

Sun, Wind Energize Club Repeater

How can a small club deal with the ever-increasing repeater electric bill and the vagaries of the power grid?

Austin Lesea, AB6VU

The members of the Loma Prieta (CA) Amateur Radio Club always desired that the repeater and its related equipment be a minimal burden on the owner of the site. The club repeater, AB6VS, is located north and west of Loma Prieta peak, at about 3000 feet elevation, serving the communities of the Santa Cruz Mountains that overlook the Monterey Bay. The equipment consists of a 440 MHz repeater and three remote bases at our site, as well as a 6 meter repeater.

Against the Wind

A 35 W RF output repeater, with controller and remote bases, even with occasional use, used a utility power budget of about 100 W, continuous. That doesn't sound too bad, but since this is the average, and it is a 24/7 operation, it can and does add up. At from 13 to 25 cents per kWh (depending on time of day), the energy needs of the site came to about 2.5 kWh per day, or about

75 kWh per month. If the rate is approximately 20 cents per kWh, then the cost per month is \$15.

To replace this amount of electrical power seemed to be something that the club could do. Along with being self-sufficient at the site, we would also be improving our emergency response capability, for not only our immediate local community, but also for the greater Santa Cruz ARES area (which serves the northern part of the central California Coast along the Monterey Bay).

The AB6VS system is uniquely located to tie together many of the smaller repeater coverage areas, allowing a county-wide net to be conducted (or a response to a county-wide emergency). Additionally, with the 1.2 GHz remote base, we can tie into repeaters that would allow us to communicate back to the California Office of Emergency Services in Sacramento.

At first the club thought that solar panels would be the best solution. With my background in energy systems (my minor in college), I knew that there were other sources of much more economical power.

Wind and water are the first two choices when it comes to generating power at a low cost. A repeater shack at the top of a mountain is unlikely to have a source of falling water nearby, but the wind at the site is, in fact, legendary.

A 500 W wind power generator costs about \$1 per watt; a solar panel costs about \$4-5 per watt. You don't need to be a math genius to figure this one out: generate most of your power from the wind, and then top off the batteries with the fewest number of solar panels possible. I mention the word "batteries," since you need something to hold all those electrons when the sun and wind are not cooperating.

The Answer, My Friend...

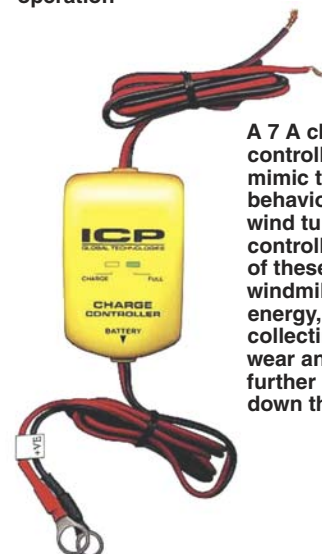
In order to meet the needs of the site, the club decided to use lead acid 200 Ah (wet cell) batteries. Two 8 V strings could be arranged for 12 V by tapping off after six cells. These were diesel electric train starter batteries, made of lead-calcium wet cells, and well suited for deep discharge cycle operation. You can check out these batteries at www.gnb.com/motive/GB3709-2005-03.pdf.

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We chose the Air-X 500 W (in a 25 MPH wind) wind turbine, also called a windmill; a single 80 W, 12 V solar panel was also purchased (see www.windenergy.com/Air_X_Spec_Sheet.pdf). The total cost to the club was less than \$900. Materials, wire, switches and breakers were all donated, but



The batteries used to power the site. These are lead acid 200 Ah (wet cell) batteries, well suited for deep discharge cycle operation



A 7 A charge controller. These mimic the exact behavior of the wind turbine charge controller. With one of these, when the windmill is "full" of energy, it stops collecting it, saving wear and tear (and further capital costs down the road!)



This is the windmill that runs the AB6VS repeater site. With a total cost of under \$1000, it not only saves the Loma Prieta Amateur Radio Club money on the electric bill, it saves energy, too.

Why the Wind is So Good for Power

The power in the wind rises as the cube root of the velocity (wind speed). Because of this wonderful relationship, the difference between a 5 MPH breeze and a 15 MPH blowing wind is as follows:

$$5 \times 5 \times 5 = 125$$
$$10 \times 10 \times 10 = 1000$$

Or, $1000/125 = 8$ times more power at 15 MPH, than at 5 MPH.

This cubic relationship means that the power is increasing with wind speed at a really impressive rate! Every electron from the wind can be stored by the battery (or used by the repeater), and even gusts can be “captured” and put to work.

if the club had to purchase these items, they would have cost less than \$100.

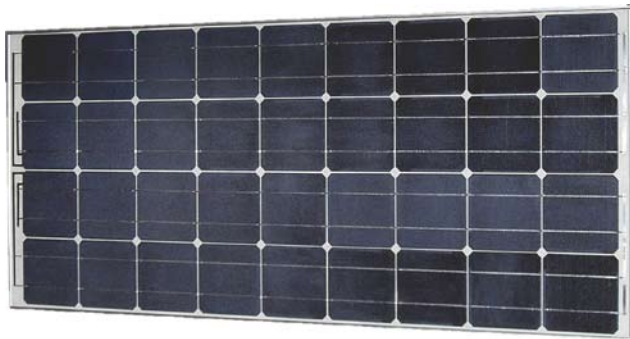
The batteries would normally have cost another \$200, but I had obtained them some years earlier, and I didn't really have a good use for them. At over 300 pounds each, I was actually happy to see them off to a new life where they would do some really heavy lifting.

