

State of charge recovery for an Enphase Energy System

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Overview

This document provides a complete list of equipment and the procedure to recover an Enphase Energy System when it stops forming a microgrid due to excessive discharge of batteries. This situation may arise if there is an extended utility grid outage and solar power is limited or not available during the outage. The steps outlined here can be used in the event of battery charge depletion during 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. This technical brief may not include all requirements from additional state and local codes, standards, and other requirements from Authorities Having Jurisdiction (AHJs) applicable to a site.

The Enphase storage system has a built-in intelligence that enables automatic charge recovery for batteries. This document provides steps to recover the battery in *emergency cases* when the battery is completely discharged (for example, due to the absence of solar power production during an extended grid outage).

This technical brief applies to the listed IQ System Controllers and IQ Batteries.

Model	SKUs
IQ System Controller 1	EP200G101-M240US00
IQ System Controller 2	EP200G101-M240US01/EP200G-SC2-RSD-BRK-KIT
IQ System Controller 3/3G	SC200D111C240US01/SC200G111C240US01
IQ Battery 3T	ENCHARGE-3T-1P-NA
IQ Battery 10T	ENCHARGE-10T-1P-NA
IQ Battery 5P	IQBATTERY-5P-1P-NA

Automatic charge recovery

When forming a microgrid (that is, system operating in backup mode), IQ Battery stops discharging when their state of charge (SoC) reaches a very low SoC limit (VLS) (default- 10%, which is configurable by homeowner). The automatic charge recovery algorithm starts functioning in this scenario:

- The algorithm functions when the battery SoC is between 2% and 10%.
- The algorithm restarts the system, forms a microgrid, and charges from available solar power.
- The algorithm follows an exponential timeout between restart attempts, that is, 10 minutes, 20 minutes, 40 minutes, and 120 minutes. The maximum timeout is 120 minutes. The system will continue to try to form a microgrid and attempt to charge the batteries from solar power every 120 minutes.
- Each attempt to restart and charge lasts for a maximum of six 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.
- When the battery SoC reaches 2% or lower, the automatic charge recovery algorithm is turned off, and all electronics within the battery are shut down to prevent irrecoverable damage to the batteries.
- The algorithm for charge recovery only operates during good solar production time i.e. 9.30 a.m. and 5.30 p.m. local time to avoid wasting battery charge at night.



NOTE: The automatic charge recovery described above applies to systems with the IQ Gateway software version 7.03.XXX and above.



NOTE: For successful automatic charge recovery, homeowners must turn off all loads in the home to ensure that a microgrid can be successfully formed without overloading and batteries can start charging.

Emergency charge recovery using portable generators

Use portable generators in an emergency situation where batteries cannot recover automatically from SoC, or if SoC is below 2%, or if homeowner cannot wait for.



WARNING: This procedure 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 the battery state of charge. Do not use this procedure to continuously power home loads. Running home loads with generator and batteries or solar in parallel can damage the home loads, Enphase equipment, and the generator. The correct method for using backup generators in parallel with batteries and /or solar is covered as part of the [Generator with Enphase Storage Tech Brief](#).

Secure the necessary equipment before visiting the site

Portable generator

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



WARNING: The Enphase Energy System supports only the portable generators listed in the following table. Using other generators for this recovery procedure may fail to charge the batteries and could damage the generator or Enphase equipment.

Make	Model	Nameplate	Outlet to be used
Predator	8750 (SKU: 57480)	Starting wattage: 8,750 W Running wattage: 7,000 W	120/240 VAC 30 A (L14-30R) receptacle
Champion	6250 (SKU: 100519)	Starting wattage: 6,250 W Running wattage: 5,000 W	120/240 VAC 30 A (L14-30R) receptacle
Powerhorse	4500i (SKU: 83171)	Starting wattage: 4,500 W Running wattage: 3,700 W	120/240 VAC 30 A (L14-30R) receptacle

An inverter generator that produces a clean sine wave is essential to ensure that the power quality of the generator supply is within the voltage and frequency limits supported by the IQ System Controller and IQ Batteries. Enphase has tested the above generators and has ensured that these comply with the requirements of the Enphase Energy System.



