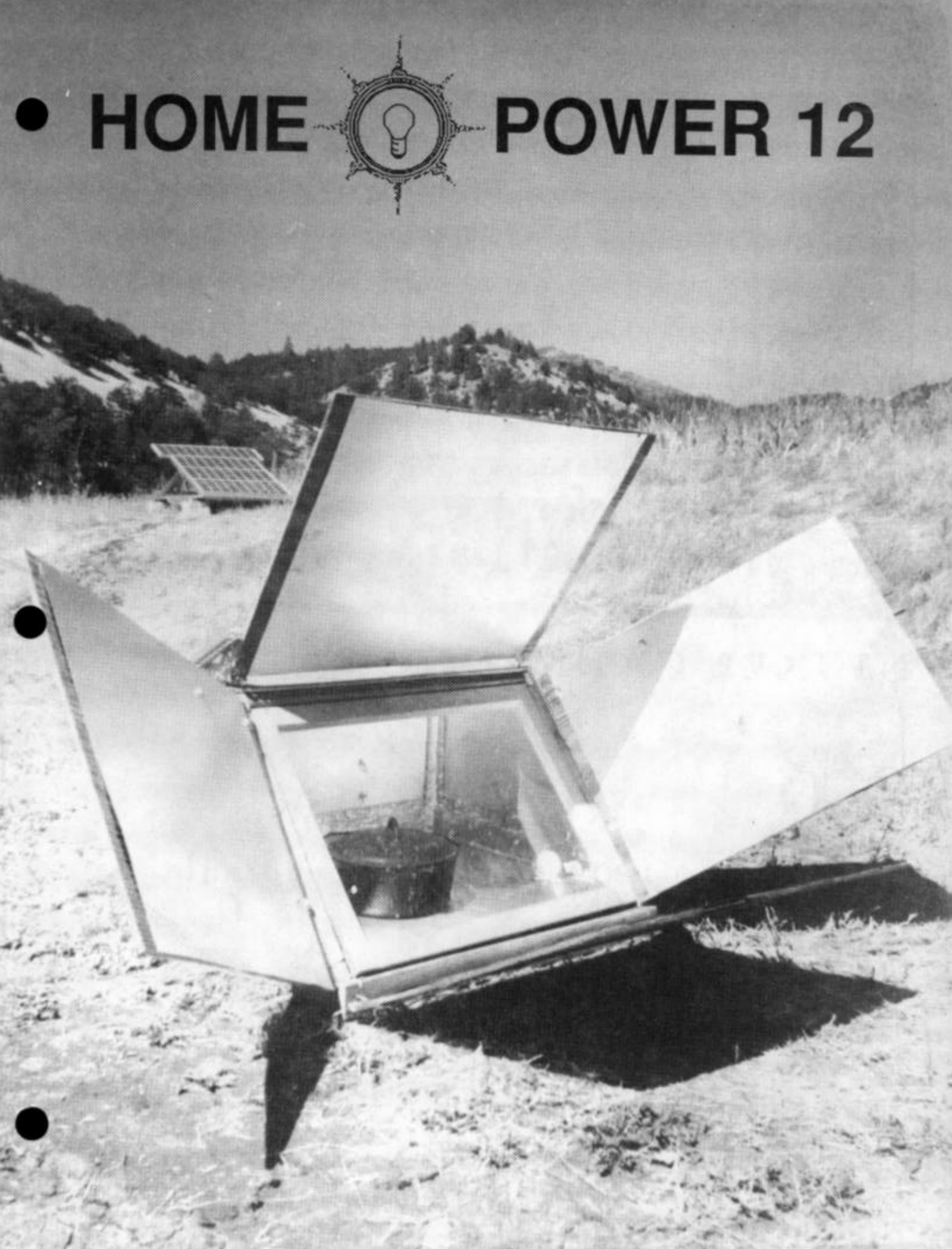
HOME POWER 12



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Contents

Access

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Think About It

"Anybody who isn't confused isn't well informed."

from an anonymous Home Power Reader

Cover

Two views of Solar Energy. Dinner cooking in the solar oven, while the PVs charge the batteries!

Photo by Brian Green & Sonia Cantrell

Welcome to Home Power #12

Sometimes it's hard for us to believe that we've actually published 12 Home Power issues in the last twenty months. What started out as a private fantasy has become a public reality. With now over 13,000 readers, Home Power has grown faster than our wildest expectations. We thank each and every of you for your attention. We realize that this is a busy world with many inputs competing for your attention. We're proud that you choose to read Home Power. We do our best to make the information we publish as easy as possible to understand, technically accurate, useful and maybe (hopefully) fun to access.

We thank our advertisers. It's these fine folks who pick up the bill for Home Power. And truthfully, do more business (and make more money) because of it. Why? Well, because Home Power readers are a delirious crew. We're not talking sitting in an arm chair dreaming a renewable energy powered fantasy. We're talking get out there and actually **do it**. Such doers buy equipment and use it. Many of you have been buying hardware, information and services from our advertisers. You complete the economic cycle that makes this magazine work.

We went to RETSIE again this year. I originally thought to write an article about all the swell new energy devices we found there. Except there weren't any. The biggest news from RETSIE was a monster power failure that plunged the convention into darkness on its last afternoon. The entire San Francisco peninsula, from San Jose to the Golden Gate Bridge was effected. Traffic lights went out and the freeways were snarled until way after sunset. The only lights at RETSIE? Well, they belonged to delirious Home Power crew. It seems that in a international conference dedicated to renewable energy, we were the **only** ones who bothered to truck in some batteries. And so it goes…

So we're thinking that we, home power types, can do a better job of organizing a renewable energy conference. A People's Energy Fair. A meeting of home power producers, not in an air conditioned concrete shell, but outside in the sunshine. With power provided exclusively by renewable sources of energy, not by the local pollution specialists. A gathering for sharing information, ideas, hardware, fun and good times. See Page 27 in this issue for more on People's Energy Fair.
RP

A Special Pair Of Robins

 Daniel Statnekov

There's a very special Robin
Unlike the others here
She has a scar across her breast
Now faded white with years

The searing streak traverses
Lady Robin wing to wing
With a line that parts her feathers
To nearly make a ring

That seems an ashen ruffle
Or a garland loosely draped
Like an ornament acquired
Or the neckline of a cape

It's a miracle the bird survived
The blow that sliced her chest
I marvel when I see her
And rejoice she has a nest

In a tree top near our orchard
That she shares with her proud mate
A fretful male protector
Who displays a curious trait

For within his jet-black glassy eyes
A blaze of white appears
Albino apparition
Or a trace from ancient tears

He may have shed in helpless grief
When in his sight she swooned
Before she rose to fly again
Despite her terrible wound

I wondered why two birds like this
Have joined their lives to share
and then I saw a symmetry
Inherent in the pair

The color of her vestige scar
Indelibly has dyed
The soul of her beloved mate
Reflects now in his eyes.

Bridges System

Orin Bridges

A view of the Bridges homestead from the south. On the roof are the PV modules and the solar hot water colletors. In the foreground is the garden. Photo by Orin Bridges

Unlike most alternative energy homes, our residence is not a remote homesite. It is located just 5.5 miles from Sandpoint, Idaho on 4.2 acres of land and electrical power is just 1/2 mile away. Our main objective was to sever the umbilical cord of utility companies and become more self sufficient. The fact that the original outlay of cash and the absence of monthly bills represents a monetary savings is an additional bonus.

Location

5.5 miles west of Sandpoint , Idaho. Although not remote by most standards, the property is at the end of a 1/2 mile road and has a remote feeling. In addition to the "feel", the lay of the land makes it highly unlikely that others can build within the immediate area. The land is from flat to gently rolling hills, mostly wooded, with 1 acre open for residence, outbuildings, garden and meadow.

Power Requirements

This system was designed to maximize the use of DC. The ac requirements are appliances that are used infrequently or for short periods of time. DC power is utilized for all lighting (mostly fluorescent), water pumping, hot water circulation, solar hot water

pump, refrigeration, color TV, answering machine, grain grinder and ceiling fan.
The ac requirements are washing machine, vacuum, computer and peripherals, electric broom, circular saw, drill, juicer, food processor, blender, VCR, electronic typewriter and hair dryer. The inverter is a Power Pal, which has been modified to include remote switches operated from the kitchen, one for general use and one on the electric ignition propane stove. The vacuum takes the most power - 13 amps ac, but is used at most once every 10 days. In the interim, a very efficient, small Bissel carpet sweeper is used. The next largest consumer is the washing machine - 11 amps ac, but this high energy consumption is used only during the agitation and spinning cycles, not during the filling cycles. The washer is used, at most, every week.

During the "gray sky period", which lasts a long time in Northern Idaho, the vacuum, washing machine and all other possible ac appliances are put to use when the generator is simultaneously charging the batteries. When the generator is running, one extension cord goes from the generator to the battery charger and another from the generator directly into the ac circuits in the house, by-passing the Power Pal inverter.

Power Sources
A Briggs and Stratton Industrial gasoline engine drives a 4,000 watt ac generator. 28 PV panels are mounted on the roof, 26 of which are Sovonics and 2 "left over" small panels that were installed on the original cabin. The Sovonics panels in this installation are individual cells, so the Sovonics array consists of 13 cells connected in series in each array. On a sunny day, the 2 "left over" panels are producing 1.5 Amps and the Sovonics arrays are collectively producing an additional 28 - 31 Amps. This has not changed since they were installed almost 2 years ago.

A special note: the Sovonics panels, not having been field tested in this area, had no track record, but two unsuspected benefits came to light after installation. First, there is no tempered glass over the panels, making them much lighter than other brands. This means that with five panels attached to each roof mounting bracket, the tilt adjustment for seasonal solar changes can be done by one person with little effort and in about 15 minutes. Secondly, during a very heavy storm last winter, which blew down many trees in the area, a loose bolt came out of the aluminum foot which attaches the brackets to the roof, allowing the 5 panels to thrash about on the roof for 2 or 3 hours during the night, before it was rebolted. I believe that if the panels had been covered with tempered glass, they might have broken.

There is no charge controller used in the system, since the C/60 charge rate will not be able to overcharge the 2,016 Ampere-hour battery.

Batteries
12 Volt DC is stored by 6 @ 2 Volt lead-acid batteries. We purchased 9 year old telephone cells which were in good shape, hooked them in series using 3/4" copper tubing with the ends flattened in a vise. We installed them in the garage on the common wall of our "sun space". (Note: I wish I could take credit for the 3/4" copper tubing idea, but in my many trips to the salvage yard looking for copper bus bars, the young man working there finally said "Why don't you use copper pipe?")

The only thing that didn't work according to plan was the "sun space". It has insulation below the slab, and a concrete wall filled with sand and painted black. The full windows faced true south and the batteries were placed on the opposite side of this concrete block wall. The theory was that the solar heat storage would discharge into the well insulated battery area during the winter months. Since there was little sun for the first half of the winter, we heated the sun space with natural convection from the woodstove in the living area. After that, we deserted our hopes for sun in the sun space. We finally put a sliding door & insulated drape between the sun space and the living area to save heat. It did the job, but the batteries were deprived of the heat.

Late last winter, I moved the batteries. The sheetrock on the lower part of the garage side of the living room was removed along with the insulation. We built a box around the batteries. It was double insulated with R-19 insulation, thereby trapping the heat that was escaping from the dining area. This will reduce our reliance on the generator considerably, since the capacity of the batteries will not be as greatly diminished due to the cold. Last January, they remained about 48°F. to 50°F. when it was between zero and 20°F. above outside.

We heated the sun space most of the winter the year before last and as a result we only used the generator 34 1/2 hours that year, after the initial charging. Last year, due to the colder sun space and more gray skies, we used the generator 69 hours. The sun space is now used to propagate seedlings during warm spring days and cold nights.

DC and ac Connections
In order to differentiate between the DC and ac outlets in the house, the receptacles that are DC supplied are ivory (99 44/99% pure power) and the ac are brown (like air pollution from petroleum products). As an extra precaution, to prevent any damage to DC appliances that were plugged into a

The Sovonics photovoltaic panels on Orin's roof. Photo by Orin Bridges.

brown (ac) outlet, I wired the DC receptacles with the negative connected to the round (grounding) point and the positive to one of the slot connectors. This turned out to be over kill. There are three reasons I would not do this again. 1) Since the inverter must be switched on manually, the odds against the accidental plugging in a DC appliance are high. 2) The only DC appliance that we own is the answering machine, which remains plugged into the same outlet. 3) All of the lamps had to be converted to 3 wire, bulky, expensive, and unattractive plugs.

Water

Water cannot be separated from energy. It takes energy to bring it up from the ground, to distribute it and to heat it. The well on the property is 325 feet deep, with a static water level of 124 feet. The former owner of the cabin had put in the well and pumped the water by hand, with a long pump handle. He had installed a 500 gallon cistern which is lower than the well house, so the water was - and is - delivered to the cistern by gravity. From the cistern, the water is pumped by a Flojet pump to a pressure tank to supply the house.

When we added on our house to the cabin, I bought a used jack pump, a 12 Volt DC motor which had been used to power a motorized wheelchair. I picked up a scrapped garage door spring, cut it into the proper lengths and used the springs as a counter balance for the jack pump. I ran #00 gauge aluminum wire in PVC pipe underground to the mechanical room. There, a toggle switch, ammeter and electronic water level sensor provide all the information needed to assure the proper supply of water.

This is an example of what is very important to an alternative energy home; work with sun/wind/water, whatever is available. Limit the use of automatic devices. When the sun shines and the batteries are up, we pump water. If it is cloudy, we wait. I set a mechanical timer for 1/2 hour, check the ammeter to make sure the pumping is smooth, reset the timer, etc. After the pump makes a few strokes to warm up, the ammeter rides between 18-20 Amps in warm weather and 22-25 Amps in the winter. The movement of the meter tells me if the well pump is running smoothly or if one of the counter balance springs is broken. (There are extra springs on hand.)

The Flojet pump caused our copper plumbing to vibrate noisily, so at Steve Willey's suggestion, I installed some garden hose between the pump and the pressure tank. This dampened the noise. My first try was about 6-8 feet of hose. This has been recently replaced by an entire 50' length. We can now barely hear the pump when it is on.

Hot Water

Hot water is supplied by two different systems. In the winter, all the hot water we can use is provided by 3/4" copper pipe passing through the woodstove. Since the storage tanks are in the attic, the heated water is moved by thermosiphon to the tanks, eliminating the need for pumps, controls and energy consumption.

