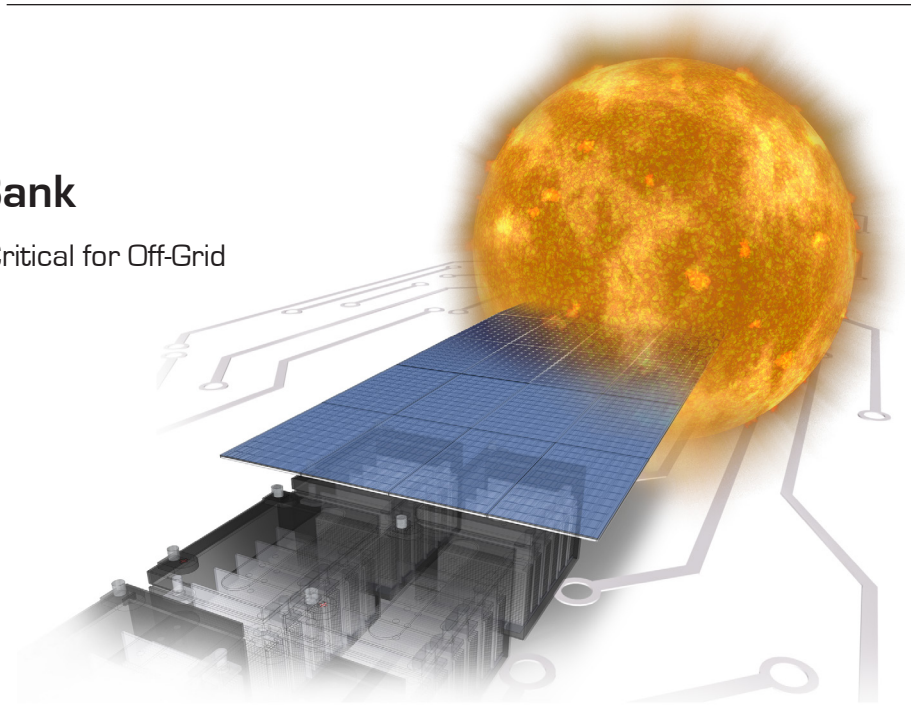
From Sun to Battery Bank

How Effective Battery Charging is Critical for Off-Grid Photovoltaic Power Systems



Content Highlights

- In off-grid systems, PV panels charge the battery bank for storing power.
- Battery performance is critical to a reliable off-grid PV system.
- Battery lifespan has a direct impact on PV operational cost.
- Correct charging improves battery performance and lifespan.

The primary power source, the sun, is the most important part of an off-grid photovoltaic (PV) system, but the battery bank is not far behind. The batteries are among the most critical components of an off-grid PV system in terms of overall system reliability and cost. Therefore, battery management and charging is important to optimize operation and functional life of the battery bank. If not properly charged, the battery bank can fail prematurely, requiring replacement at significant cost.

The Battery Bank is the Power Supply Center

The battery bank accepts the charge from the PV panels* or generator and serves as the power supply center, storing the harvested power for distribution via a DC/AC inverter to power AC appliances, computers, lights, and other electronic devices. If the power supply center does not have sufficient power to meet the load requirements then power is not delivered to all equipment or appliances on the load. In other words, an off-grid PV system is only as good as its battery bank.

PV systems typically use banks of deep-cycle flooded lead acid batteries. Lead acid batteries are an economical choice with a relatively low purchase cost compared to gel and AGM batteries. The number of lead acid batteries needed varies based on the output of PV panels, load requirements, availability of other energy sources and other system design factors. Like any deep-cycle battery application, the performance of these batteries in solar applications depends on proper management of the discharge/recharge cycles, charging to full capacity, and maintenance.

*While the focus of this particular application is photovoltaic systems, other alternative energy sources, such as wind turbines, can also apply depending on the system design.