NOTE: Acceptable voltage and frequency variations and total harmonic distortion are given below:

- Line-to-line voltage (0.5–1.2 pu)
- Frequency: 56 Hz–64 Hz
- Total harmonic distortion (THD) < 10%

Generator extension cord stripped to work with the IQ System Controller

A 10-gauge (10 AWG), generator-duty, twist-lock extension cord rated for 120/240 VAC, 30 A (for example, the [champion generator extension cord](#)). These cables have a NEMA L14-30P plug on one end intended to be used with the L14-30R female receptacle on the generator. The cable has an L14-30R female plug on the opposite end. For use with the IQ System Controller, the female plug must be cut off

and the outer jacket stripped. The L1, L2, ground, and neutral wires in the extension cord must be stripped with an appropriate wire stripping tool for use with the IQ System Controller.

Multimeter

Use a multimeter with a clamp to measure the current, wherever required.

Multitap connectors and wire (2 AWG to 14 AWG)

The AC combiner lugs in the IQ System Controller are rated for 2 AWG to 14 AWG Cu/AL wires. Use insulated multitap connectors to connect 10 AWG L1 and L2 wires from the generator extension cord to the IQ System Controller lugs. Carry at least two multitap connectors, one for L1 and one for L2. An example of a suitable multitap connector is the [Polaris double-sided entry, insulated multitap connector with 2 ports](#) that support a minimum conductor size of 14 AWG and a maximum conductor size of 1/0 AWG. Use one port of the multitap lugs to connect the generator. If required to power the IQ Gateway, use the second port to power the IQ Combiner.

Procedure

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. Follow the procedure to recover the batteries from a very low state of charge.



WARNING: 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.

- Step 1. Turn OFF the grid supply to the IQ System Controller.
Disconnect the utility supply from the IQ System Controller to de-energize the conductors going into the utility input of the IQ System Controller.
- If there is a utility system disconnect (outside the IQ System Controller and connected to the utility input of the IQ System Controller), turn OFF the utility disconnect.
 - If there is a panel on the utility side of the IQ System Controller, turn OFF the breaker feeding the IQ System Controller in the panel.
 - If the IQ System Controller is being used as service equipment with a utility breaker inside the IQ System Controller acting as the service disconnect, ensure the service conductors cannot be energized and turn OFF the CSR breaker within the IQ System Controller.
- Step 2. Turn OFF the DC switches in all IQ Batteries.
- For IQ Battery 3T (ENCHARGE-3T-1P-NA) and IQ Battery 10T (ENCHARGE-10T-1P-NA), turn off the DC switch on all batteries by opening the top cover.
 - The IQ Battery 5P's LED-based DC switch is activated by the battery's power. If the battery SoC is less than 2%, one may not be able to turn OFF. Also, the IQ Battery 5P automatically turns off when the battery's state of charge is very low (less than 2% SoC). This is done to prevent the battery from further discharging, which helps avoid the battery entering a non-recoverable mode.
 - It is recommended to physically disconnect all the batteries and only connect the batteries that are specifically intended for recovery purposes.
- Step 3. Turn OFF all PV branch circuit breakers in the IQ Combiner or sub-panel used to aggregate solar
- Ensure all the PV branch circuit breakers are turned OFF.
 - Ensure the IQ Gateway breaker is turned ON if the IQ Gateway is powered from the load center in the IQ Combiner.
- Step 4. Confirm the state of the following breakers inside the IQ System Controller
- Ensure the AC combiner breaker (PV breaker) is turned ON.
 - Ensure the NFT breaker is turned OFF.
 - Ensure the IQ Gateway breaker is turned ON if the IQ Gateway is powered from the load center in the IQ System Controller.
 - Ensure the IQ Battery breaker is turned ON.
 - 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.
 - Ensure that RSD is disengaged.
- Step 5. Prepare the generator for connection to the IQ System Controller
- Ensure the generator is turned OFF.
 - Ensure the generator has been filled with fuel and oil.

