the grid.
      - b) If house loads exceed battery discharge power, battery discharge power and photovoltaic power is used to service loads, until SoC reaches the reserve SoC limit. Battery power is not exported to the grid. Any excess photovoltaic power is exported to the grid to maximize economic benefit.
      - c) If house loads exceed photovoltaic and battery discharge power, utility power is imported to service excess loads.
    - ii. When the battery SoC is less than or equal to the reserve SoC limit -
      - a) Batteries do not discharge to serve house loads. Photovoltaic power is used to charge batteries at the maximum rate supported by the batteries till the batteries reach reserve SoC limit.

- b) Any photovoltaic power not consumed by the batteries is used to service loads. If photovoltaic power exceeds the loads, then the excess photovoltaic power may be exported to grid depending on the interconnection agreement.
- c) If house loads exceed the photovoltaic power, utility power is imported to service excess loads.

B. During off-peak rates:

- i. Batteries will remain idle if at maximum i.e. 100% SoC. If battery SoC is less than 100%, photovoltaic power is used to charge batteries.
- ii. Excess photovoltaic power is used to service house loads.
- iii. Any surplus photovoltaic power is exported to grid depending on the interconnection agreement.
- iv. If house loads exceed photovoltaic power, utility power is imported to service all loads.

C. During off-peak rates with “Energy Independence after peak hours” enabled:

- i. Between 7am and 7pm:
  - a) Batteries will remain idle if at maximum i.e., 100% SoC. If battery SoC is less than 100%, photovoltaic power is used to charge batteries.
  - b) Excess photovoltaic power is used to service house loads.
  - c) Any surplus photovoltaic power is exported to grid depending on the interconnection agreement.
  - d) If house loads exceed photovoltaic power, utility power is imported to service all loads.
- i. At night:
  - a) If battery SoC is above reserve limit battery discharges till it reaches the reserve limit to serve loads.

3. **Battery storage mode is “Full Backup”**. When the system is connected to the utility grid:

- i. Batteries do not discharge to service loads.
- ii. If batteries have SoC below maximum SoC i.e., 100% (due to discharging to service loads when the utility grid was offline), photovoltaic power is used to charge batteries.
- iii. Excess photovoltaic power is used to service house loads. If photovoltaic power exceeds house loads then photovoltaic power is exported to the grid depending on interconnection agreement with utility.
- iv. If house loads exceed photovoltaic power, utility power is imported to service loads.

Description of these modes with screenshots of how homeowners can select the same is available in the [Enphase Storage system owner's guide](#). Note in all modes the battery will charge from the grid until the reserve charge limit to ensure that the desired amount of battery charge for backup is guaranteed to be available.

## Economic Use Cases

There are many economic goals that the IQ Battery supports. These include **reducing the utility bill** by charging during low tariff periods and saving charge to ensure that loads can be served through the battery(ies) during the peak tariff period. Power from PV can be exported to the grid especially during peak tariff periods.

The system also supports the special case of **power export limiting**, where the utility does not allow a homeowner to export power from the PV system to the grid. Examples are the Hawaii self-supply and NEM+ programs where no export is allowed, which is called **zero export**.

Optimizing energy storage capacity sizing for economic use cases is beyond the scope of this document. You can use simulation tools like NREL SAM (System Advisor Model) or Energy Tool base to assist with sizing in these use cases.

## Enphase Energy System Products

### IQ System Controller



The Enphase IQ System Controller consolidates interconnection equipment into a single enclosure and streamlines grid-independent capabilities of PV and storage distributed energy resources (DER) installations by providing a consistent, prewired solution for residential applications. IQ System Controller is a service entrance rated microgrid interconnect device that includes a neutral-forming transformer for single-phase backup operation and an Eaton BR bus bar assembly.

- Centered mounting brackets support single stud mounting
- Supports conduit entry from the lower sides, back, or bottom
- Up to 200A rating
- Includes neutral-forming transformer for single-phase backup operation
- Includes lugs and circuits for interconnection of line-side power, PV combiner, IQ battery system, backup load panel, and generator

Mechanical Data	IQ System Controller 1 EP200G101-M240US00	IQ System Controller 2 EP200G101-M240US01
<b>Dimensions (WxHxD):</b>	19.7 in x 36 in x 9.7 in (50 cm x 91.6 cm x 24.6 cm)	19.7 in x 36 in x 9.7 in (50 cm x 91.6 cm x 24.6 cm)
<b>Weight:</b>	38.5 kg (85 lbs)	39.4 kg (87 lbs)
<b>Ambient temperature range:</b>	-40° C to +50° C (-40° to 122° F)	-40° C to +50° C (-40° to 122° F)

Model Number	Description	Shipment Contents
<b>EP200G101-M240US00</b>	Enphase IQ System Controller 1 with 200A capacity, neutral-forming transformer providing microgrid interconnect device (MID) functionality. Supports M-Series, IQ6 and IQ7 Series Microinverters	One box of one unit
<b>EP200G101-M240US01</b>	Enphase IQ System Controller 2 smart switch with 200A capacity, neutral-forming transformer providing microgrid interconnect device (MID) functionality. Supports IQ8 as well as M-Series, IQ6 and IQ7 Series Microinverters	One box of one unit

**NOTE:** When IQ System Controller 2 is used with IQ6, IQ7 or M-Series Microinverters, the Enphase Energy System Shutdown switch (EP200G-NA-02-RSD) should not be used as a rapid shutdown initiator. The installers need to short the RSD auxiliary contacts of IQ System Controller 2 to make the system operational. Refer Installer memo - [Wiring the Rapid Shutdown Switch with IQ System Controller 2](#)

#### Main and Load Breakers

For wire sizes accepted by each terminal, see the IQ System Controller data sheet. IQ System Controller supports optional circuit breakers on both the input (line-side) and output (load side) of the MID relay. IQ System Controller can be configured with the following main circuit breakers to support different field requirements in compliance with NEC 705.12. Pay special attention to conductor ampacity rating when selecting the main breakers for the line-side and load side. Breakers are not included in the IQ System Controller and must be ordered separately.



Model Number	Description	Shipment Contents
<b>BRK-200A-2P-240V</b>	Main breaker, 2-pole, 200A, 25kAIC, CSR2200N for IQ System Controller	One box of one unit
<b>BRK-175A-2P-240V</b>	Main breaker, 2-pole, 175A, 25kAIC, CSR2175N for IQ System Controller	One box of one unit
<b>BRK-150A-2P-240V</b>	Main breaker, 2-pole, 150A, 25kAIC, CSR2150N for IQ System Controller	One box of one unit
<b>BRK-125A-2P-240V</b>	Main breaker, 2-pole, 125A, 25kAIC, CSR2125N for IQ System Controller	One box of one unit
<b>BRK-100A-2P-240V</b>	Main breaker, 2-pole, 100A, 25kAIC, CSR2100N for IQ System Controller	One box of one unit

#### ***Main Breaker and Load Breaker Installed in the IQ System Controller***

When installed on a new or existing electrical service as the service equipment disconnecting means and over current protection device, IQ System Controller typically needs a circuit breaker installed for a main breaker and another breaker for the load breaker. The main and load breakers should be of equivalent rating of the service for whole-home (main panel) backup configurations. For example, a 200 A service would typically have two 200 A rated Eaton CSR2200N (BRK-200A-2P-240V) installed.

When IQ System Controller is used as the service disconnect with a main bonding jumper installed, all equipment grounding conductors and neutrals on downstream feeders and panel boards must be separated.

#### ***Load Breaker Installed in the IQ System Controller***

If there is an existing service equipment such as an existing fusible disconnect on the line-side of IQ System Controller, a main breaker may not be required on the line-side input of IQ System Controller. However, a load breaker may still be required. Size the load breaker with the same rating as the system over current protection device for the whole-home (main panel) backup configuration. For example, if there is an existing 200 A meter disconnect combo feeding a main lug panel board, IQ System Controller would be installed with a 200 A rated Eaton CSR2200N (Enphase SKU: BRK-200A-2P-240V) as a load breaker inside IQ System Controller.

#### ***Main Breaker Installed in the IQ System Controller***

For the whole-home (main panel) backup configuration, if the service rating is less than 200 A, a load breaker may not be required. For example, a 100 A service has DER over current protection totaling less than 100A. In this case, IQ System Controller would be installed with a 100 A rated Eaton CSR2100N (BRK-100A-2P-240V) as a main breaker on the line-side of the main load panel. Ensure that the sum of load and DER breakers does not exceed 200 A rating of the busbar and IQ System Controller load conductors are rated appropriately.

#### ***IQ System Controller Without Main or Load Breakers Installed***

When IQ System Controller is installed on the load side of the service equipment disconnect means, main and load breakers may not need to be installed in the IQ System Controller. For example, an IQ System Controller is installed with total of 40 A of DER over current protection and that is back feeding a 200 A main breaker load center. In this case, it necessary to install main or load breakers in the IQ System Controller. Ensure that the sum of the load and DER over current protection is less than 200 A and that conductors are sized to comply with 2017 NEC 705.12(B)(2)(1).

#### ***IQ battery System, IQ Combiner or Generator Breakers***

When connecting the IQ Battery, IQ Combiner, or generator to the IQ System Controller, use one of the following circuit breakers depending on system requirements.

Model Number	Description	Shipment Contents
<b>BRK-80A-2P-240V</b>	Circuit breaker, 2-pole, 80A, 10kAIC, BR280 for IQ System Controller	One box of one unit
<b>BRK-60A-2P-240V</b>	Circuit breaker, 2-pole, 60A, 10kAIC, BR260 for IQ System Controller	One box of one unit
<b>BRK-40A-2P-240V</b>	Circuit breaker, 2-pole, 40A, 10kAIC, BR240B for IQ System Controller	One box of one unit
<b>BRK-30A-2P-240V</b>	Circuit breaker, 2-pole, 30A, 10kAIC, BR230B for IQ System Controller	One box of one unit
<b>BRK-20A-2P-240V-B</b>	Circuit breaker, 2-pole, 20A, 10kAIC, BR220B for IQ System Controller	One box of one unit

IQ Battery and generator breakers may require a BRHDK125 hold down kit in accordance with 408.36(D) as referenced in NEC 710.15(E). This hold down is not required for the IQ Combiner circuits with IQ 6 / IQ 7 Series Microinverters since these inverters are still interactive inverters and are permitted to omit the additional fastener 2017 NEC 705.12(B)(5). **However, IQ8 PV breakers require BRHDK125 hold down kit.** This aligns with the AC coupled multimode system diagram, Figure 1, in 2017 NEC 690.1(b), which shows both an interactive and multimode inverter. IQ Battery includes the multimode inverters forming an intentional local EPS island, and IQ 6 / IQ 7 Series Microinverters are utility-interactive inverters.

**Generator Interface**

The IQ System Controller includes a 60 A generator connection for qualified generators (reserved for future use). This document does not address this function, as the software functionality is not yet released. The IQ System Controller does not support integration with third-party automatic transfer switches (ATS) for the interconnection of generators. Third-party transfer switches and unqualified generators may be connected on the load side of the IQ System Controller in compliance with NEC 705.2 and require isolating the Enphase DER equipment from the electrical system powered by unqualified generators. Such third-party transfer switches and accompanying generators cannot operate at the same time as IQ batteries and charge them.

Note that M-Series, Microinverter-based Enphase Energy Systems, when used with a generator, require all PV to be wired via an external contactor. The contactor’s coil must be connected to Line 2 through the control terminals of the Envoy-S Metered. This is similar to how the Envoy-S Metered is used with M-Series Microinverters for Power Export Limiting in the case of customer self-supply. Details can be seen in the [Secondary Protection for Customer Self Supply Tech Brief](#).

