Better Buildings Series

A Winning Combination—Design, Efficiency, and Solar Technology

Battery Power for Your Residential Solar Electric System

A battery bank stores electricity produced by a solar electric system. If your house is not connected to the utility grid, or if you anticipate long power outages from the grid, you will need a battery bank. This fact sheet provides an overview of battery basics, including information to help you select and maintain your battery bank.

Types of Batteries

There are many types of batteries available, and each type is designed for specific applications. Lead-acid batteries have been used for residential solar electric systems for many years and are still the best choice for this application because of their low maintenance requirements and cost. You may remember the flooded version, which used to be widely used in automobiles. The sealed version is used in most types of portable equipment. Other names for sealed batteries are absorbed glass mat, valve regulated lead acid, and gel. Lithium and nickel metal hydride (NiMH) batteries, which are commonly used in cell phones, laptop computers, and camcorders because of their energy-to-weight ratios, are very expensive and may be difficult to use in residential solar applications.

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This 24-volt battery bank, used at a remote home powered by a solar-electric system, consists of 2-volt, lead-acid batteries. The batteries are flooded and have clear cases for easy maintenance and quick visual inspection of the plates and the electrolyte levels.

The best kinds of batteries to use in a residential power system are deep-discharge lead-acid batteries specially designed for stationary solar electric systems. Some golf cart batteries may be a less expensive alternative. Car and marine batteries are not recommended for solar electric system use because they are designed to give a large burst of energy when starting a vehicle and are not made for deep discharges. Although they are sometimes used in situations in which deep-discharge batteries are not available, car and marine batteries will quickly fail if used in a solar electric application.

The Battery Bank

The basic building block of a lead-acid battery is a 2-volt cell. A battery bank is a collection of connected 2-, 6-, or 12-volt batteries that supply power to the household in case of outages or low production from renewable energy sources. The batteries are wired together in series to produce 12-, 24-, or 48-volt strings. These strings are then connected together in parallel to make up the entire battery bank. The battery bank supplies DC power to an inverter, which produces AC power that can be used to run appliances. The decision to select a 12-, 24-, or 48-volt battery bank will be determined by the inverter's input, the type of battery you select, and the amount of energy storage you require.

Sizes and Costs

To determine the number of batteries you need, you must first determine how much energy storage you need in kilowatt-hours (kWh). If you are connected to the utility grid, you can use your monthly utility bill to calculate past energy usage for your household. (Keep in mind that implementing energy-efficiency measures in your home is a preliminary step to installing a solar electric system. Reducing energy consumption and installing energy-efficient appliances are far cheaper than purchasing larger solar electric systems.) A second way to determine your required kWh of energy storage is to multiply the wattage of your appliances by the number of hours you use them in a day. Because watts = amps x volts, if you require 1,000 watt-hours (or 1 kWh) per day, and if you have a 24-volt battery bank, then you need 42 amp-hours of useful storage. Because you cannot fully discharge lead-acid

batteries, you would need to install a larger battery to get the needed 42 amp-hours of capacity.

Over the lifetime of the solar electric system, batteries will be the most expensive component of the renewable energy system in an off-grid home due to maintenance and replacement costs. Initial costs for residential batteries range from $80 to $200 per kWh.

What should you look for when purchasing a new battery?

1. A long cycle life, or how many deep discharges the batteries can provide.
2. Thick lead plates—the thicker the plates, the deeper the discharge and the longer the battery life.
3. If you have flooded batteries, look for space at the bottom of the battery case to hold sloughed-off material, which can lower the battery's performance level, and adequate head space above the plates so you don't have to water as often.

Flooded (unsealed, watered) batteries may be the least expensive choice. However, flooded batteries require periodic electrolyte maintenance by adding distilled water and equalizing the charge among cells. Keep in mind that sealed batteries still require maintenance, even though you don't have to check electrolyte levels. Sealed batteries are sometimes specified in difficult or remote locations.

Battery Maintenance

All batteries will wear out in 1-15 years, even if they are rarely used, because the acid in the battery wears down the internal components regardless of use. However, you can maximize the life of your battery bank by adhering to the following practices:

1. Avoid repeated deep discharging of batteries. The more a battery is discharged, the shorter its lifetime. In addition, if your batteries are deeply discharged every day, you should increase the size of your battery bank.
2. Keep batteries at rated temperatures. Battery life is rated for 70°-75° temperatures. Keeping batteries warmer than this significantly reduces their life. Passive solar is a great way to heat a battery storage unit, but it must be well insulated. Keeping the batteries cooler than 70°-75° will not significantly extend their life but will reduce their capacity. Discharged batteries may freeze and burst, so maintain an adequate charge on the batteries in cold weather.
3. Maintain the same charge in all the batteries. Although the entire series of batteries may have an overall charge of 24 volts, some cells may have more or less voltage than neighboring batteries.
4. Inspect your batteries often. Some things to look for are leakage (buildup on the outside of the battery), appropriate fluid levels (for flooded batteries), and equal voltage. Your battery manufacturer may have additional recommendations.

Battery Tips

1. The largest cost, over the life of the system, is the batteries. The lifetime cost, including maintenance, of your batteries is dependent on your initial purchase price, how well you adhere to a maintenance schedule, and the replacement interval for the batteries you select.
2. The energy storage capacity of a battery is measured in watt-hours, which is the amp-hour rating times the voltage. For example, a 12-volt, 100-amp-hour battery has a storage capacity of 1,200 watt-hours, which is the same as a 600-amp-hour, 2-volt battery.
3. Follow manufacturer recommendations for voltage set points. Make sure that your charger or charge controller will supply the correct voltage.
4. Place batteries in a well-ventilated, temperature-moderated area because batteries give off gases that could accumulate to form an explosive mixture. Batteries should be kept in an uncluttered, dry area of a shed or garage or placed in a vented box with a strong lock for easy but safe access.
5. Always refer to the battery manufacturer's recommendations for use and maintenance.

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