



HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

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Cover: After 100,000 years of burning things, we've finally found better energy sources. See page 6. Photo by Richard Perez

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Building a Battery Box



Bill Battagin

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We folks who choose a photovoltaic system as our source of power, enter a relationship much like that we enjoy/endure with our significant other. Sunshine and smiles have long been associated as a symbiotic pair. Occasionally the system (or “Honey”) blows a fuse, right? We need to be ready! The design, sense of safety, and construction of my new battery box evolved from living with a photovoltaic system for the last ten years.

In the beginning there was (sun)light

When photovoltaics entered my life, I was a novice concerning electrical wiring, batteries, metering, balance of systems, inverters, and so on. Eagerly, I forged ahead with tape, glue, and bailing wire in hand. At the time I felt my installation was copacetic and safe. Now, though the upgrades made on my system are still fueled by “PV dreams”, they are more sophisticated and based on knowledge and experience.

“Drive carefully, Honey”

Safety is the foremost reason that a battery should be enclosed in an appropriate container. Why not just plop them heavy little buggers in some back room somewhere out of the way, bolt a few wires to ‘em, and forget it? Well, a battery generates hydrogen gas which is explosive and contains sulfuric acid which can burn skin, eyes, and other parts of biological units. The acid can corrode your once beautiful looking terminals, cables, joints, and surroundings. We’ve been told before, it’s something we already know: a battery (like that boyfriend) can be obnoxious.

So from a safety standpoint, a battery needs to be kept away from and inaccessible to people of all ages. Your enclosure should be able to contain acid in the event of a spill or leakage. It should also collect hydrogen gas and vent it to a safe outside location.

Cost of Bill Battagin’s Battery Box

Equipment	Cost
Copper bus bar, 1/0 cable, interconnects	\$65
Hot air ducting & 12 V fan	\$74
1/8 inch Acrylic sheet (4 feet x 4 feet)	\$55
1/4 inch AC plywood (4 feet x 8 feet)	\$15
One pint each primer, paint, & linseed oil	\$10
Misc. caulk, screws, nails, slide bolts	\$9
Fiberglass insulation, R-11	\$5
Lumber, recycled	\$0
1 inch PVC pipe, recycled	\$0
Three door hinges, recycled	\$0
Total	\$233