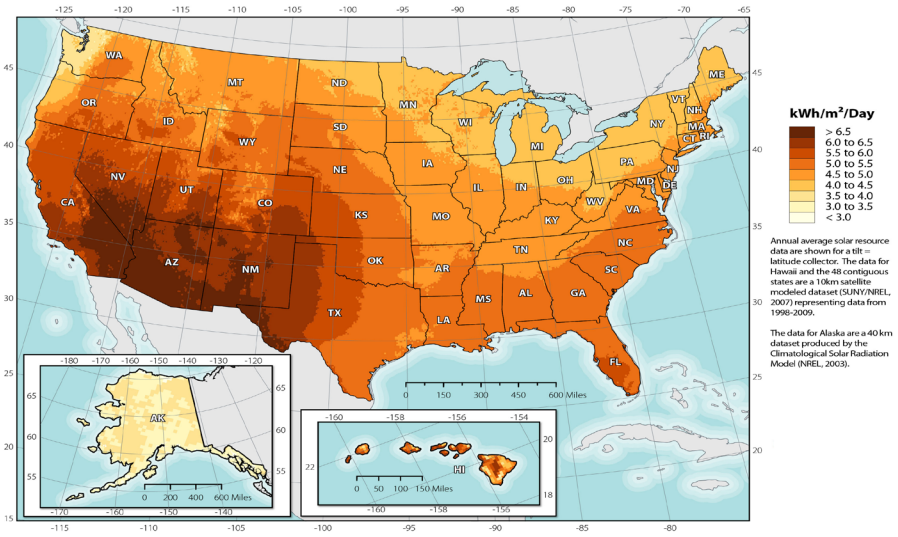


Illustration 1: Photovoltaic Resource Map
Solar resources vary greatly across regions. Photovoltaic power can fluctuate, resulting in the need for a supplemental supply, such as a generator, to maintain the charge to the battery bank. *Map Source: U.S. Department of Energy - National Renewable Energy Laboratory.*

Battery Charging in a PV System

The battery bank is charged in one of two ways. During peak sun hours the PV panels charge the batteries. In much of the United States, peak sun hours average from three to six hours per day, with some areas in the southwest averaging more than 6.5 hours per day. During the other 18 to 21 hours or during cloudy weather when solar radiation energy is insufficient to recharge the battery bank, off-grid PV systems depend on a back-up power source, typically a generator, to charge the battery bank. (In grid-tie PV systems, line power is typically the back-up source and does not require a battery bank. However, if the location is prone to both cloudy weather and black outs, a back-up battery supply may be present and can utilize line power instead of a generator for auxiliary charging).

When the PV panels generate DC power, a solar charge controller prevents overcharging by regulating the voltage and amperage going from the panels to the battery bank. When AC power is supplied by the generator, a power converter/battery charger is used to properly charge the battery bank.

Another approach is using an inverter/charger that performs both functions of inverting power from DC to AC and charging the battery bank. The use of separate chargers and an inverter or a multifunction inverter/charger depends on the application and the budget. Inverter/chargers can contribute to higher system cost. Separate chargers and inverters can be more economical and flexible.

Battery Management and PV System Reliability

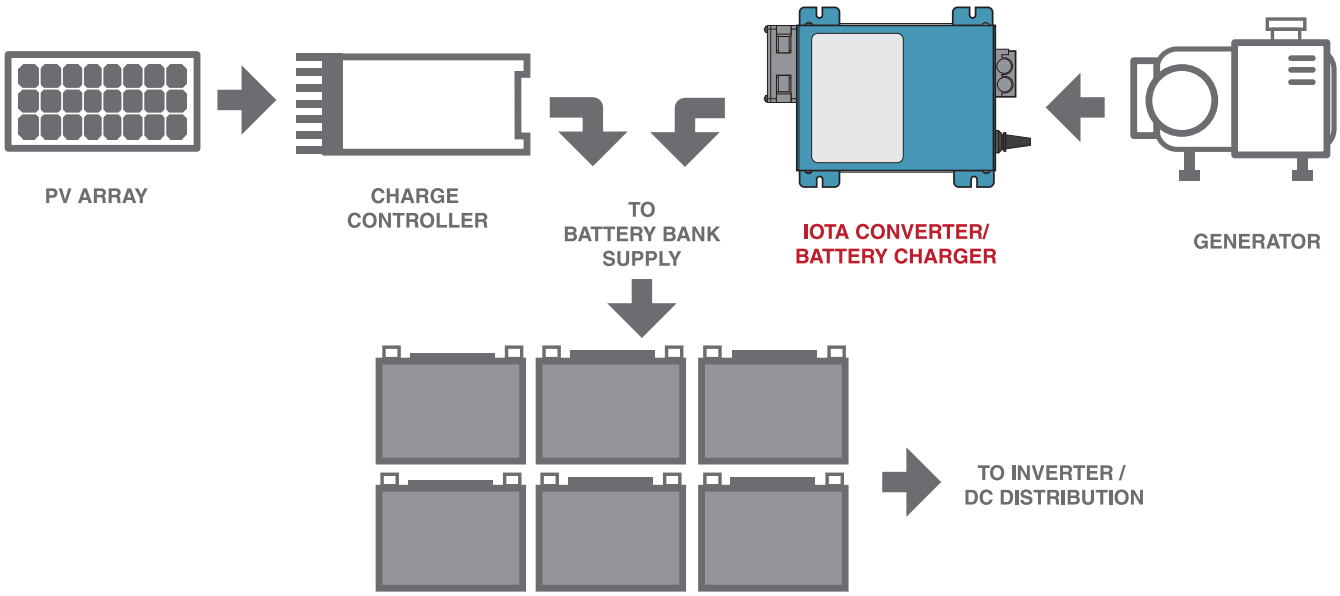
Improper battery management and charging can reduce the reliability and increase the cost of the system. Deep cycle solar batteries are designed to be discharged (up to 80%) and recharged (full) in cycles. Manufacturer's suggested battery life is estimated by the number of cycles at varying depths of discharge. To optimize performance and to prevent premature battery failure, the best option is to charge batteries using multi-stage charge controllers that can achieve full charge.

