Planning an Ensemble Upgrade to an Enphase M-Series Solar Installation

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Overview

This document provides site surveyors and design engineers with the information required to plan the installation of the Enphase Ensemble™ energy management technology system on a site that has Enphase M-Series microinverters. 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.

STOP: This guide describes an Ensemble system with M-Series microinverters. If you need the planning guide for Ensemble systems with IQ-series microinverters, refer to https://enphase.com/sites/default/files/downloads/support/Tech-Brief-Planning-Ensemble-Technology-System-EN-US.pdf

Ensemble Technology System Overview

With Ensemble technology, homeowners have power when the grid goes down and can save money when the grid is up. Ensemble technology systems include the following Enphase products:

- **Enphase Encharge™ storage system** is an all-in-one AC coupled storage system that includes embedded grid-forming multimode microinverters. You can connect multiple Encharge storage systems to maximize potential backup for homes. The Encharge 3 storage system provides flexibility to customers to start small and add capacity incrementally.
- **Enphase Enpower™ smart switch** connects the home to grid power, the Encharge storage system, 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 Encharge storage systems 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 Wireless communication kit** enables direct communication between Encharge, Enpower, and the Envoy-S™ using 2.4 GHz frequency. The kit is connected to one of the USB ports on the Envoy-S.
- 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 Envoy-S.
- An **Enphase Envoy-S Metered** is required. It is a communications gateway that collects system performance information and transmits that information over the internet to Enlighten. There are several different versions of the Envoy as pictured in the following. An Envoy-S Metered is required for every Ensemble system with M-Series microinverters.

  Note: The IQ Envoy will not communicate with M-Series microinverters and M-Series microinverters will not communicate with the IQ Envoy.

  Note: Legacy Envoy/EMU SKUs (ENV-120-01 or ENV-120-02, IEMU-03 or IEMU-01 or IEMU02) will not work with an Ensemble system. You must replace these legacy SKUs with an Envoy-S Metered for an Ensemble upgrade.
- **Enphase Consumption CTs** enable home energy consumption monitoring and are required for Ensemble to operate correctly.
- **Enphase M-Series microinverters and accessories.** Ensemble technology is compatible with Enphase M215 and M250 microinverters and makes retrofit upgrades as simple as new installations.

  Note: The Ensemble upgrade is only compatible with M215 and M250 series microinverters. Other legacy microinverters are not supported.

Ensemble Technology Systems Common Configurations

Regulatory Background – National Electrical Code

Grid-tied PV inverters are required to shut down in the event of a utility grid power outage. They cannot form an unintentional island, and their anti-islanding technology prevents the formation unintentional islands. Ensemble technology systems may provide backup to some or all the load circuits in a home by forming an intentional island according to 2017 NEC sections 690 and 705. The Enpower smart switch with MID function, in conjunction with the multimode inverters in the Encharge energy storage system, comprise a microgrid system that forms an intentional island entirely within the bounds of the local electric power system (EPS). Figure 1 shows a drawing of an AC coupled multimode system based on 2017 NEC section 690 and 705.

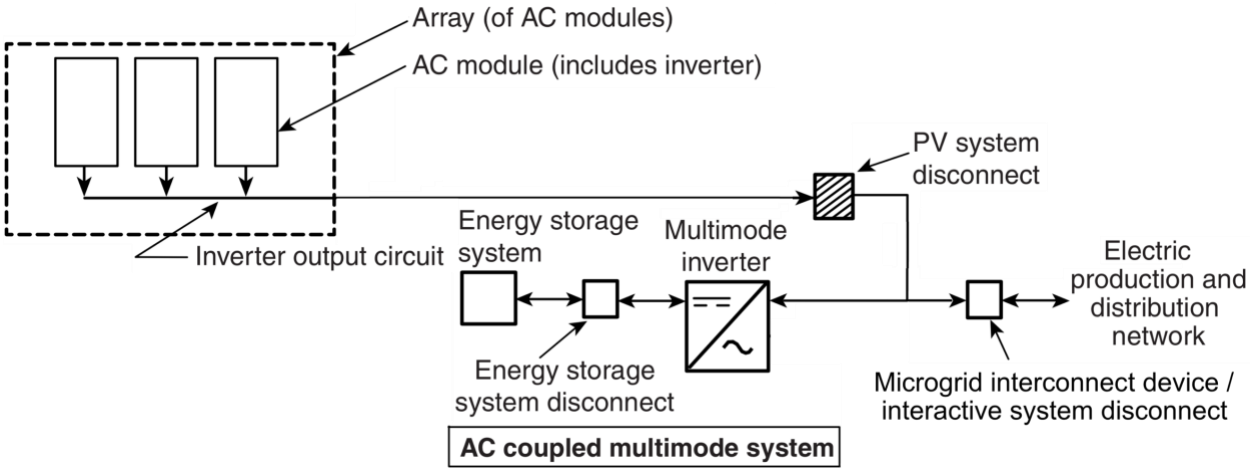


Figure 1: Microgrid system components based on 2017 NEC 690 and 705

Backup Configurations

The flexibility of the Ensemble technology system enables many backup configurations for varying customer goals and needs. There are two common configurations that allow the Encharge storage system to provide power to customer loads independent of the grid.

Whole Home Backup – Enpower Installed on the Line-Side of the Main Load Panel

In the whole home (main load panel) backup configuration, the Enpower smart switch is installed on the line-side of the main load panels rated up to 200A. This allows a properly sized Ensemble technology system to provide power to all loads in the main load panel in the event of a grid outage. In this configuration, you can configure the Enpower smart switch with a main breaker to act as the service disconnecting means. You can interconnect the PV system to the Enpower smart switch on a dedicated breaker or interconnect it to the main load panel. This configuration typically supports larger PV and storage system sizes and may allow you to avoid expensive utility service and/or main service panel upgrades. One example of this whole home (main load panel) backup configuration is shown in Figure 2.

