

# Planning an Enphase Ensemble Energy Management Technology System

## Table of Contents

<b>Planning an Enphase Ensemble Energy Management Technology System.....</b>	<b>1</b>
<b>Table of Contents .....</b>	<b>1</b>
<b>Overview.....</b>	<b>2</b>
<b>Ensemble Technology System Overview.....</b>	<b>2</b>
<b>Ensemble Technology Systems Common Configurations .....</b>	<b>2</b>
Backup Configurations.....	3
Non-backup Configuration - Installing Ensemble without Enpower .....	5
<b>Use Cases and Sizing.....</b>	<b>5</b>
Load Analysis .....	5
Backup Use Case.....	5
IQ Microinverter PV System to Encharge Pairing .....	6
Self Consumption Use Case .....	7
Economic Use Cases.....	7
<b>Ensemble Products .....</b>	<b>8</b>
Enpower Smart Switch.....	8
Encharge Storage System .....	10
Wireless Communication Kit.....	10
<b>Key Planning Considerations.....</b>	<b>11</b>
Physical Installation Considerations.....	11
Temperature Considerations .....	11
Electrical Installation Requirements .....	11
Voltage Regulation Considerations.....	12
Rapid Shutdown Considerations.....	12
<b>Glossary .....</b>	<b>13</b>

## Overview

This document provides site surveyors and design engineers with the information required to evaluate a site and plan the installation of the Enphase Ensemble™ energy management technology 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.

## 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:

- **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.
- **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.
- **Wireless communication kit** enables direct communication between Encharge, Enpower, and IQ Envoy™. It uses 2.4 GHz and 915 MHz frequencies in parallel for maximum reliability. The kit is connected to one of the USB ports on the IQ Envoy.
- **Enphase Mobile Connect™** cellular modem is required unless already present in the IQ™ combiner. This ensures the best performance of your system.
- **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. Install the new communication kit in any IQ combiner to enable wireless communication with Encharge and Enpower.
- **Consumption CTs.** Enphase consumption CTs enable home energy consumption monitoring and are required for Ensemble to operate correctly.
- **IQ 6™ / IQ 7™ series microinverters and accessories.** Ensemble technology is fully compatible with IQ 7 and IQ 6 series microinverters and makes retrofit upgrades as simple as new installations.

## Ensemble Technology 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 un-intentional islands. Ensemble technology 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 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 below shows a drawing of an AC coupled multimode system based on 2017 NEC section 690 and 705.