During the sunnier 3 seasons, the 3 solar collectors are used to provide plenty of hot water. There is a solar circulating pump in this circuit, since the water storage tanks are level with or below the collectors on the roof. If it had not been for the design of the house with the living areas on the south side or if we had a hillside sloping away from the south side, I would have used thermosiphon for the summer hot water too. A manual switch turns on the solar circulating pump as it is needed. My first inclination was to dedicate one PV panel to this pump, but since we don't need the water heated every single day during the sunny period, this is another example of working with the weather and balancing the needs with availability.

Reusing Water

The washing machine is located in the attic. The gray water from the washer goes into the septic tank during the winter, but is routed to a couple of 55 gallon barrels during the summer. The combination of gray water and rain water form a low tech method of using water twice. These sources of water flush the toilet in the cabin and furnish water for the garden. In order to prevent clogging the pump between the barrels and the toilet, I removed some of the filtering material from a water filter so it would not take all the dirt out of the water, but would take out the large particles, such as dead bugs, twigs, etc. Additional 55 gallon barrels - a total of 18 of them - plus a 250 gallon storage tank, reduce pumping water for the garden. The large roof area provides a large shed, routing the rainwater to the rain barrels below the downspouts. The water is then siphoned from the downspout barrels to the storage barrels in the garden. The garden is hand-watered from these storage barrels. These barrels are covered to avoid mosquito propagation.

Hot Water Circulation

It takes about 20 Amps to pump water from the well and only 3 Amps to circulate hot water. I designed a loop in the hot water system. The long runs from the storage tanks to the kitchen and bath could be the cause of much water loss - and subsequent additional pumping - while waiting for the cool water in the hot water lines to move out. Rather than waste that water, a pump moves the cooler water in the hot water lines back into the storage tanks. One switch, controlling the hot water circulation pump is located by the kitchen sink and another in the bathroom. A switch is turned on before hot water is drawn. Within one minute, hot water is at the tap. No wasted water or energy.

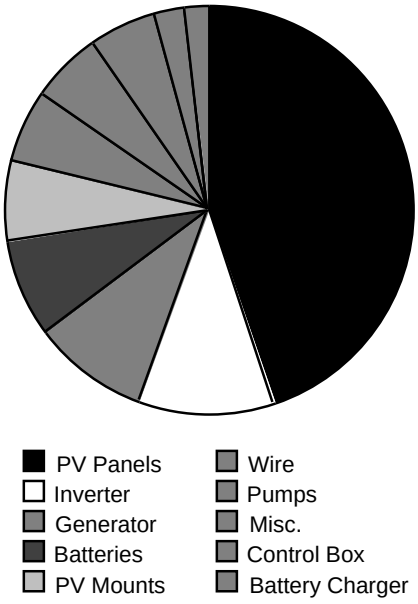
Solar hot water from these 3 @ 4'X8" collectors on the roof. Photo by Orin Bridges.

Refrigeration/Cold Box
On the North side of the house is a small room we call the cold box. This room provides all the cooling needed for food from about November to May. The other months, when the sun is shining at its best, a small Nova-Kool refrigerator located in the cold box is used. The cold box has three outside vents and by opening and closing - and in the coldest weather insulating these vents, the temperature is kept within tolerance.

System Cost
In as much as all the design, plumbing, wiring and installation - except for the PV mount - was done by myself, the costs were kept to a minimum. The costs shown here do not include items that would have been necessary whether or not the home was powered by alternative energy. Such items as the solar hot water collectors ($525), refrigerator ($600), the DC pump and pump jack ($235) and the additional copper pipe used for the solar hot water would still be a part of the design if there was a grid-connected utility.

Cost Breakdown- Bridges' System

Equipment	Cost	%
PV Panels	$2,600	44.9%
Inverter	$629	10.9%
Generator	$530	9.1%
Batteries	$446	7.7%
PV Mounts	$382	6.6%
Wire	$333	5.7%
Pumps	$314	5.4%
Misc.	$310	5.3%
Control Box	$152	2.6%
Battery Charger	$100	1.7%
Total	$5,796	



Recycled water waters the Bridges' garden. Photo by Orin Bridges.

With a little help from our friends…
The batteries, as well as the solar panels, inverter and 99% of the solar electric items were purchased from Backwoods Solar Electric (208-263-4290), owned by Steve and Elizabeth Willey. They have never - in 2 1/2 years - failed to return a phone call, their prices are competitive, their philosophy relating to the cooperation with the earth and all its inhabitants is greatly in tune with our beliefs. Their personal service and willingness to share information is invaluable.

Afterthoughts
Had it occurred to me at the time, I might have designed and included, in the main bath, the flushing system now used for the cabin toilet - rainwater and washwater, with a "Y" connector for use when neither are available.

If I were to do it again, I would give more thought to the battery location and installed them in a warmer area to maximize their capacity, maybe about 10° to 20°F warmer than they are now during the winter. Outside of that, there is nothing I can think of that I would change, except perhaps our gray winters.

Access: Orin Bridges, 6307 Hwy 2, Sandpoint, ID 83864. Please include SASE.

Michael & Orin Bridges.

Simple Designs for Efficient, Low Cost & Reliable Systems

Steve Willey

After a dozen issues of Home Power, you will have noticed the wide variety of systems. Folks are using wind, solar, hydro, & engines of all kinds and combinations to make electricity. Some use big batteries to store the power, some use smaller ones, some folks use several different sets of batteries at the same time. The system voltage may be from 12 to 130 VDC. Some folks use the stored power as direct current (DC)- right from the batteries. Others use an inverter to convert all the low voltage DC to 110 vac- just like downtown. And others wire their home for both 110 volts ac and low voltage DC. What the folks use the power for is even more varied. This diversity is to be expected from individualist, pioneer types. Some designs fit one set of opportunities and needs; different approaches are called for elsewhere. There are many home power design concepts that work and more or less meet our needs. The field narrows if we require the working system to also have the lowest possible cost, high reliability, simplicity and low maintenance. All of this at the same time. Here are some ways to do just that.

Reducing Power Consumption Costs Less And Works Better Than Overpowering The Real Problem With Brute Force Kilowatts.

Example: Replacing one 60 watt bulb operated 6 hours a day with one PL-13 compact fluorescent lamp saves 282 watt-hours each day. That would be the same extra power available each day as adding one more 48 watt PV panel. The lamp change over costs about $35. An added panel costs over $300. Notice that this savings of 200 watt-hours is gained every day the lamp is used: on the sunny days when an extra panel would give the same, but the lamp change ALSO saves 200 watt hours on sunless days when an extra panel would do little or nothing. That is why conservation in design is MORE important than the energy source itself.

The Choice: ac, DC, or Both

One of the first choices is whether ac only, DC only, or a combination of the two will be used in the home. I use and recommend a combination of ac and DC together. Even though this means two separate sets of wiring, it usually meets your needs better while giving you significant cost savings and reliability gains.

Alternating current of course, is appropriate for most regular 120 vac appliances, power tools, large screen TVs, microwave ovens... But not all. Telephone answering machines, alarms, chargers for cordless appliances or ni-cad batteries, two-way radios and radio-phones and electronic clocks and intercoms all need power on a FULL-TIME basis. All of these use minutely small amounts of DC power. When connected to ac, they use a few more watts, because they must convert it back to the DC which they actually use internally. If an inverter is operating 24 hours a day to continuously maintain a few watts of ac for any of these, it is forced to operate in its lowest efficiency range for a large part of the day. Look at the efficiency chart for the greatest inverter you can find. It will be 85 to 95% efficient from about 80 watts to over 3000 watts, but plunges to 50% efficiency or less anywhere below 80 watts. 50% efficiency means it wastes as much power as it uses. If you run just 35 watts full time you will use most of an extra kilowatt hour every day. For this you must buy at least three extra PV modules and you lose power you could use more productively. Most solar technicians can set up answering machines, alarms and ni-cad battery chargers to plug into 12 volts DC, where the power consumption is far less. Fans and lights are other items that are often used in low enough wattage to make inverters operate inefficiently. The very efficient Compact Fluorescents provide good light in 7 and 13 watt versions. Although available in efficient ac versions, three, four or more of these can be used together and still not add up to an efficient loading of a large inverter. DC wiring for the most used lights can save substantial energy each day for the rest of your life!

Other classes of appliances are simply not available in energy saving models for ac, but the portable or DC versions are quite efficient. The most interesting examples are computers and refrigerators. The computer I am writing on is an IBM compatible "laptop", with hard disk. It is designed to be portable, although I never move it from my desk. It is built with "CMOS" circuitry, which uses far less power than ordinary integrated circuits. My meter shows it is using 9 watts right now and NOTHING can interrupt my power. Inverters will run nearly any computer, but the power used will be 10 to 20 times higher than a computer designed for DC power source. This will cost you a lot in dollars and inconvenience, if it is used many hours a day.

Refrigerators generally require about 350 watts in conventional versions and run time is about 8 to 14 hours of each day. Sun Frost DC refrigerators run less than 50 watts DC and their run time is also 8 to 14 hours of each day. Part of this power savings is because the compressors are designed to use minimum power and part is because the Sun Frost refrigerator is so well insulated. Yes, inverters made today can handle a 350 watt standard ac refrigerator with ease. Just plug it in, add more solar modules and feed it the kilowatts. Let's say I add such a refrigerator to a home that already has 6 or 8 PV modules. Instead of adding 3 to 5 extra modules to handle the Sun Frost load, I would have to add 10 to 20 extra modules to handles the added inverter load. And bigger batteries too. You can add up the prices.

Ideally, I like to provide nearly all outlets for ac, but provide one or more DC outlets in each room for the items discussed above, with heavier wiring to the refrigerator outlet. Then lighting circuits, with associated wall switches, are nearly all DC circuits. This requires dividing the wiring to two systems, not necessarily twice as much wiring.

The Choice: Battery Voltage

When autos changed from 6 volts to 12 volts, it would have been better if they had gone to 24 volts instead. They established a very

solid standard of 12 volts without foreseeing the future of high powered automotive stereo and motor homes with all their electrical loads. Nevertheless, we have today a very well established standard of 12 volts. I suppose the most practical standard for homes someday might be 150 volt batteries. Alot easier to convert to high power 120 volt ac (which has 150+ volt peaks) than any other voltage. But that doesn't fit most small and growing solar electric homes because it requires lots of PVs and lots of batteries and a large inverter- all right at the start. And, since it's not yet a standard, few inverters are available without voltage step-up for home scale power. Common choices are 12, 24, 36, or 48 volt and a few 32 volt from the original windmill era.

I advocate 12 volts for the typical remote home unless there is a very good reason for a different choice. Most DC applications: lights, answering machines, auto and RV accessories, as well as remote home products like DC ceiling fans are most available in 12 volt. Portable computers and video cameras have 12 volt power cords now. PV equipment such as charge controllers and inverters are often more easily available at lower prices in 12 volt.

Other voltages are available if there is a real need, usually 24 volts. Some 32, 36, and 48 volt and 115 volt DC systems are in use. You will find that 24 volt inverters cost more per watt. Several 48 volt inverters have been discontinued because small sales and technical problems did not justify further development. 24 volt systems have half the current flow, which means smaller DC wires can be used. Some lights are available in 24 volt, usually at a higher price and less variety. If a system is all ac, no DC used directly, than a 24 volt battery system may be an advantage. PV or hydro transmission can cover twice the distance with the same wire size. If a cottage industry calls for motorized tools to run many hours a day, 24 and higher volt motors are less in demand, lower cost on the surplus market and higher horsepower. These are a few good reasons to use higher battery voltage. But IF THESE GOOD REASONS DO NOT APPLY TO YOU, consider that in the typical remote home, a 12 volt system will offer more opportunities to save money and headaches over the years.

Limits To The Pursuit Of Efficiency?

There are other tricks available to the resourceful inventors and tinkerers, such as converting washer motors to DC. This does save some energy, but is not a path for everyone. If the budget is very tight and the washer is used a lot, such savings can be important. For most, the inverter is the easiest way to power a washer.

Inverter Tips

1) A 1200 watt or larger inverter with high surge capability can run most clothes washers. The starting surge is the real test, sometimes the motor won't start and it will overheat. This is usually cured by adding a motor start capacitor if the washer doesn't already have one (most newer ones don't). This device costs from $4 (solar dealer) to $10 (washer servicemen) and is easy to install. Unplug the washer. Find the diagram of the washer's wiring, locate the START wire of the motor by color, cut it and attach the cut ends to the two connections on the capacitor. If that frightens you, the washer serviceman can do it. (Kenmore washers with 2 or 3 wires to the motor don't take capacitors).

2) Wiring an inverter to a home that also uses an ac generator should be done so that power from both CANNOT be connected to the wiring at the same time. The simplest way is to bring the generator power in on a separate line direct to just one outlet, next to the inverter. The house wiring is fed from a fuse box or breaker box. The power TO this box is fed through a permanently attached "line cord", just as if the whole house were a giant appliance with a cord to plug in. Its plug matches the outlet from the generator, OR the outlet on the inverter, but of course cannot be accidentally plugged into both at once. If the inverter is a "standby" model, its power cord plugs into the generator outlet and the house line cord plugs into the inverter outlet. The inverter switches everything automatically, you never move the plugs. If the inverter should need service, you can remove it and during its absence simply plug the house into the generator outlet directly. This arrangement absolutely requires cords and outlets rated to carry the full power capability of your of your house breaker box. Keep hot and ground polarities correct on all plugs and outlets used.

3) Small neon lights plugged in around the house will let you see at a glance whether your automatic inverter is running or idling or shut off. These orange neon night-lights use so little power that 5 of them in my home will neither start up the inverter nor hold it on. Trace inverters are quite clear in their indication, the nights flicker when idling and glow steady orange when running. Heart inverters show two levels of brightness for idle or running. One of these in the bedroom has stopped me from forgetting to turn off the computer printer several times. Another accessory is the clamp on ammeters used for testing auto starters and alternators. These can be clamped onto the inverter's battery cable to get a reading of current and a confirmation of standby charger operation. They are not numerically accurate, but do help a lot. We give both meters and neons free with each standby inverter installation. If your solar dealer does not have them, they are available in drug stores and auto parts stores and both together will cost you about $15.

Steve Willey can be reached at Backwoods Solar Electric, 8530 Rapid Lightning Creek Road, Sandpoint, ID 83864 or call 208-263-4290.