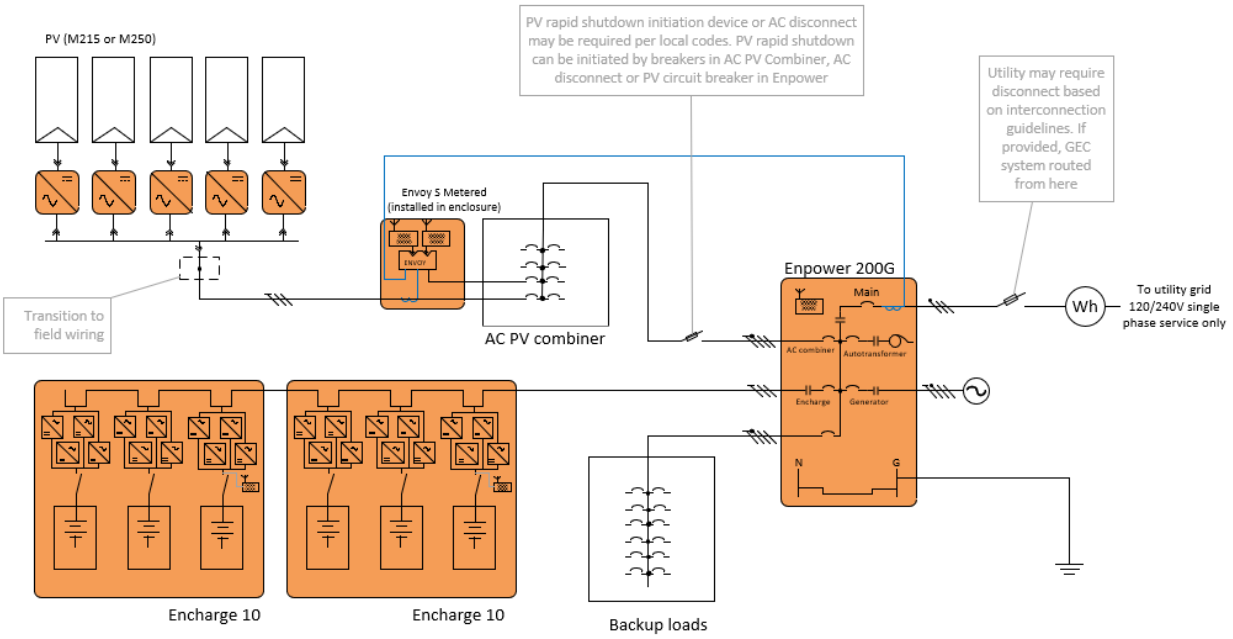


Figure 2: Always-On Ensemble technology system with whole home (main load panel) backup. The Enpower smart switch is installed on the line-side of the main load panel, and PV and Encharge storage system are interconnected into the Enpower smart switch.

Partial Home (Subpanel) Backup – Enpower Smart Switch and a Backup Subpanel Installed on the Load Side of the Main Load Panel

You can also install the Enpower smart switch on the load side of the exiting main load panel or service equipment. Use this configuration when the Ensemble technology system is configured to provide backup to several pre-selected load circuits. This configuration is recommended when an Encharge storage system with smaller energy and power capacity and some basic load backup is desired by the customer, or when existing constraints prevent main panel backup or other installation methods. The following Figure 3 shows an example of a partial home (subpanel) backup configuration.

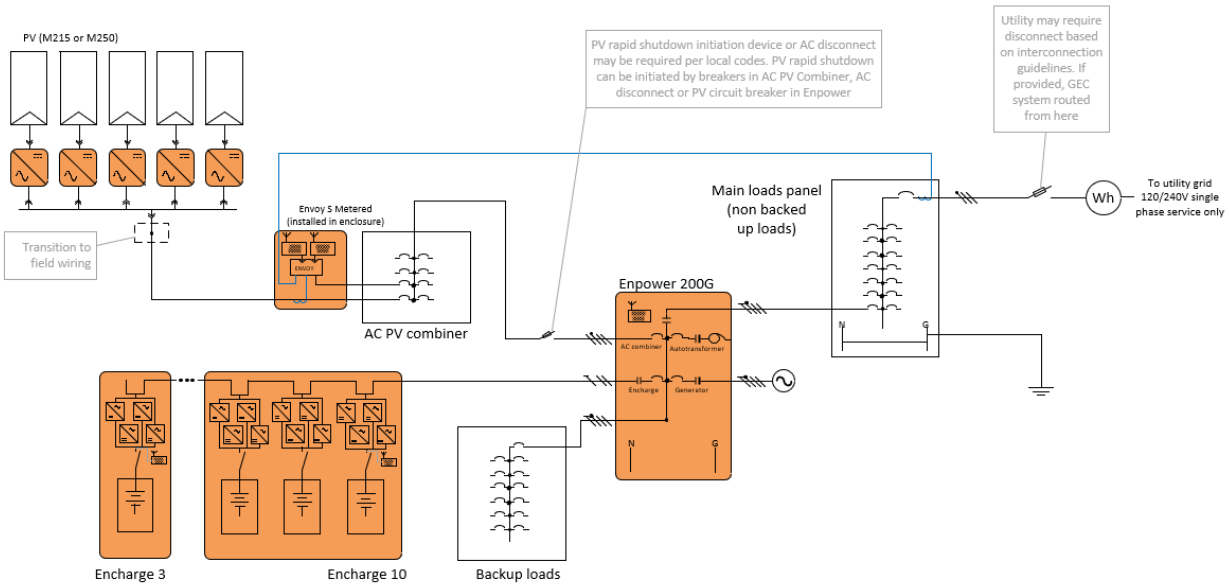


Figure 3: Always-On Ensemble technology system with partial home (subpanel) backup. Enpower is installed on the load side of the main load panel with select loads backed up in a backup subpanel.