**IQ Battery System**

The Enphase IQ Battery 3/3T and IQ Battery 10/10T units are reliable, smart, simple, and safe. They provide the lowest lifetime energy costs with backup for both new and retrofit solar customers. As an installer, you can quickly design the right system size to meet the needs of the homeowner.

Each IQ Battery consists of a mounting bracket, battery unit with disconnecting means, and cosmetic cover.



Model Number	Description	Shipment Contents
<b>ENCHARGE-3-1P-NA or ENCHARGE-3T-1P-NA</b>	Enphase IQ Battery 3/3T base kit with one 1.28 kVA, 3.36* kWh, single phase battery unit with four integrated IQ8X-BAT Microinverters and backup feature	One box of IQ Battery 3/3T base kit
	Enphase IQ Battery 3/3T cover kit with IQ Battery 3/3T cover, mounting bracket, and screws	One box of IQ Battery 3/3T cover kit
<b>ENCHARGE-10-1P-NA or ENCHARGE-10T-1P-NA</b>	Enphase IQ Battery 10/10T base kit with three 1.28 kVA, 3.36 kWh, single phase battery units with 12 integrated IQ8X-BAT Microinverters and backup feature	Three boxes of IQ Battery 3/3T base kits
	Enphase IQ Battery 10/10T cover kit with IQ Battery 10/10T cover, mounting bracket, screws, two raceway joiners, set of wires for daisy chaining the three battery units	One box of IQ Battery 10/10T cover kit

**\*Note:** When used with M-Series Microinverters, the IQ Battery 3/3T has a usable capacity of 3.26kWh. The IQ Battery 10/10T with 3x IQ Battery 3/3T units, therefore, has a usable capacity of 9.78kWh.

Mechanical Data	IQ Battery 3	IQ Battery 3T	IQ Battery 10	IQ Battery 10T
<b>Dimensions (WxHxD)</b>	14.45 in x 26.14 in x 12.56 in (36.7 cm x 66.4 cm x 31.9 cm)	16.77 in x 30.19 in x 7.2 in (42.6 cm x 76.7 cm x 18.3 cm)	42.13 in x 26.14 in x 12.56 in (107.0 cm x 66.4 cm x 31.9 cm)	50.3 in x 30.19 in x 7.2 in (127.8 cm x 76.7 cm x 18.3 cm)
<b>Weight</b>	One each 44.2 kg (97.4 lbs) base unit plus 8.4 kg (18.6 lbs) cover and mounting bracket; total 52.6 kg (116 lbs)	One each 40.5 kg (89.3 lbs) base unit plus 8.4 kg (18.6 lbs) cover and mounting bracket; total 48.8 kg (107.6 lbs)	Three each 44.2 kg (97.4 lbs) base units plus 24.4 kg (53.8 lbs) cover and mounting bracket; total 156.9 kg (346 lbs)	Three each 40.5 kg (89.3 lbs) base units plus 24.4 kg (53.8 lbs) cover and mounting bracket; total 143.6 kg (316.5 lbs)
<b>Enclosure</b>	Outdoor - NEMA 3R			
<b>Ambient operating temperature range</b>	-15° C to 55° C (5° F to 131° F) non-condensing			
<b>Optimum operating temperature range</b>	0° C to 30° C (32° F to 86° F)			
<b>Altitude</b>	Up to 2500 meters (8200 feet)			
<b>Chemistry</b>	Lithium iron phosphate LiFePO <sub>4</sub>			

## IQ Combiner or IQ Gateway standalone for IQ-Series Microinverters



An Enphase solar system with IQ Series Microinverters needs an IQ Combiner with an IQ Gateway or a discrete IQ Gateway. An IQ Combiner consolidates interconnection equipment for the system and houses the following:

- Multiple PV branch circuits to ensure a streamlined installation and interconnection
- IQ Gateway – This collects production and performance data from the IQ Batteries and from the IQ Series Microinverters. It then transmits the data to Enphase Cloud through ethernet, Wi-Fi, and cellular.

A standalone IQ Gateway can also be used if needed.

The IQ Combiners listed below include the consumption CTs. However, if using an existing IQ Gateway or IQ Combiner on a site that does not have the consumption CTs, a pair of consumption CTs (CT-200-SPLIT) must be procured and installed.

The IQ Combiner 3C-ES and IQ Combiner 4C includes a cellular modem, so an Enphase

Communications Kit without a cellular modem (i.e., COMMS-KIT-01) can be used with this combiner for Enphase Energy System installations

Model Number	Description	Shipment Contents
<b>IQ Combiner 3-ES (X-IQ-AM1-240-3-ES)</b>	AC combiner with IQ Gateway PCB, 80A, 240V split-phase Includes a pair of consumption CT's (CT-200-SPLIT - Split-core current transformer, accuracy +/- 2.5%) Also includes a solar shield (XA-SOLARSHIELD-ES) that matches with the Enphase Energy System aesthetics and deflects heat	1 Box of 1 Unit
<b>IQ Combiner 3C-ES (X-IQ-AM1-240-3C-ES)</b>	AC combiner with IQ Gateway CR PCBA, 80A, 240V split-phase, with integrated CELLMODEM-M1, silver solar shield and includes 2x CT-200-SPLIT	1 Box of 1 Unit
<b>IQ Combiner 4 (X-IQ-AM1-240-4)</b>	AC Combiner Box with IQ Gateway PCB, 80A, 240V split-phase Includes a pair of consumption CT's (CT-200-SPLIT - Split-core current transformer, accuracy +/- 2.5%). These support BRHDK125 hold down kit required to comply with NEC 705.12(B)(5) for IQ8 Series microinverter installations in multimode.	1 Box of 1 Unit
<b>IQ Combiner 4C (X-IQ-AM1-240-4C)</b>	AC Combiner Box with IQ Gateway CR PCBA, 80A, 240V split-phase, with integrated CELLMODEM-M1-06-SP-05, silver solar shield and includes 2x CT-200-SPLIT. These support BRHDK125 hold down kit required to comply with NEC 705.12(B)(5) for IQ8 Series microinverter installations in multimode.	1 Box of 1 Unit

## Envoy-S Metered For M-Series Microinverters

The Enphase Envoy-S Metered communications gateway delivers solar production and energy consumption data to Enphase Cloud monitoring and analysis software for comprehensive, remote maintenance and management of the Enphase Microinverter System.

The Envoy-S Metered is packaged with one production current transformer to enable accurate production monitoring with an accuracy of +/-2.5%. For consumption monitoring, two consumption current transformers (CT-200-SPLIT) must be purchased by the installer.



Model Number	Description	Shipment Contents
<b>Envoy-S Metered (ENV-S-AM1-120)</b>	Enphase Envoy-S, Metered. Single phase, Revenue grade accuracy (ANSI C12.20 +/- 0.5%) with Production CT	1 Box of 12 Units

## Enphase Communications Kit



The Enphase communications kit includes the COMMS-KIT-01 and the CELLMODEM-M1. The COMMS-KIT-01 is plugged into a USB port on IQ Gateway or Envoy-S Metered. It enables direct communication between the IQ Battery system, the IQ System Controller, and the Envoy-S Metered using 2.4 GHz frequency. The CELLMODEM-M1 is an LTE CAT-M1 cellular modem with a five-year AT&T data plan for Enphase Energy Systems. It acts as a backup for a broadband Wi-Fi or Ethernet connection and ensures connectivity to the Enphase Cloud.

If the site already has a cellular modem the COMMS-KIT-01 is also available independently.

Model Number	Description	Shipment Contents
<b>COMMS-CELLMODEM-M1</b>	COMMS-KIT-01: USB adapter kit for Gateway. Enables wireless communication with IQ Battery and IQ System Controller CELLMODEM-M1: LTE CAT M1 cellular modem. When purchased as part of COMMS-KIT-M1 it includes a five-year data plan for Enphase Energy Systems with up to 60 Microinverters, 12 IQ Battery 3/3T batteries and one IQ System Controller. Works in US, Puerto Rico, US Virgin Islands, Canada, and Mexico.	1 Box of 1 Unit
<b>COMMS-CELLMODEM-M1-06</b>	COMMS-KIT-01: USB adapter kit for Gateway. Enables wireless communication with IQ Battery and IQ System Controller CELLMODEM-M1-06-SP-05: LTE CAT M1 cellular modem. When purchased as part of COMMS-KIT-M1 it includes a five-year data plan for Enphase Energy Systems with up to 60 Microinverters, 12 IQ Battery 3/3T batteries and one IQ System Controller. Works in US, Puerto Rico, US Virgin Islands, Canada.	1 Box of 1 Unit
<b>COMMS-KIT-01</b>	USB adapter kit for IQ Gateway. Enables wireless communication with IQ Battery and IQ System Controller	1 Box of 1 Unit

## M-Series Microinverters Replacements

Enphase provides M-Series RMA SKUs based in the IQ7 hardware platform to replace M-Series Microinverters that have failed or to expand an existing M-Series site. Note that you cannot mix IQ6- and IQ7-Series Microinverters SKUs with M-Series Microinverters at a site. You can only use the SKUs provided below with M-Series Microinverters at a site.

SKU	Description
<b>M215240-IQ7-S22-US</b>	M215 240VAC Microinverter based on 7th generation IQ Series; MC locking connector, for existing M215 system expansion or replacing out-of-warranty M215 Microinverters
<b>M215240-IQ7-S25-US</b>	M215 240VAC Microinverter based on 7th generation IQ Series; Amphenol H4 connector, for existing M215 system expansion or replacing out-of-warranty M215 Microinverters
<b>M250240-IQ7-S22-US</b>	M250 240VAC Microinverter based on 7th generation IQ Series; MC locking connector, for existing M250 system expansion or replacing out-of-warranty M250 Microinverters
<b>M250240-IQ7-S25-US</b>	M250 240VAC Microinverter based on 7th generation IQ Series; Amphenol H4 connector, for existing M250 system expansion or replacing out-of-warranty M250 Microinverters

When using the M-Series RMA SKUs you must use the Engage Cable and associated accessories. The following table lists these.

SKU	Description
<b>ET10-240-BULK</b>	Voltage type and conductor count: 240 VAC, four conductors Connector count: 240 Connector spacing: 1.025m (40") PV module orientation: Portrait
<b>ET17-240-BULK</b>	Voltage type and conductor count: 240 VAC, four conductors Connector count: 240 Connector spacing: 1.7m (67") PV module orientation: Landscape
<b>ET-SPLK-05</b>	Pack of five Engage couplers. Used to connect two Engage Cables
<b>ET-CLIP-100</b>	Pack of 100 steel clips to fasten the Engage Cable to racking
<b>ET-INSTL</b>	Includes: <ul style="list-style-type: none"> <li>• Pack of four ET-TERM terminators for Engage Cables</li> <li>• One ET-DISC disconnect tool used to disconnect M-Series Microinverters from Engage Cable</li> <li>• Pak of five ET-SEAL sealing caps for unused connectors on the Engage Cable</li> </ul>

Note that the cables and accessories listed above are available only through the Enphase store.

## IQ Load Controller



The Enphase IQ Load Controller (EP-NA-LK02-040), when used in conjunction with the IQ System Controller, enables control of up to two dedicated loads or shedding of up to two solar circuits when operating in an off-grid mode with the Enphase Energy System.