A Pedal/PV System

David Haaren & Kathy Abbott

We live in a small house on 14 acres of land in southern Vermont. The house is located a mile from utilities in a wooded, sloping area. Solar access is excellent. Three photovoltaic panels, which produce 65 watts in full sun, charge our two deep cycle batteries. An exercise bike and generator are also used to charge the batteries.

The batteries power a variety of appliances: a dozen incandescent bulbs, five fluorescent lights, a TV, video cassette player, stereo, water pump (our supply is gravity), fan, Makita cordless tools, vacuum cleaner, weed-wacker, typewriter and an inverter for a computer, printer and movie projector. We find that the pedaled generator is enough to provide the necessary boost to take our system through the winter. We prefer pedaling to a noisy and polluting gas generator. A gas refrigerator and stove and wood heat help provide for our other needs.

The system shown here has evolved over a dozen years. Earlier systems have been more portable or made use of a ten-speed bike, but none have performed as well. The power transmission is incredibly efficient, as evidenced by the length of time it takes for the flywheel to slow down once it's going. The permanent-magnet generator converts most of the pedal power into useful electricity.

With this system you can pedal-charge a 12 volt battery at up to 15 amps. The generator is rated to deliver 5 amps continuously and is more efficient at easier cruising rates, say 3 amps.

We don't generally measure amps but instead watch the voltage of the battery as indicated by LED voltmeters. The "V for Voltage" has been in the Sunnyside Solar catalog. These voltmeters are similar to the ones featured in HP #10 and The Mother Earth News, May/June "82.

The pedal system consists of a Schwinn DX 900 exercise bike and a Thermax generator, mounted with what we will call a Haaren aluminum bracket. Power transmission from Schwinn's large flywheel to the generator is accomplished using Berg sprockets and plastic chain. This steel reinforced plastic chain runs on precision sprocket gears and is efficient and quiet, quiet enough so that you can read or converse while pedaling. All parts are easily attached and aligned, though a drill and tap are needed to mount the sprocket onto the flywheel.

Our pedal system performs very well as a supplement to our PV home power system. We can offer a kit to retrofit the Schwinn DX 900 or we can assemble a complete machine.

For more information write
Pedal Systems
Box 6
Westminster Station, VT 05159

A Schwinn bike and a Thermax generator turn muscle power into electricity. Power transfer is handled by Berg sprockets and a plastic chain. Photo by Pedal Systems

Solar Box Cookers

Chris Greacen

There's a lot of energy in sunlight - on the order of a thousand watts per square meter. Converting this energy into usable heat takes only an insulated box and a window. It is certainly less round about than burning trees or fossilized plants to cook food. Or worse, burning these fuels in electric power plants which send electricity miles to homes to heat ovens with giant resistors.

Building solar box cookers is simple. Just apply a little common sense and go for it. Below are a couple of general designs to get you started - one I built from scrap plywood in a barn near the Home Power office, and Solar Box Cookers International's even simpler design.

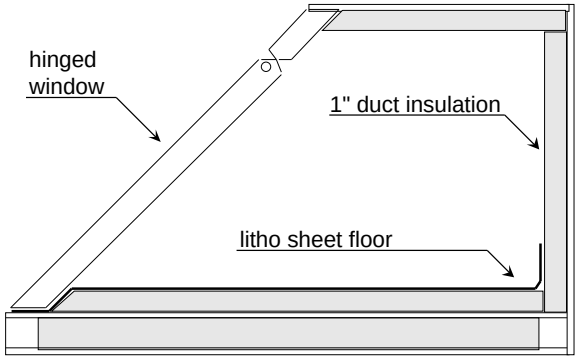
Home Power's First Cooker

Inspired by the solar cooker articles in HP 7 and HP 9, I got fired up about trying to make one. I had no plan, but I knew I wanted the glass to be more or less facing the sun so that light would pass through the glass, not reflect off it, and that I wanted it well insulated. The size of my window pretty much determined the dimensions of everything. The cooker, when finished, was a box of 3/8" plywood with 1" duct insulation on the inside, shiny side facing in. Surrounding the window were four reflective panels: litho sheets stapled to plywood. Litho sheets are great, they are thin steel sheets used by newspapers. We got them for 25¢ for each 2' X 3' sheet. The ink washes off with kerosine, but I enjoyed leaving it making time capsules behind my reflectors.

I wondered about using plywood in the cooker, we joked about it being a plywood flavored solar barbecue, but haven't had any problems. We finished at 4 pm, set it out in the sun, and soon the Home Power crew was eating a big pot of solar coos coos and a fried egg.

The Solar Box Cooker International design

A week later we saw a whole family of solar box cookers set up outside the RETSIE convention in Santa Clara. These units were



A cross section of Home Power's solar cooker. Chris made this one out of scraps on hand: plywood, an old window, some scrap insulation and leftover slotted steel angle. The only item purchased for the project was the aluminium litho sheets. The entire HP crew is amazed how well these solar cookers work! Even on partially cloudy and windy days, this cooker develops an interior temperature over 280°F. Through heating water in the cooker and measuring its temperature rise per unit time, Chris determined that the heat production of this cooker is about 350 Watts.

Left: Chris Greacen does the Solar Cookin'
Above: A view of the rear of the solar cooker.
Right: Solar cooked coos-coos and an egg.
Temperature in the oven was 275°F.
Photos by Brian Green.

simpler than mine and cooked great food for convention goers. The oven is essentially two nested cardboard boxes, covered (all except the outside of the outer box) with aluminum foil. There is a dead air space between the boxes a few inches thick created by balls of wadded newspaper. Four foiled cardboard strips bridge the two nested boxes, keeping the hot air from escaping from the dead air space. On top goes a tight fitting cardboard lid with a window glued in with heat resistant glue. Attached to the lid is a single aluminum foiled cardboard reflector propped up with a stick and tightened down with a loop of string. As simple as you can get - and they work - at lunch time they were cooking at a good 250°F, hot enough to bake cake and cook pounds of meat, rice, and vegies.

Tips

•Use sufficient insulation. Be sure to use a type which will not out-gas. Some insulations were not meant for high temperature and will break down and emit nasty chemicals. Don't use foam. Regular fiberglass insulation works well, just be sure to cover it so you're not eating insulation in your cooked food.

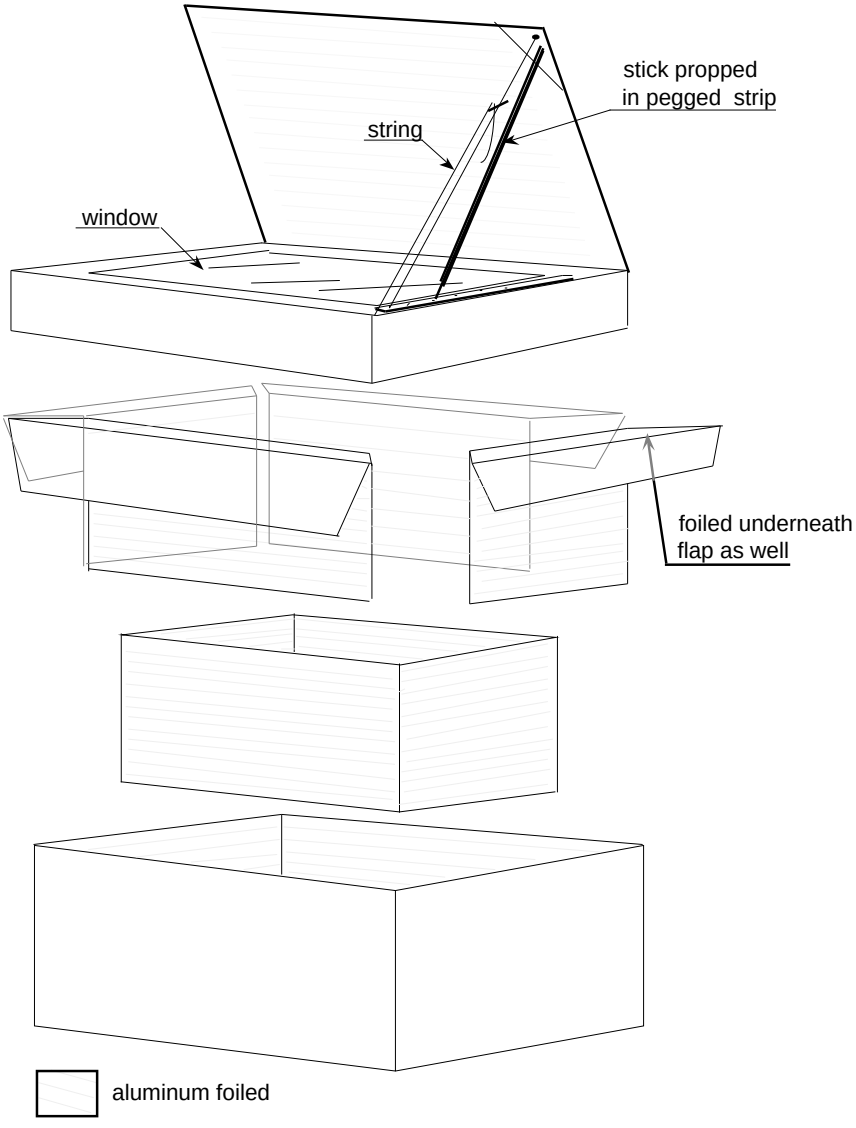
•Paint the inside, or at least the bottom, of your box black.

•Cook in dark pots with tight fitting lids.

Information access

•Solar Box Cookers International, 1823 11th Street, Sacramento, CA 95314. (916) 447-8691. This organization stages workshops all over the third world to teach folks about cooking with the sun. They're also working on a way to reliably kill water bacteria with these units. They've got solar cooking info.

•Home Power Magazine issues 7 and 9 - each has a bibliography with solar cookbooks, etc.



Nickel-Cadmium Batteries

Richard Perez

The lead-acid batteries are the weakest component in home power systems. Large nickel-cadmium cells offer us a better way to store the electricity we make. Nickel-cadmium cells are more efficient, longer lived, and much more rugged than the lead-acid cells. This is the first in a series of articles about using large pocket plate nickel-cadmium batteries in home power systems. It is an introduction to the nickel-cadmium cell and how it works. The next article will contain actual test and performance data of a working PV/nicad system.

Meet the nickel-cadmium cell

While it may seem that nickel-cadmium (or nicad) cells are a recent development, they have been in use since the early 1900s. The nicad stores electricity in a reversible chemical reaction, just like a lead acid cell. Electrochemical cells convert chemical energy into electrical energy. Rechargeable, or secondary, cells are happily able to reverse the process and convert electrical energy back into chemical energy.

Electrochemical cells consist of three basic elements- 1) an anode, 2) a cathode, and 3) an electrolyte. The anode and cathode are made from two materials (usually metallic compounds) which form an "electrochemical couple". This means that the two metals making up the couple release free electrons (electricity) as they chemically react. Since the anode and cathode materials are not in actual physical contact, a medium for electron exchange between the anode and cathode is necessary. This medium is called the electrolyte and is usually an electrically conductive liquid.

In the lead-acid battery the electrolyte is a dilute (≈25%) solution of sulphuric acid in water. However, the nicad uses an alkaline (caustic) chemical reaction rather than the ascetic (acid) reaction the the lead-acid cell uses.

The electrolyte of the nicad cell is a dilute solution (≈21%) of potassium hydroxide (KOH) in water. The differences between lead-acid and nickel-cadmium reactions doesn't stop here. In the lead-acid reaction, the sulphuric acid electrolyte actually participates in the cell's chemical reaction. The amount of sulphuric acid in the electrolyte solution decreases as the cell is discharged. In the nickel-cadmium cell, the potassium hydroxide electrolyte acts only as an electron transfer medium and does not chemically change as the cell discharges. For this reason, it is impossible to determine the state of charge of a nicad cell using a hydrometer.

Nickel-cadmium cell electrochemistry

The anode (or positive pole) of a nicad cell is chemically nickel oxide hydroxide (NiOOH) when fully charged, and nickel hydroxide [$Ni(OH)_2$] when fully discharged. The cathode (or negative pole) of the nicad cell is chemically composed of cadmium (Cd) when fully charged, and cadmium hydroxide [$Cd(OH)_2$] when fully discharged. The potassium hydroxide electrolyte has a density of 1.17 to 1.30 irrespective of the cell's state of charge. The electrolyte also contains a small amount of lithium hydroxide (LiOH).

The discharge and charge chemical reaction is shown below:

$$2NiOOH + 2H_2O + Cd \underset{\text{Charging}}{\overset{\text{Discharging}}{\rightleftharpoons}} 2Ni(OH)_2 + Cd(OH)_2$$

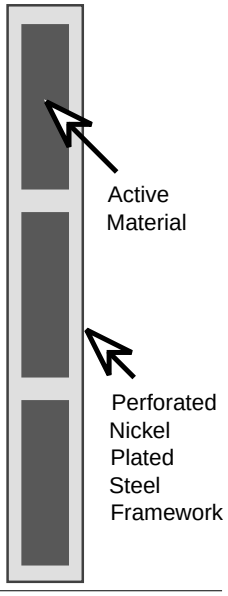
The nicad cell's particular electrochemistry yields a working voltage of about 1.2 VDC. A wet, pocket plate, nicad cell should be considered fully discharged at between 1.00 and 1.15 VDC. Under charge, the nicad cell's voltage will vary from 1.35 to 1.65 VDC depending on state of charge, amount of recharging current in relation to the cell's capacity and temperature. These types of cycle characteristics mean that a battery pack for a 12 VDC system would use 10 nicad cells in series. A 24 VDC system would use 20 nicad cells in series.