- Step 6. Connect the generator to the IQ System Controller
- Connect the generator extension cord to the generator. Insert the L14-30P male plug of the cord into the generator’s L14-30R receptacle and twist lock the plug in place.
 - Remove the IQ System Controller dead front.
 - Disconnect the PV combiner Port L1 and L2 conductors.

Ensure to use the correct wiring diagram for the system controller after verifying the SKU. The wiring diagram may vary depending on the SKU.

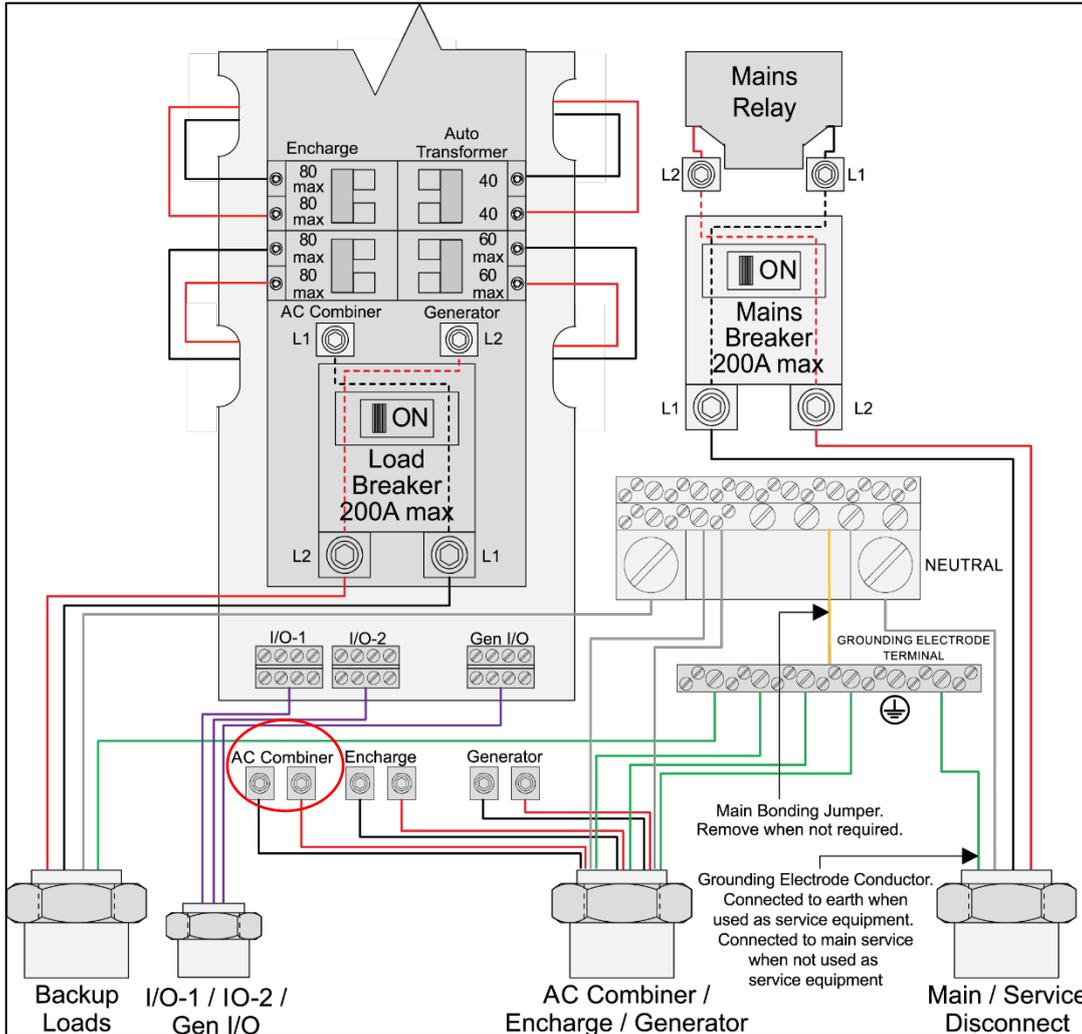


Figure 1: Wiring diagram for SKUs EP200G101-M240US00



NOTE: EP200G101-M240US00 is only applicable for systems with non-IQ8 Microinverters. IQ Gateway is powered ON using a breaker in IQ Combiner; disconnecting the combiner port will switch off IQ Gateway. In this case, the IQ Gateway and generator should be connected in parallel, using Polaris multitap lugs to connect both simultaneously.

