

State of Charge Recovery for An Enphase Storage System

Overview

This document provides a complete list of equipment and the procedure to recover an Enphase storage system when it stops forming a microgrid due to energy shortage while there is no utility grid available. The steps outlined here can be used in the event of a sustained grid outage due to a natural disaster, such as a hurricane. The information provided in this document supplements the information in the datasheets, quick install guides, and product manuals. Also note, this brief may not include all requirements from additional state and local codes, standards, and other Authorities Having Jurisdiction (AHJs), applicable to a site.

Note that the Enphase storage system has built-in intelligence that enables automatic charge recovery for batteries. This document provides steps to use in emergency cases when the battery charge is severely depleted (e.g. due to absence of solar power production) or when there are unforeseen events that cause the system's automatic charge recovery algorithms to fail.

To watch a video demonstration of the process of emergency state of charge recovery click [here](#).

Automatic Charge Recovery

When forming a microgrid (i.e., in backup mode), Encharge batteries stop discharging when their State of Charge (SoC) reaches 10% (for systems with Envoy software versions lower than 6.0.103 the limit is 5%) of their rated usable capacity. The automatic charge recovery algorithm starts functioning in this scenario and has the following characteristics:

- The algorithm functions when the battery SoC is between 2% and 10% (for systems with Envoy software versions lower than 6.0.103 the upper limit is 5%).
- The algorithm will restart the system, form a microgrid, and charge from available solar power.
- The algorithm follows an exponential timeout between restart attempts, i.e., 10 mins, 20 mins, 40 mins...120 mins. The maximum timeout is 120 minutes. The system will continue to try to form a microgrid and charge from solar power every 120 minutes while the battery SoC is greater than 2%.
- Each attempt to restart and charge lasts for a maximum of 6 minutes or until the battery loses 0.5% SoC, whichever occurs earlier. If the battery is unable to charge from solar within this time, the battery will stop forming the microgrid and will try again after the timeout described above.
Note: System owners must turn off all loads in the home to ensure that a microgrid can be successfully formed and batteries can start charging.
- In newer software and firmware revisions (Envoy software 6.0.102 and Ensemble firmware 21.06.xx or later) the algorithm for charge recovery only operates between 9.30am and 5.30pm local time to avoid wasting battery charge at night.

When the battery state of charge reaches 2% or lower the automatic charge recovery algorithm is turned off and all electronics within the battery are shutdown to prevent irrecoverable damage to the batteries.

In an emergency, if the system owner is unable/unwilling to wait for automatic charge recovery or if SoC is below 2%, the emergency charge recovery using generator method can be used to charge batteries using a generator.

Emergency Charge Recovery using Portable Generators



This is a procedure that involves accessing high-voltage current carrying conductors. Only certified Enphase installers and qualified electricians should attempt this procedure. This procedure is only intended for recovering battery state of charge. Do not use this procedure to continuously power home loads in parallel from batteries and a generator. Running loads with generator and storage in parallel in this manner can damage the home loads, Enphase equipment and the generator. Using generators in parallel with storage and solar is covered as part of the [Generator with Enphase Storage Tech Brief](#).

Before Visiting the Site

Secure Necessary Equipment

1. Portable generator

A 120/240V portable **inverter** generator from the list below is required.



Only the portable generators listed in the table below are supported by the Ensemble system. Using other generators for this recovery procedure may result in a failure to charge batteries and could damage the generator and Enphase equipment.

Make	Model	Nameplate	Outlet To Be Used
Predator	8750 (SKU: 57480)	Starting Wattage: 8750W Running Wattage: 7000W	120/240V 30A (L14-30R) receptacle
Champion	6250 (SKU: 100519)	Starting Wattage: 6250W Running Wattage: 5000W	120/240V 30A (L14-30R) receptacle
Powerhorse	4500i (SKU: 83171)	Starting Wattage: 4500W Running Wattage: 3700W	120/240V 30A (L14-30R) receptacle

An inverter generator that produces a clean sine wave is essential to ensure that the generator's power quality is within the voltage and frequency limits required by Enpower and Encharge. In addition, the harmonics produced by the generator on the power lines should not interfere with the Power Line Communication (PLC) frequencies used by the solar and storage microinverters. Enphase has tested the above generators and has ensured that these comply with the requirements of the Enphase system.

2. Generator Extension cord stripped to work with Enpower

10-gauge (10 AWG), generator-duty, twist lock extension cord rated for 120/240V 30A (for example, the [Champion generator extension cord](#)). These cables will have a NEMA L14-30P plug on one end intended to be used with the L14-30R female receptacle on the generator. The cable will have a L14-30R female plug on the opposite end. For use with Enpower, the female plug will have to be cut off and the outer jacket stripped. The L1, L2, Ground and Neutral wires in the extension cord will need to be stripped with an appropriate wire stripping tool for use with Enpower.