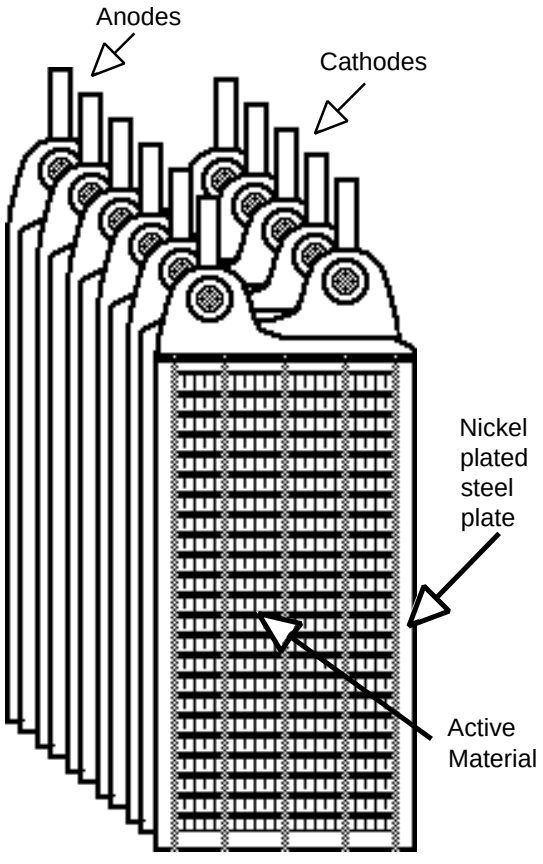
Nickel-cadmium cell construction

The active materials in the nicad cell are impregnated into pockets in the cell's plates. The actual plates are made of nickel plated steel and do not participate in the cell's chemical reaction.

This is a very different type of cell construction from that used in lead-acid batteries. In the lead-acid cell, active materials ARE the plate and everything undergoes chemical change. This means that the plates are continually being chemically broken down and rebuilt. In the nicad cell, the reactive ingredients are held in pockets in an **inert** grid of nickel plated steel. The net result of "pocket plate" construction is that the reactive compounds stay where they belong and the cell lasts much longer.

In the particular nicad cells we are testing, the active materials are formed into long strips which are encased in perforated pockets in the nickel plated steel plates. The plates are intermeshed with separators between them to make up the working cell. The illustration shows a cross section of a typical pocket plate design.





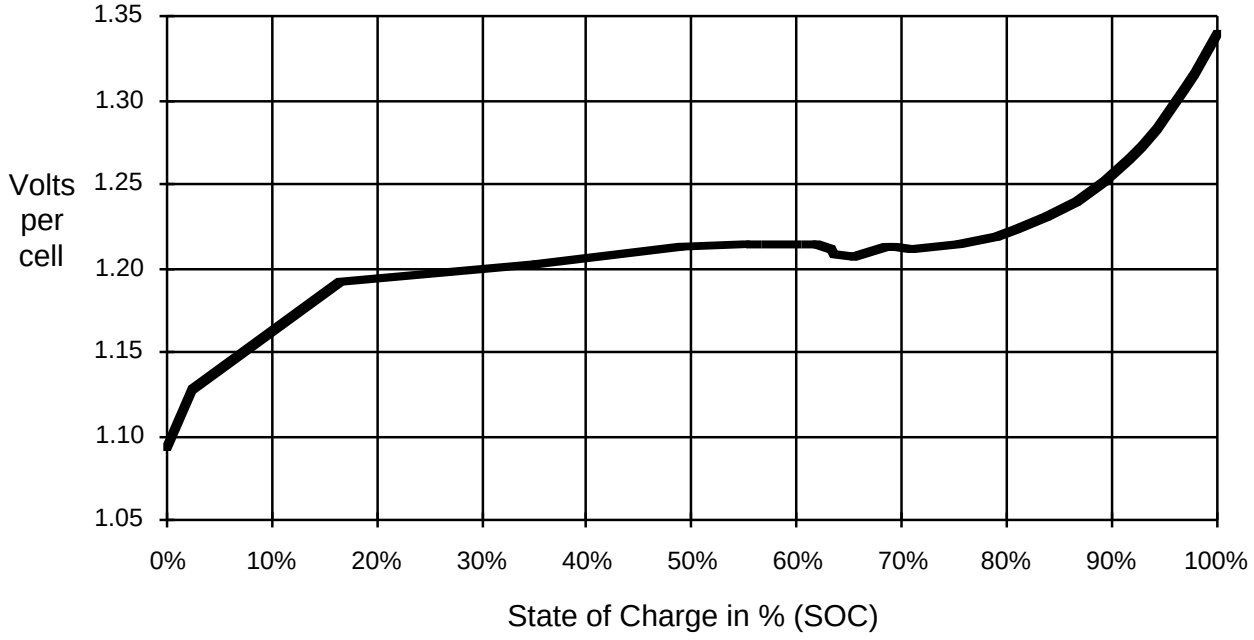
Nickel-cadmium types & sizes

Wet, pocket plate, nicad cells are available in several types. These types are designated by their discharge current rating in relation to the cell's capacity. High current nicads are designed to deliver large amounts of current within a very short interval, i.e. total discharge of the cell in a few minutes. Medium current nicads cells are designed to have their total electrical capacity withdrawn in a 7 to 48 hour period. Low current nicads are designed to be emptied slowly over longer period, up to several weeks.

While the chemical reaction is the same for all types of nicads, their physical construction differs slightly. The major difference is the number and thickness of the plates within a equal volume cell case. The high discharge rate cells have a greater number of thin plates, the medium rate cells have fewer and thicker plates, and the low rate cells have very few, very thick, plates. Considering the requirements of home power systems, the best types for us to use are the Medium rate nicads. They have a combination of relatively thick plates (for longevity) and high enough discharge current ratings to handle the surge demands of a large inverter.

Wet, pocket plate, nicad cells are available in capacities of between 80 and 1,200 Ampere-hours. Over 400 Amp-hrs.(≈180 pounds), the cells get so heavy that you need a forklift to move them. To give you an idea of their size and weight, let's look at the Edison ED-160 cells we are currently testing. The ED-160 nicad cell is a medium rate cell with a capacity of 160 Ampere-hours at a discharge rate of 32 Amperes (its C/5 rate). Each cell is 6.37" wide, 18.25" tall, 3.37" long, and weighs 21 pounds.

Discharge Voltage vs. State of Charge
for 160 Ampere-hour Ni-Cd Cell
discharge rate = C/26 • ambient temperature = 65°F. to 76°F.



Nickel-cadmium performance
Voltage vs. state of charge (SOC)
The nicad has vastly superior voltage to SOC performance over the lead-acid cell. The voltage of the nicad remains fairly constant during cell discharge, while the lead acid cell's voltage decreases more rapidly as the cell is discharged. The chart below shows our actual test data on an ED-160 nicad cell. Note that the voltage remains fairly stable throughout the discharge cycle.

The chart shows voltage for a single cell. To extrapolate the performance of a 12 VDC battery pack (10 series cells) multiply the voltage figure by 10. What this translates to in actual service is vastly improved operation of 12 VDC gear because they are being fed a higher average voltage. For example, one evening we put the entire house on the ED-160 test pack. The pack had been recently recharged and its voltage was running about 13.4 VDC under a small load of two car tail lights (≈4 Amps). The lights were much brighter than normal due to the higher voltage. Our 2m Ham radio put out more power. My 12 VDC Weller soldering iron got hot faster. And so on.

Current
The nicad cell can deliver more current faster, with less voltage loss, than the lead-acid cell. The reason for this is the internal resistance of the cell. Lead-acid cells have an internal resistance that is about twice that of the nicad cells. The nicads lower internal resistance makes them more able to deliver very high current in relation to their electrical capacity. For example, the ED-160 cells we are testing can be discharged at rates over 600 Amperes (and they are Medium rate cells!). The current handling capabilities of the nicad cell make it possible to reduce the ampere-hour capacity of a battery pack and still deliver the high surge currents needed by equipment like inverters.

Temperature
It is in low temperature performance that the nicads really shine. You can even freeze these cells without damaging them. For example, at 50°F. (10°C.) the lead-acid cell has 90% of its capacity available, while the nicad has 97% of its energy available. At 32°F. (0°C.) the lead-acid cell has 75% capacity available, while the nicad has 92%. At 14°F. (-10°C.) the lead acid's capacity has dropped to 53%, while the nicad still has 85% of its rated capacity available.

Self-discharge rate
Here the lead-acid cell starts out even with the nicad. They will both loose about 10% of their stored energy in a 1 month period. The nicad cell's self-discharge rate remains constant over its entire lifetime. The self-discharge rate of the lead-acid cell increases as the cell ages. For example, a 6 to 8 year old deep cycle lead acid cell will loose about 30% of its stored energy monthly to internal self-discharge.

Nickel-cadmium maintenance
All that's necessary is adding distilled water to the electrolyte to maintain it at the proper level. As with all batteries, keep them clean and all their connections tight and bright.

Nickel-Cadmium cells & Abuse
It's very easy to abuse a lead-acid battery. For example, just leave it discharged for several months and it will permanently loose most of its capacity. This is not the case with pocket plate nicads. They can be totally discharged and stored for a year. When they are recharged, they will still have all their rated electrical capacity. The nicads are more resistant to overdischarge and overcharge damage than are the lead-acid cells. It makes no difference to a nicad if it is operated extensively without being totally refilled. Operation of lead-acid cells without periodically totally refilling them will result in diminished capacity.

Longevity
The maximum lifetime for a properly maintained nicad cell can be as long as fifty (50) years. Average nicad lifetime is around 20 to 25 years. Lead-acid cells will last, if properly maintained, for about ten (10) years. In terms of how many cycles the cell will deliver, the nicad is well ahead of the lead-acid cell. While a lead-acid cell will deliver about 1,000 cycles, the nicads will deliver more than 2,000 cycles. The actual limiting factor of the nicad's lifetime is how they are used and maintained. If the nicad pack is properly sized, recharged and if the pack has its water level maintained, then the nicads may last much longer than described above.

Price & cost-effectiveness
Currently a brand new nicad battery pack will cost between 6 and 10 times the amount of a similar capacity lead-acid pack. This appears to be a major wrinkle. Sure the nicads work better, but at that price there is no way that they'll pay for themselves. True Enuff. However, if the nicads are purchased used and reconditioned, then the cost is about twice that of a lead-acid system and the nicads do pay for themselves by lasting longer.

Will the reconditioned nicad cells last? Are they worth what they cost? Will they work in home power systems? Stay tuned. Home Power #13 will feature our complete test report on a reconditioned nicad pack in actual PV system service. We're dong the testing now, but it will be six weeks before the data is complete.

Things that Work!

A WATER PUMPING SYSTEM USING AN EXPERIMENTAL LCB™ CONFIGURATION

Gary Waldsmith

Building a home is at best described as a traumatic experience. Building a home yourself, and trying to achieve 100% energy independence has been called an insane undertaking by my most trusted and closest friends. These same people cave in every month and pay the pound of flesh to the local utility companies, so what do they know.

But now, 8 months later, I have a 90% finished home, 16 @ L-16 batteries, an inverter, a 2500 watt Jacobs wind generator, a custom Sun Selector NDR type charge controller, a fully autonomous water system, and a supply of ARCO M-75 panels.

Throughout this undertaking, there have been many interesting engineering adventures and wonderful discoveries. These rewarding experiences should be shared, and what better way than the "Things That Work" section in "Home Power".

The LCB™ or Linear Current Booster, a product of West Virginia based Sun Selector®, has been one of the more pleasant discoveries of my adventure. This report should help explain one way I have found of utilizing the product and the benefits thereof.

I tested the LCB™ in an unusual configuration, that at the time of the test had not been tried in the field, although a technical note from Sun Selector had indicated that the configuration was possible.

The test configuration involved the arrangement of the LCB's in a series parallel combination that would allow the system as a whole to operate at my desired 90 VDC @ 6 amps. The normal LCB model 3-4-8 is designed to operate at a maximum of 42 VDC and 3 amps. With this disparity in product design limits and system requirements, I decided to try the series parallel configuration that Sun Selector had suggested.

I was of course reluctant to subject the LCB's to the test, being uncomfortable risking my investment in the product. A call to the Sun Selector toll free tech. support number (1-800-222-3988) found a company eager to extend the warranty to cover the configuration. At this point I became involved with Mr. Joseph Bobier. He spent time explaining the properties of the product and provided details and precautionary information for a proper installation and adjustment of the LCB's. The actual electrical connections are depicted in chart #1

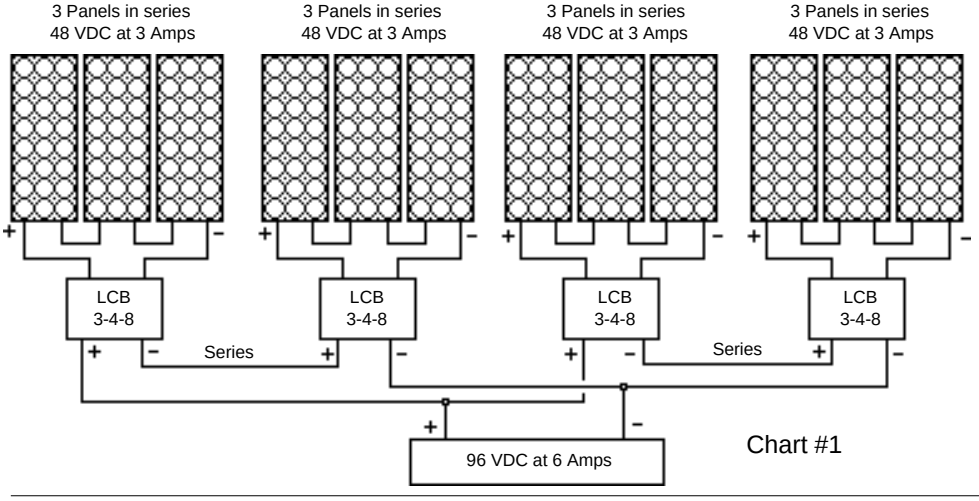


Chart #1

A very nice feature of the LCB in this configuration is that the control system becomes extremely reliable. This is because the power processing is spread out over four independent devices, thereby exponentially reducing the likelihood of a cataclysmic failure. In this case, if the MTBF (Mean Time Between Failure) is defined as X, the failure of the entire system would be calculated as X4. If one unit does fail, it will automatically bypass itself and allow the remaining units to function. The same feature works when part of the PV array is shaded, eliminating all stress on the other units, and the PV array.

Pump Mechanism:

The pump is a Churchill double gear reduction walking beam type developing a maximum of 600 ft. lbs. of torque. To develop full output of this equipment, it was originally powered by a 4x4 matrix of 16 panels to achieve 128 VDC @ 6 amps. Recall from chart 2 that I now use only 12 panels to achieve optimum performance and the maximum 1750 RPM's to drive the motor with 318.3 watts of power. NOTE: The original pump configuration required 768 watts (128 VDC X 6.0 amps) of power to achieve the same performance.