The IQ Load Controller is an outdoor-rated, NRTL-certified NEMA type 4X enclosure with a DIN rail that contains two contactors, a power supply, wire for control connections and other wiring accessories. Use the IQ Load Controller for controlling dedicated, heavy, split-phase loads or for solar circuit shedding when solar power exceeds allowed solar to storage ratios. Heavy loads are those that exceed the power or surge capabilities of your energy management system.

The IQ Load Controller supports control of 2 split-phase loads i.e., loads wired L1-L2 and running at 240V nominal AC voltage or 4 loads running at 120V nominal AC voltage.

## Enphase Energy System Shutdown switch



EP200G-NA-02-RSD is the Enphase Energy System Shutdown switch which also provide Rapid shutdown capability for System Controller 2 as required by NEC standard. This component is certified by UL1741 PVRSE requirement. The component also contains necessary labels which are required as per the NEC to identify the Rapid Shut down switch.

**WARNING:** Install the Enphase System shutdown switch before powering on IQ System Controller 2. If the live wire to the Enphase System shutdown switch from IQ System Controller 2 touches metal surfaces or ground or neutral conductors, the resulting current surge will damage the IQ System Controller components. The IQ System Controller 2 will be damaged and needs to be replaced.

**NOTE:** When IQ System Controller 2 is used with IQ6, IQ7 or M-Series Microinverters, the Enphase Energy System Shutdown switch (EP200G-NA-02-RSD) should not be used as a rapid shutdown initiator. The installers need to short the RSD auxiliary contacts of IQ System Controller 2 to make the system operational. Refer Installer memo - [Wiring the Rapid Shutdown Switch with IQ System Controller 2](#)

## Key Planning Considerations

To ensure optimal wireless and power line communication between Enphase Energy System products and cleanest installation, consider the following:

1. Identify a suitable environment for temperature, enclosure ratings, and wall area, for secure mounting of the weight of the required IQ Battery and IQ System Controller units.
2. For wireless communications between the IQ Gateway, IQ Battery, and IQ System Controller, the best practice is to have a line-of-sight between them.
3. For power line communications, the best practice is to have the IQ Gateway located closest to PV branch circuit collection, for example in an IQ Combiner or near/in an off-the shelf PV combiner.
4. Determine the electrical interconnection points and required breakers for IQ System Controller, IQ Battery circuit, PV combiner branch circuits, and the IQ Gateway.
5. Ensure that the IQ Gateway with both production and consumption CTs can be installed at the site.
6. In case of an IQ8 based system, the IQ Gateway must now be connected directly to IQ System Controller or another location on the load side of IQ System Controller.
7. Size conductors properly for ampacity and voltage regulation given conductor lengths.
8. Identify the location the PV system disconnect for rapid shutdown initiation and labeling.
9. Always ensure that the IQ Gateway is connected to the internet via a Wi-Fi or ethernet connection. Note that the cellular modem is provided as a **backup** connection for internet connectivity.

The following sections detail each of these considerations:

## Physical Installation Considerations

1. For all products, always follow the instructions in the Enphase installation manuals.
2. Following local standards, choose a well-ventilated location where the ambient temperature and humidity are within equipment specifications, preferably out of direct sunlight. The IQ Battery does not require additional ventilation as Lithium Iron Phosphate (LFP) chemistry used in battery cells does not off-gas.
3. Ensure that the mounting location can sustain the weight of the equipment, mounting equipment, and accessory equipment.
4. Plan the mounting location of IQ Battery:
  - Minimum distance between IQ Battery 3/3T units shall be 1 inch.
  - Minimum distance between IQ Battery 10 and IQ Battery 3/3T or another IQ Battery 10 shall be 6 inches.
  - Minimum distance between IQ Battery 10T and IQ Battery 3/3T or another IQ Battery 10 shall be 3feet. For an IQ Battery 10T to be exempt from the 3 ft spacing requirements, it must be installed using second-generation wall mount parts B10T-AWM-1280-O and B10T-MWM-1280-O.
  - Indoors: at least 15 cm (6 inches) off the ground and 15 cm (6 inches) from the ceiling.
  - Outdoors: at least 15 cm (6 inches) off the ground.
  - If mounted in the path of a motor vehicle, we recommend a 91cm (36 inches) minimum mounting height
5. Plan the mounting location of IQ System Controller:
  - Indoors: at least 15 cm (6 inches) off the ground and 15 cm (6 inches) from the ceiling.
  - Outdoors: at least 91cm (3 feet) off the ground.
  - Indoors: at least 15 cm (6 inches) off the ground and 15 cm (6 inches) from the ceiling.
  - Outdoors: at least 15 cm (6 inches) off the ground.
  - If mounted in the path of a motor vehicle, we recommend a 91cm (36 inches) minimum mounting height
6. Ensure that there are no pipes or electrical wires where you plan to drill.
7. Plan to maintain at least 90 cm (three feet) of clearance in front of Enphase Energy System equipment for working space.
8. Consider the dimensions of the Enphase equipment, easy access, height, and length of system conductors and conduit requirements between products and the system interconnection location when selecting the location of equipment. The recommended minimum spacing is shown in the following figure and table. Conduit options are as follows:
  - IQ System Controller – Main supply conductors may enter IQ System Controller from the bottom or from the bottom-left side. Backup load conductors may enter IQ System Controller from the bottom or bottom-right side. IQ Battery and PV combiner and generator conductors may enter from the bottom, bottom-left or bottom-right sides.
  - IQ Battery– Conduit may enter from the top right or top left of the IQ Battery at the pre-defined knockout locations.
  - IQ Combiner Series – Conduit may enter at the bottom and sides or rear entry below the busbar assembly.
9. Do not block vents.

IQ Battery 3 and IQ Battery 10 Bracket Data

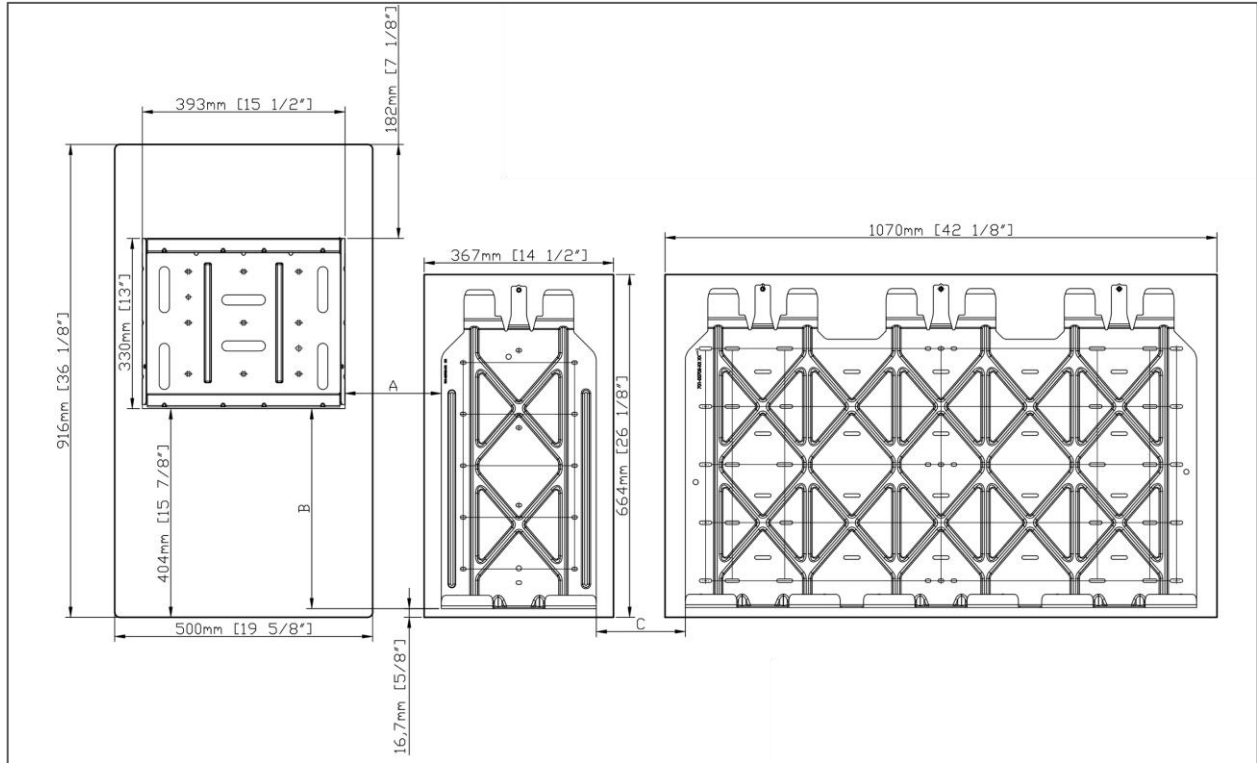


Figure 19: Bracket spacing for IQ Battery 3 or IQ Battery 10

Table 3: Bracket spacing for IQ Battery 3 or IQ Battery 10

Dimension	Description	Recommended Minimum
<b>A</b>	IQ System Controller and IQ Battery horizontal bracket spacing	152 mm (6")
<b>B - Bottom aligned</b>	IQ System Controller wall mount bracket bottom to IQ Battery wall mount bracket bottom	387 mm (15 1/4")
<b>B - Center aligned</b>	IQ System Controller wall mount bracket bottom to IQ Battery wall mount bracket bottom	261 mm (10 5/16")
<b>B - Top aligned</b>	IQ System Controller wall mount bracket bottom to IQ Battery wall mount bracket bottom	135 mm (5 5/16")
<b>C</b>	IQ Battery wall horizontal bracket spacing	152 mm (6")