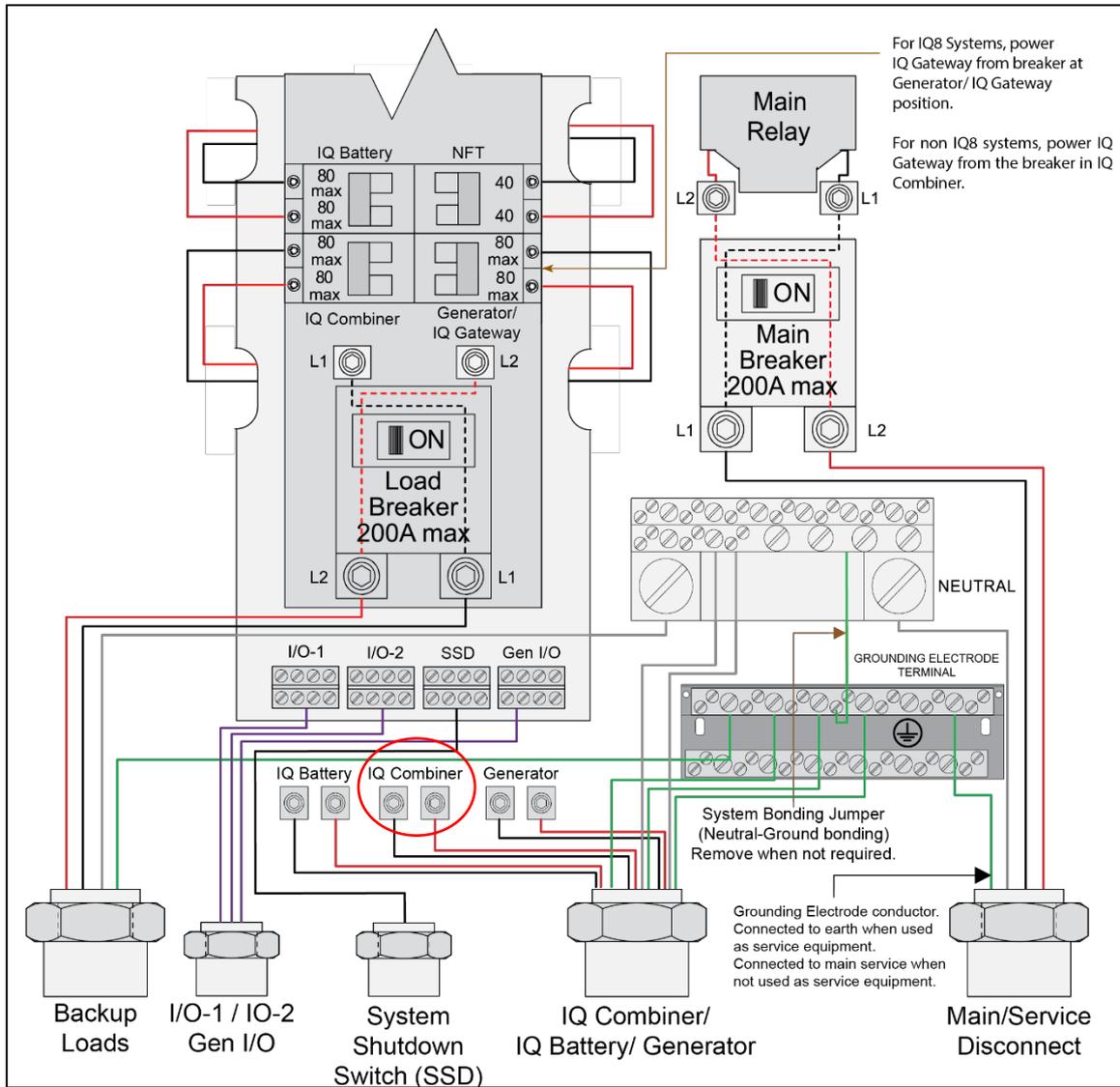


Figure 2: Wiring diagram for SKUs EP200G101-M240US01/ EP200G-SC2-RSD-KIT/ EP200G-SC2-RSD-BRK-KIT



NOTE: For systems with non-IQ8 Microinverters, IQ Gateway is powered ON using a breaker in IQ Combiner; disconnecting the combiner port will switch off IQ Gateway. In this case, connect the IQ Gateway and generator in parallel using Polaris multitap lugs for simultaneous connection.