3. Multimeter with current clamp

4. Multitap connectors and wire (gauge between 300kcmil to 1 AWG)

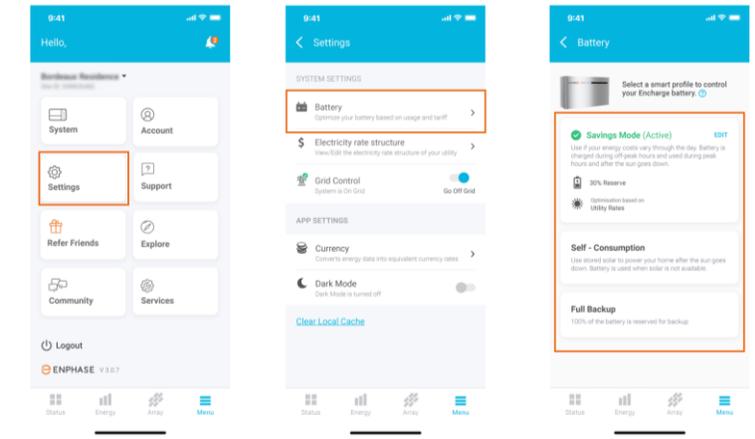
The main lugs in Enpower are rated for 300kcmil to 1 AWG Cu/AL wires. Insulated multitap connectors can be used to connect 10 AWG L1 and L2 wires from the generator extension cord to the Enpower main lugs. Multitap connectors that allow minimum wire gauges of 10 AWG or lower and maximum wire gauges of 1 AWG or higher can be used. Carry at least 2 multitap connectors, one for L1 and one for L2. An example of a suitable multitap connector is the [Polaris double-sided entry, insulated multitap connectors with 2 ports that supports minimum conductor size of 14 AWG and a maximum conductor size of 1/0 AWG](#). These multitap connectors can be used to connect the 10 AWG L1 and L2 wires from the generator to the main lugs or utility side CSR breaker lugs inside Enpower.

Configure the system to charge from utility grid

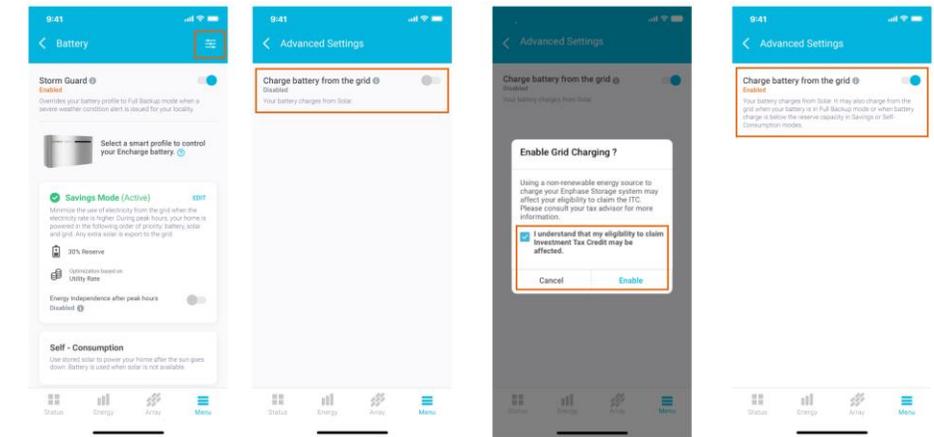
The portable generator will be connected to the utility input of the Enphase as part of the charge recovery steps when on site. The Enphase storage system must be configured to the Full Backup battery profile and to charge from grid so that the batteries can charge from the generator connected to the utility input of Enpower. This step can be done before visiting the site or when at the site.

The system owner can enable the batteries to charge from the utility grid input using the Enlighten Homeowner app.

1. The system owner must navigate to the Menu screen, tap Settings and then select battery.



2. The system owner must select the Full Backup smart profile for the battery to set the reserve SoC to 100% of the battery capacity.
3. Next the homeowner needs to click on the Advanced Settings icon and enable the battery to charge from grid as shown below.



In case the system owner is unable to use the Enlighten Homeowner app as shown above or for third party owned systems that do not have the charge from grid option in the app, contact [Enphase customer support](#) via Chat or call at +1-877-797-4743. Enphase customer support with the permission of the homeowner can set the battery profile to Full Backup and set the batteries to charge from grid. Customer support teams can make these changes remotely when the installer is on site and opens a secure connection (aka tunnel) to the Envoy for the customer support team.