Multiple Enphase Systems on a Single Site

In some situations, when the size of a PV system at a site is larger than the maximum amount of PV that can be paired with the installed Encharge storage system, the PV system may need to be split into two separate systems. For guidance on the maximum amount of M-Series microinverters that can be paired with the Encharge storage system, see the section: M-Series Microinverter PV System to Encharge Pairing. In this situation, one system operates in both grid-tied and backup operations, and one system operates only during grid-tied operation. This configuration may be necessary to accommodate physical, AHJ, or technical requirements.

The best practice is to install a second Envoy-S Metered with a line communication filter (LCF), such as the RP220, RP225, RP230, or RP240 series from Radius Power. Install the LCF electrically between the two systems to prevent unintentional power line communications between the two systems. You can install the LCF either as shown in Figure 4 or between the Envoy-S Metered and the Enpower smart switch. This configuration does not support power export limiting. When the second PV system is interconnected on the load side of the consumption CT for Ensemble, a second pair of consumption CTs must be added to the non-Ensemble PV system (with the arrow facing towards the loads) to offset the effect of the non-Ensemble PV system on the consumption reading of the Envoy-S Metered.

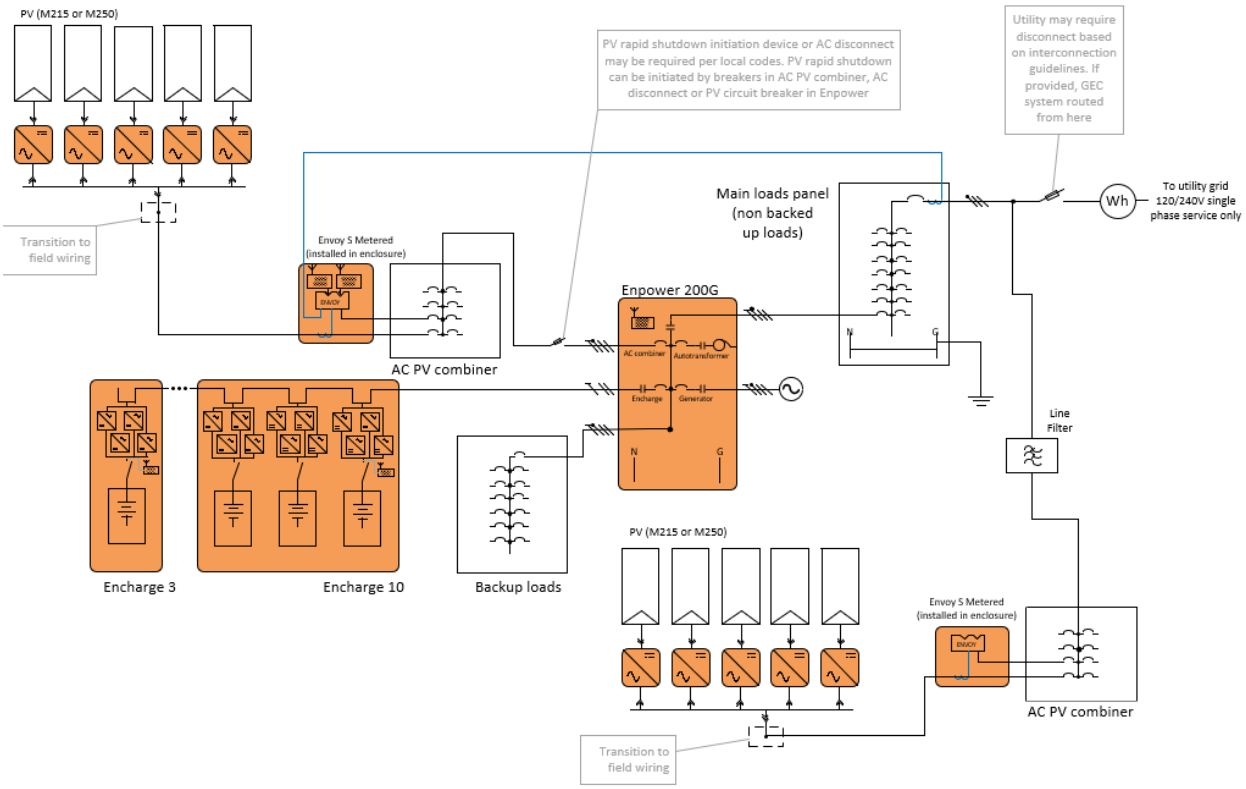


Figure 4: Ensemble technology system and an additional grid-interactive Enphase system on a single installation site

Note: Enphase is developing a solution that allows installers to wire the excess PV to an external definite purpose Normally Open (NO) contactor. The Enphase Enpower smart switch can de-energize the coil of the definite purpose contactor, thereby shedding the excess PV when the system goes off grid. A technical brief outlining this approach is under development. Once available, this solution will eliminate the need for the second Envoy and line filter for systems with excess PV.

Multiple Ensemble Systems on a Single Site

When more than one Enpower is added to a site, each microgrid acts independently. The position of consumption CTs should be such that the production and consumption of each microgrid is separate. The best practice is to install a line communication filter (LCF), electrically between the two systems, to prevent unintentional power line communications between the two systems.

Installing Ensemble without Enpower

You can add the Encharge storage system to an existing system without using an Enpower smart switch. However, it will not provide backup power. When installed in this configuration, the Encharge storage system is treated as a distributed energy resource (DER), equivalent to a PV system, and cannot form an intentional island. It may be connected on a user-provided distribution point in compliance with the NEC. Ensure that the consumption CTs are installed on the line-side of Encharge storage system interconnection point and that the Encharge storage system circuits are not included in the production CT.