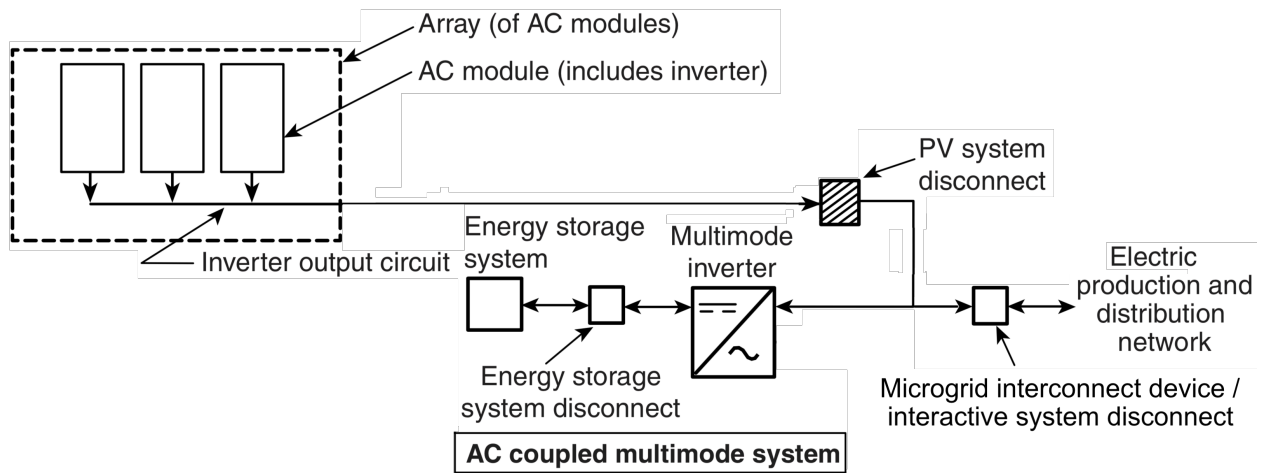


Figure 1: Microgrid system components based on 2017 NEC 690 and 705

### Backup Configurations

Ensemble technology system flexibility enables many backup configurations for different 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, 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, the Enpower smart switch can be configured with a main breaker to act as the service disconnecting means. The PV system can be interconnected to the Enpower smart switch on a dedicated breaker or may be interconnected to the main load panel. This configuration typically supports larger PV and storage system sizes and may allow avoiding 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.

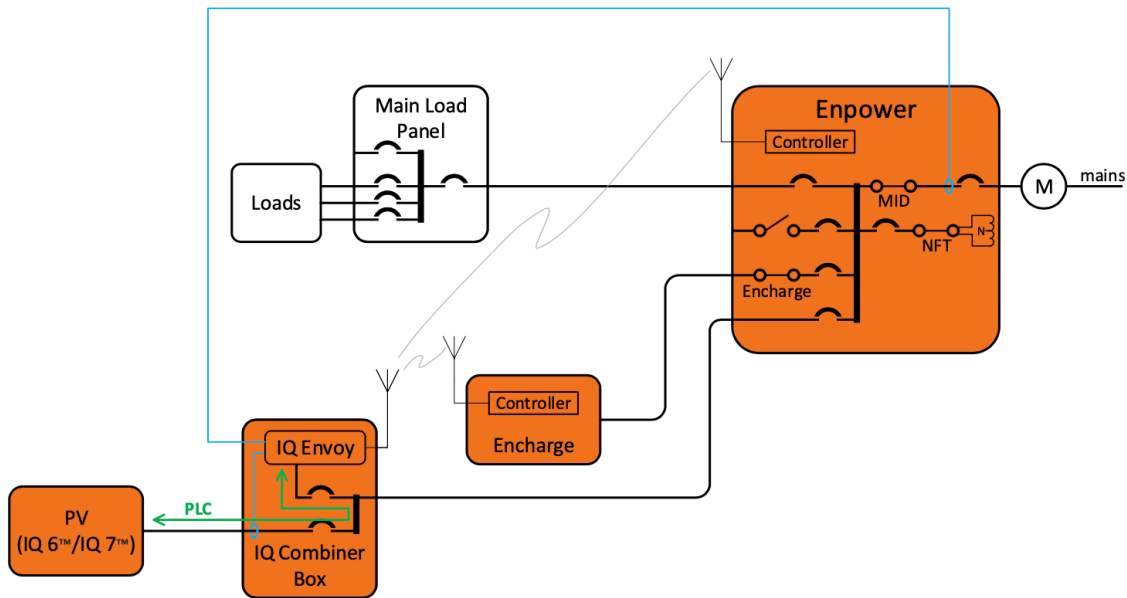


Figure 2: Always-On Ensemble technology system with whole home (main load panel) backup. The Enpower smart switch is installed on the line-side of main load panel, and PV and Encharge storage system are interconnected into the Enpower smart switch.

**Partial Home (subpanel) Backup – Enpower smart switch and a backup subpanel installed on load side of the main load panel**

The Enpower smart switch can also be installed on the load side of the exiting main load panel or service equipment. This configuration can be used when the Ensemble technology system is configured to provide backup to a number of pre-selected load circuits. This configuration is recommended when Encharge storage systems 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. Figure 3 below shows an example of a partial home (subpanel) backup configuration.