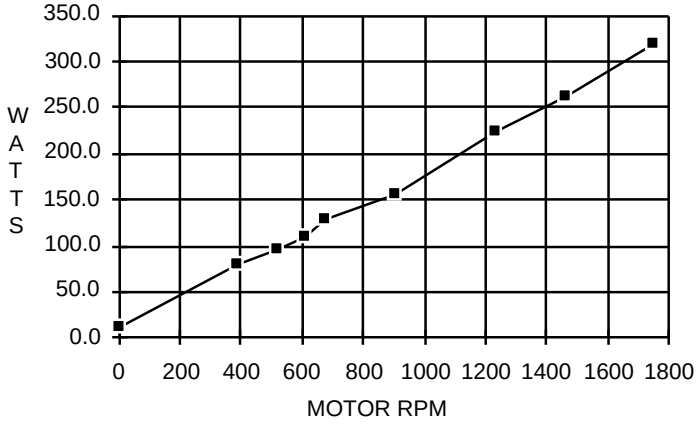
The pump cylinder has a 2 inch bore and an 11.5 inch stroke. Using the formula $V=\pi R2S$ we can find a volume (V) of 36.13 cubic inches when the radius (R) equals 1 and the Stroke (S) = 11.5. 36.13 cubic inches of water equals 0.1564 gallons. The motor revolves 129.62 times for every stroke, so knowing the motor RPM's, I can calculate the water production rate from my 460 feet deep well.

Reviewing chart#2 you can see that the motor performance was decidedly linear under ALL levels of sunlight. This is the essence of the LCB contribution. Without the LCB, the motor performance would quickly deteriorate in an exponential curve as the sunlight decreased. The LCB allowed FULL utilization of the available power throughout the entire day from dawn until dusk.

CHART2

Motor Volts	Motor Watts	Motor RPM	Gallons/ Minute	Gallons/ Hour
100.0	318.3	1750	2.10	126.0
87.0	261.1	1460	1.75	105.0
74.2	224.8	1231	1.48	88.8
57.1	157.0	907	1.09	65.4
41.5	128.7	674	0.81	48.6
39.5	109.6	609	0.73	43.8
31.6	97.0	518	0.62	37.2
26.5	**78.8**	**388**	**0.47**	**28.2**
3.8	10.6	0.1	0.0001	0.006

CHART 3



This chart shows the ability of the LCB's to keep the system pumping under even very low levels of light. The bold row of data represents an approximately 25% insolation level. Notice that even at this low light level you could take a bath every hour. At even a 3% power level the pump is still running.

Of particular interest is the linearity of the power delivery curve of chart #3 (straight line). The LCB's are clearly doing a great job of maintaining a high level of internal efficiency and minimal throughput loss throughout the entire power level range.

LCB MOUNTING & ELECTRICAL WIRING

The entire electrical system is wired with #10 stranded wire utilizing crimp terminals and 40 feet of wire. (See chart #1) The LCB's are small metal cans about 2" X 2" X 11/4". The units are mounted within 2 feet of the PV modules.

I mounted all four of the LCB's on a 12" long aluminum heat sink with thermally conductive epoxy cement to help with heat dissipation. This elaborate mounting proved to be un-necessary as the LCB's never generated a large amount of heat, even at the lower motor voltages when the conversion ratio of current input to current output was the most demanding.

Although the LCB's are running at Sun Selectors' maximum specified limit, there is no significant heating evident, even with last summer's 105 degree peak daytime temperatures, a good sign of high efficiency and built in reserve power handling capability.

Cost vs. Benefit:

The LCB's are retailing in the $50.00 price range. I've used four so they would cost about $200.00 to the end user. I used them to replace four PV panels that cost about $250.00 each wholesale. My direct savings is about $800.00. But we really aren't comparing apples to apples. My system now runs better with fewer panels. To get the same performance without the LCB's I would need more than the extra four panels, and since I would be dealing in groups of four, (series / parallel), I would have to buy extra panels four at a time. If I REALLY wanted to maximize the system efficiency, I could; shorten wire run's, solder all of the crimp connectors, fine tune the LCB's and remove instrumentation (meters, etc.). I could run the pump on only 318 peak watts (see chart #3). This would just about be achievable with only six PV modules.

Sun Selector makes LCB's in several sizes for every possible application, and with the now proven ability to cascade units in series / parallel to achieve any desired voltage and current level, no pumping system should be engineered without them.

Access: Gary R. Waldsmith, 1441 Hound Hollow Rd., Pilot Hill, CA 95664

Gary Waldsmith is both a physicist, and an electrical engineer working for the Dept. of Defense in the Sacramento area. He has been building electrical / electronics projects and a ham radio operator most of his life. He would be glad to help anyone with similar projects or "adventures" in the works. An SASE is welcomed anytime. With prior arrangements, Mr. Waldsmith will show his equipment to interested visitors.

We would like to take time-out from nuts and Volts and tell you about Redwood Alliance, a non-profit group in Northwestern California. The Redwood Alliance is dedicated to the conversion from polluting and unsafe energy technologies to those that are renewable, safe, and decentralized.

These folks have been at it for 11 years, mostly in an "anti-nuclear" mode. Now, they're branching into the "pro" side of the battle with some new projects which we at Home Power support and we think you will too.

Renewable Energy User Group
Redwood Alliance is starting a Renewable Energy User Group for folks in Humboldt County, California. People interested in using alternatives will be able to get together for presentations and discussions, idea development, experience sharing, and whatever else they might want to do as a group. Hopefully, this idea will spread, and the Alliance's Renewable Energy User Group idea will become a model for groups in other communities. Contact the Alliance if you're interested.

Home Power Electronic Bulletin Board
Another project the Alliance is working on is the Home Power Electronic Bulletin Board. Those of you with access to computers and modems, will be able to download entire issues of Home Power Magazine as well as leave and receive all kinds of information related to renewable energy systems. At first, reaching the bulletin board will require a long distance phone call, but eventually the Alliance hopes to provide toll-free access from anywhere in the U.S.

Redwood Alliance is Unplugging
The third Alliance project ties into the other two; Redwood Alliance wants to "practice what they preach." They want to disconnect from PG&E and its Diablo Canyon Nuclear Power Plant and run their office and the Home Power Electronic Bulletin Board strictly by photovoltaic power. The public will be able to visit the office in Arcata, California and see on display a working home power system, right in the middle of a grid serviced town.

Both the Home Power Crew and Redwood Alliance Folks believe that as more and more people are exposed to environmentally sane, renewable energy technologies, they will begin to use them at an increasing rate. As renewable energy equipment prices decrease and utility rates and line extension costs increase, unsafe and centralized power systems will fade into the past.

If you have expertise in the field of electronic bulletin boards or if you have equipment to donate to the Alliance's PV system, your help is needed. Please contact the Redwood Alliance at 707-822-7884 or POB 293, Arcata, CA 95521.

Home Power

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☐ **As my only power source** ☐ **As my primary power source**

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☐ **As my backup power source** ☐ **As a recreational power source (RVs)**

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☐ **Wind Power** ☐ **Other** _____

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☐	☐	Wind generator	☐	☐	Batteries
☐	☐	Water power generator	☐	☐	Inverter
☐	☐	Battery Charger	☐	☐	Control systems
☐	☐	Instrumentation	☐	☐	PV Tracker

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Please write to us here. Tell us what you liked and didn't like about Home Power. Tell us what you would like to read about in future issues. Thanks for your time, attention & support.

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What should happen at such a Fair?

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Fund Raising	☐	☐	Waste Recycling	☐	☐
Financial	☐	☐	Fair's Power System	☐	☐
Legal	☐	☐	Fair's Siting	☐	☐
Clean-Up	☐	☐	Fair's Water System	☐	☐

Please use the rest of this page for any comments, ideas, or information that you may have.
If this Fair is to happen, then it will be the efforts of many. Please let us know what you can contribute. It could be information, it could be work, it could be money, or it could be whatever. This project is now in the dreaming stage. Do you want to come and dream with us?

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People's Energy Fair- a dream

Richard Perez

After years of attending energy conferences populated by people who go home to public utility power, I think it's time for a change. Those of us living on our own power need to get together. During the last two years we have actually received over 20,000 letters from renewable energy producers and would be producers. We have seen, first hand, the enormous amounts of interest, energy and information within this group. We need to get together face to face, as many of us as possible in the same place and at the same time.

Spirit as Energy

Most energy conferences seem to concentrate on hardware. I guess this is natural considering that the attendees are paid by their companies to be there- and to sell something. I'm thinking that we need to concentrate, not on the hardware involved, but on the more intangible and important aspects of renewable energy. After all, most of us use the hardware in our daily lives and it presents little mystery to us. What we really have to share is our diverse information, opinions and experiences.

We need to get together so we can realize how many of us there are. If Home Power has shown us anything, it is that the use of renewable energy in small stand-alone systems is spreading like wildfire. Why? Well, many reasons- environmental, it's cheaper than the Power Company in rural situations, it offers freedom, and it's clean & safe.

We need to get together so we can become a whole that is greater than the sum of its parts. Our correspondence with HP readers has shown us that many of us have the same needs and are seeking and finding similar solution to similar problems. What we have failed to realize is the amount and quality of our information. While government and big business carry on megabucks research projects for the future of renewable energy, we are living on it today! And usually doing it on a budget that wouldn't buy paperclips for an "official" R&D project. Why wait for the energy establishment to implement the renewable technologies that our planet so desperately needs?

We need to get together because we are living in a World that needs our information and the spirit to make it work. Every oil spill, every nuclear disaster, every acid rainfall, makes what we are doing more critical. Most folks still think of renewable energy as a future source. We're living proof that it's the energy of today.

And we need to get together to meet, and share the joy of knowing each other. The outpouring of the finest of the human spirit has overwhelmed us at Home Power. We want to get everyone together so we can all share in the spirit of renewable energy.

So now what?

Well, for the above mentioned reasons, we need to get together. So let's do it. We at Home Power realize that this is a big project. To get maybe a thousand people together in the same place and time will require lots of energy, time, work and even some money. After doing some research, we realized that we could not do this by ourselves. In our initial discussions about this project, our summer intern, Chris Greacen had an interesting and challenging idea. Let's organize this event in public via the magazine. Let's throw it open to everyone reading this. Are you interested? Would you come? Will you work on this project? What does the project need? Oh, just everything…

Decisions to make…

Organization? Does the fair require an organization? Our initial research indicates yes. The issues of liability insurance and legal responsibility seems to make a non-profit type organization the best bet to sponsor this event. Whether the organization will be an already existing one or a new one created specifically for the fair needs resolving. While several organizations (both biz type and nonprofit) have already expressed support, we still need to either form an official organization to handle the event or secure an existing organization as an official legal type sponsor.

What goes on?

I suggest a live in type situation. This will give folks time to share all that will be happening. How about discussion groups based around the different renewable technologies? How about organizing to encourage the local utilities to develop renewable sources? How about cooking meals in solar cookers? How about technical discussions complete with working examples? How about a communications network so fair goers can communicate worldwide using free radio sources and sunlight for power? How about practicing what we preach and running the fair-everything from energy input to waste- as a model of the best ideas we are now using. How about the latest hardware, not only on display, but actually working on site doing necessary jobs for fair goers? How about meeting old friends you never knew you had? How about your ideas?

Where?

This is a good question. With people coming nationwide, it's bound to be a very long drive for someone. The location will greatly affect the cash necessary to pull this off. My personal inclination is toward a natural outdoor site, devoid of the "conveniences". Such a site would allow free or low cost camping for between several hundred and a thousand people. Since we can bring our own energy via portable PV systems, the only real requirements are space, sunshine, water, and beauty. Should the site be public or private? Where should it be? What do you think? Do you know of the perfect site?

When?

I think the earliest date possible would be during the summer of 1990. It's going to take time to organize this fair, especially doing it with a nationwide committee of home power folks.

How Long
At least several days and maybe as long as a week or more. If we are going to get together from all over the country, we might as well make good use of our efforts. What do you think?

Jobs To Get Done
The following are jobs or job titles that have occurred to me. I'm sure that you can add to the list. And maybe even do one of the many things necessary to make this happen.

We at Home Power will do everything we can for this project. We don't have the horsepower to pull it off by ourselves. We are prepared to act as a clearing house for information and organization. Our phone, computers, people will handle things like mailings, publicity, database work, and keep a running record of progress in Home Power Magazine.

The HEAD CHEESE
This is a job and a half. Someone needs to ride herd on this entire process. A project like this needs one person to coordinate the activities of everyone working on it. This will be especially true if the fair is to be accomplished by a group spread out all over the country. I imagine that this job will become full time a month or two before the fair actually happens. Any volunteers? Someone who has organized a similar event in the past is needed.

Activities
Someone needs to work up a program of events. Here's a micro list of some discussion group subjects: Conservation, System Specification, RE Tax Credits, PVs, Solar Cooking, Batteries, Solar Hot Water, Water Pumping, Wind Machines, MicroHydro, System Controls, Wiring, Maintenance, Site Preparation, etc. The support I have canvassed from the industry to date tells me that we've no problem filling each group with knowledgeable hands-on people. Fun activities will also be scheduled. How about PV powered live music and entertainment? What kind of activities would you like?

Business Coordination
Many small business have expressed interest in attending. You know the folks, you probably bought your PVs from them. I favor allowing business to flow. If folks want to come and sell their wares, then it should be allowed. In any case, businesses would like to support this project, attend and display their hardware, information and services. The fair will need someone to coordinate and structure the participation of businesses in the event.

Communications
From the number of Hams reading Home Power, I'm sure that Amateur Radio will play a major part in the fair's communication systems. We've already dreamed up a complete PV powered Ham station that will allow fair goers to talk round the world. Ham radio can also handle local communications around the fair itself. We are trying to set up a radiotelephone link that would provide regular phone service at the fair for both voice and computers.

First-Aid
A first-aid station needs to be planned, housed and stocked. A doctor or nurse would be the best person for this task.

Food
I would encourage everyone to bring slightly more than they can eat, then there's some to share with others. Solar cooking should be the preferred mode. If combustion is used, let it have a renewable source- campfire. Should site-prepared food be sold? There is interest in setting up everything from juice stands to tacos.

Fund Raising & Financial
Someone needs to fill and keep and empty the fair's purse. Whether by charging businesses for space, charging fair goers for attending, donations solicited from who knows where, or any other legal manner, the fair needs to be funded. Someone with accounting and bookkeeping skills is needed here.

Legal
If the fair is to be an organization by itself, then this needs to be legally accomplished. Legal requirements like insurance must be dealt met. A lawyer is probably best suited for this job if we can find a pro bono RE person.