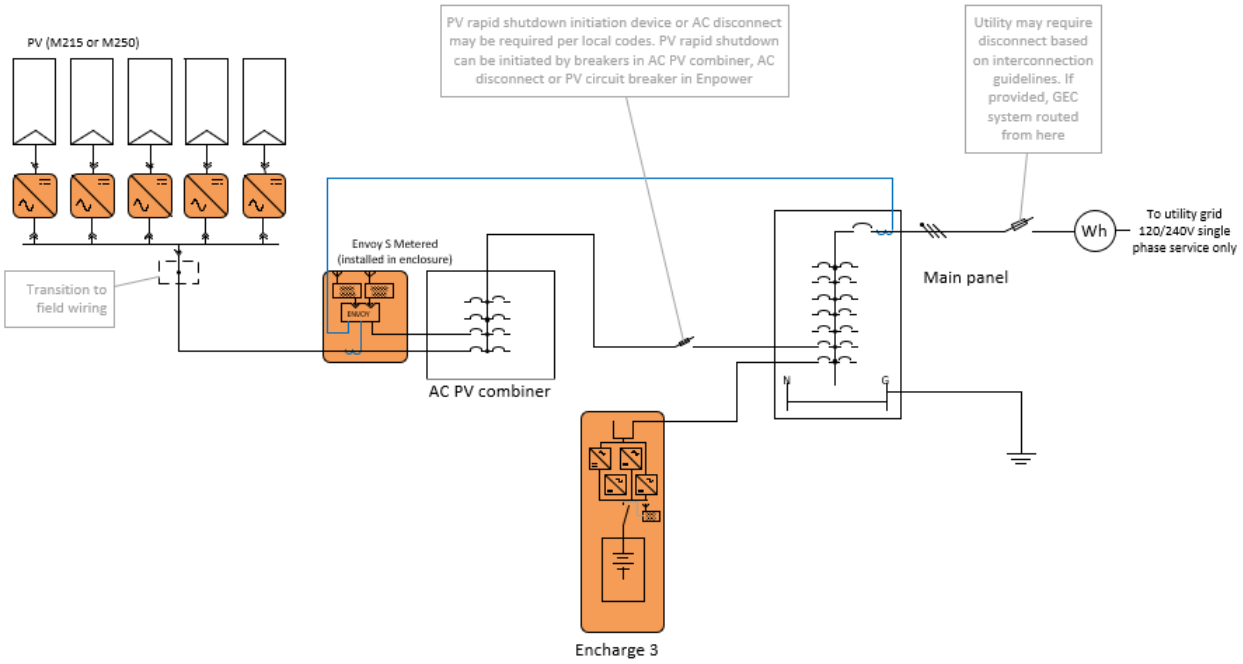


Figure 5: Grid-interactive Encharge storage system installation with no backup

Use Cases and Sizing

Load Analysis for System Sizing

The first step in correctly sizing a system is a proper load analysis. A complete load analysis includes considerations for continuous power, any peak, surge, or starting power (or current factors such as LRA on HVAC units), and energy usage. If an Envoy-S with correctly configured consumption CTs is already installed at a site, you can use data from Enlighten to study the energy usage patterns of the household. A site survey, electric bills, and third-party consumption meters can also provide useful load data for system sizing. Also review the *Enphase Ensemble Project Survey* document at the end of this planning guide (Appendix B) and System Estimator at estimator.enphaseenergy.com.

Backup Use Case

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 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 Encharge storage system **power** rating to **power** loads that might have higher starting currents (such as motors, pumps, compressors). The size of the PV array defines how fast the Encharge storage units recharge during intentional island or microgrid mode. You can increase the power rating by adding additional Encharge storage units, which also provide additional energy, improving the customer user experience.

- **Power** (kW) capacity from the Encharge storage system *must* exceed the maximum single load and 67% of the total M-Series microinverters AC nameplate installed at the site (Table 1).

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.*

- **Energy** storage (kWh) capacity must be sized to supply the estimated backup loads for a user-defined period.

Sizing Encharge Storage System for Whole Home (Main Panel) Backup

For **whole home backup**, when an Enpower smart switch is installed on the line-side of the main load panel, at minimum, the greater of a) two Encharge 10 units when compliant with 2017 NEC 710.15(A) or b) 67% of PV AC nameplate rating is recommended.

Sizing Encharge Storage System for Partial Home (Subpanel) Backup

For **partial home backup**, when an Enpower smart switch is installed on the load side of the main load panel follow these steps to size an Encharge storage system:

1. Identify the largest maximum single load power rating (kW) that you want to backup and select the absolute minimum number of Encharge units required to meet the 2017 NEC 690.10->710.15(A) requirements.
2. Calculate the total PV system maximum continuous output power of all M-Series microinverters in the system. Then, select the minimum number of Encharge storage units required so that the total Encharge storage system power capacity is equal to or greater than 67% of the total PV system output AC power per Table 1. In other words, do not design systems where total PV system output AC power is more than 150% of total Encharge storage system power capacity.
3. Based on the estimated backup loads for the user-defined period, calculate the required Encharge energy storage (kWh) capacity and the minimum number of Encharge required.
4. Based on a site's load analysis of both power (kW) and energy capacity (kWh) needed, determine the total number of Encharge units required for the storage system.
    a. The minimum number of Encharge 3 units required is the largest of the calculated values in steps 1 and 2.
    b. The desired number of Encharge storage system units is the value calculated in step 3.
    c. The maximum allowed number of Encharge units that can be connected to a single Enpower smart switch is 12 x Encharge 3 or 4 x Encharge 10.

M-Series Microinverter PV System to Encharge Pairing

The following table identifies the maximum number of microinverters that can be connected to a given Encharge storage system size.