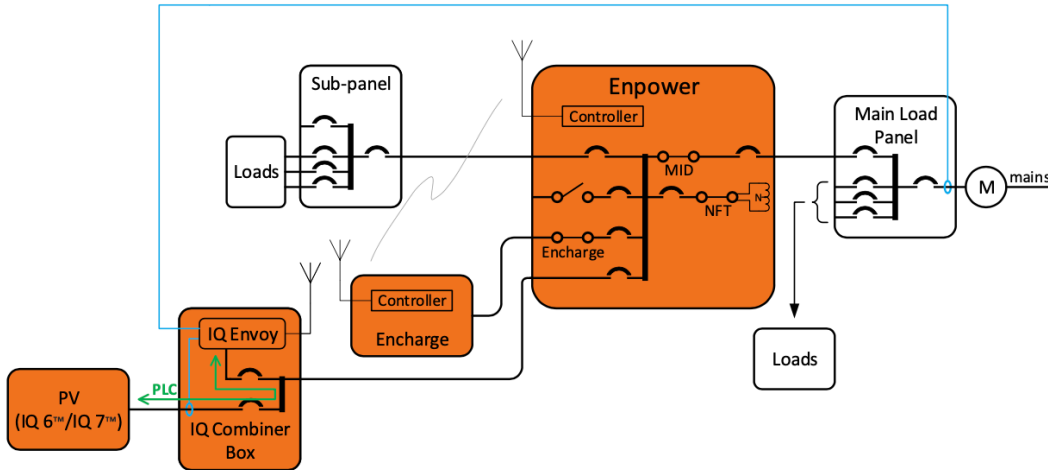


Figure 3: Always-On Ensemble technology system with partial home (subpanel) backup. Enpower is installed on the load side of the main load panel with select loads backed up in a backup subpanel.

**Multiple Enphase systems on 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 installed Encharge storage system, the PV system may need to be split into two separate systems. See the IQ Microinverter PV System to Encharge Pairing section for guidance. One system operates in both grid-tied and backup operations, and one system only operate during grid-tied operation. This may be necessary to accommodate physical, AHJ, or technical requirements. Best practice is to install a second IQ Envoy with a line communication filter (LCF), such as Enphase Q-LCF-064-1P, electrically between the two systems to prevent power line communications between the two systems. The LCF can be installed either as shown in Figure 4 or alternatively between the IQ combiner and the Enpower smart switch. This configuration does not support power export limiting.