**IQ Battery 3T and IQ Battery 10T Bracket Data**

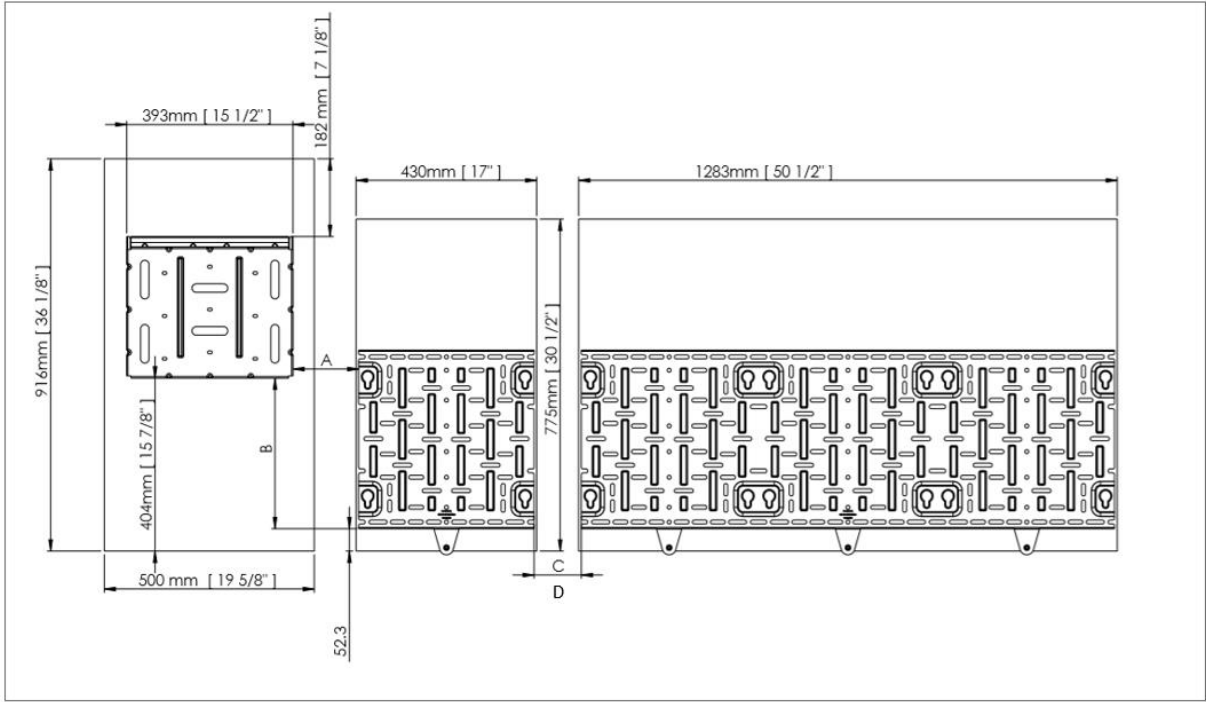


Figure 20: Bracket spacing for IQ Battery 3T or IQ Battery 10T

Table 4: Bracket spacing for IQ Battery 3T or IQ Battery 10T

Dimension	Description	Recommended Minimum
<b>A</b>	IQ System Controller and IQ battery horizontal bracket spacing	152 mm (6")
<b>B - Bottom aligned</b>	IQ System Controller wall mount bracket bottom to IQ Battery wall mount bracket bottom	352 mm (13 14/16")
<b>B - Center aligned</b>	IQ System Controller wall mount bracket bottom to IQ Battery wall mount bracket bottom	281 mm (11 1/16")
<b>B - Top aligned</b>	IQ System Controller wall mount bracket bottom to IQ Battery wall mount bracket bottom	211 mm (8 5/16")
<b>C</b>	IQ Battery wall horizontal bracket spacing between 3T and 10T	914 mm (36")*
<b>D</b>	IQ Battery wall horizontal bracket spacing between adjacent 10T units	914 mm (36")*

\* For an IQ Battery 10T to be exempt from the 3 ft spacing requirements, it must be installed using second-generation wall mount parts B10T-AWM-1280-O and B10T-MWM-1280-O.

**Temperature Considerations**

Unlike other battery chemistries, an IQ Battery does not require ventilation for off-gassing and does not require active cooling. IQ Batteries perform best when not subjected to extreme hot or cold temperatures and remain within the optimal temperature range of 0° C to 30° C (32° F to 86° F). Temperature may be affected by location, exposure, and ventilation. Consider factors that may result in undesirable temperature swings outside the optimal temperature range. For example, in enclosed unconditioned spaces such as garages or utility closets, the temperature may be higher than the outdoor ambient.



## Electrical Installation Requirements

For full installation instructions, always refer to the Enphase Installation Manuals, including the following documents:

- *Quick Install Guide – Install the Enphase IQ Battery*
- *Quick Install Guide – Install the Enphase IQ System Controller*

### Current Transformers (CTs)

It is critical that installers correctly configure the IQ Gateway, with the combined solar PV output passing through the production CT. The production CT monitors **only** the PV output circuit(s) and must not have IQ battery circuit(s) installed on it. Install the IQ Battery circuit(s) on the load side of the production CTs on the correct terminals in IQ System Controller.

Installers may extend the consumption CT leads, but not the production CT leads. Therefore, it is best to locate the IQ Gateway close to the Microinverter output circuits and then extend consumption CT wires if necessary. Refer to the [IQ Gateway Installation and Operations Manual](#) or the [Enphase Envoy-S Installation and Operation Manual](#) when installing and/or extending consumption CTs. Refer also to the [Tech Brief: Four Guidelines for Successful Current Transformer \(CT\) Installation](#).

### IQ System Controller Connections

The IQ System Controller can accept a maximum of 64 A of continuous output current (maximum 80A breaker) of a combined PV subpanel or IQ Combiner (labeled AC Combiner). The busbar in the IQ System Controller can accept a maximum of an 80 A breaker for the IQ Combiner over current protection.

The IQ System Controller can accept a maximum of 64 A of rated output current (maximum 80A breaker) of combined IQ Battery circuits. The busbar in the IQ System Controller can accept a maximum of an 80 A breaker for the IQ Battery circuit over current protection. This equates to a maximum of twelve IQ Battery 3/3T storage units **or** four IQ Battery 10/10T units per IQ System Controller. Up to six IQ Battery 3/3T storage units **or** two IQ Battery 10/10T units, equal to 32 A of rated output current, can be connected in Series prior to landing on the IQ Battery terminal in the IQ System Controller and protected by a no higher than a 40 A over current protection breaker. If more than six IQ battery 3/3T (or more than two IQ Battery 10/10T) are to be connected to IQ System Controller, an external subpanel must be used to combine each circuit of up to 32 A of rated output current IQ Battery circuits. You should size conductors appropriately for the overcurrent protection selected for the application.

## Voltage Regulation Considerations

When the IQ Battery is charging, it acts like a load, and the voltage decreases at the terminals of the battery based upon Ohm's law and wire resistance. When the IQ Battery is discharging to feed loads, it behaves like a source, and the voltage increases at the terminals of the battery.

The voltage rise to voltage drop delta divided by the nominal voltage is roughly equivalent to voltage regulation. Since the peak charge and discharge values for IQ Battery are the same value, voltage rise, and voltage drop will be the same value.

Voltage regulation in Enphase Energy System is calculated as

$$\text{Percent VR} = \frac{2 \cdot |V_d|}{V_{nom}}$$

where:

$V_d$  is the voltage change from 0 to max current out of IQ Battery, and  
 $V_{nom}$  is the nominal RMS voltage.

Ensure that the IQ Battery conductors are sized correctly for the number of units on the circuit and voltage regulation does not exceed 1% between the first IQ Battery and IQ System Controller.

## Rapid Shutdown Considerations

2017 NEC 690.12 requires a rapid shutdown for PV Systems on buildings by an initiation device in a readily accessible location. In grid interactive systems this is often the service disconnecting means or PV system disconnect. Rapid shutdown requirements do not apply to optional standby systems such as energy storage and as seen in Figure 1, the PV system disconnect can still initiate rapid shutdown.

The rapid shutdown initiation device can be either:

- the PV system breaker in IQ System Controller,
- an additional disconnect such as a fusible disconnect between IQ System Controller and the IQ Combiner, or

- the circuit breakers in the IQ Combiner since these breakers are less than six and grouped.

The rapid shutdown initiator must be labeled in accordance with 2017 NEC 690.56.

Enphase IQ 6 / 7 Series and M215 and M250 Microinverters comply with the rapid shutdown requirements per the UL certifications.

For an Enphase Energy system with IQ8 Series Microinverters in grid agnostic mode, the **Enphase System shutdown switch (EP200G-NA-02-RSD)** must be installed with IQ System Controller 2, to act as the only rapid shutdown device of the system. Refer to *QIG of Enphase System shutdown switch* for instructions on wiring the rapid shutdown device.

**SAFETY:** IQ System Controller 2 and Enphase System shutdown switch can enforce rapid shutdown **ONLY** on PV Microinverters connected the AC Combiner port in IQ System Controller 2.

## System override using Enphase System shutdown switch for backup systems with IQ8-Series Microinverters

### Steps for Initiating System Shutdown (Tied to Grid)

1. Put the remote rapid shutdown switch to **OFF** state.
2. **OPEN** the breakers for PV, IQ Battery, generator, and NFT in IQ System Controller R2.
3. Open the cover of the manual override switch and turn the manual override toggle to the **LEFT** to manually **CLOSE** the MID relay.
4. The IQ System Controller system is now in manual override mode and grid tied.

### Steps for Exiting System Shutdown:

1. Put the remote rapid shutdown switch to **ON** state.
2. Turn the manual override toggle to the **RIGHT** to manually **OPEN** the MID relay.
3. **CLOSE** the PV, IQ Battery, generator, and NFT breakers in IQ System Controller.

The IQ System Controller system is now no longer in manual override mode and is fully functional.

**WARNING:** Install the Enphase System shutdown switch before powering on IQ System Controller 2. If the live wire to the Enphase System shutdown switch from IQ System Controller 2 touches metal surfaces or ground or neutral conductors, the resulting current surge will damage the IQ System Controller components. The IQ System Controller 2 will be damaged and needs to be replaced.

## Glossary

**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 this standard is part of a DER. (IEEE 1547-2018)

**intentional island:** An intentionally planned electrical island that is capable of being energized independently of the area electric power system (EPS). IQ System Controller and IQ Battery comprise a microgrid system that forms an intentional island totally within the bounds of the Local EPS. (2017 NEC/IEEE 1547-2018/IEEE 1547.1-2011)

**main load panel:** Also referred to as the main load center or main panelboard, this is the unit where the majority of load circuits for the premises have over current protection.

**microgrid interconnect device (MID):** A device that allows a microgrid system to separate from and reconnect to a primary power source. (NEC 705.2)

**microgrid system:** A premises wiring system that has generation, energy storage, and load(s), or any combination thereof, that includes the ability to disconnect from and parallel with the primary source. (NEC 705.2)

**multimode inverter:** Equipment having the capabilities of both the interactive inverter and the stand-alone inverter. (NEC 705.2)

**service:** The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served. (NEC CMP-4)

**service equipment:** The necessary equipment, usually consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the load end of service conductors to a building or other structure, or an otherwise designated area and intended to constitute the main control and cutoff of the supply. (NEC CMP-4)

**voltage regulation:** The measure of change of voltage magnitude in a component such as a feeder. Poor voltage regulation may result in unwanted behavior such as dimming lights or flicker.