Table 1: Maximum number of M-Series microinverters for Encharge storage system for backup operation

Encharge 3 units	Equivalent Encharge 10 units	Encharge energy capacity (kWh)	Encharge 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 Encharge 10)	9.78	3.84	5.76	26	24
4		13.04	5.12	7.68	35	32
5		16.30	6.40	9.60	44	40
6	(2 x Encharge 10)	19.56	7.68	11.52	53	48

Encharge 3 units	Equivalent Encharge 10 units	Encharge energy capacity (kWh)	Encharge continuous power (kWAC)	Max PV system power (kWAC)	# of microinverters	
					M215	M250
7		22.81	8.96	13.44	62	56
8		26.07	10.24	15.36	71	64
9	(3 x Encharge 10)	29.33	11.52	17.28	80	72
10		32.59	12.80	19.20	89	80
11		35.85	14.08	21.12	98	88
12	(3 x Encharge 10)	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.

Self-Consumption Use Case

In ***Self-Consumption*** scenarios, a homeowner's PV system generation is stored in the Encharge storage system for use later in the day when there is not sufficient power from solar PV to supply the home loads. Homeowners benefit by consuming the onsite-generated energy themselves instead of exporting it to the grid during the day and purchasing power from the grid during evening and night times.

In customer self-consumption scenarios, size the Encharge storage capacity to accommodate the expected daily energy export. This is roughly less than two-thirds of the average daily energy load of the home.

Economic Use Cases

There are many economic goals that the Encharge storage system supports. These include **reducing the utility bill** by charging during low tariff periods and saving the 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 Toolbase to assist with sizing in these use cases.

Replacing M-Series Microinverters or Expanding an Existing Installation

Enphase provides M-Series RMA SKUs 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 with M-Series microinverters at a site.

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

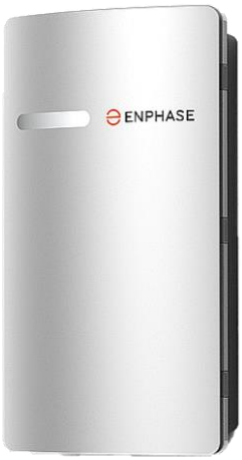
Note that when using the M-Series RMA SKUs you must use the Engage Cable and associated accessories. The following table lists these.

SKU	Description
ET10-240-BULK	Voltage type and conductor count: 240 VAC, four conductor Connector count: 240 Connector spacing: 1.025m (40”) PV module orientation: Portrait
ET17-240-BULK	Voltage type and conductor count: 240 VAC, four conductor Connector count: 240 Connector spacing: 1.7m (67”) PV module orientation: Landscape
ET-SPLK-05	Pack of five Engage couplers. Used to connect two Engage Cables
ET-CLIP-100	Pack of 100 steel clips to fasten the Engage Cable to racking
ET-INSTL	Includes: • Pack of four ET-TERM terminators for Engage Cables. • One ET-DISC disconnect tool used to disconnect M-Series microinverters from Engage Cable. • Pak of five ET-SEAL sealing caps for unused connectors on the Engage Cable

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

Ensemble Products

Enpower Smart Switch



The Enphase Enpower smart switch 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. The Enpower 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, Encharge storage system, backup load panel, and generator (reserved for future use)

Mechanical Data	Enpower
Dimensions (WxHxD):	19.7 in x 36 in x 9.7 in (50 cm x 91.6 cm x 24.6 cm)
Weight:	38.5 kg (85 lbs)
Ambient temperature range:	-40º C to +50º C (-40º F to 122º F)

Model Number	Description	Shipment Contents
EP200G101-M240US00	Enphase Enpower smart switch with 200A capacity, neutral-forming transformer providing microgrid interconnect device (MID) functionality.	One box of one unit

Main and Load Breakers

For wire sizes accepted by each terminal, see the Enpower smart switch data sheet. Enpower supports optional circuit breakers on both the input (line-side) and output (load side) of the MID relay. You can configure Enpower 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 Enpower smart switch and you must order them separately.

Model Number	Description	Shipment Contents
BRK-200A-2P-240V	Main breaker, 2-pole, 200A, 25kAIC, CSR2200N for Enpower	One box of one unit
BRK-175A-2P-240V	Main breaker, 2-pole, 175A, 25kAIC, CSR2175N for Enpower	One box of one unit
BRK-150A-2P-240V	Main breaker, 2-pole, 150A, 25kAIC, CSR2150N for Enpower	One box of one unit
BRK-125A-2P-240V	Main breaker, 2-pole, 125A, 25kAIC, CSR2125N for Enpower	One box of one unit
BRK-100A-2P-240V	Main breaker, 2-pole, 100A, 25kAIC, CSR2100 for Enpower	One box of one unit

Main Breaker and Load Breaker Installed in the Enpower Smart Switch

When installed on a new or existing electrical service as the service equipment disconnecting means and overcurrent protection device, Enpower smart switch 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 breakers (BRK-200A-2P-240V) installed.

When Enpower is used as the service disconnect with a main bonding jumper installed, all equipment grounding conductors and neutrals on the load side of Enpower feeders and panelboards must be separated.

Load Breaker Installed in the Enpower Smart Switch

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

Main Breaker Installed in the Enpower Smart Switch

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 overcurrent protection totaling less than 100A. In this case, install the Enpower smart switch with a 100 A-rated Eaton CSR2100N breaker (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 that the Enpower smart switch load conductors are rated appropriately.

Enpower Smart Switch Without Main or Load Breakers Installed

When the Enpower smart switch is installed on the load side of the service equipment disconnect means, main and load breakers may not need to be installed in the Enpower. For example, an Enpower smart switch is installed with a total of 40 A of DER overcurrent protection, and that is back feeding a 200 A main breaker load center. In this case, it might not be necessary to install main or load breakers in the

Enpower smart switch. Ensure that the sum of the load and DER overcurrent protection is less than 200 A and that conductors are sized to comply with 2017 NEC 705.12(B)(2)(1).

Encharge Storage System and PV Breakers

When connecting the Encharge storage system, PV, or generator (reserved for future use) to the Enpower smart switch, use one of the following circuit breakers depending on system requirements.