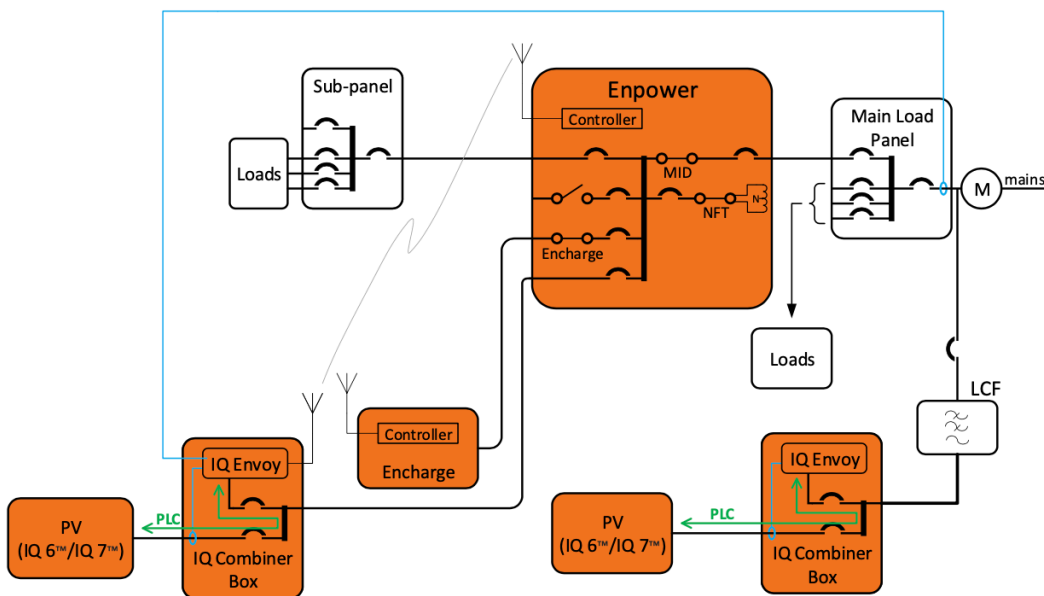


Figure 4: Ensemble technology system and an additional grid interactive Enphase system on a single installation site.

## Non-backup Configuration - Installing Ensemble without Enpower

The Encharge storage system can be added to an existing system without using an Enpower smart switch, however, it will not provide backup. When installed in this configuration, 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 in the IQ combiner or on a user-provided distribution storage 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 Encharge storage system circuits are not included in the production CT.

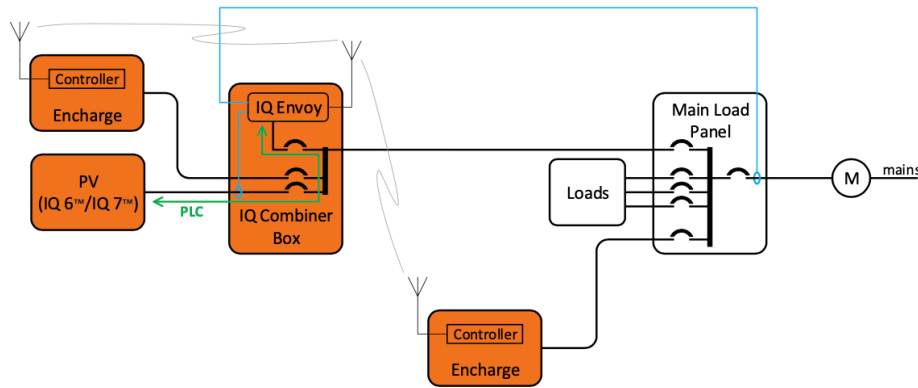


Figure 5: Grid interactive Encharge storage system installation with no backup

## Use Cases and Sizing

### Load Analysis

The first step in correctly sizing a system is a proper load analysis. If an IQ Envoy with correctly configured consumption CTs is already installed at a site, you can use data from Enlighten to properly size the system. A site survey, electric bills, and third-party consumption meters can also provide useful load data for system sizing. Please also review the *Enphase Ensemble Project Survey* document at [estimator.enphaseenergy.com](http://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 it is expressed in units of watts (W) or kilowatts (kW). **Energy** is the accumulated or integrated power used over time and it 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 Encharge storage system **power** rating to **power** loads and charge from PV power generation. 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 Encharge storage system *must* exceed the maximum single load and 67% of total IQ 7 or IQ 6 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 should be sized to supply to the estimated backup loads for a user defined time 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 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 IQ 6 / IQ 7 microinverters in the system. Then select the minimum number of Encharge storage units required so that 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 size 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 time 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 3 units that can be connected to a single Enpower smart switch is 12 (four Encharge 10).

**IQ 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.

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

Table 1: Maximum number of IQ microinverters for Encharge storage system size for backup operation

**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 is 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 bill reduction, demand charge reduction, and energy arbitrage. A special case of **Self Consumption**, called **power export limiting**, is supported for applications where the utility does not allow a homeowner to export power from the PV system to the grid. One example is 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. Simulation tools like NREL SAM (System Advisor Model) or Energy Toolbase can be used to assist with sizing in these use cases.