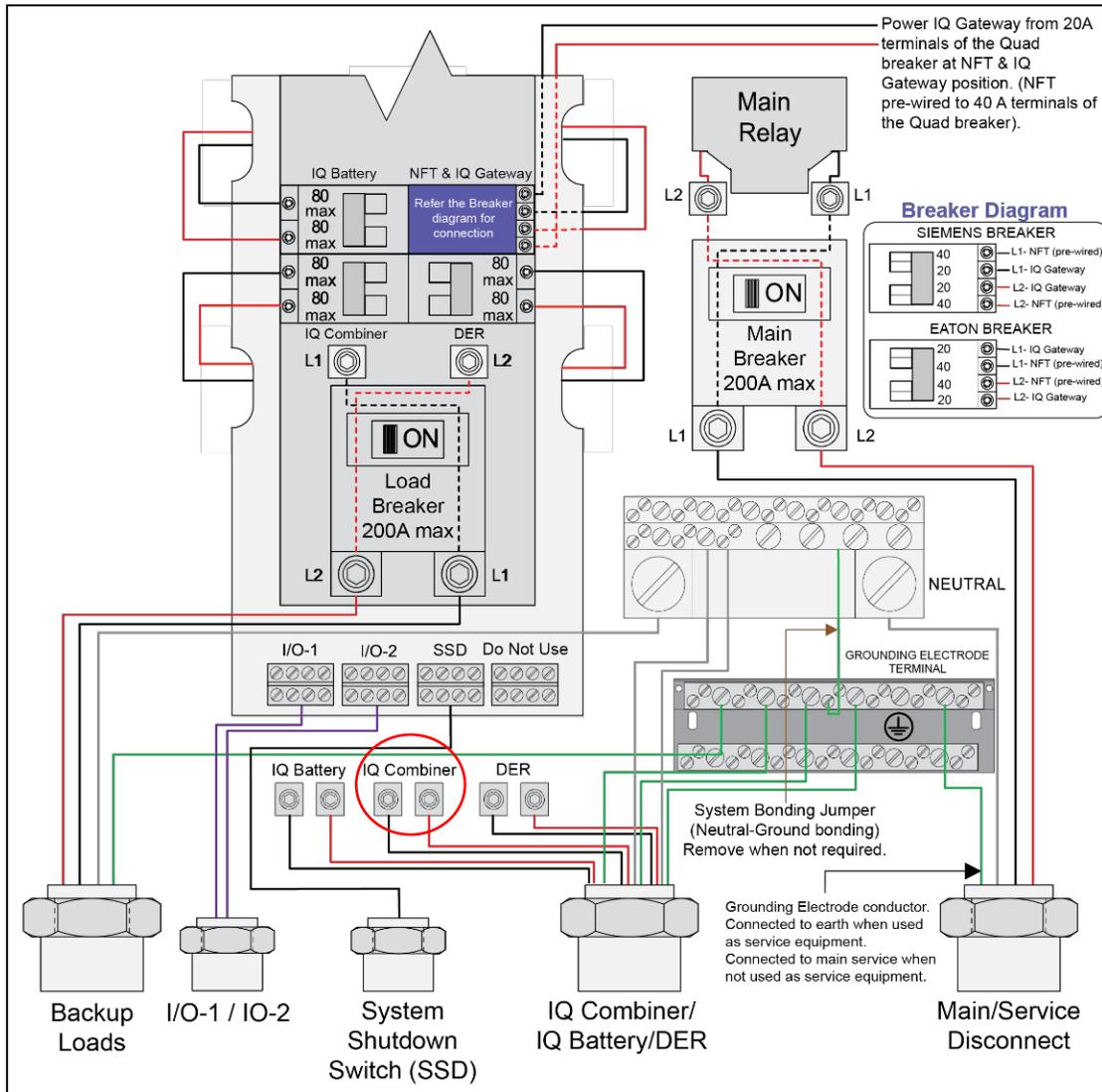


Figure 3: Wiring diagram for SKUs SC200D111C240US01/SC200G111C240US01



NOTE: IQ Gateway with IQ System Controller SKUs (SC200D111C240US01/ SC200G111C240US01) will be powered from a quad breaker used for NFT. IQ Gateway and NFT position may interchange depending on Eaton or Seimens Quad Breaker.

- Connect the other end of the generator-stripped generator extension cord to the IQ Combiner port within the IQ System Controller.
- Connect the neutral wire in the generator extension cord to an empty hole on the neutral bar inside of the IQ System Controller.
- Connect the ground wire in the extension cord to an empty hole on the ground bar inside of the IQ System Controller.



NOTE: Ensure the generator fulfills the criteria.

The following are the accepted voltage, and frequency range by the combiner port for IQ System Controller.

- Line-to-line voltage (0.5-1.2 pu)
- Frequency: 56 Hz-64 Hz
- Total harmonic distortion (THD) <10%

- Step 7. Turn ON the generator
- Check oil and fuel levels.
 - Turn ON the fuel valve on the generator.
 - Move the choke to the CLOSED position.
 - Turn ON the engine switch on the generator to electrically start the generator.
 - Turn ON the engine switch on the generator and pull the cord for the recoil/pull start generator.
 - Move the choke to the OPEN position.

- Step 8. Observe the system



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.

- Once the generator starts, the IQ System Controller will power up from the generator power.
- The system's functioning can be verified by opening the IQ Combiner that contains the IQ Gateway and ensuring the four LEDs of the IQ Gateway are blinking red. This indicates the IQ Gateway is powered and is booting up. Note that if this step is delayed, all the Gateway LEDs may no longer be blinking red; however, at least one LED will be lit with green or red color.
- Once the IQ Gateway has finished booting up, the IQ Gateway will connect to the IQ System Controller via Zigbee for IQ System Controller 2 and over control bus in case of IQ System Controller 3/3G.