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

Encharge 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 PV circuit with M-Series microinverters since these inverters are still interactive and are permitted to omit the additional fastener 2017 NEC 705.12(B)(5). This aligns with the AC-coupled multimode system diagram, Figure 1, in 2017 NEC Figure 690.1(b), which shows both an interactive and multimode inverter. The Encharge storage system includes the multimode inverters forming an intentional local EPS island, and M-Series microinverters are utility-interactive inverters.

For Ensemble configurations where the PV continuous current is greater than 64 A (maximum 80A breaker) and still less than 150% of total Encharge storage system power capacity, the PV system must be interconnected outside of Enpower, on the load-side of the Enphase Consumption CTs and in compliance with NEC 705.12 (B). A common example is to connect the PV breaker at the backup loads center.

Generator Interface

The Enpower smart switch 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 Enpower smart switch 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 Enpower smart switch 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 Encharge storage systems and charge them. Note that M-Series-microinverter-based Ensemble systems require all PV to be wired via an external contactor. The contactor’s coil must be connected to a power supply switched by the IO ports on the Enpower Smart Switch.

Encharge Storage System

The Enphase Encharge 3 and Encharge 10 storage system 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 Encharge consists of a mounting bracket, battery unit with disconnecting means, and cosmetic cover.

Model Number	Description	Shipment Contents
ENCHARGE-3-1P-NA	Enphase Encharge 3 base kit with one 1.28 kVA, 3.3* kWh, single-phase battery unit with four integrated IQ8X-BAT microinverters and backup feature	One box of Encharge 3 base kit
	Enphase Encharge 3 cover kit with Encharge 3 cover, mounting bracket, and screws	One box of Encharge 3 cover kit
ENCHARGE-10-1P-NA	Enphase Encharge 10 base kit with three 1.28 kVA, 3.3* kWh, single-phase battery units with 12 integrated IQ8X-BAT microinverters and backup feature	Three boxes of Encharge 3 base kits
	Enphase Encharge 10 cover kit with Encharge 10 cover, mounting bracket, screws, two raceway joiners, set of wires for daisy chaining the three battery units	One box of Encharge 10 cover kit

*__Note__: When used with M-Series microinverters, the Encharge 3 has a usable capacity of 3.3kWh. The Encharge 10 with 3x Encharge 3 units, therefore, has a usable capacity of 9.9kWh.

Mechanical Data	Encharge 3	Encharge 10
Dimensions (WxHxD)	14.45 in x 26.14 in x 12.56 in (36.7 cm x 66.4 cm x 31.9 cm)	42.13 in x 26.14 in x 12.56 in (107.0 cm x 66.4 cm x 31.9 cm)
Weight	One 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)	Three 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)
Enclosure	Outdoor - NEMA 3R	
Ambient operating temperature range	-15º C to 55º C (5º F to 131º F) non-condensing	
Optimum operating temperature range	0º C to 30º C (32º F to 86º F)	
Altitude	Up to 2500 meters (8200 feet)	
Chemistry	Lithium iron phosphate $LiFePO_4$	

Ensemble Communications Kit

The Ensemble communications kit includes the COMMS-KIT-01 and the CELLMODEM-M1. The COMMS-KIT-01 is plugged into a USB port on Envoy-S. It enables direct communication between the Encharge storage system, the Enpower smart switch, and the Envoy-S using 2.4 GHz frequency. The CELLMODEM-01 is an LTE CAT-M1 cellular modem with a five-year AT&T data plan for Ensemble systems. It acts as a backup for a broadband Wi-Fi or Ethernet connection and ensures connectivity to the Enlighten cloud.

Model Number	Description	Shipment Contents
COMMS-CELLMODEM-M1	COMMS-KIT-01: USB adapter kit for Envoy. Enables wireless communication with Encharge and Enpower CELLMODEM-M1: LTE CAT M1 cellular modem. When purchased as part of COMMS-KIT-M1 it includes a five-year data plan for Ensemble systems with up to 60 microinverters, 12 Encharge 3 batteries and one Enpower. Works in US, Puerto Rico, US Virgin Islands, Canada, and Mexico.	One box of one unit

Component List

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

Component	Name (model number)	Quantity
Energy Storage System (ESS)	**Encharge:** Encharge-3-1P-NA Encharge-10-1P-NA	Encharge 3 units and Encharge 10 units (see pairing chart for minimums)
Microgrid interconnection device (MID)	**Enpower:** EP200G101-M240US00	1
Enpower switch main breaker and/or load breaker	**Enpower main breakers:** BRK-200A-2P-240V BRK-175A-2P-240V BRK-150A-2P-240V BRK-125A-2P-240V BRK-100A-2P-240V	0, 1 or 2
Enpower switch circuit breakers for PV and Encharge circuits	**Enpower circuit breakers:** 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
Ensemble Technology System communications	**Ensemble Communications Kit:** COMMS-CELLMODEM-M1	1 Includes: • 1 x COMMS-KIT-01 for communication between Envoy and Encharge units as well as Enpower • 1 x CELLMODEM-M1 with five-year AT&T data plan for Ensemble systems
Gateway	**Envoy-S Metered:** ENV-S-AM1-120	1
Consumption CTs	**Current transformers:** CT-200-SPLIT	2 (one for each phase)
Microinverters	**M-Series RMA SKUs:** M215240-IQ7-S22-US M215240-IQ7-S25-US M250240-IQ7-S22-US M250240-IQ7-S25-US	As needed per system design
Cables and accessories	**Cable:** ET10-240-BULK cable for portrait PV module orientation ET17-240-BULK cable for landscape PV module orientation	Voltage type and conductor count: 240 VAC, four conductor Connector count: 240 Connector spacing: 1.025m (40”) PV module orientation: Portrait
	Accessories: ET-SPLK-05: Engage couplers to couple 2 Engage AC cables ET-CLIP-100: Steel clips to fasten the Engage cables to racking ET-INSTL: Kit with disconnect tool for M-Series microinverters, watertight sealing caps and terminators for Engage cables	Voltage type and conductor count: 240 VAC, four conductor Connector count: 240 Connector spacing: 1.7m (67”) PV module orientation: Landscape
PV Modules	Any	As needed per system design

