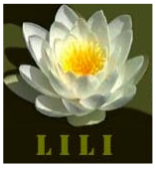
batteries



24 x 600 amp-hour, 2-volt cells wired in series

what are they?

They are units containing combinations of metals and chemicals, between which occur reversible chemical reactions to store and provide electrical power. We will focus on lead-acid batteries, which form the heart of many off-grid, or hybrid renewable energy systems. Although other chemical reactions can provide more electricity, the lead-acid battery is the most successful, because of its affordability, availability, and because it is so robust. A basic lead-acid battery comprises 3 elements - a collection of positive plates, a collection of negative plates and a liquid or gel electrolyte. In a lead-acid battery, the active material of the plates is lead oxide, and the electrolyte is dilute sulphuric acid. In a discharge situation (when giving out energy), elements of the electrolyte react chemically with elements of the plates to release electrons. The flow of electrons through a conductor is electricity. When being charged, the reaction is reversed and the battery absorbs electrons.

Alessandro Volta (who gave his name to the volt) invented the first electric battery in 1800. His plates were of copper and zinc, and the electrolyte was brine. The technology has been constantly improving since then, and now there are many different kinds of battery, including nickel-cadmium and lithium. But lead-acid are still the most popular, because of their bulk manufacture and 2nd-hand availability.

There are 3 kinds of lead-acid battery.

gel: the electrolyte is in a gel form. They are used mainly for emergency standby, and are no good in a cycling (charge/discharge) situation.

glass mat: the electrolyte is held within a soaked glass mat between the plates. They are better than gel batteries for cycling, but over time, anomalies will develop between the individual cells as regards voltage and state of charge. They are used in situations where a liquid electrolyte might spill.

flooded battery: contains liquid electrolyte - the best type for a renewable system. They need to be topped up with distilled water from time to time.

what are the benefits?

The main benefit is for people who are off-grid. If you're building a renewable electricity system, you're not looking to use electricity as it's generated - the sun won't be shining all the time, and the wind won't be blowing all the time (although if you've got micro-hydro, your stream is probably going to be flowing all the time), and you'll need more electricity at some times than others. So you'll need to store it. If you're not on the grid, that means batteries. There is a strong environmental case for saying that if you can have a grid connection, then you should have one, and use the grid like an enormous battery, as the infrastructure is already there. Also, batteries contain lots of noxious metals and chemicals - so the fewer of them the better.

A second benefit, however, is not environmental, it's about energy independence. Many people want to be sure that they are in control of their energy supply all the time. They don't want to give money to giant electricity companies, or risk

testing the specific gravity of the electrolyte in a cell with a hydrometer

4 leisure batteries and an inverter in a vehicle with pv panels and a wind turbine

everything going down if there is a power cut, especially as they have generated their portion of the grid electricity themselves. Also, with loving care, renewable electricity enthusiasts can extend the life of second-hand batteries that would otherwise have died in scrap yards.
The third benefit of batteries is transportability - rechargeable leisure batteries allow the use of renewables in boats and vehicles.

what can I do?

First, work out how much storage you need. Battery capacity is based on amp-hours and volts. Here's an example: a 12-volt bulb drawing 1 amp from a 12-volt battery will draw 1 amp-hour per hour. So if you have a 50 amp-hour battery, then theoretically you could run the bulb for 50 hours before the battery is flat. But, you shouldn't discharge a battery below 50% of its capacity, or you'll create serious imbalances within the battery over a short period of time. So, in this case - a 12-volt bulb drawing 1 amp - you can safely run for 25 hours with a fully-charged battery.
If you want to run something bigger - say a fridge - you have to think about wattage. If the fridge takes 150 watts to run, and the time it's actually running over the course of a day is 3 hours, then it's using 450 watt-hours (150x3) per day. If you disregard the extra current needed to start the fridge, and the inefficiencies of your inverter, then just to run the fridge, you will need almost 40 amp-hours per day (450/12 - because watts = volts x amps). But when you do take those things into consideration, it will be more like 70 amp-hours. And then, because batteries are only around 80% efficient, you'll need to put around 80 amp-hours into your battery on average every 24 hours to run the fridge. You can extrapolate from this for the other appliances you want to run.
Next get your batteries - from industrial battery manufacturers (Google), or forklift/traction battery suppliers & recyclers. Traction batteries are designed to be cycled, and are tougher than leisure batteries (for caravans and mobile homes). You can get them from scrap yards, but only if you know what you're doing. The price varies with the scrap price of lead. The more you understand batteries, the cheaper you'll get them. How many? Well, if an average house requires about 7kW-hours a day, this equates to 300 amp-hours a day from a 24-volt battery bank. So to give enough power for 2 days without discharging the battery below 50%, you'll need 1200 amp-hours. That's 2 battery packs of 12 cells per pack - so 24 cells, each weighing around 25kg.
You'll need a charge controller in your system to make sure you don't damage your batteries, and to run standard 240-volt appliances, you'll need an inverter. It's possible to buy 12-volt appliances, but they are more expensive, plus mainstream 240-volt appliances are becoming much more efficient all the time - so it may be as well to focus on getting a really good inverter.
So, looking after batteries is a bit of a dark art, and can be quite complicated. Batteries are the recalcitrant teenager of your renewables system. Keep an eye on them and they'll be alright, but ignore them and they'll cause problems.

resources

- Thomas Lindsay, *Secrets of Lead-Acid Batteries,* available from LILI
- LILI run a one-day course in London and Manchester on batteries for renewables
- otherpower.com/otherpower_battery.html - information on batteries
- reuk.co.uk/Lead-Acid-Batteries.htm - more information on batteries for people looking at renewable electrical systems

Low-impact Living Initiative (LILI), Redfield Community, Winslow, Bucks, MK18 3LZ
tel: +44 (0)1296 714184 email: lili@lowimpact.org web: lowimpact.org
Registered in England. Company Ltd. by Guarantee no: 420502