## 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. 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 (to be activated in future)

Mechanical Data	Enpower
<b>Dimensions (HxWxD):</b>	19.7 in x 36 in x 9.7 in (50 cm x 91.6 cm x 24.6 cm)
<b>Weight:</b>	37.2 kg (82 lbs)
<b>Ambient temperature range:</b>	-40° C to +50° C (-40° to 122° 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. Enpower 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 Enpower smart switch and must be ordered 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, CSR2100N 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 over current 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 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 Enpower 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 Enpower smart switch***

If there is an existing service equipment such as an existing fusible disconnect on the line-side of 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 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, Enpower smart switch would be installed with a 200 A rated Eaton CSR2200N (Enphase SKU: BRK-200A-2P-240V) as a load breaker inside 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 over current protection totaling less than 100A. In this case, Enpower smart switch 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 Enpower smart switch load conductors are rated appropriately.

***Enpower smart switch without main or load breakers installed***

When 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 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 Enpower smart switch. Ensure that 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).

***Encharge storage system, IQ combiner or generator (future) breakers***

When connecting Encharge storage system, IQ combiner or generator to the Enpower smart switch, use one of the following circuit breakers depending on system requirements.

<b>Model Number</b>	<b>Description</b>	<b>Shipment Contents</b>
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, BR240 for Enpower	One box of one unit
BRK-30A-2P-240V	Circuit breaker, 2-pole, 30A, 10kAIC, BR230 for Enpower	One box of one unit
BRK-20A-2P-240V	Circuit breaker, 2-pole, 20A, 10kAIC, BR220 for Enpower	One box of one unit

Encharge 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 microinverters since these inverters are still interactive inverters 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. Encharge storage system includes the multimode inverters forming an intentional local EPS island, and IQ 6/IQ 7 microinverters are utility interactive inverters.

***Generator interface***

The Enpower smart switch includes a 60 A generator connection for qualified generators. This document does not address this function, as the software functionality is not yet released. 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 requires 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.

## 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, 3.36 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, 3.36 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

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 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)	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)
Enclosure	Outdoor - NEMA 3R	
Ambient operating temperature range	-15° C to 55° C (5° F to 131° F) non-condensing	
Optimum operating temperature range	0° C to 30° C (32° F to 86° F)	
Altitude	Up to 2500 meters (8200 feet)	
Chemistry	Lithium iron phosphate LiFePO <sub>4</sub>	

## Wireless Communication Kit



The wireless communication kit enables direct communication between the Encharge storage system, the Enpower smart switch, and the IQ Envoy. It uses 2.4 GHz and 915 MHz frequencies in parallel for maximum reliability. The kit is connected to one of the USB ports on the IQ Envoy.

Model Number	Description	Shipment Contents
COMMS-KIT-01	USB adapter kit for IQ Envoy / IQ combiner. Enables wireless communication with Encharge and Enpower	One box of one unit

## Key Planning Considerations

To ensure best wireless and power line communication between Ensemble system products and cleanest installation, consider the following:

1. Identify a suitable environment, for temperature and enclosure ratings, and wall area, for secure mounting of the weight, of the required number of Encharge storage system and Enpower smart switch.
2. For wireless communications between the IQ Envoy, Encharge storage system, and Enpower smart switch, the best practice is to have a line-of-sight between them.
3. For power line communications, best practice is to have the IQ Envoy located closest to PV branch circuit collection, for example in an IQ combiner.
4. Determine the electrical interconnection points and required breakers for Enpower smart switch, Encharge storage system circuit, PV combiner branch circuits, and the IQ Envoy.
5. Ensure that the IQ Envoy with both production and consumption CTs can be installed at the site.
6. Size conductors properly for ampacity and voltage regulation given conductor lengths.
7. Identify the location the PV system disconnect for rapid shutdown initiation and labeling.