Key Planning Considerations

To ensure the best wireless and power line communication between Ensemble 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 for the Encharge storage system and Enpower smart switch units.
2. For wireless communications between the Envoy-S Metered, Encharge storage system, and Enpower smart switch, the best practice is to have a clear line-of-sight with no obstructions between them. The distance to the Envoy-S should be less than 30 meters (100 feet). If obstacles are in the way, the required distance will be shorter. For power line communications, the best practice is to have the Envoy-S located less than 250 feet from the PV branch circuit collection. If you use a power line communication filter, that distance might be extended.
3. Determine the electrical interconnection points and required breakers for the Enpower smart switch, Encharge storage system circuit, PV combiner branch circuits, and the Envoy-S Metered.
4. Ensure that the Envoy-S Metered with both production and consumption CTs can be installed at the site.
5. Size conductors properly for ampacity and voltage regulation given conductor lengths.
6. Identify the location of the PV system disconnect for rapid shutdown initiation and labeling.
7. Always ensure that the Envoy-S Metered 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 Encharge storage system 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 **Encharge**:
    - 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 **Enpower**:
    - Indoors: at least 15 cm (6 inches) off the ground and 15 cm (6 inches) from the ceiling. Allow 6 cm (15 inches) on each side.
    - Outdoors: at least 91cm (3 feet) off the ground. Allow 6 cm (15 inches) on each side.
    - 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 Ensemble technology equipment for working space.
8. Consider the dimensions of the Ensemble equipment, easy access, height, length of system conductors, conduit requirements between products, and the system interconnection location when selecting the location of equipment. The recommended minimum spacing is shown in Figure 4 and Table 2. Conduit options are as follows:

- Enpower smart switch: Main supply conductors can enter Enpower smart switch from the bottom or the bottom-left side. Backup load conductors can enter Enpower smart switch from the bottom or bottom-right side. Encharge storage system and PV combiner conductors can enter from the bottom, bottom-left, or bottom-right sides.
- Encharge storage system: Conduit can enter from the top right or top left of the Encharge storage system at the pre-defined knockout locations.

9. Do not block vents.

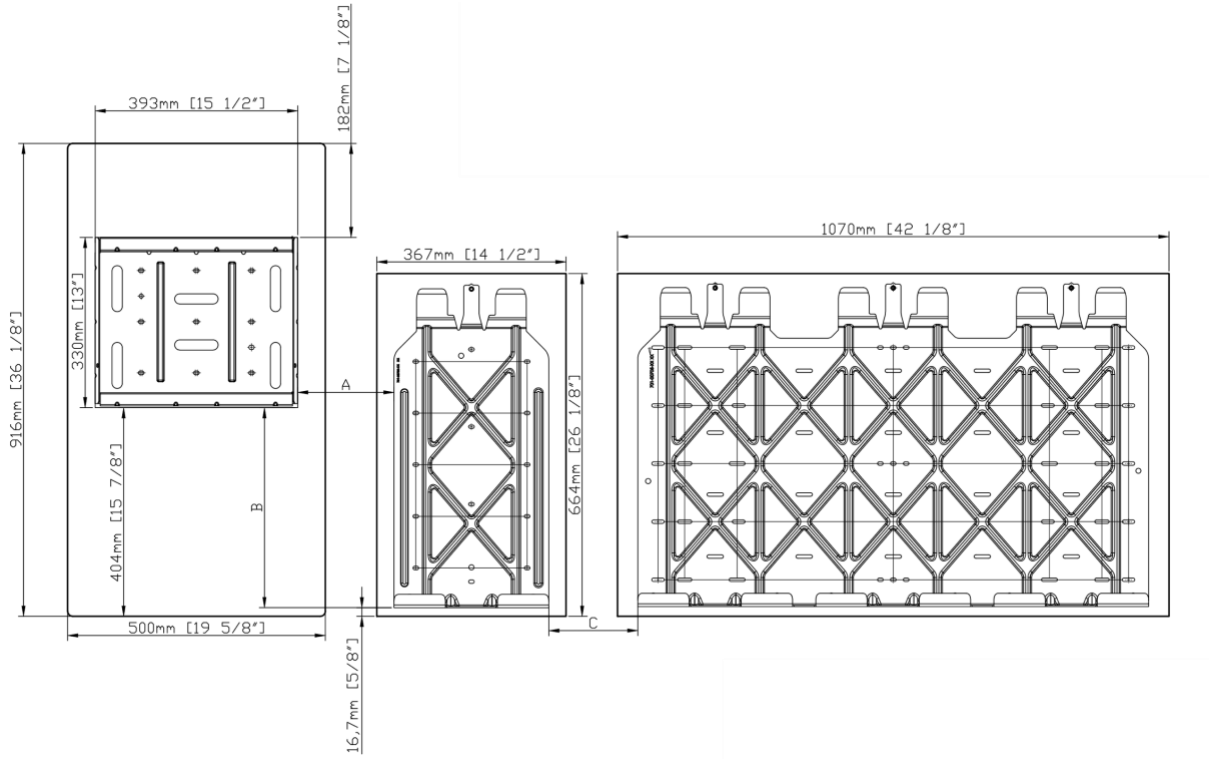


Figure 6: Bracket spacing

Table 2: Bracket spacing

Dimension	Description	Recommended Minimum
A	Enpower and Encharge horizontal bracket spacing	152 mm (6”)
B - Bottom aligned	Enpower wall mount bracket bottom to Encharge wall mount bracket bottom	387 mm (15 1/4”)
B - Center aligned	Enpower wall mount bracket bottom to Encharge wall mount bracket bottom	261 mm (10 5/16”)
B - Top aligned	Enpower wall mount bracket bottom to Encharge wall mount bracket bottom	135 mm (5 5/16”)
C	Encharge wall horizontal bracket spacing	152 mm (6”)