- The IQ Gateway will try to connect to the IQ Batteries via Zigbee/Control bus 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 IQ Gateway to boot and 10 minutes for the Zigbee/Control bus timeout for IQ Batteries), the IQ Gateway will command the IQ System Controller to close the IQ Battery relay. An audible click of the IQ Battery relay closing may be heard. The LEDs on all the IQ Battery units will start blinking red, indicating it is powered on via AC.

- Step 9. Turn ON the DC switches

- For IQ Battery 3T (ENCHARGE-3T-1P-NA) and IQ Battery 10T (ENCHARGE-10T-1P-NA) turn ON the DC switch as per listed in the table.
- The IQ Battery 5P's LED-based DC switch is activated by the battery's power. If the battery Soc is less than 2%, one may not be able to turn ON, as The IQ Battery 5P (IQBATTERY-5P-1P-NA) turns on automatically when the battery's state of charge is recovered after being connected to a generator.



WARNING: Only allow batteries as per specified table to be switched ON, switch OFF the remaining batteries to avoid overloading the generator. Recommended to physically disconnect all the batteries and only connect the batteries that are specifically intended for recovery purposes.

The table shows number of batteries can be recovered with a specific generator wattage.

Make	Model	Nameplate	Maximum quantity of IQ Batteries switched ON for charging		
			IQ Battery 3T (1.28 kW)/(3.36 kWh)	IQ Battery 10T (3.84 kW)/(10.08 kWh)	IQ Battery 5P (3.84 kW)/(5.0 kWh)
Predator	8750 (SKU: 57480)	Starting wattage: 8,750 W running wattage: 7000 W	5	1	1
Champion	6250 (SKU: 100519)	Starting wattage: 6,250 W running wattage: 5000 W	3	1	1
Powerhorse	4500i (SKU: 83171)	Starting wattage: 4,500 W running wattage: 3,700 W	2	0	0



NOTE: Do not overload the generator. To ensure this, switch ON the DC switches in IQ Batteries based on IQ Battery power rating and generator rating. The total power required for the number of batteries charging must be less than the generator output power.