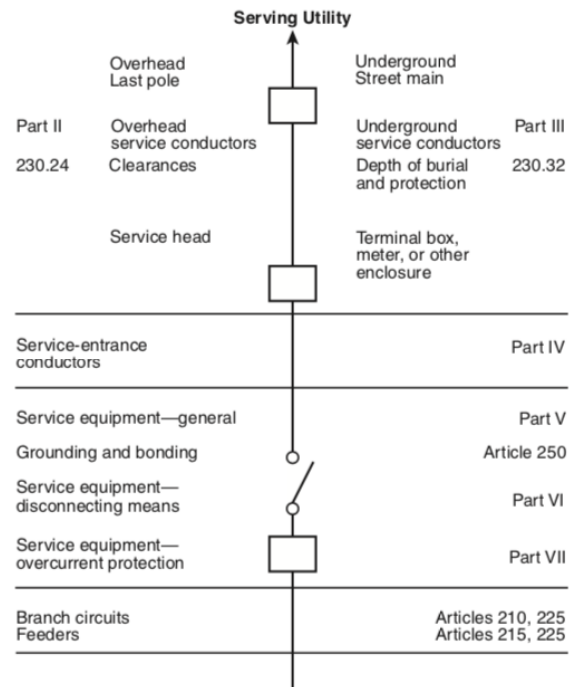
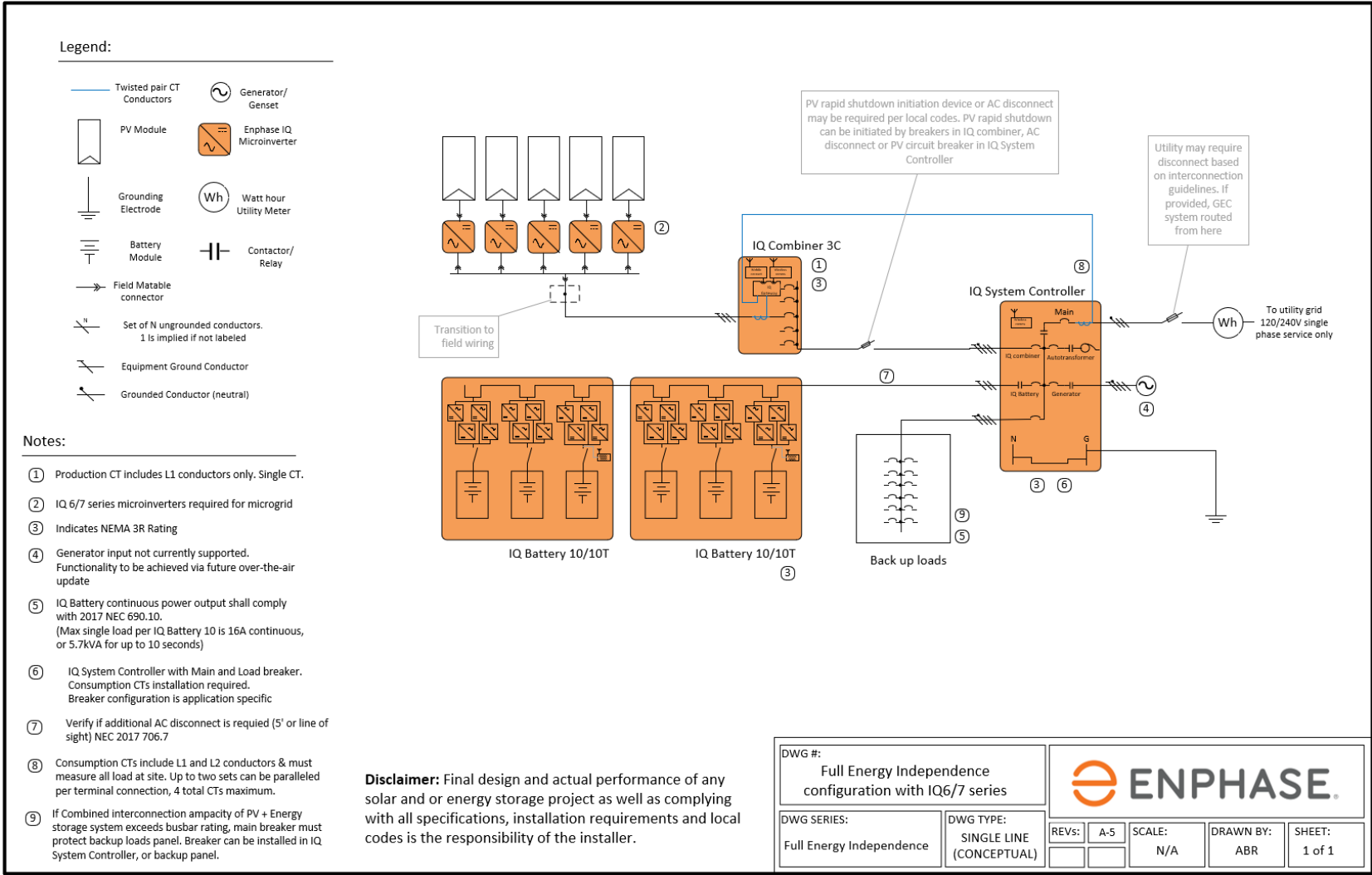


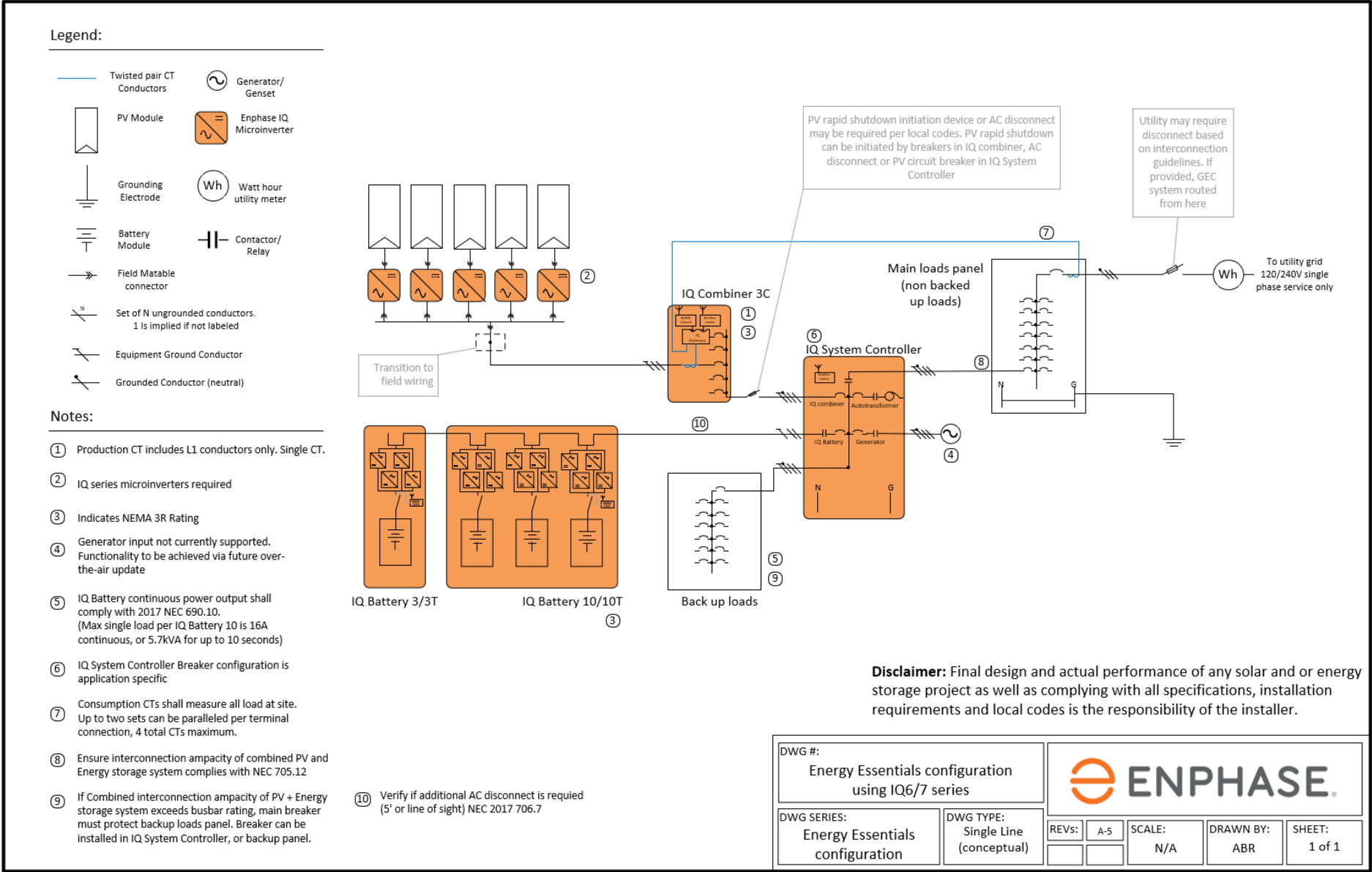
Figure 12: NEC 2017 Figure 203.1 Services © NFPA

# Appendix A – Single line diagrams for IQ6/7-Series systems

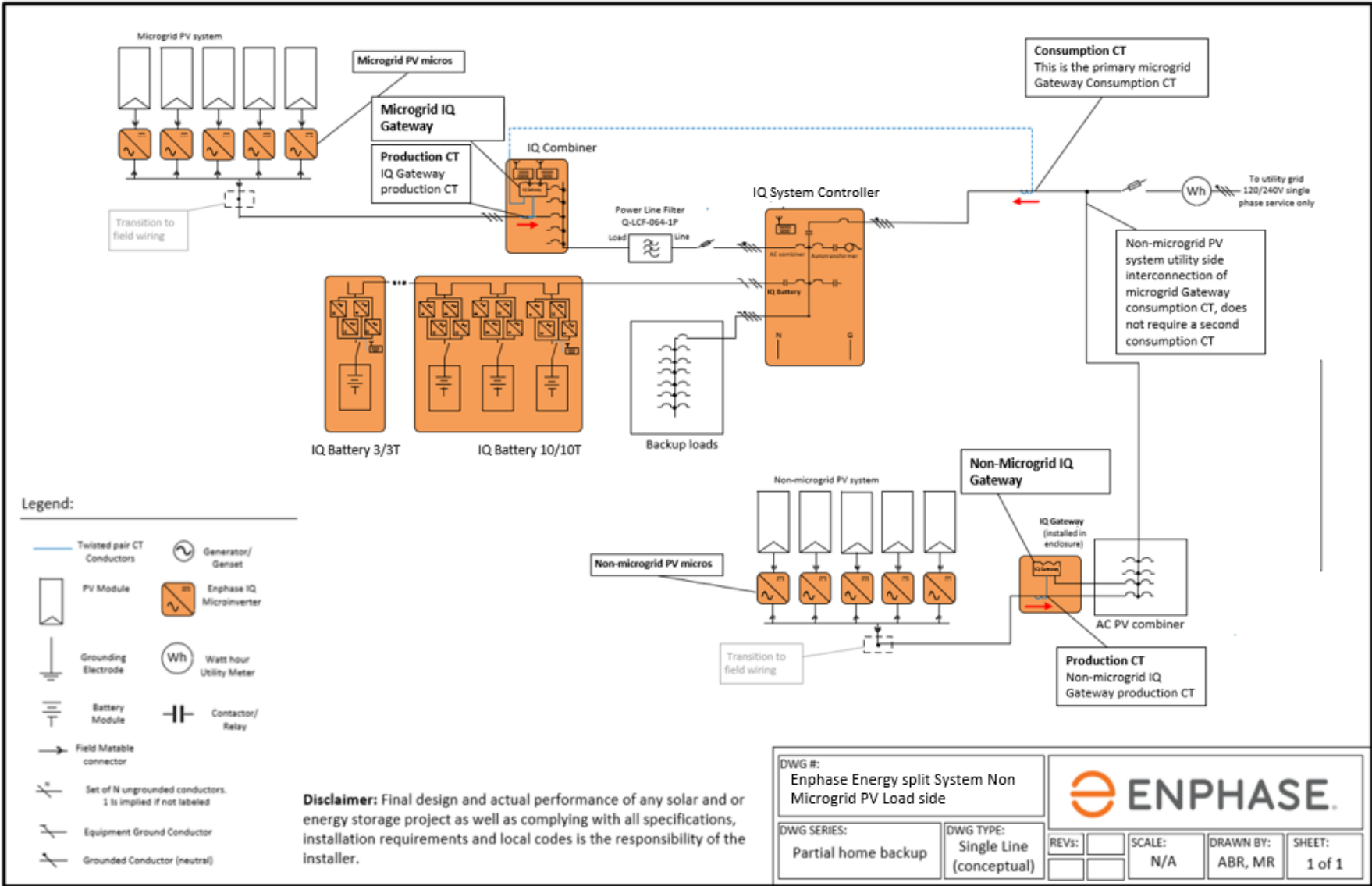
## Full Energy Independence configuration