Clean-Up
A crew will have to be organized to clean-up afterwards. Hopefully, everyone will clean up after themselves, but being a realist I think a crew will be necessary. If a place can be found to accept such a delirious gathering, then we should at least leave it in better condition than when we arrived.

Security
Any gathering this size is going to need some gentle security. Someone needs to organize and implement this, along with forming some basic rules of conduct for the fair.

Transportation
The logistics of a fair in a remote location will place a heavy burden on transportation. Someone needs to corral and coordinate a herd of vehicles for this job. Equipment and supplies will need to be delivered to the fair and transportation will be needed inside the fair site itself. I vote for no motor vehicles within the actual fair area while the fair is going on.

Publicity
Home Power can do this. We plan on running a bi-monthly report on the fair's progress in the pages of each Home Power issue.

Health
Bathing facilities should be constructed using solar heated water. Fresh water should be pumped via PV power to many sites within the fair. Sanitary facilities must be provided. I know that this isn't the most glorious job, but it's an area where we can really teach the establishment something. Although plumbing and power systems are a lot of trouble to set up, I think that the fair should implement our best ideas for all to see.

Waste Recycling
All the fair's waste that can be recycled should be. Other waste needs to be disposed of in a healthful and responsible manner.

Now you tell me.
Can we do it? Do we need to do it? Do we want to do it? Are you interested? See any job that you could do? What to talk about it? If this fair is going to fly, then it will be from the work of renewable energy folks nationwide. Otherwise, it probably isn't worth doing…

Write or call: Richard, Home Power, POB 130, Hornbrook, CA 96044 • 916-475-3179. There's a check the boxes type communications form in the middle of this issue for your convenience in this matter.

Building Your Own Wind Generator

Steve Hicks

If work doesn't scare you off and you have a windy site, then building your own wind generator can be a very rewarding experience. Such a project is not for everyone, it will take above average mechanical skills or an extra amount of determination if you don't yet have those skills.

I have visited a number of do-it-yourself wind machines around the country since 1980 and have developed a profile of the successful builder. Answer yes or no to the following questions and see how you compare to the wind generator homebuilder that succeeds.

1) Desire to work hard and see the project completed?
2) Own a drill press?
3) Own a welder?
4) Own a metal lathe?
5) Are you willing to read and study wind generator books?
6) Do you do most of your own car repairs?
7) Do you have any talent for scrounging used parts?

Of the home craftsmen that have completed a wind generator, I only recall one person that would answer yes to only four questions. The average is about five and a half yes answers. If you answer yes to three or less, a wind generator project is probably not for you. If you only have four yes answers, then you should have yes answers to questions one and five. All of the do-it-yourselfers that had six or seven yes answers took on a more difficult project than the one that follows.

If you think you might be interested in building a wind generator, there are three basic things you should do. First check the libraries for wind related articles and books to learn estimating the local wind speed, site selection, types of towers and appropriate height and descriptions of successful wind generators. Surprisingly, many home builders do not do these things. The second and third items are to design for simplicity and reliability. A simple first time project is more likely to be completed. It is a lot easier to make changes on a reliable machine that is still standing than a light duty one on the ground that looks like Beetle Bailey after Sarge has beaten him up.

The key to simplicity comes from building a direct drive machine with the propeller mounted directly to the generator. This means there are no power robbing gearboxes or belts to deal with but it will take some time to locate the ideal generator. Although a good 6 or 7 foot diameter prop will reach 1000 rpm, this is still too slow to be a good match for common car alternators and generators. Most car alternators will not start generating power without their field current switched on which means more complex controls for the wind machine. Another problem with alternators and car generators is that they usually only have a small 5/8 inch or 17 mm diameter shafts, a little on the light side for a wind machine.

The ideal generator will be a large four pole one that weighs at least 40 pounds. A few semi type trucks and old city buses used such generators. Eventhough these generators will be 20-30 years old, they are generally quite serviceable after replacing or repacking the bearings and replacing worn brushes. Sometimes the commutator will need to be turned down on a lathe, a job that isn't expensive. Here are some examples of 12 Volt generator specifications obtained from truck repair manuals in the local library.

Generator Model	Maker	Amps	RPM	Type Vehicle
FAE-10002A	Ford	55	640	Ford Truck
518	Delco	57	650	White Truck
1117567	Delco	120	710	Mack Truck
1117568	Delco	120	710	Bus

Some generators even have their rated output at a specific rpm on the generator tag. The most desirable generators are the ones with the lowest rated rpm since it will lower the wind speed at which the generator starts to put out usable power. For best results the generator should have a rated output no greater than 650 rpm when using a seven foot prop and no greater than 750 rpm with a higher speed six foot diameter prop.

A six or seven foot diameter prop can easily put out more than 55 Amps in plus 35 mph winds. If the wind gets too strong, even a large 130 pound, 120 Amp generator isn't large enough to keep a good seven foot prop from over speeding. For high winds you need a governor. A governor can change the pitch of the blades at a certain speed or it can act as a drag brake, much like the simpler Wincharger type air brake governors. Another type of over speed protection is to have the tail fold parallel with the prop in high winds. Folding the tail manually is also a very good way to shut down the wind plant during periods of high winds.

A home built wind machine in a good site has lots of things going for it: very low cost, a little over a kiloWatt-hour a day on the average with a 6 ft. prop where winds average 12 mph, tremendous job satisfaction and a joy to watch especially on those stormy windy days or nights when solar panels aren't doing anything.

All these benefits sound like a free lunch. Low cost wind generated electricity is only achieved by not figuring in your labor. This labor will be many times the amount needed for installing a PV system. If you are going to build your own wind plant, keep it relatively small and simple. If you start with a larger complex machine for high Amps in light winds, you are almost certain to fail. This is similar to telling the Wright brothers in 1903, "Now you can fly, go out, design and build a 747."

My wind system

I live in Livingston, Montana where the average wind speed is 16 mph and over 20 mph during the winter months. In the winter, the winds are a mixture of strong gusty days and calm ones. It is common for 12 to 48 hour winter periods to average over 40 mph

with frequent 60-80 mph gusts. Plus 100 mph winds occur each winter. My residential location and city height restrictions result in tremendous turbulence and lower average speeds with peak gusts only reaching 75 mph.

My machine is a restored 1500 Watt 32 Volt Wincharger that uses a very small tail year round to cope with the turbulent shifting winds. During the summer I drive the generator with either a 10 or 11 foot diameter Wincharger prop and use the airbrake governor. During the winter months, the prop and governor are replaced with my own design variable pitch governor and a 9 foot diameter rotor. Although this 1500 Watt machine originally came with 12 and sometimes 13 foot diameter blades, the 9 foot prop will still easily pull 1500 Watts in under 30 mph winds. In higher wind speeds this prop has put out 3 kiloWatts but the generator isn't capable of this amount of sustained power so the governor is adjusted to limit the output to 1700 Watts.

The generator charges a 36 Volt bank of nickel cadmium batteries which quickly fill up on windy days, then the excess power is automatically diverted into a large heater. The generator is always fully loaded which maximizes the output and limits the governor wear and tear. On windy nights, all of my 800 Watts of incandescent lights are on in my small 12X15 foot shop.

I will try to provide answers to short specific questions from potential homebuilders if you provide an SASE. My address is Mountain Pass Wind, 711 North C, Livingston, MT 59047.

Things that Work!

Home Power tests EchoLite™ PV Mounting Brackets

The Brackets

These mounting frames are made from 1/8 inch thick, 1" by 1.5" solid aluminum angle stock. The aluminium stock is aircraft grade 6063-T52, and is corrosion resistant. They are far thicker and thereby stronger than any type I've encountered. The mounting hardware is stainless steel and comes with its own special tools for installation. All the nuts are permanently swaged into the aluminum angle and are captive.

Models & Types

The Echolite brackets are made for most major brands and sizes of PV panels. We tested three brackets designed to mount a single Kyocera 48 Watt PV panel. The first bracket was designed for quick seasonal tilting and came equipped with captive, finger operated, hardware. Large thumbscrews, each with its own captive spring allow for instant adjustment of the panel's tilt.

A second bracket was also adjustable, but required the supplied Allen wrench for adjustment. Holes for the different tilt angles are predrilled in the mounting framework.

A third bracket came equipped with "tamperproof" hardware that requires an ultrasecure tool to operate. And tamperproof it is. I tried every tool in the shop, including the visegrips, and I couldn't budge the fasteners without the special tool. This model also comes with an optional padlock for the totally paranoid. I think the tamperproof hardware is enough to discourage the casual thief, and the lock may just be overkill. Vandalism of PVs is not a problem in our neighborhood, since the PVs are near houses and someone (maybe just the family dog) is always home.

Brackets are now available to mount one or two modules, with four module models on the way. Other options include: anodized finish (black or clear), portable-free standing- base models, a flat on the roof model with no legs, and a swivel base for manual tracking.

Bracket Performance

Well, there's not a lot a fella can say about a bracket. It just sits there and does its job. The thing about EchoLite brackets is that they will obviously continue to do their job during a hurricane while being attacked by rip-off artists armed with wrenches. These brackets are designed to withstand the force of 125 MPH winds (50 pounds per square foot).

The quality of the materials used in the EchoLite brackets are the absolute best. The basic aluminum stock is much thicker than any we've ever seen used in PV mounting brackets (and that includes frameworks for 4 panels). The stainless steel fittings are all perfectly installed. The bracket's finish is flawless, with not a burr or sharp edge anywhere. EchoLite's manufacturers, Doug Brown and George Hug, are to be commended on their workmanship.

Cost

These brackets ain't cheap. A single module bracket will cost about $40 to $56, depending on the options (like tilt or tamperproof hardware). Two module models cost between $53 and $78. While these brackets do cost more than others, the weight of the materials used, and the obvious care that went into their making, justifies their additional expense. They are not for those on a budget, but for those wanting the most secure, durable and versatile PV mounting brackets available.

Conclusion

EchoLite PV mounting brackets are the heaviest duty and best made units ever. If you want the finest in materials and workmanship holding your PVs down, then these brackets are for you. Access: George Hug, Echo Energy Products, 219 Van Ness Ave., Santa Cruz, CA 95060 or call 408-423-2429.
RP

An Affordable Radiotelephone System

the answer to the problem was a group effort

Curtis Tidmore

Reliable telephone systems for remote areas have always been a problem. None of the commonly used modes have been entirely satisfactory. Some are simply too expensive, some do not have "phone" audio quality, some are illegal for business use, some are primarily used for urban mobile use and do not offer coverage in the rural areas.

R/T System Requirements

We set about to design and build a relatively low cost, quality radiotelephone system. We wanted several features in the system. The first was a completely legal system which could be used for business as well as personal use. We decided the system must be licensed by the FCC in the business band.

Our next requirement was good quality audio with no noticeable noise. We choose Frequency Modulation of the radio signal in the UHF (≈460 MHz.) range to satisfy this requirement.

We wanted a private or semiprivate system. To accomplish this, we choose a method of selecting each radiotelephone user by a specific subaudible tone which only unsquelches that specific radiotelephone. For the radiotelephone users we wanted the touch tone and the voice audio masked by a busy signal (even if someone is monitoring the radio repeater output they will only hear one side of the conversation). A type of repeater controller was selected that filled that need. We wanted the ability to use Duplex mode if an individual wished. Again, the selected controller provided this feature.

Lastly, we wanted the system to be able to call every user in an emergency or if the incoming caller did not know the "extension" number of the individual user he wished to speak with. This required some modifications of the radiotelephone itself.

Other factors to be considered were power, site selection, availability of the telephone company lines, but all of these had to wait for the next step.

In our area, there is a 20 mile stretch of highway without any phone service. There are also several areas off the main highway that are not served by the telephone company. For years, many of the residents of these areas had tried to get the telephone company to service the area. They were basically not interested in the small amount of revenue that would result from such a large capital expenditure.

In order for this R/T venture to be affordable, we had to have a large group involved. Our next step was to contact our acquaintances and friends in this area and determine if they would be serious enough to invest money in a radiotelephone system to service our area. In our casual conversations we determined approximately how much money people were willing to invest in the project. The system as visualized seemed to fit in with most of the potential users available funds. Knowing the approximate costs and the available funds meant we had to have at least 20 "subscribers". Twenty people in that area without phone service were easy to enlist. A meeting was called and we presented our plan to those 20 people. The decision of the group was to go ahead with the plan, with partial payments from individuals as the funds were needed.

Organizing the R/T System

A site selection committee was formed (a couple of people that knew the area well) and several potential sites were considered. Some would have required PV panels, all would require running some telephone wire from the radio site to the regular telephone line. The final selection was made based on several factors; coverage, commercial power and the nearness of telephone lines. The owner of the land was contacted and he agreed to lease the land for the antenna and radio shack. We would be required to put in our own electric meter since this site had commercial power.

At this point, it was necessary to do some testing to make sure those users farthest from the radio site would indeed have good coverage. Two potential users had to be dropped because of poor coverage (their money was refunded, as this was agreed at the first meeting). Another meeting was held and the results of our coverage survey, a better estimate of costs and a time schedule were discussed and finalized. As can be expected in our style of rural living, we were way off in the time schedule.

Arrangements were made to purchase a tower, an antenna and a UHF radio repeater with the proper controller. We had a small radio building built which could be trucked to the repeater site. A concrete base for the tower was poured and the building delivered to the site. A bulldozer was used to dig the 1 mile trench for the underground telephone line from the repeater to the end of the commercial telephone. We applied for an FCC license and we applied for a telephone number to be terminated at the end of the telephone line. All of this took some time, about 6 months longer than we had anticipated. Most of the delay came because we had to learn the proper bureaucratic procedures to follow.

Finally, everything came together and we were ready to start ordering the individual radiotelephones that each user would have at his home. We choose an inexpensive but well made and engineered import. Some modifications to the radios were necessary to have them work with the system. The supplier made these modifications at a nominal cost. The radio supplier furnished a complete system; antenna, coax cable, radio, telephone deskset and modifications. Installation was up to the individual user, although technical help was also part of the purchase.

Considering the remote location, the complexity of the system and the widely diversified background of the users, the system has had

very few problems. The system has been in full operation for nearly a year. We have 20 users and 6 of them are businesses. We have 4 or 5 families with teenagers that also use the phone system. We are all quite surprised that the system can handle the phone load with time to spare. Seldom do we have to wait to make a call, and when we do, it seems as if it is never more than a few minutes. What this suggests to me is that the system as designed could handle more users, perhaps as many as 30 or more. This would reduce the cost to each individual by 1/3.