- The LEDs on IQ Battery units pulse softly green when charging with DC switch ON. A current clamp multimeter can be connected to the L1 or L2 wires from the IQ Battery, landing in the IQ System Controller to verify that the batteries are charging.
- 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.
- If the batteries are still not charging after 20 minutes, as per the procedure described above, then contact [Enphase Support](#) and follow instructions to open a secure connection (aka tunnel) to the IQ Gateway so that Enphase Support can make the appropriate changes to the system and enable the batteries to charge.

- Step 10. Verify that the IQ Battery units have charged up to the desired SoC and, if applicable, charge the remaining IQ Battery units
- To check the IQ Battery SoC
 - a) Press the Access Point, i.e., AP mode button on the IQ Gateway. The AP mode LED should light up green in colour.
 - b) Connect your phone to the IQ Gateway’s Wi-Fi network.
 - c) Open the Enphase Installer App and open the site being recovered.
 - d) Go to **Devices and Array > IQ Battery > <serial number of IQ Battery being recovered>** Check the SoC.
 - e) Repeat steps ii and iii for all IQ Battery units that are being charged.
 - If charging during daytime with good irradiance, one can stop charging batteries when they reach 15% SoC. IQ Batteries can charge later from solar power.



NOTE: If charging when there is poor irradiance or at nighttime, one can stop charging batteries when SoC is higher than 75% or preferably wait until the batteries are fully charged, i.e., are at 100% SoC.

- At this point, the DC switches for the IQ Battery units that have finished charging to the desired level must be turned OFF.
- Repeat the process for the next set of batteries for charging and recovering the SoC.

Step 11. After the requisite IQ Batteries have been charged, disconnect and turn OFF the generator

- Turn OFF the engine switch on the generator.



NOTE: Do not turn OFF the generator with batteries not adequately recovered, failing to do so might leave the system stuck in a non-recoverable state. If this happens, please contact customer support for further help.

- Turn OFF the fuel valve on the generator.
- Disconnect the generator extension cord from the L14-30R receptacle on the generator.



WARNING: Do not touch the prongs of the L14-30P plug on the generator extension cord. Measure L1 to L2 voltage on the combiner lugs of generator connection. Ensure the reading shows there is no voltage and the lugs are de-energized before moving to the next step.

- Disconnect the generator L1, L2, neutral, and ground wires from the IQ System Controller.

Step 12. Restore the system to the normal operating state.

- Turn OFF the DC switches on all IQ Batteries.
- Reconnect the IQ Combiner L1 and L2 conductors to the IQ System Controller.
- Reinstall the IQ System Controller's dead front.
- Turn ON the NFT breaker.
- 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.
- Turn ON the DC switches on all IQ Batteries.
- Verify the IQ Batteries are discharging. The LED on each IQ Battery unit will be pulsing blue, indicating discharge.
- Turn ON the PV branch circuit breakers inside the IQ Combiner or solar aggregation subpanel that were turned OFF in step 3.
- If IQ Batteries were charged to 15% SoC:
 - a) Open the Live Status item in the Enphase Installer App and check that PV is producing and batteries are charging.



NOTE: It can take anywhere between 15 seconds to 5 minutes for PV to start producing power. This is dependent on the grid profile applicable to the region and applied to the site.

- b) Wait until batteries reach SoC higher than 75%, or preferably wait until the batteries are fully charged at 100% SoC.
- Ensure only the essential backed-up loads are turned on in the home.
 - Turn on the backup loads breaker or supply breaker in the backed-up loads panel that was turned OFF.

- Step 13. The home should now be operating in a microgrid with the IQ Batteries fully functional.
- Verify the loads using the **Live Status** screen in the Enphase Installer App.
 - Discuss with the homeowner 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 adjusts their consumption habits to use power judiciously while they are going through a sustained outage.

Revision history

Revision	Date	Description
TEB-00084-1.0	November 2023	Revised the procedure for SoC recovery.
Previous releases.		