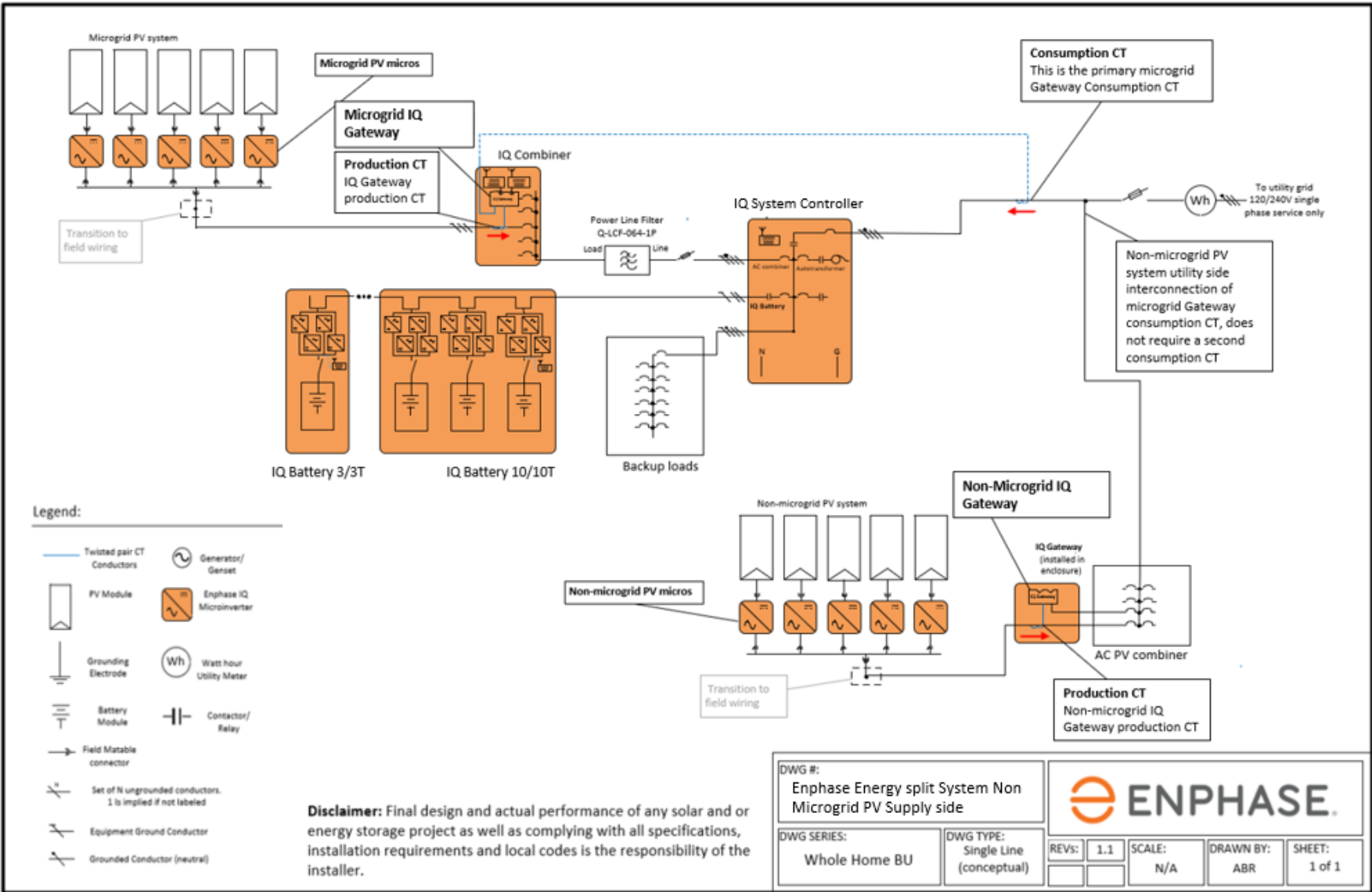
Energy Essentials configuration



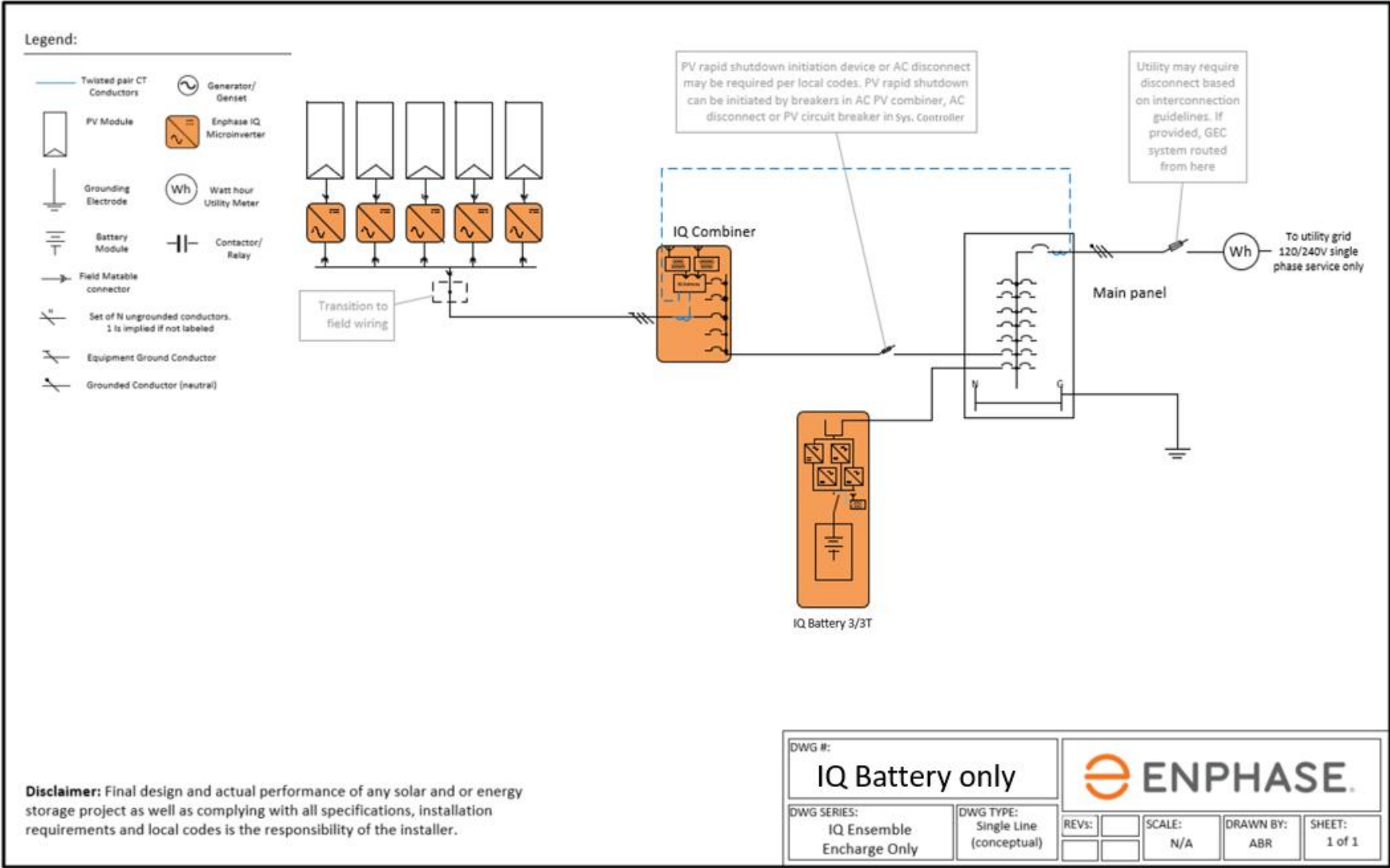
Energy Essentials configuration, split system with additional consumption CTs