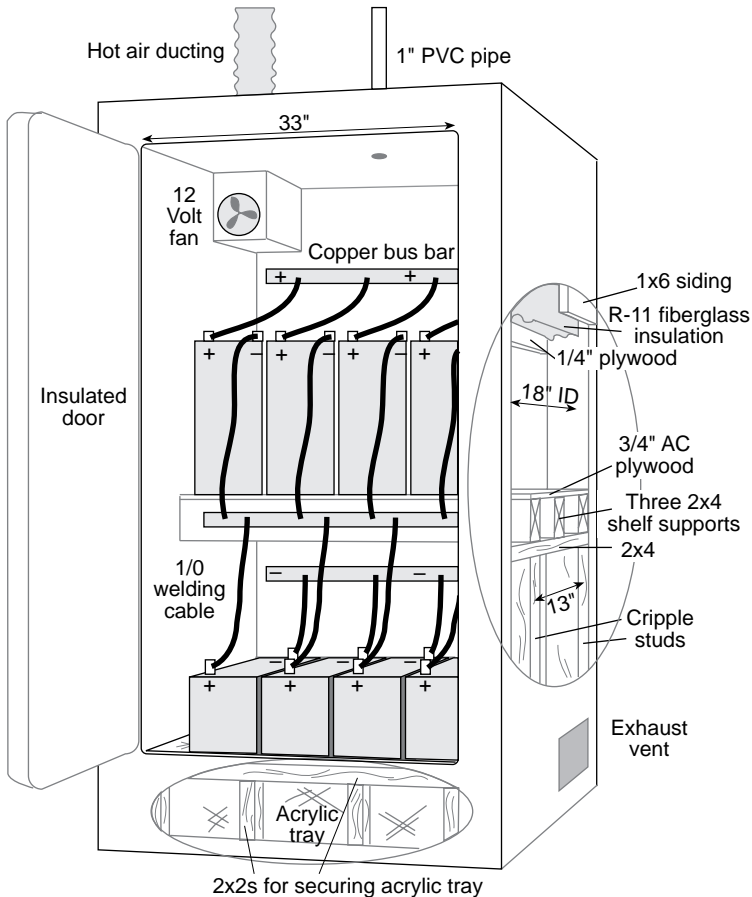
What she’ll do

Performance! You want to get the most from your new battery. I chose eight 6 Volt L-16 wrapped-plate lead-acid batteries manufactured by U.S. Energy (1400 Amp-hours at 12 Volts). Somehow when we install our spiffy new (or used) battery bank, we think that we’re done! These puppies will last forever. Not! It will be too soon that you are elbows deep in battery cables and sulfuric acid again, changing them out. So we want to get as many miles as we can from this expensive investment. The way you connect your battery, the gauge and materials of your conductors, and the integrity of the electrical connections at your terminals all make a difference. For these low voltage systems, any resistance created by poor connections, too small a wire gauge, and the yuk that builds up means less juice reaches the battery. Keeping dirt and other contaminants away from your battery and connections will increase performance and lifespan.

Another function of a battery enclosure is to regulate the temperature of your bank. That location on the floor, in the back room, in the basement, or outside that you chose for your battery may have satisfied most of their needs. But in the winter, it (she) likes to be warm, in the 70°F range. Don’t locate the battery where it will get too warm (over 90°F). Winter warming will have a significant effect on performance, believe me!

Living together

Whether your battery lives inside or outside your home will be determined by many factors: proximity to the PV array (or other energy source) and the inverter, space availability, considerations for venting hydrogen, ease of maintenance, and a method of adding heat to the battery bank. I like the concept of a small power/battery shed separate from my house, but it would increase the cost of my system in time and money. An inside location can be safe and functional, if done properly. And it’s definitely easier to add heat.



The previous relationship

My last battery bank consisted of twelve 220 Amp-hour U.S. Energy 6 Volt golf cart batteries which lasted about five years. At 1320 Amp-hours in a 12 Volt configuration, the battery bank gave me about a five to six day storage capacity. My C/40 rate for charging (my 11 photovoltaic modules deliver 33 Amps) seemed to treat the battery with respect. In any big emergency I still use my grid connection for back-up. I chose to stay with a lead-acid battery because it is recyclable and easily obtainable. Eight L-16 batteries require fewer connections, cables, and joints than a comparable nickel-cadmium battery bank. The space required for a nickel-cadmium bank is significantly larger, since they have a lower energy density. Finally, I found a good deal on these L-16s. This new bank gives me a bit more storage at 1400 Amp-hours. We could talk about usable storage (you should only discharge lead-acids 50–80% whereas nickel-cadmiums can be fully discharged), but uh, I hear my mom calling.... Onward!

Making it work

My battery box was constructed somewhat like a closet. My brother, Dr. Goose, built the four inch stud frame construction walls, insulated and put exterior siding on them. The exterior siding was once the

decking for a roof, some nice looking 1x6 Douglas fir. Four L-16s weigh about 536 pounds so he installed cripple studs under the end support for the three horizontal 2x4s that support the batteries. The door on the box is also four inches thick and is large to allow easy access (see diagram left). The walls, ceiling and door are insulated to R-11, with an inside sheathing of 1/4 inch AC plywood. The existing south wall in the utility room is the back wall of the battery box.

I primed and painted the plywood with a high quality enamel paint. Though certainly not acid proof, it would safely shed any vagrant acid down to a 1/8 inch thick acrylic "tray" in the bottom of the box. The tray is the length and width of the box by ten inches tall, large enough to contain all the acid in one battery. To build the tray, cut the bottom (18 by 33 inches), two sides (10 by 33 inches), and two ends (10 by 18 inches) from a 48 by 48 inch sheet. The bottom of the box had plenty of backing and nailers to solidly support the acrylic sheets which formed the tray. Holes were predrilled and countersunk for the 1 5/8 inch sheet rock screws which secure these pieces to the walls and floor. All corners, screw heads, cracks and penetrations were caulked with 100% silicone seal.

Must have been something I ate

I dealt with hydrogen gas in two ways. First, I installed Hydrocap battery tops on all the cells. Voila, 90% less hydrogen to worry about. Second, a one inch PVC pipe exits the top of the box to allow any gas to escape to the great outdoors (would you please do that outside?) Remember that a hydrogen vent pipe must always rise upward. Horizontal runs should have a little slope so the gas rises to an elevated location, away from ignition sources. Another feature of Hydrocaps is less yuk to clean off the top of your batteries and your terminals and cable connections. I love it. Wiring to and from the inverter, controller, and loads is caulked where it penetrates the walls.