R/T System Equipment
A UHF commercial repeater is located at a mountain top site with a 40 foot tower for the antenna. All of this is high quality commercial equipment. No one likes to travel to a mountain top in the middle of winter to work on malfunctioning radio equipment. The commercial 110 volt power is used to operate the radio and also to keep a bank of 12 volt batteries on a float charge. In the event of a power failure, the repeater automatically switches to battery power. The repeater will run for several days on battery power depending on usage. When 110 volt commercial power is restored, the repeater automatically goes to 110 volt power and starts recharging the battery bank.

Each individual user has a small set and a small UHF antenna. All are 12 volt radios. Some users have purchased ac power supplies for their radios but these were not part of the original cost estimate and were paid for by each individual who wanted one. Each individual user is assigned an "extension" number.

R/T System Operation
When an incoming call (an outsider calls an individual user) the repeater controller answers the telephone line on the first ring. The incoming caller now has the opportunity to dial (touch tone) the "extension" of the person he wishes to speak with. The specific telephone for that "extension" will ring. No other radiotelephone rings and no one else on the system will hear any of this transaction. The user being called answers his phone and talks to the incoming caller. All of the present users have Simplex radios (only one party can talk at a time) but the system as it is built would support a Duplex user (both parties talking at the same time). Duplex radios are more expensive and no one felt the added cost was worth the minor convenience.

If an incoming caller does not dial an "extension", the repeater then reverts to "ALL CALL" and rings every phone. Usually one user is designated operator for the day and answers any ALL CALLs that come in. Since everyone can hear this conversation, the specific user being called will hear the incoming caller ask for them specifically and will then answer the call.

For a user to make an outgoing call, he simply logs onto the system with his extension number and calls the number he wants. The repeater controller is toll restricted so any long distance calls must be put on an individuals credit card. The controller also has ten "autodial" numbers which will be automatically dialed. These are used for emergency numbers and for frequently called numbers.

In addition to being able to make and receive outside calls, the system also allows for one user to call another user and not be heard by anyone else on the system.

One more feature is the ALL CALL repeater mode. This configuration was included in case all users need to be notified of an emergency, forest fires in particular. We have not used this feature but it is still reassuring to have available.

System Cost
This system cost a total of $27,000.00. There are twenty users. $27,000.00 divided by 20 users = $1350.00 each. With this investment, the individual owner is part owner of the repeater system and full owner of the radiotelephone at their house. The radiotelephone cost $825.00 complete as described before. If we decide to have 30 users, the price would drop to $900.00 each. A method for refunding some of the original users money has been provided for if we do go to 30 users. In addition to the one time cost of $1350.00, we each pay $12.00 a month for the phone line costs, any repairs to the repeater system, site lease costs and incidental costs of keeping the system going. We pay for one of the users to be a secretary and a treasurer. Since we decided that each individual user would own his own radiotelephone unit, any repairs to the individual radiotelephone is the responsibility of each user.

Summary
A high quality radiotelephone system was constructed and installed because of the cooperation and dedication of the 20 users of the system. Because of the group involvement, the individuals investment was far less expensive than any one person would have had to spend to provide the same level of telephone, intercom and emergency network service this system provides. The key to success was the cooperation of the users and the willingness to experiment with the various engineering concepts which were needed to make the low cost radiotelephones work properly. Without this, the venture would have been a failure.

I have been told that this is the first time such cooperation on a large project (number of users) has been achieved in this area. It has definitely brought the "community" closer together. Our experience and expertise from this project has prompted us to offer these systems, the engineering, the testing, the licensing and the installation to other groups of rural life stylers. The costs for each system will vary according to the specific repeater site and the number of users, but multiple user R/T can be accomplished at a reasonable cost.
Access: Curtis Tidmore, POB 1344, Jacksonville, OR 97530, or call 503-770-5883 (Evenings).

Expanded Scale Voltmeters

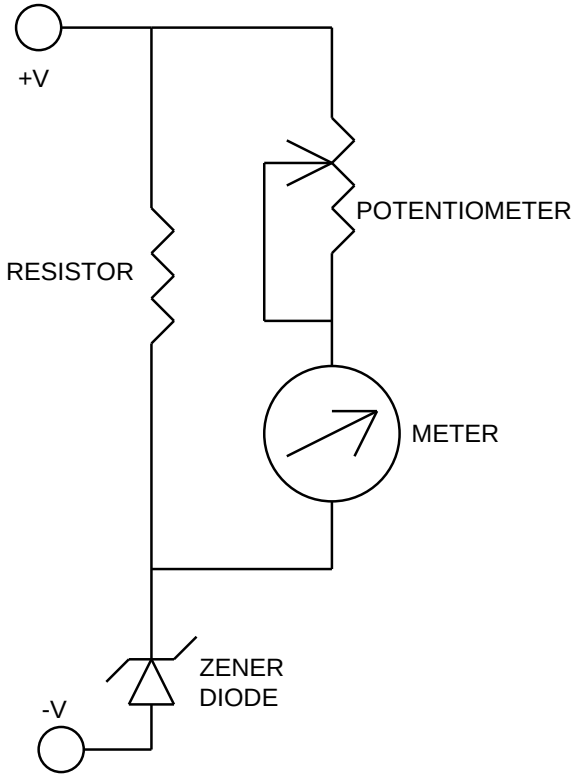
Jeff Damm

Building accurate and inexpensive battery state of charge instrumentation is easily done with very few parts. If you're willing to do some scrounging, the final meter can be built very cheaply and easily.

A dedicated state of charge meter for lead acid and nicad batteries can be built very easily with four basic components: a zener diode, a resistor, a potentiometer, and a current meter. The current meter can be either a micro-ammeter or milli-ammeter. Figure 1 shows a basic schematic for a generic system that is easily designed for battery banks ranging from 6 VDC to 120 VDC. A design procedure using only Ohms law will allow the builder to customize the state of charge meter for his/her system needs.

Figure 1 shows the general schematic for the generic state of charge meter. The zener diode is chosen to be a few volts below the minimum voltage of interest, i.e. less than the battery voltage at a minimum SAFE discharge condition. A 12 VDC system would need a zener voltage between 9 VDC and 11 VDC The resistor is chosen to limit current into the zener to about 5 mA. The potentiometer is chosen to provide a current that will give maximum meter reading for the condition of full charge voltage minus the zener voltage. The zener voltage is independent of battery voltage (for the case of the battery never going completely dead!). Now lets design a state of charge meter for a 12 Volt battery.

Start with a 10.0 VDC zener (1N961B). In order to flow 5 mA of current through the zener, we use Ohm's law to determine the proper resistor value. The voltage we need to use is the voltage DIFFERENCE between the battery voltage and zener voltage, which is 12 VDC-10 VDC =2.0 VDC. From Ohms law we have:
R=E/I=2VDC/.005A=400 Ohms
Since 400 Ohms is not a standard 5% resistor value, we would want to compromise with 390 Ohms or 430 Ohms. We have now established a standing current in the zener diode. A few milliAmps to about 10 milliAmps will be quite sufficient to "turn the zener on",



which implies that we could use resistor values between 220 Ohms and 1000 Ohms and still have a well behaved reference voltage.

The voltage across the zener diode is essentially constant with respect to the current passing through the zener. If the battery voltage moves around, which it will (that's why we are doing this in the first place), the zener voltage will remain fixed at 10 VDC. the design concept is to use a meter to measure the difference between the fixed zener voltage and the batteries positive terminal. In our case, the voltmeter is formed by the potentiometer and the milliAmp meter shown in Figure 1.

In our present design example, we need to measure a battery voltage range between 10 VDC and 15 VDC, assuming that there is no load on the batteries and full charge is nearly 15 VDC. Our potentiometer/milliammeter will then need to cover a range of 0 VDC to 5 VDC, since we are referencing against the zener voltage. Let us assume that we have a 1 mA. full scale meter movement. Using Ohms law, we can calculate the necessary pot resistance as:
R=E/I=5V/1mA=5k Ohms
A 10k pot would do the job nicely. A better choice would be a 4700 Ohm resistor and a 1000 Ohm pot in order to offer a mechanical "fine tune" on the calibration of the entire circuit. Lets do another arbitrary design for a 24 VDC system.

Jeff Damm on New Year's Eve 1985, working 75m SSB on a homemade 10 Watt Ham Radio from a snow cave at 6,500' on Mt. Hood in Northern Oregon.

For a 24 VDC state of charge meter, we could use a 22 VDC zener (1N969B). The current setting resistor value is
R=E/I=(24V-22V)/2mA =1000 Ohms
Remember that there is nothing sacred about how much current we stand in the zener as long as we have at least a few mA. The 1N969B is rated at 400 mW of power dissipation. Power is V times A so we can calculate what the maximum zener current could be before we run into overheating and reliability problems from flowing too much current through the zener. Since P=VA, we know that A=P/V, and hence the maximum current that we can safely put into the 22 VDC zener is:
A=P/V=400mW/22VDC=18.18 mA.
A safe bet would be to use something between 1 mA and 15 mA of current in the zener. Let's assume that we have access to some cheap 200 microAmp meters (200 µA full scale). Our batteries will come out to a little less than 30 VDC when fully charged. This means that we need to measure a charge-discharge range of a little less than 8 volts (full charge battery voltage minus discharge voltage). Our potentiometer needs to make our 200 µA meter behave like an 8 VDC meter. Ohms law tells us that we will have:
R=E/I=8VDC/20µA=40k Ohms
A pot value of 50k Ohms would work here. A better alternative for fine tuning would be to use a 39k resistor in series with a 5k pot. The ultra-nerd (and expensive!) method would call for a 50k 10 turn pot for gross adjust and a 1k pot for fine tuning.

Alternative choices for zeners

1N5241B- 11.0 VDC	1N5251B- 22 VDC
1N5240B- 10.0 VDC	1N969B- 22 VDC
1N961B- 10.0 VDC	1N1359A- 22 VDC
1N962B- 11.5 VDC	1N5232B- 5.6 VDC

Low voltage zeners can also be wired in series to generate other reference voltages. A pair of 5.6VDC zeners in series would yield an effective zener voltage of 11.2 volts.

I am assuming that calibration will be be done with an accurate DVM (digital voltmeter). Using the DVM in voltage mode across the meter/pot nodes while adjusting the pot to "set" the meter is all that is necessary. My personal choice would be to calibrate the entire meter assembly with a variable power supply in place of the actual battery to be monitored. HP2 has a very similar article by Alex Mason based on a 723 voltage regulator IC.

The latter design examples will have custom meter scales. A custom scale will provide the best resolution. However, a user friendly scale that matches the mechanical meter scale would give up resolution for the convenience of an already calibrated scale. Our 24 V example would then require a 10 VDC range, hence a pot value of R=E/I=10VDC/200µA=50k. If you go through a few examples, it can be readily seen that the pot will allow alot of options for scale choice. Don't forget that you can also remove the cover of most meters and pencil in your own scale marks on a custom version.

Meters can be expensive if purchased new. Cheap (low to medium quality) meters can run $8 to $15 new, depending on the supplier. If one is on a budget, or a true scavenger like myself, there are nice alternatives. Remember that dead stereo receiver that you never got fixed? If it has one or more meters in it's front panel, they are almost always 100µA to 300µA movements. They are asking to be gutted. Even if the receiver still works. Also, the small round meters found on the little cassette tape player/recorders are usually 1mA movements. Soil moisture meters are often a few hundred microamp meters. Another excellent choice to look for meters is at Amateur Radio fairs, also known as Hamfests. Used meters can be obtained at Hamfests for usually 50 cents to $1.50 in good working order, on an "as is" basis.

Many of the volume/tone/bass controls on FM receivers and cassette recorders are suitable sources for the potentiometer used in this project. Unknown value pots can be verified with the Ohm-meter function of a DVM. If the pot value that you salvage is too large in value, an external resistor may be paralleled with the pot to reduce its equivalent value.

Mail order is another option for new meters and components. Two good sources are:

DC Electronics	Mouser Electronics
P.O. Box 3203	11433 Woodside Ave.
Scottsdale, Az 85271	Santee, Ca. 92071
1-800-423-0070	619-449-2222

Both DC and Mouser will accept Visa or MasterCard. Mouser and DC Electronics carry a good assortment of zener voltages, resistors and potentiometers.

Construction time for this SOC meter should only take a few hours at most, depending on prior electronics skill level and cosmetic details the builder wants. I can be reached during the evenings at 503-645-0213 (Portland). The cheapest way to talk shop is via Amateur radio. I can be found via 3860 kHz on the 75 meter ham band most evenings. I am also planning to be a regular participant in the Sunday afternoon 40 meter Home Power Net, 13:30 PDT on 7230 kHz. Jeff Damm,18205 N.W. Bronson Rd. Apt O1, Portland, Oregon 97229

the Wizard Speaks…

For many eons now objective reality has presented seekers after wisdom with a picture of decay, dissolution, and death. This is, however, only one of the many faces of the many faceted diamond matrix of existence. This one face was seen because this was the face sought. In seeking after absolutes in philosophy, science and religion the seekers found only the universe of **entropy**. In looking for the great status quo universe they could only see one facet of reality.

This is not, however, an immutable state. The wheel can be turned. Other facets of the diamond can be revealed. Instead of seeking the great changelessness whose face is decay, we must begin to find those local patterns of dynamically changing equilibrium, whose relationships define the faces of growth and freedom. We must become the outlaws of science, philosophy and religion, whose major purpose is to locally violate all the so called immutable laws of the universe of entropy and thus begin to unveil the diamond matrix of reality.

In an information sense we must begin to correlate patterns in parallel rather than bits in series. In this way we can achieve new visions with a minimum of input and not suffer burnout from information overload. We can experience and create the miraculous without the all encompassing explanations of why. We can individually and collectively begin to orient our true beings toward a reality in which almost anything is locally possible.

Correction to HP#11, Page 42, second paragraph, sentences 2 and 3. These sentences should read: "Heavy water is a compound, deuterium oxide, in which the hydrogen atoms have **1** neutron. The hydrogen atoms of normal water have **no** neutrons." Thanks to Mark C. O'Conner of Yreka, CA for catching this stupid mistake.