Multi-stage chargers, such as the IOTA DLS with IQ4 smart charging technology, are the safest and most effective method of charging lead acid batteries. The electrolyte solution in lead acid batteries has phases of accepting a full and complete charge. Correct application of the charging stages helps to prevent undercharging and overcharging, both of which can reduce charge capacity, performance and lifespan of the battery.

The first three stages are bulk, absorption, and float. The fourth charging phase, equalization, is very important in deep-cycle solar applications to exercise the battery bank. If the batteries have remained in the float stage for a certain length of time or if the battery voltage drops below a minimum level, the smart charge controller automatically initiates a new round of charging through the multi-stage cycle, correcting the undercharge

Illustration 2: The Role of the Battery Charger in an Off-Grid PV System

This simplified schematic illustrates the role of the battery charger in the PV system. Like the charge controller, the battery charger delivers an appropriate charge to the battery bank. The charging portion of the system can consist of several battery chargers depending on the size of the battery supply.



condition and stimulating the mixing of the electrolyte solution*. Using AC power from the generator, the IOTA IQ4 Smart Controller enables the IOTA DLS Series Charger/Converter to automatically deliver these four charging stages.

Reliable Charging from Generators

Reliability of the batteries also depends on the reliability of the charger to operate to the manufacturer's specifications. Not all chargers operate reliably with generators, contributing to the battery bank being the weakest link in a PV system. The IOTA DLS Series chargers are engineered to quickly and efficiently charge deep-cycle batteries from generators and other AC power sources with exceptional clean DC output and no AC ripple effects.

Select Quality for Performance and ROI

High performance and quality of chargers and multi-stage charge controllers improve reliability and extend the life of deep-cycle, lead acid batteries that serve as the power supply center in off-grid PV systems. As an important and economical part of the PV system, IOTA DLS Series Charger/Converters with IQ4 Smart Charging Technology deliver the proven quality and the necessary four-stage charging process for optimal performance and life of the system, helping to ensure the system meets or exceeds the return on investment.

*See IOTA's Technical Article **Charging Stored Batteries for Longer Life** for further details on multi-stage charging advantages.

IOTA Chargers in Solar Applications

IOTA DLS Series Chargers are widely used in PV applications across the globe. The rugged design of the IOTA DLS handles the potential of erratic generator AC power and converts it to a proper DC battery voltage. The versatile selection of input and output models, combined with the optional multi-charging capability, make the DLS Series a popular solution for solar power applications.

What's Your Battery Bank Size?

Battery bank sizes can vary greatly depending on the scope and demands of the PV system. In addition to offering a wide variety of battery chargers for input/output voltage and amperage sizes, IOTA DLS Series chargers are engineered for confident series and parallel operation. Utilizing multiple IOTA DLS chargers in series or parallel allows you to increase output voltage or amperage levels to match your system requirements, essentially customizing your charging solution. For more information regarding series and parallel charging, read our technical article **"Best Solutions for Series and Parallel Charger Installations"** in the IOTA Technical Library at www.iotaengineering.com.

About IOTA Engineering

IOTA is a privately held, family-owned company that has worked continuously in the electronic R & D field, designing and manufacturing innovative products for the lighting and electronics industries since 1968. Initially focused on the development of low voltage solid state ballasts, IOTA has expanded to include emergency battery packs for contemporary lighting designs, DC inverter ballasts, and AC/DC power converters and battery chargers. The company is a leader in developing technology for smart chargers for specialty applications and configurable smart chargers to meet unique customer specifications. IOTA is continually expanding its development of state-of-the-art electronics that keep pace with customer needs and industry demands. From the circuit board design to the completed unit, IOTA designs and develops products that maintain superior performance, and is dedicated to providing the highest levels in customer satisfaction, quality and innovation in the industry.

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P.O. BOX 11846 TUCSON, AZ 85734 • 1361 E. WIEDING ROAD TUCSON, AZ 85706 • 1-800-866-4682 • FAX (520) 741-2837
www.iotaengineering.com