Keepin' her warm

I built my battery box in a back room of my house, a utility/shop space on the north side of the house. It's a cool place — my refrigerator lives there. But batteries perform better at warm temperatures, especially lead acids (see *HP#9*, page 25–26 for a temperature comparison of lead acid batteries). Cold lead acid batteries (at 40°F) have only 80% effective capacity than at 78°F — having cold batteries is like removing some of the batteries from your bank!

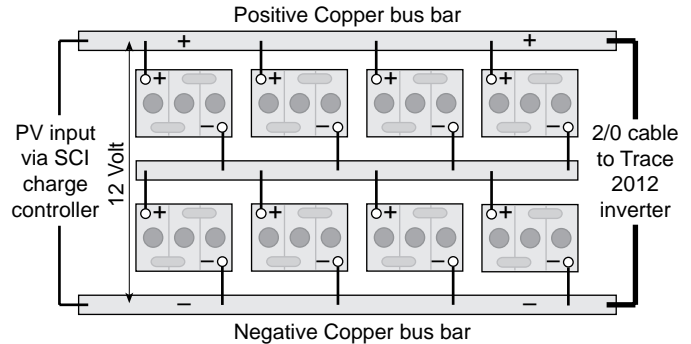
To bring my batteries up to a happy temperature, I installed four inch insulated ducting at the ceiling above my woodstove. This vent comes into the top of the battery box and then enters a sheet metal enclosure inside the top. This enclosure drops about ten inches down into the box and is six inches square. On one side of the enclosure towards the bottom, I cut a 3 1/2 inch round hole where I attached a 12 Volt DC brushless fan. I mounted the fan below the top of the box to prevent hydrogen gas from entering this duct. The fan draws 80–90°F air heated by the woodstove (it's best to pull with a fan, not push) into battery box, warming the batteries. Cool air is exhausted into the room at the bottom of the box on the opposite side.

The uniform heating of all cells was considered in this design. Some baffling may be required after further testing. At this point, I manually turn on and off the fan (on at 10 PM and off at 7 AM), but my mind is conjuring up some schemes for an automatic system.

Solar heating is a viable option. I heat the battery for the solar electric system at my store with a solar hot air panel using a sun synchronous DC fan ducted into my exterior add-on battery box. It works like a champ.

Good Connections

Following Richard's instructions in *HP#7*, page 36–37, I made and soldered ends onto 1/0 welding cable for my interconnects. Basically, I used short (about 2 inch) pieces of soft copper tubing, stuffed a stripped end of



Eight L-16s cross wired for 1400 Amp-hours at 12 Volts

the cable into the tubing. I flattened one end of the tubing with a hammer, soldered the connection, and drilled a hole in the flattened end.

I wired this new battery bank differently from my old bank. I used three lengths of 3/16 inch by 1 1/2 inch copper bus bar to cross wire the battery (see diagram above). Each bus was mounted to the box's interior using one inch porcelain standoffs, secured at both ends with sheetrock screws. The middle bus bar, the heavy gauge cables, and the connecting points for the PVs and inverters allow a nearly identical input and load at each battery. Each individual cell sees a uniform charge and discharge. The cross wiring prevents discharging (and eventually losing) some cells more than others in the battery pack. All the cells should reach float voltage under equalizing charge sooner as well.

The bus bars were placed to ensure that a careless move with a metallic object such as a wrench would not short the battery. I could have bolted the buses directly to the battery terminals, but I prefer to have clear and easy access to the tops of my batteries for cleaning. And, well, I had some extra bus bar, so I bent it and used it for some of the interconnects.

(Almost) Perfect Match

A little wood dough here and there, linseed oil, weatherstripping the door, a couple slide-bolt catches, and we're done. I look way forward to the distant prospect (ten years?) of changing out the L-16s to a high inertia flywheel, or a hydrogen/fuel cell/hydride storage system. In the meantime, I'm gonna go smell the roses (with my honey, of course!).

Access

Bill Battagin, Feather River Stove Works, 5575 Genesee Road, Taylorsville, CA 95983 • 916-284-7849. Questions? If you write, please send an SASE or call between 6–7 AM or 8–9:30 PM.

12/24 Volt fan: Graingers, local phone book. Copper bus bar: check local steel & metal supply houses. Acrylic sheet: check plastic fabricators