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:
  - a) Indoors: at least 15 cm (6 inches) off the ground and 15 cm (6 inches) from the ceiling.
  - b) Outdoors: at least 15 cm (6 inches) off the ground.
- 5) Ensure that there are no pipes or electrical wires where you plan to drill.
- 6) Plan to maintain at least 90 cm (three feet) of clearance in front of Ensemble technology equipment working space.
- 7) Consider the dimensions of the Ensemble 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. Conduit options are as follows:
  - a) Enpower smart switch – Main supply conductors may enter Enpower smart switch from the bottom or from the bottom-left side. Backup load conductors may enter Enpower smart switch from the bottom or bottom-right side. Encharge storage system, PV combiner and generator conductors may enter from the bottom, bottom-left or bottom-right sides.
  - b) Encharge storage system – Conduit may enter from the top right or top left of the Encharge storage system at the pre-defined knockout locations.
  - c) IQ Combiner series – Conduit may enter at the bottom and sides or rear entry below the busbar assembly.
- 8) Do not block vents.

## 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 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, which may result in undesirable temperature swings outside 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 Encharge Storage System*
- *Quick Install Guide – Install the Enphase Enpower Smart Switch*

### Current Transformers (CTs)

It is critical that installers correctly configure the IQ Envoy, 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.

Installers may extend the consumption CT leads, but not the production CT leads. Therefore, it is best to locate the IQ Envoy close to the microinverter output circuits and then extend consumption CT wires if necessary. Refer to the *IQ Envoy 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 or IQ combiner (labeled AC Combiner). The busbar in the Enpower smart switch can accept a maximum of an 80 A breaker for the IQ combiner over current protection.

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 over current 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 over current 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, an external subpanel must be used 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

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

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 number of units on the circuit and voltage regulation does not exceed 1% between the first Encharge storage system and Enpower smart switch.

## Rapid Shutdown Considerations

Any Enphase IQ 7 and IQ 6 microinverter PV system disconnecting means is capable of meeting the requirements of rapid shutdown initiation. When installing Enpower smart switch and Encharge storage system, the PV system disconnecting means becomes the rapid shutdown initiator. The breakers in the IQ combiner can be used to initiate rapid shutdown since it contains fewer than six breakers to shut down the entire system. Comply with local and National Electric Code requirements for identification, grouping and labeling.