Charge control is of the utmost importance when dealing with lead acid batteries. Let no one fool you: there is one right way to charge batteries — and many wrong ways. The Air-X wind turbine has an advanced microprocessor controller generator. When the battery voltage is below 13.4 V, the generator will provide all it can to increase the battery terminal voltage. Once the voltage reaches 13.4 V, the microprocessor disconnects the generator from the batteries, and waits until the terminal voltage drops to 12.6 V (or less). One wonderful side feature of this arrangement is that if the wind is too strong, or if the power is not needed, the controller throws a short across the generator and the blades will hardly even turn, even in a gale of 90 MPH wind! This saves much wear and tear on the wind turbine and the blades.

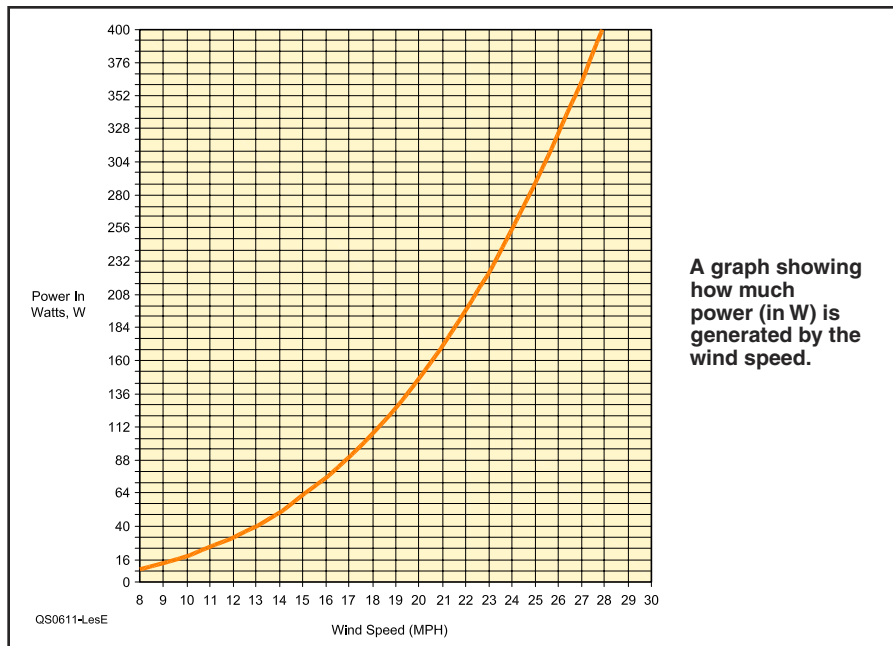
In a similar fashion, solar panel charge controllers are also available for less than \$30 that will mimic the exact behavior of the wind turbine charge controller. So, a 120 W panel (about 8 A in the full sun) will also stop charging the batteries when the batteries are “topped off” and unable to store any more charge (without boiling water and damage).

Dust in the Wind

The two combined systems worked perfectly. As we came into the fall from a breezy and sunny summer, we disconnected the last battery charger from the 117 V ac wall plug in the shack. As autumn came to a



An 80 W solar panel. These are used to capture solar energy, allowing the windmill to run “off grid.”



A graph showing how much power (in W) is generated by the wind speed.

close, we were feeling pretty good.

But then, just when we thought we were in the clear, Murphy made his presence known. The solar panel we had been using was a hand-me-down from 10 years worth of Field Days from another club. Only used once a year, the panel had somehow been dropped, stepped on and otherwise pretty badly abused. The panel still made 6 A in full sun, so no one was complaining on Field Day; however, when the safety glass in front of the solar cells is shattered, they no longer have any physical strength. One windy night, with gusts of over 90 MPH, the solar panel decided that it felt more like a jib sail than a solar panel, and flew off the tower.

Arriving at the site, I realized that the panel had finally given its all for ham radio, and probably was not going to be able to give us any more power. I took the panel and stuck it to a plywood base for support with a tube or three of silicone caulk — and it is still putting out 6 A in full sun!

For the repeater site, we decided to invest in a real panel that had not been so abused. Our new panel (www.mrsolar.com/pdf/bp/BP_380.pdf) is producing copious quantities of electrons.

The Wind Beneath My Wings

So here we are, almost in a new year, with just about 24 months of “off-grid” power being supplied to the site. At less than \$1200 cash, it doesn't appear that we will be breaking even with the local electric company anytime soon (it will take approximately seven years to pay off the cost of the equipment). But if we chose to do this with solar panels only, we would never reach a break-even point before the end of the useful life of the panels.

If you want to go off-grid for your repeater power, consider the use of alternative energy sources like wind or water, and fill in the remaining need with solar panels. Choose your batteries and charging system carefully. And make sure that in a 90 MPH wind, the windmill and panels don't decide to go for a flight!

Photos courtesy of the author.

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