Procedure



This procedure deals with multiple high voltage sources of power. Following the steps outlined below in the sequence that they are stated is necessary to ensure the safety of the installer/electrician.

1. **Turn OFF all power sources to the Enpower.**
 - a. Disconnect the utility supply from Enpower to deenergize the conductors going into the utility input of the Enpower.
 - i. If there is a utility system disconnect (outside the Enpower and connected to the utility input of Enpower) – turn OFF the utility disconnect.
 - ii. OR if there is a panel on the utility side of Enpower - turn OFF the breaker feeding the Enpower in the panel.
 - iii. OR if Enpower is being used as service equipment with a utility breaker inside the Enpower acting as the service disconnect – ensure the service conductors cannot be energized. This may need coordination with the local utility to pull the utility meter out of the meter socket.
 - b. Remove the covers on all Encharge batteries.
Turn the DC switches to the OFF position on all Encharge batteries.
2. **Confirm the state of the following breakers inside the Enpower smart switch**
 - a. Ensure the AC Combiner breaker is turned ON.
 - b. Ensure the autotransformer breaker is turned ON.
 - c. Ensure the Encharge breaker is turned ON.
 - d. Ensure the backup loads breaker, if present, is turned OFF. If there is no backup loads breaker then turn OFF the main supply breaker in the backed-up loads panel.
3. **Confirm the state of the following breakers inside the Combiner or sub panel used to aggregate solar**
 - a. Ensure all the PV breakers are turned OFF.
 - b. Ensure the Envoy breaker is turned ON.
4. **Ready the generator for connection to the Enpower**
 - a. Ensure the generator is turned OFF.
 - b. Ensure the generator has been filled with fuel and oil.
5. **Connect the generator to the Enpower**
 - a. Connect the generator extension cord to the generator. Insert the L 14-30P male plug of the cord into the generator's L 14-30R receptacle and twist lock the plug-in place.
 - b. Remove the Enpower dead front.
 - c. Disconnect the utility L1 and L2 conductors from the main lugs or main breaker inside the Enpower. Cap and Stow away the conductors.
 - d. Connect the L1 and L2 wires from the generator to the main lugs on the utility side of the MID (Microgrid Interconnect Device) relay or lugs on the utility side of the CSR main breaker if there is one inside Enpower.
 - i. Connect the L1 wire on the end of the generator extension cord to the L1 main lug or if there is a utility breaker in Enpower then to the L1 lug at the input of the CSR breaker. Use a multitap connector and a wire of gauge between 300kcmil to 1 AWG to connect the generator wire to the lugs inside Enpower.
 - ii. Connect the L2 wire on the end of the generator extension cord to the L2 main lug or if there is a utility breaker in Enpower then to the L2 lug at the input of the CSR breaker. Use a multitap connector and a wire of gauge between 300kcmil to 1 AWG to connect the generator wire to the lugs inside Enpower.
 - e. Connect the neutral wire in the generator extension cord to an empty hole on the neutral bar inside of Enpower.
 - f. Connect the ground wire in the generator extension cord to an empty hole on the ground bar inside of Enpower.
6. **Turn ON the generator**
 - a. Check oil and fuel levels.
 - b. Turn ON the fuel valve on the generator.
 - c. Move the choke to the CLOSED position.
 - d. Turn ON the engine switch on the generator for electric start generator.
 - e. Turn ON the engine switch on the generator and pull the cord for recoil/pull start generator.
 - f. Move the choke to the OPEN position.

7. Observe the system to ensure it starts using the generator power and is ready to charge batteries

Note: The installer/electrician can use the content in this section to verify system behavior. No action from the installer/electrician is required as part of this section.

- a. Once the generator starts, the Enpower smart switch powers up from the generator power available at the utility side of the MID. Depending on the grid profile applicable for the region, the Enpower smart switch may take anywhere between 15 seconds to 6 minutes to close the MID relay. An audible click of the MID relay closing may be heard.
- b. The MID relay closure can be verified by opening the combiner box or opening the enclosure that contains the Envoy gateway and ensuring the 4 LEDs of the Envoy gateway are blinking red. This indicates the Envoy is powered and is booting up. Note that if this step is delayed the Envoy LEDs may no longer be blinking red, however at least one LED will be lit with green or red color.
- c. Once the Envoy has finished booting up, the Envoy will connect to the Enpower via Zigbee. Envoy will try to connect to the Encharge batteries via Zigbee but will be unable to do so since the batteries will be powered down due to extremely low SoC (<2%). After a maximum of 15 minutes (5 minutes of Envoy to boot and 10 minutes for the Zigbee communication timeout for Encharge batteries), the Envoy will command the Enpower to close the Encharge relay. An audible click of the Encharge relay closing may be heard. The LEDs on all the Encharge units will start blinking red indicating it is powered on via AC.