## 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 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.

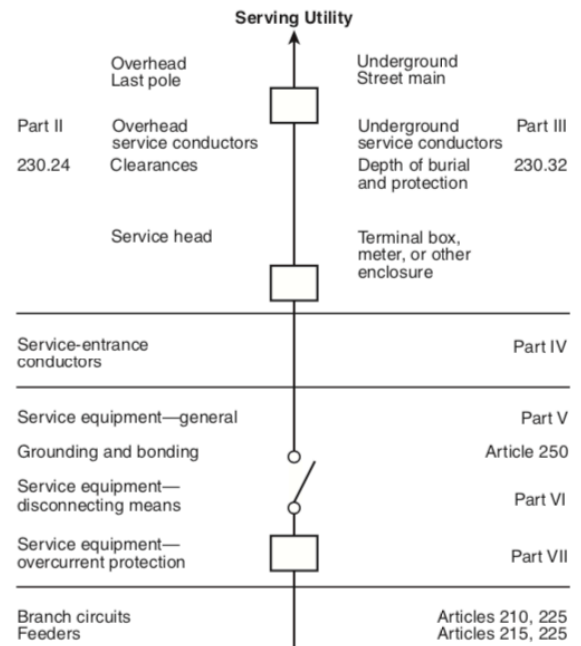
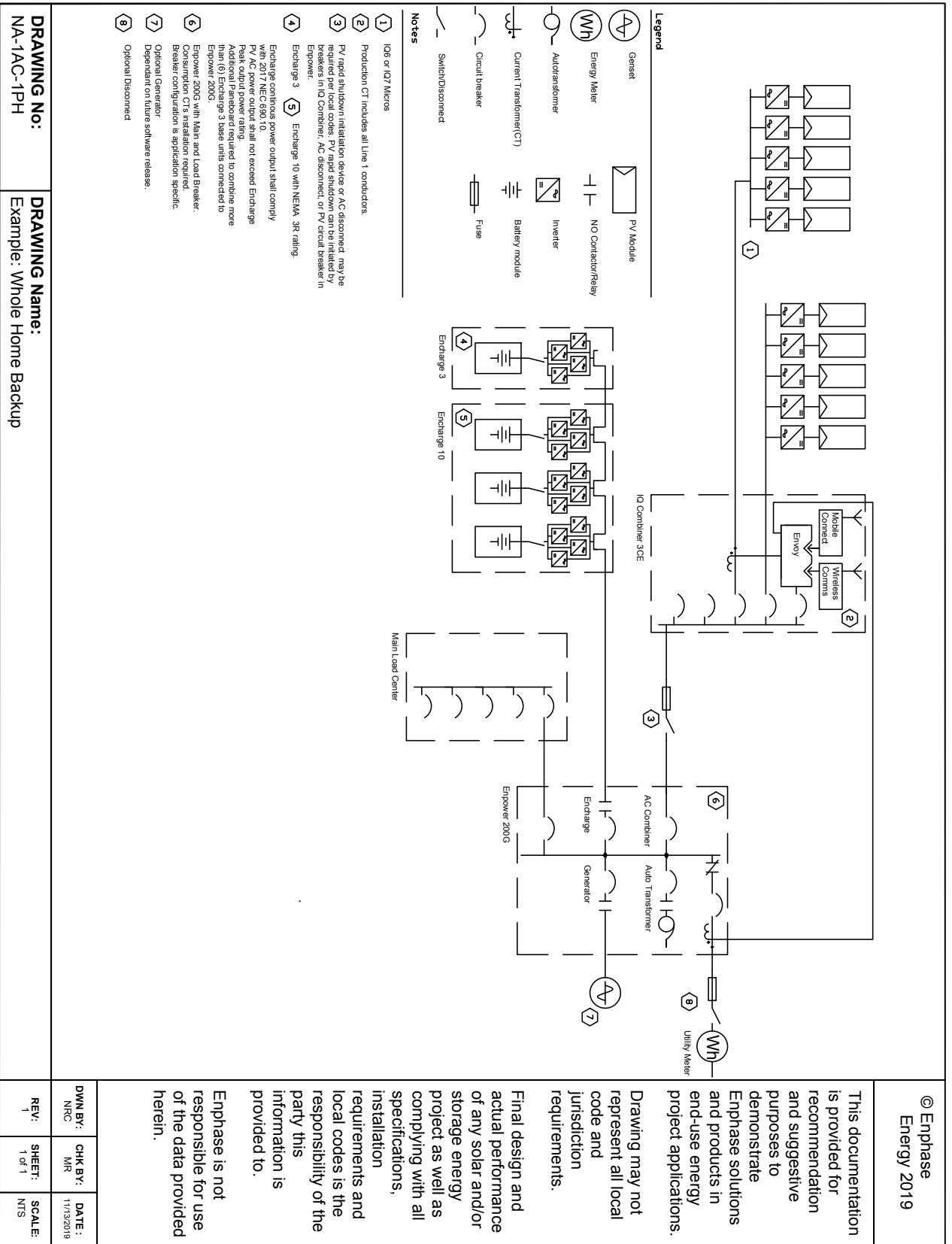
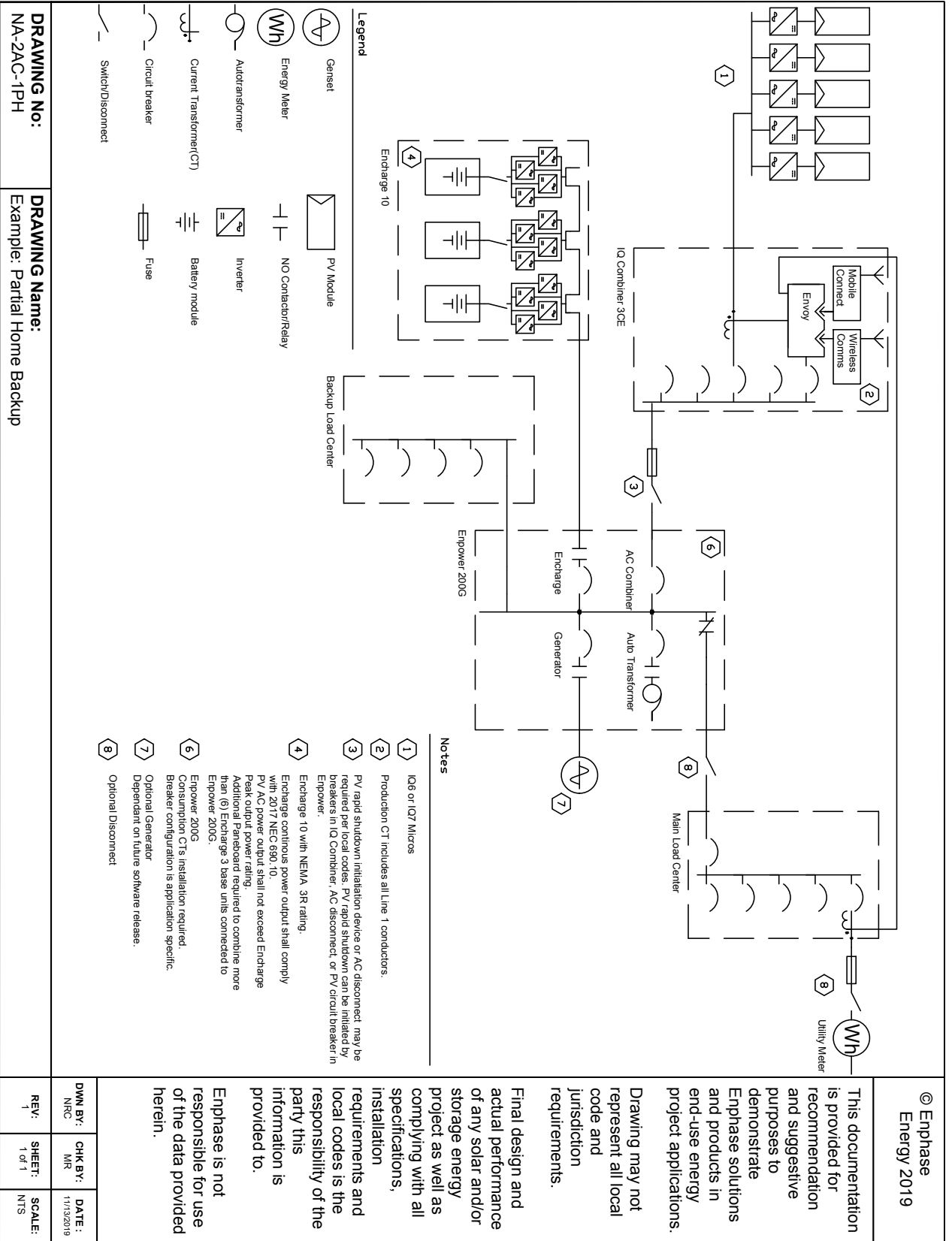


Figure 6: NEC 2017 Figure 203.1 Services © NFPA

# Appendix A – Single line diagrams





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This documentation is provided for recommendation and suggestive purposes to demonstrate Enphase solutions and products in end-use energy project applications.

Drawing may not represent all local code and jurisdiction requirements.

Final design and actual performance of any solar and/or storage energy project as well as complying with all specifications, installation requirements and local codes is the responsibility of the party this information is provided to.

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