Energy Essentials configuration, split system with NO additional consumption CTs



### IQ battery only configuration

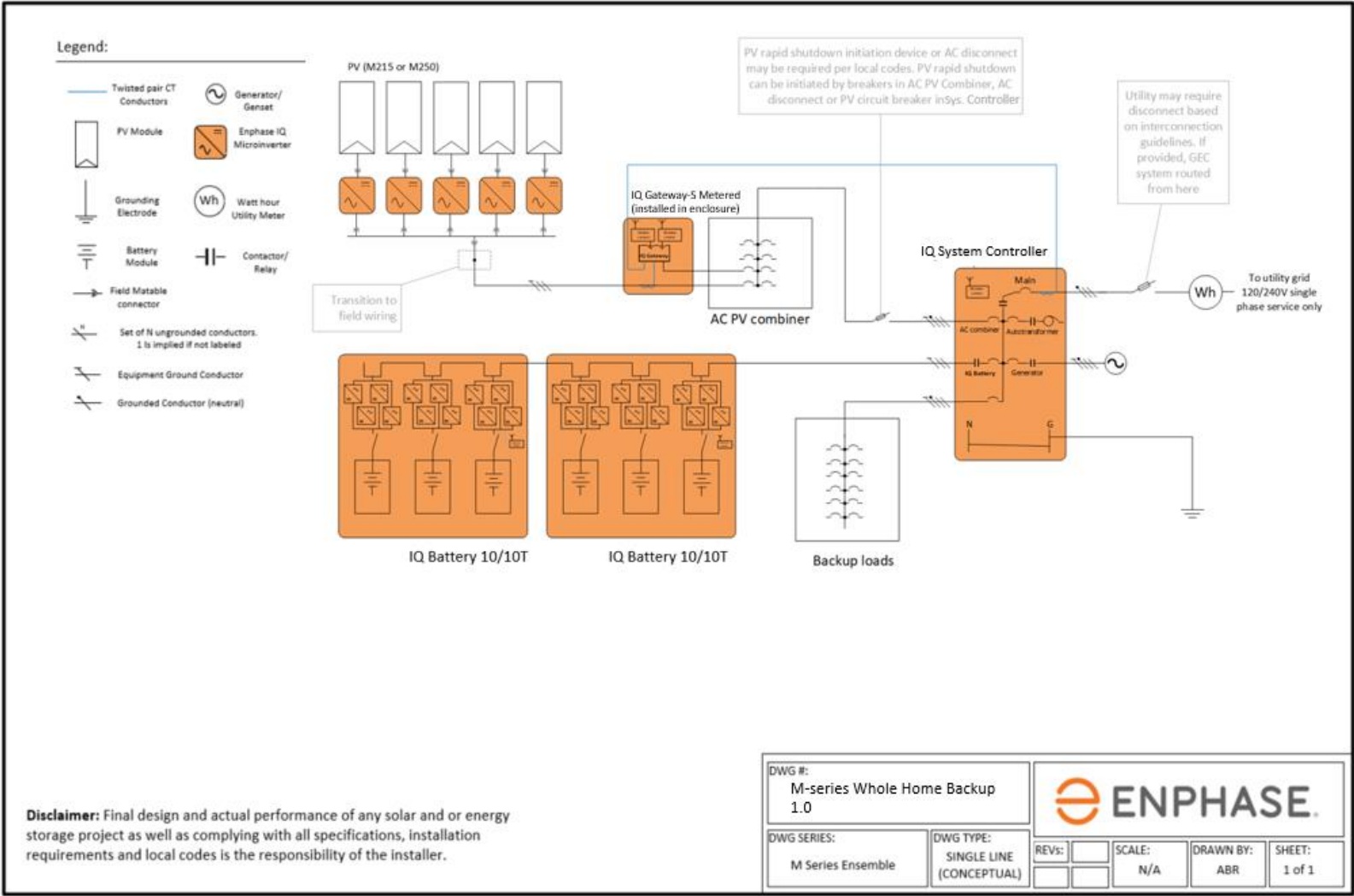




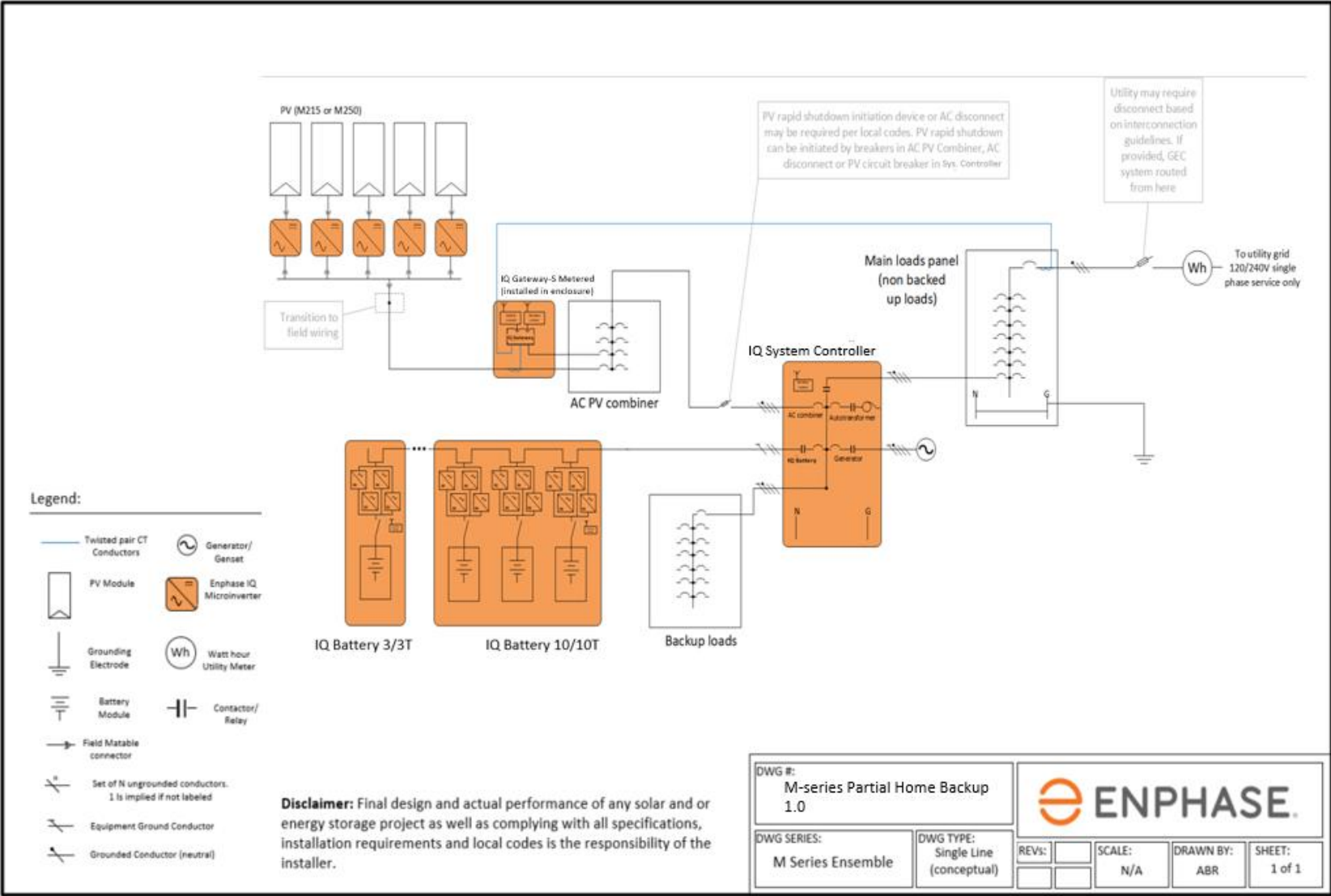
# Appendix B – Single line diagrams for M-Series systems

(Download [here](#))

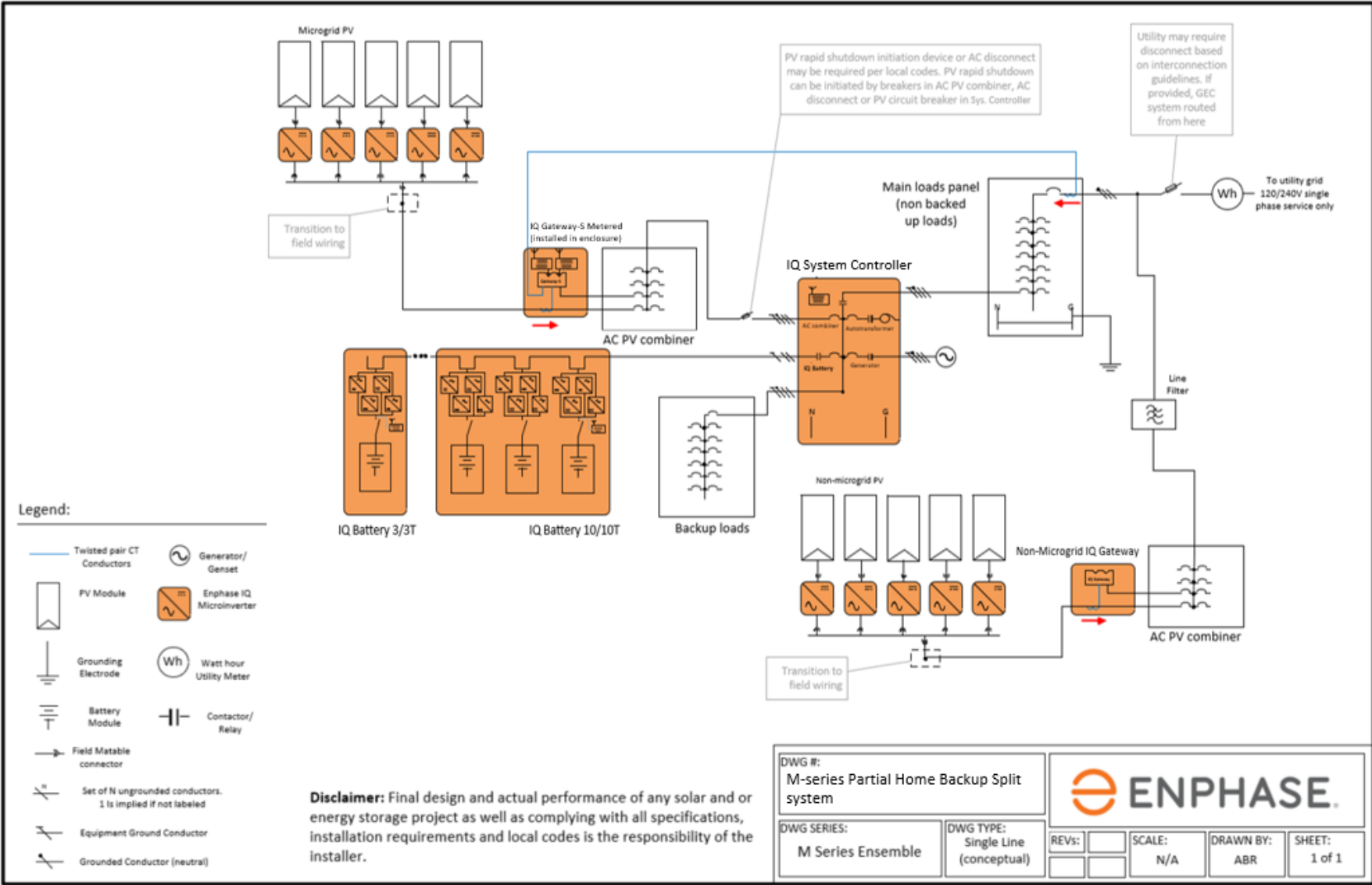
## Full Energy Independence configuration