8. Turn ON the DC switches on a maximum of (3) Encharge-3 units to begin charging the Encharge units

- a. Turn the DC switches to the right to place them in the ON position for up to three Encharge-3 units. Note that each Encharge-10 unit has three Encharge-3 units.
- b. The LEDs on the Encharge units that have the DC switches turn ON will pulse green softly when they are charging. A current clamp multimeter can be connected to the L1 or L2 wires from Encharge landing in Enpower to verify that the batteries are charging.
- c. It can take up to 20 minutes for the batteries to start charging initially and the rate of charging may be low. The rate of charging will increase once the batteries have recovered to more than 2% SoC.
- d. If the batteries are still not charging after 20 minutes the settings as documented in the [“Configure the system to charge from utility grid”](#) section (page 3) may not have reached the Envoy on site due to poor network connectivity. Contact [Enphase customer support](#) and follow instructions to open a secure connection (aka tunnel) to the Envoy so that customer support can make the appropriate changes to the system and enable the batteries to charge.

9. Verify that the Encharge-3 units have charged up to the desired SoC and if applicable charge the remaining Encharge units

- a. To check the Encharge SoC
 - i. Press the Access Point i.e., AP mode button on the Envoy. The AP mode LED should light up with a green color.
 - ii. Connect your phone to the Envoy’s Wi-Fi network.
 - iii. Open the Enphase Installer Toolkit app and open the site being recovered.
 - iv. Go to Devices and Array -> Encharges -> <serial number of Encharge being recovered>
 - v. Check the SoC.
 - vi. Repeated steps ii and iii for all Encharge-3 units that are being charged
- b. If charging during daytime with good irradiance stop charging batteries when they reach 15% SoC. Batteries can charge faster with solar power later.
Note:
If charging when there is poor irradiance or at nighttime stop charging batteries when SoC is higher than 75% or preferably wait until the batteries are fully charged i.e., are at 100% SoC.
- c. At this point the DC switches for the Encharge-3 units that have finished charging to the desired level must be turned OFF.
- d. Next, up to three more Encharge-3 units can be charged by repeating the steps in sections 8 and 9. Never charge more than three Encharge-3 units at a time. This ensures the generator is not overloaded or damaged while charging batteries.

10. After the requisite Encharge batteries have been charged, disconnect, and turn OFF the generator.

- a. Disconnect the generator extension cord from the L 14-30R receptacle on the generator.



Do not touch the prongs of the L14-30P plug on the generator extension cord. Measure L1 to L2 voltage on the lugs on the utility side of the Enpower’s MID. Ensure the reading shows there is no voltage, and the lugs are deenergized before moving to the next step.
- b. Disconnect the generator L1, L2, neutral and ground wires from the Enpower.
- c. Turn OFF the engine switch on the generator.
- d. Turn OFF the fuel valve on the generator.

11. Restore the system to normal operating state by following the sequence outlined below

- a. Turn OFF DC switches on all Encharge batteries.
- b. Connect the utility grid L1 and L2 conductors to the Enpower.
- c. Reinstall the Enpower's dead front.
- d. Turn on the utility side breaker or disconnect that was turned OFF in step 1 or reinsert the meter into the meter socket if the meter was pulled out.
- e. Turn on the DC switches on all Encharge batteries.
- f. Verify the Encharges are discharging. The LED on each Encharge unit will be pulsing blue indicating discharge.
- g. Turn on the PV breakers inside the combiner or solar aggregation sub-panel that were turned OFF in step 3.
- h. **If Encharges were charged to 15% SoC in step 9:**
 - i. Open the Live Status item in the Enphase Installer Toolkit app and check that PV is producing, and batteries are charging.
Note: It can take anywhere between 15seconds to 5 minutes for PV to start producing power. This is dependent on the grid profile applicable for the region and applied to the site.
 - ii. Wait until batteries reach SoC higher than 75% or preferably wait until the batteries are fully charged i.e., are at 100% SoC
- i. Ensure only the essential backed up loads are turned on in the home.
- j. Turn on the backup loads breaker or supply breaker in backed up loads panel that was turned OFF in step 2.

12. The home should now be operating in a microgrid with the Encharge batteries fully functional.

Verify the loads using the Live Status screen in the Enphase installer Toolkit app. Discuss with the system owner whether the system can supply their loads through the night and retain more than 10% SoC to ensure it starts charging from PV the next day. Ensure the owner is aware of the system's capacity and adjust their consumption habits to use power judiciously while they are going through a sustained outage.