Temperature Considerations

Unlike other battery chemistries, an Encharge storage system does not require ventilation for off-gassing and does not require active cooling. Encharge storage system batteries perform best when not subjected to extreme hot or cold temperatures and when they remain within the optimal temperature range of 0º C to 30º C (32º F to 86º F). The 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:

- *Quick Install Guide – Install the Enphase Encharge Storage System*
- *Quick Install Guide – Install the Enphase Enpower Smart Switch*

Current Transformers (CTs)

It is critical that installers correctly configure the Envoy-S 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 Encharge battery circuit(s) installed on it. Install the Encharge battery circuit(s) on the load side of the production CTs on the correct terminals in Enpower smart switch.

The Envoy-S only senses consumption readings for circuits that are on the load side of the Consumption CTs. Encharge batteries will support loads depending on the placement of the consumption CTs. To prevent Encharge batteries from discharging beyond the backup loads, as it might be the case with some Power Export Limiting requirements, place the consumption CTs on the line side of Enpower and before any load center that should not be energized by Encharge. Consumptions CTs for Ensemble systems are set as *load with solar*.

Installers may extend the consumption CT leads, but not the production CT leads. Therefore, it is best to locate the Envoy-S close to the microinverter output circuits and then extend consumption CT wires if necessary. Refer to the *Envoy-S Installation and Operations Manual* when installing and/or extending consumption CTs.

Enpower Smart Switch Connections

The Enpower smart switch can accept a maximum of 64 A of continuous output current (maximum 80A breaker) of a combined PV subpanel. The busbar in the Enpower smart switch can accept a maximum of an 80 A breaker for the AC combiner or PV subpanel overcurrent protection.

For larger PV systems, the PV interconnection point should be made on the load-side of the consumption CTs and in compliance with NEC 705.12 (B). The Envoy for these larger systems will not be part of an AC combiner, but an independent unit. Remember that the total PV system output AC power should not be more than 150% of the total Encharge storage system power capacity.

The Enpower smart switch can accept a maximum of 64 A of rated output current (maximum 80A breaker) of combined Encharge storage system circuits. The busbar in the Enpower smart switch can accept a maximum of an 80 A breaker for the Encharge storage system circuit overcurrent protection. This equates to a maximum of twelve Encharge 3 storage units ***or*** four Encharge 10 units per Enpower. Up to six Encharge 3 storage units ***or*** two Encharge 10 units, equal to 32 A of rated output current, can be connected in series prior to landing on the Encharge terminal in the Enpower smart switch and protected by a no higher than a 40 A overcurrent protection breaker. If more than six Encharge 3 storage systems (or more than two Encharge 10 storage systems) are to be connected to Enpower smart switch, you must use an external subpanel to combine each circuit of up to 32 A of rated output current Encharge storage system circuits. You should size conductors appropriately for the overcurrent protection selected for the application.

Voltage Regulation Considerations

When the Encharge storage system 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 Encharge storage system 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 Encharge are the same value, voltage rise and voltage drop will be the same value.

Voltage regulation in Ensemble is calculated as

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

where:

V_d is the voltage change from 0 to max current out of Encharge, and

V_{nom} is the nominal RMS voltage.

Ensure that the Encharge storage system conductors are sized correctly for the of units on the circuit and that voltage regulation does not exceed 1% between the first Encharge storage system and the Enpower smart switch.

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 is still able to initiate rapid shutdown.

The rapid shutdown initiation device can be one of the following:

- The PV system breaker in Enpower
- An additional disconnect such as a fusible disconnect between Enpower and the AC PV combiner
- The circuit breakers in the AC PV combiner. Note that there must be fewer than six breakers grouped together

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

Enphase M-Series microinverters comply with the rapid shutdown requirements per the UL certifications.

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). Enpower and Encharge 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 main load center or main panelboard, this is the unit where the majority of load circuits for the premises obtain overcurrent 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)

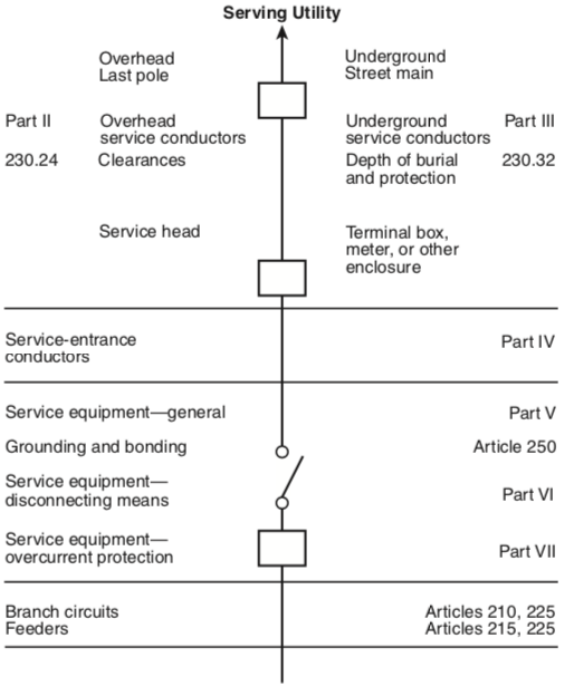


Figure 7: NEC 2017 Figure 203.1 Services © NFPA

microgrid system: A premises wiring system that has generation, energy storage, and load(s), or any combination thereof, and 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.

Appendix A: Single Line Diagrams