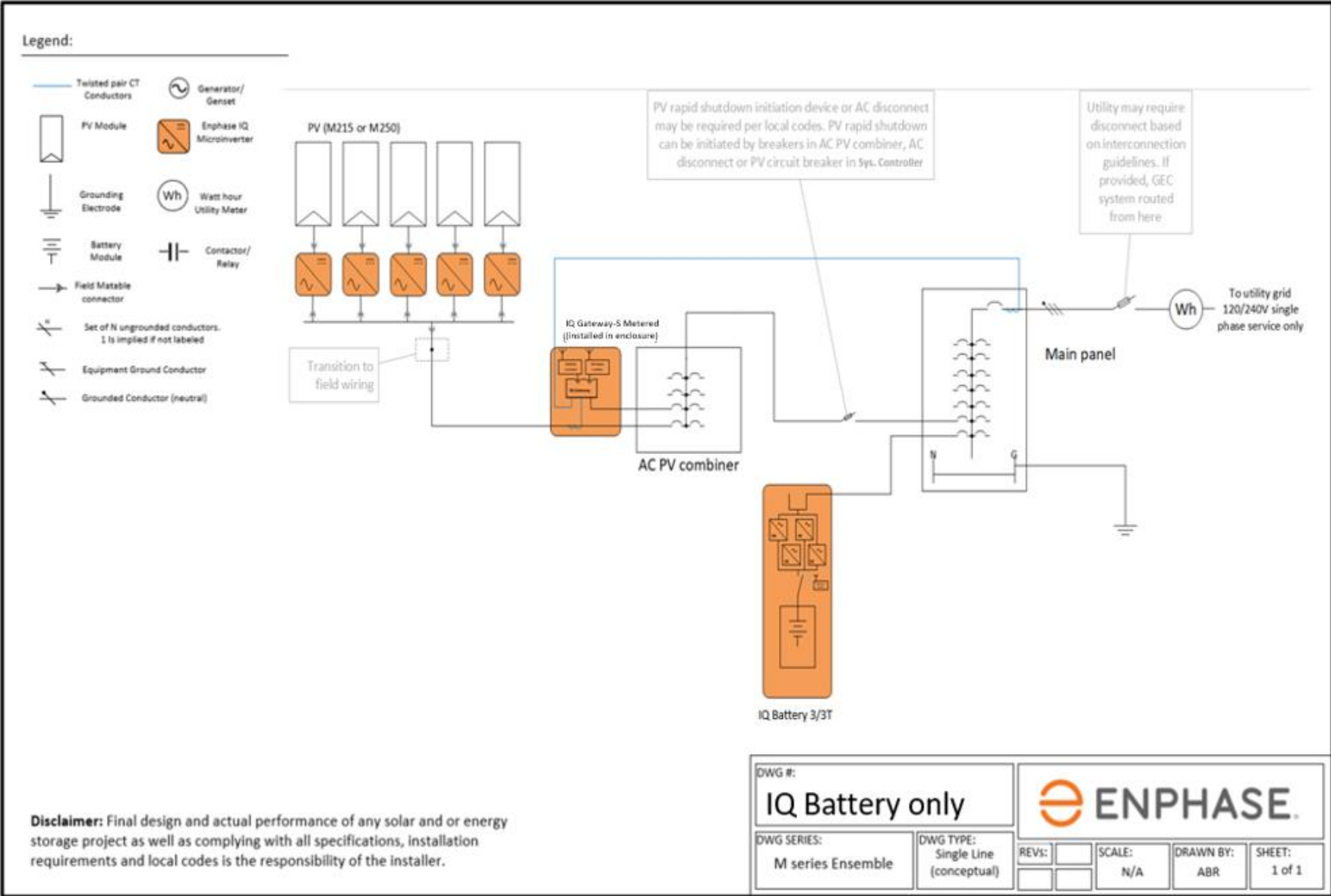
Energy Essentials configuration



Energy Essentials configuration, split system with NO additional consumption CTs

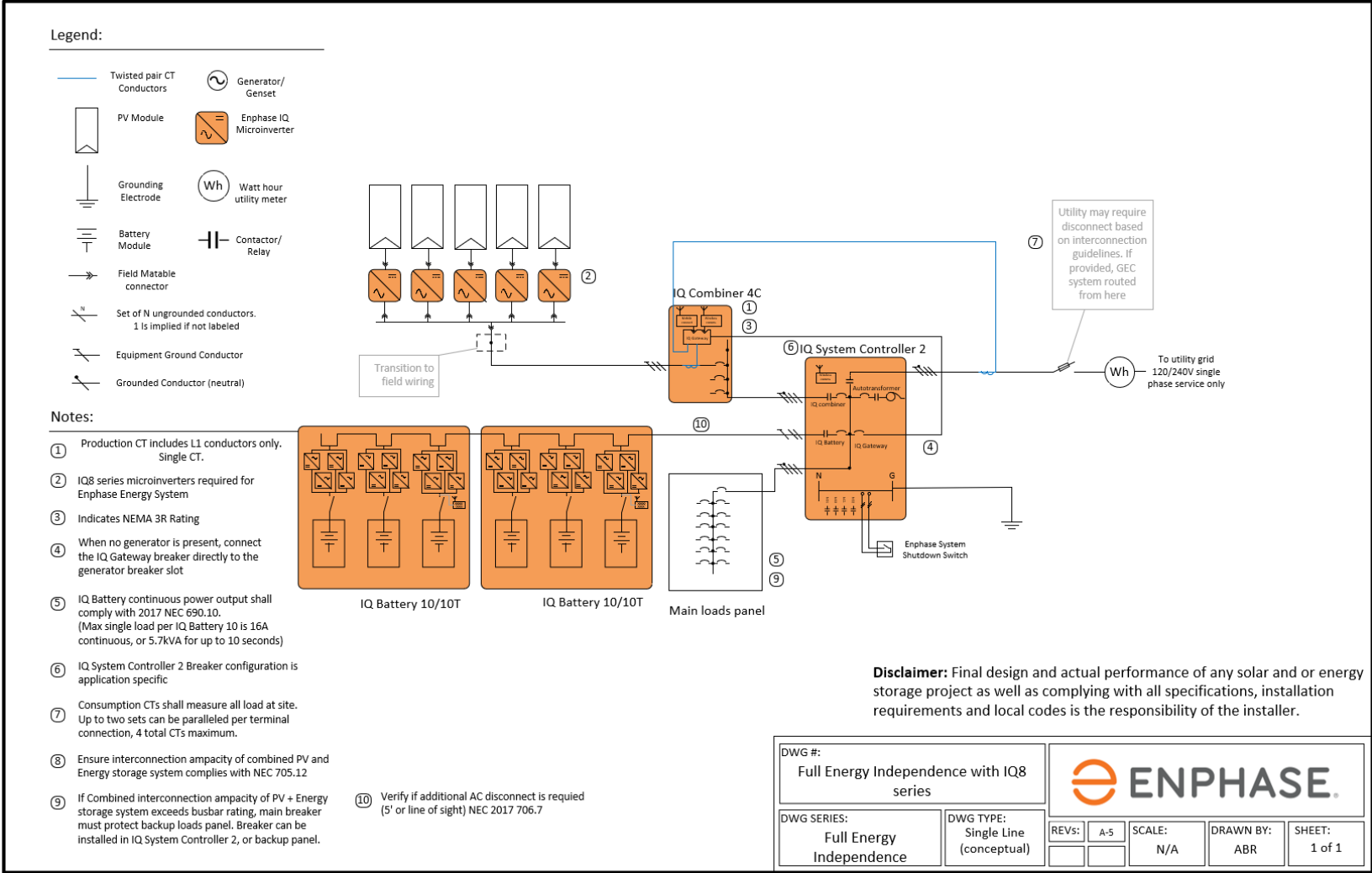


### IQ Battery only configuration

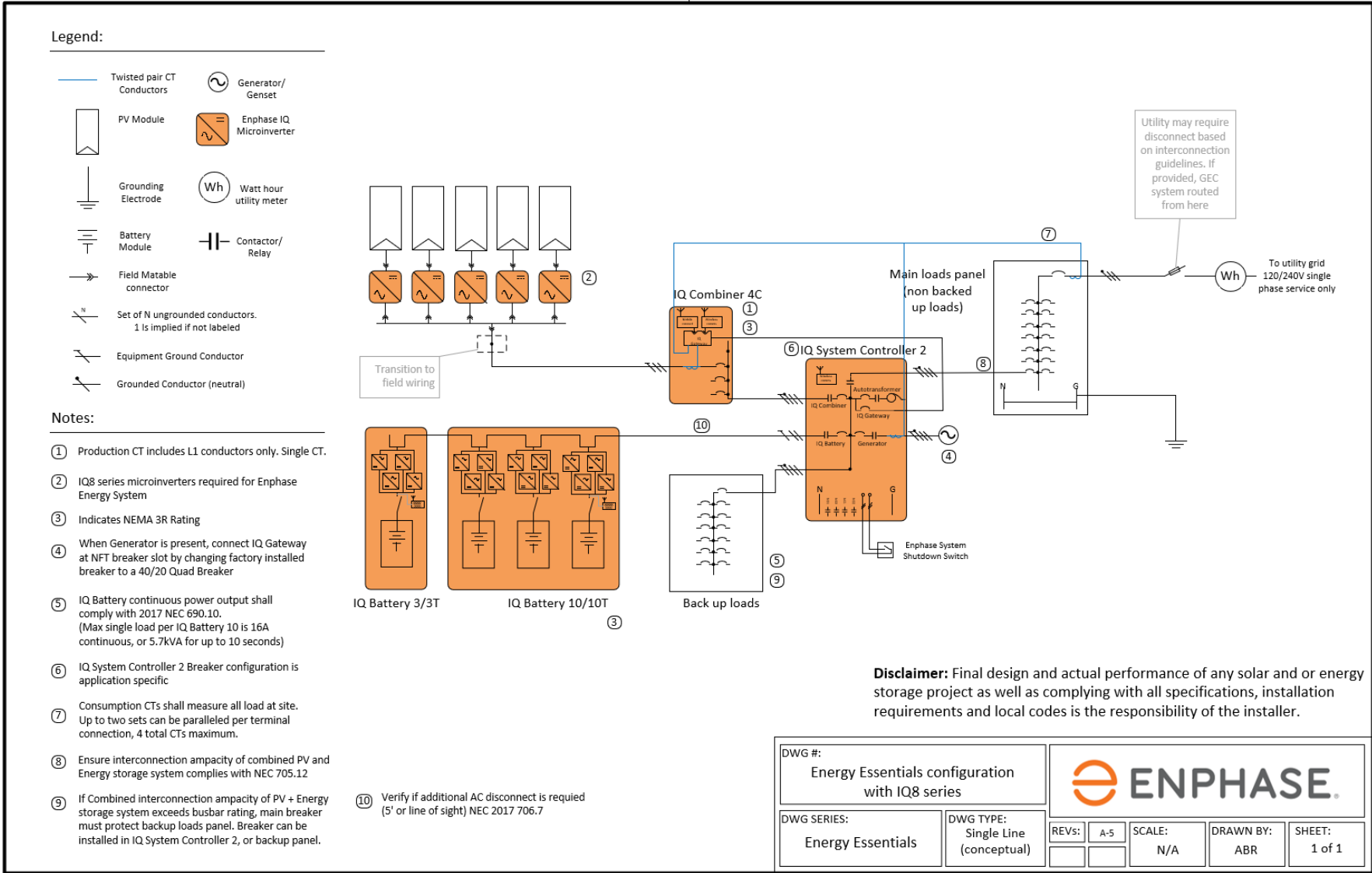


# Appendix C – Single line diagrams for IQ8-Series systems

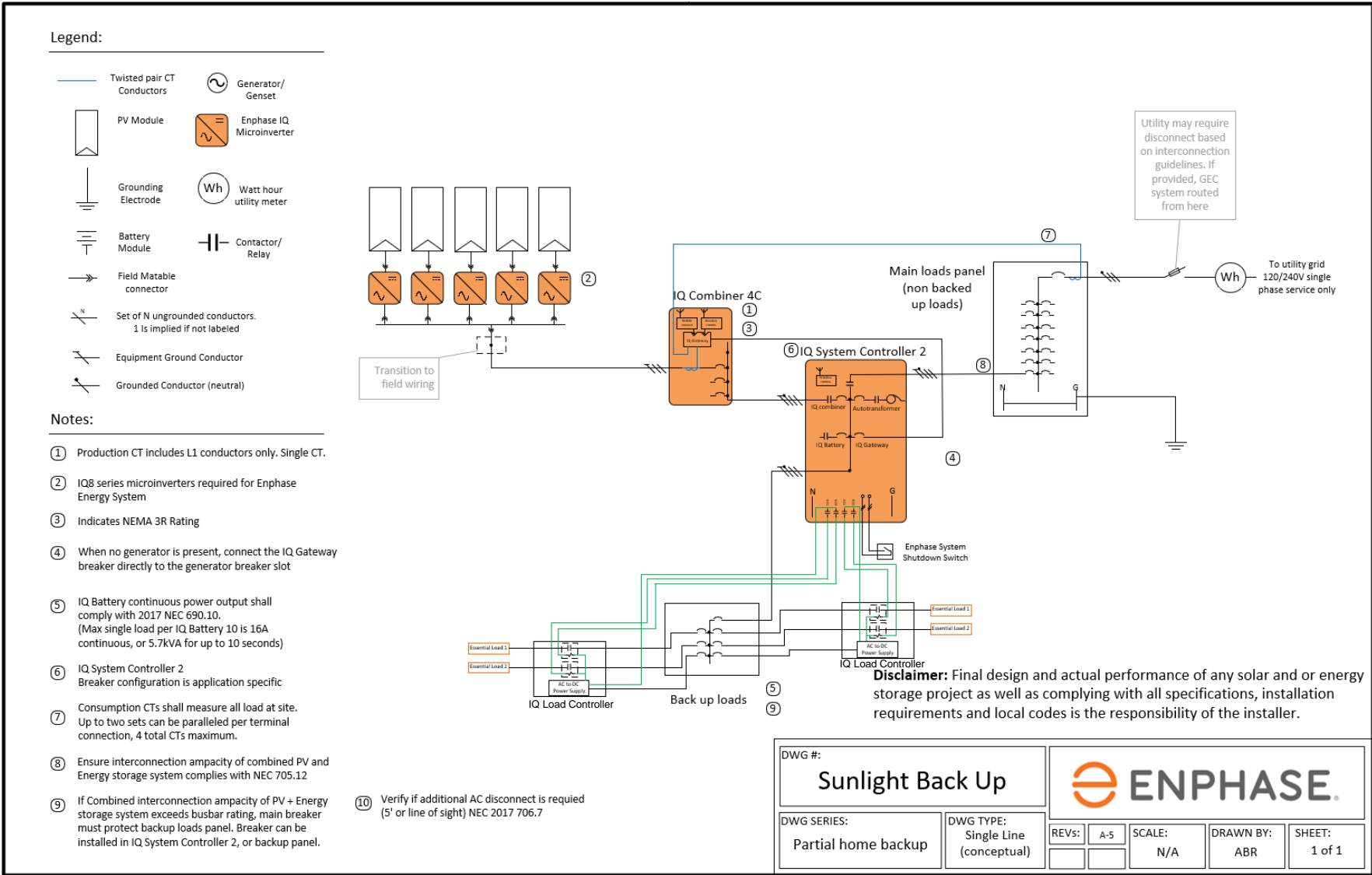
## Full Energy Independence configuration



# Energy Essentials configuration



# Sunlight Backup configuration



Energy Essentials configuration, split system with NO additional consumption CTs