Things that Work and then didn't and then got fixed…
A Radiotelephone Saga

Many of you who have called us at Home Power have experienced the trouble we've been having with our radiotelephone. Yes, it's been ill and couldn't cut the mustard over the mountainous miles. In fact, we replaced it with another one that works so well I can't stand it. So if you've talked to us and decided that R/Ts were a joke, give us a call now at 916-475-3179 and hear what a sweet system sounds like. Audio quality is strictly downtown and most folks don't know they are talking on a full duplex radio link. We've even been able to run totally error free,1200 Baud computer modem traffic between our Mac and George Patterson's IBM via the R/T link. What's next? A FAX?

We want to thank Jim Carlson & Jim Longnecker of Carlson Communications, Garberville, CA for sticking with us and providing a working system. In fact, our situation was an extremely difficult problem to solve. Our radio path is about six miles long and shoots through two mountains along the way. Jim & Jim did it!
RP

see pg. 4

Kathleen Jarschke-Schultze

Because of my husband's allergy to cats we have a recurring mouse problem. I had been plagued with a bout of "mousie wars" and had found several mouse nests in my dresser. By setting traps I had caught the offending mouse one morning while at the cabin; my husband, Bob-O being gone on a week long brushing job in Happy Camp.

I was in the kitchen when I heard a little rustling. Thinking a mouse was moving around on the tin foil on the broiler pan, I whipped open the broiler drawer. Nothing there. Still bent over I then whipped open the oven door. There, less than two feet from my face was a small snake coiled in a merciless death grip around a struggling mousie. I was so surprised I slammed the door shut and backed up to the chair in the radio shack off the kitchen. My eye fell on the CB (the local phone in our area) so I snatched it up and called our next neighbor, Barb, 3/4 of a mile up river.

"Oh, goodness," Barb responded, "Is it a rattlesnake?"

Shock and surprise had kept me from noticing. I crept back to the oven and slowly opened the door. The mousie had ceased struggling while the snake still gripped it convulsively.

"No, it's not a rattlesnake."
"Well, you just leave it alone anyway. Call me and tell me what happens."

I consoled myself, thinking, "This is Nature's way, a small animal drama, kinda like Marlin Perkins' Wild Kingdom and there IS one less mousie." When I quietly opened the oven door a few minutes later, the snake had unhinged his jaws and was swallowing the mouse whole. His beady black eyes glittered his disapproval of my intrusion. I began to cheer up. The snake was small and he was getting rid of a mousie for me. An idea formed. Once he had swallowed the mouse he would have a lump in his middle and would be trapped in the oven, unable to escape thru the narrow opening he and the mouse had entered through.

I put on my thickest oven mitts, got a gallon jar and found my biggest hot-dog tongs. I was ready. I whipped open the oven door, tongs ready. He was gone! The oven empty! I opened the broiler drawer. Empty too! I knelt down and slowly drew the drawer out, craning to see behind it into the dark bowels of the stove. Suddenly, the snake's head popped out of the shelf louvre of the drawer and stared me in the eye, six inches away. I jumped back and landed on my butt.

Recovering quickly, I whisked the broiler plate out of the drawer, dove on the surprised snake with my tongs, grasped the wiggling thing firmly and plopped it in the waiting jar. I kept the snake for two days, to show Bob-O when he got home. After all, the snake had just eaten.

Every year I get a visit or two from "my" snake. He is a little bigger each year. This spring I found him draped around a jar of home canned barbecue sauce out on the porch. It always gives me a start when I first see him but then I recognize him and it's okay.

P.S. Funny thing. I had written this in the morning and that afternoon Bob-O and I were watching the VCR when I saw a movement out of the corner of my eye. It was "my" snake climbing up the lamp shade on the end table. He took a leisurely slide thru the shelves in the living room, cruised the dining room and kitchen, then onto the porch and out. He's very quiet, if in fact it is a he.

CQ HOME POWER HAMS

KE5HV • KG6MM • N6HWY • KB6HLR

Regional Home Power Nets
(local times indicate local nets)

7.230 MHz on Sundays at 1330 Pacific, Central & Eastern.
3.900 MHz on Wednesday at 2000 Pacific & Eastern time.
14.290 MHz Sunday at 1900 UTC.

Novices

Wednesdays at 0300 UTC-
7.107 to 7.110 MHz. Listen for Dave KB6HLR
7.110 MHz on Wednesdays and Saturdays at 0500 UTC.

Letters to Home Power
we print 'em unedited.

What's Wrong With PV? © 1989 Joel Davidson

Something must be wrong with PV. Manufacturers can't make a profit. PV distributors wage module price wars. Dealers are forced to compete with distributors while relying on outside jobs just to get by.

Yet people complain about the price of PV. Sure, PV costs money. So do washing machines, well pumps, refrigerators and automobiles (all of which consume energy). Compared to the cost of utilities' impact on the environment which future generations are going to have to pay, PV today is a pretty good deal.

Perhaps PV must wait until realistic energy policies are implemented. But don't hold your breath. Or perhaps you should hold your breath because politicians are not going to risk telling voters the party is over and it's time to clean up. "No new taxes" may get votes, but it costs money to deal with the pollution, resource depletion and environmental degradation resulting from poor energy management.

Perhaps the remote energy power PV market is too small to be profitable and PV's multi-billion dollar future is only for big energy companies and centralized utilities. Let's face it. Since the Energy Crisis of the '70s, most individuals and small businesses have been unwilling or unable to invest in energy self reliance.

Perhaps things won't change until PV starts showing a profit. After more than fifteen years of terrestrial PV, why can't the industry get out of the red ink? How much longer must manufacturers, distributors and dealers continue to subsidize their own customers' power systems before they wise up or throw in the towel?

Whatever the reasons, something is wrong with PV. Change is needed. Perhaps the first order of business is to get down to real business.

There's more happening here than meets the eye. Perhaps the problem isn't with PV, but with America. Or rather with America's business. We're going to have problems as long as business is tightly focused on next quarter's profits. PVs are a long term commitment to the future, most businesses can't see that far ahead. If the true cost of America's electricity was calculated, including the costs to repair our envirnoment, then PVs are cheap by comparison. RP

Martin Jopp

Dear Home Power, RE: A Wind/PV System, HP11 pg.9

Martin Jopp lived in Princeton Minnesota. Perhaps Fred Rassman had written MN and it got reversed to NM! *(yep, that's my boo-boo. RP)*

Anyway, I learned of Martin Jopp from Organic Gardening Magazine years ago. Martin passed away July 1, 1980 at age 74. Jopp Electrical Works was known world wide. I heard that an auction was held to liquidate his estate, so I am sure nothing is left of the business.

73's Richard Walter KE5MI, Arlington, TX

P.S. The enlarged print of the polycrystalline solar cell is true art!

A Dear John Letter

This is a "Dear John" letter, in addition to a ltr-to-the-Ed epistle. The John is John Bergamini and his ltr in HP#10.

Watch this scene closely folks; a volcano has just erupted. Those of you who missed the one in the '70s, namely the personal computer revolution, have a chance to witness (and get in on the ground floor of) one of equal or greater import.

Let me first sketch in for you a brief outline of what John alluded to re the microcomputer phenomenon. It pretty much with Don Lancaster's article in Radio Electronics magazine of August '73, describing what he called a "TV typewriter". Actually what it was the first opportunity us common folk had to build **AND USE** a CRT display driven by electronics allowing entry of text to the screen thru a keyboard and then saving it to tape for later replay. In effect it was a hardwired primitive version of a full-screen editor (read early equivalent of your present-day favorite **word processor**).

It's effect was **GALVANIZING** to say the least; R-E had never had anywhere near that kind of response on any other construction project in its history. Out of the woodwork, from all parts of the country, came the hackers, the "techies", the hobbyists and various other restless inhabitants of America's technoculture. For me it meant, aside from satisfying a lifestyle addiction to playing with all those cute-colored little components and using a soldering iron, **LIBERATION** from laborious work bent over a typewriter, finally putting out copy pockmarked with white-out ink every few lines. I had just finished a book of miniscule proportions that had taken me 6 months to write; with the TV-typewriter I could have knocked it off in 3 weeks.

Meanwhile, the letters-to-the-editor column was becoming a "bulletin board" for TVT freaks. Shortly thereafter a guy came out with another article, a device you could hang the TVT onto, that was a **real live computer** and you could have it right in your own home! It was based on a **CALCULATOR CHIP**, would you believe? It was an 8-bit chip and the computer was called approximately enough, the Mark 8.

As exciting as was the advent of the TVT, it was nothing compared to what started happening after the Mark 8 article. People started phoning and writing to each other, passing on tips re where one could buy this transistor and that crystal, a source of memory chips that "actually worked", and on and on. The first techie "network" was born. Shortly thereafter, an enterprising guy down in Lompac, CA started the Micro 8 Newsletter and we were all off and running.

Next big thing was the HomeBrew Computer Club in the Silicon Valley, south of San Francisco. Those of us living in the bay area then were privy to the critical mass of techno know how, ambition, enthusiasm and surplus parts availability that has since become legendary. (To give you a little perspective on this, consider that in later meetings, as we'd enter, we'd pass by this rickety card table where a guy was peddling an all-on-one-board computer, its bare electronics sitting there hooked up to a surplus keyboard and a beatup used TV. He was putting them together on a one-by-one basis out of his garage. He named the system, "Apple".)

OK, so what has all this quaint bit of modern Americana got to do with John's letter and with Home Power mag?

The plot thickens. Be aware that up to this point the pioneers in this field were completely ignored by the big macro- (e.g., IBM) and the big mini-computer colossal (e.g., DEC, Data General). Nobody **believed** we had actual working computers in our homes. (An EE professor in one of my electronics/computer courses asked at one point, "Bill why would you **want** a computer in your home?"!)

Anyway, from the moment the first commercial entry appeared on the personal computer market (No it wasn't Apple; it was "Altair".), an interesting phenomenon developed parallel to the initial individual-based, one-on-one style of the pioneers. At the same time we were continuing to develop solutions to all kinds of hardware (and later software) bugs, **MONEY** reared its ubiquitous head.

Money, along with its many camp followers: marketing "considerations", administrative overlay, decisions by committee, advertising hype, decisions by technically ignorant executives or market-reality ignorant engineers. Attendant with these factors came the trend to **L-A-R-G-E-R S-Y-S-T-E-M-S** ("What you need, Mr Businessman, is double the hardrive capacity [No matter what he had, double that would be the recommendation.] You also need

multi-tasking ability, multi-user ability. [i.e., have 2, 5, 10 or more terminals all feeding into 1 monster computer].") The trend has continued; today significant segments of the PC market is beginning to remind of the minicomputer and macrocomputers of yesteryear: so large, so complex, so expensive that they often crash, are hard to repair and don't do what the manual says they will do.

Coming back to Home Power again. Does this sound familiar? Does it remind you of other parts of our civilization that "don't work" anymore? Including the growing energy vs environment impasse? Our government has **BIG SYSTEMS** "solutions" to these problems. So do our big corporations. So do our big universities.

Frustrated by this de ja vu phenomenon, I've been searching the alternative energy publications, PR blurbs and trade journals since I got into this field in 1980, looking for real meat. Until HP came along, the only one that came close was Paul Wilkins' PVNN (still going and still of value). The fancy multi-colored mags in the alternative energy field don't do for AE what the old Micro 8 did for the PC pioneers. (Part of the problem is too many writers impressed by their technical degrees; another part of the problem is everyone involved trying to make a yuppie living for large systems design.)

Enter HP. What a breath of fresh air! Enter John Bergamini. What a blast of high energy fuel fanned by high oxygen-content aeration! He's touched a nerve and I expect we're in for some exciting letters-to-the-editor.

Apropos, and as a final note (I'm closing not because I have nothing left to say, but because I have **too much** to get off my chest --- I'll have to do it piecemeal.) I want to briefly outline what I think the readership of HP is at present (not necessarily in order of size or importance) and will be in the not too distant future:

1. People who live far enough away from the power grid to make AE economically attractive.
2. People who are concerned about the environment and want to protect and nurture our planet.
3. People who value self-reliance and/or "don't trust the system".
4. Techie people.
5, Industry people (designers, jobbers, retailers, consultants).
6. Dope growers in Northern California and Southern Oregon (This may come as surprise and a shock to many HP readers. It may further shock and dismay them to know that this last category altho numerically small, accounts for a major slice of the cash flow in the AE business, at least out here in the West).

****The last category doesn't exist yet, but it will, when certain economic (and other unusual) events become realities.****

7. Your average ordinary man (and woman) on the street, when he finds utility bills going thru the roof.

In conclusion, hurrah for HP, for the (electronic) Sloop John B. and for his putting the ball in play.

Sincerely, Bill, William J. Schenker, M.D., retired country doctor, retired computer hardware and software consultant, active alternative energy enthusiast. POB 1277, Zillah, WA 98953

ADDENDUM: Altho there's not time nor place to expand at this juncture, it might be good food for thought to suggest a possible agenda or list of subject's to focus on in future issues. In addition to John's ac vs DC, hi voltage vs lo voltage dialog we could look at the following:

1. Big system approach vs little system approach.
2. Lead acid batteries vs large nicad batteries.
3. The nitty gritty of charging/discharging/repairing small nicads.
4. Are Hydrocaps worth the investment?
5. Is a hydrogen detector worth the investment?
6. Should you buy or build your electronic control modules?
7. If you lean to building, just how much electronics do you need to know?
8. If you're low on electronic know how, how to get up to speed?
9. How to build a bicycle generator that really works, is relatively inexpensive and can put out 30 watts at a relaxed pace & >60 while getting exercise.
10. How to reduce your wood burning requirements from 6 cords to 1 cord per winter (for a 3000 sq. ft. house).
11. Take a closer look at wood stove water heating.
12. Take a good look at wood stoves (particularly the Sotz kit).
13. How to weld at 3000°F. using the sun.
14. How to use the same setup to cook your food (with a simple tracker).
15. How much electric light do you really need.
16. How to get maximum daylighting thru your windows losing all your heat in the winter or cool in the summer.
17. Eaves and trees for shading.
18. What's all this about radon gas and air-tight houses?
19. Does home power have anything to do with food power? (If we called gardens "food generating systems" would that be OK?)
20. What kind of computer setup is appropriate in an AE environment? What kind isn't?
21. What is the proper mix of high tech (e.g., electronics) and low tech (e.g., growing your own food, sewing your own clothes)? Can they mix?
22. Is there any connection between Home Power and ethics? (Does technology have anything to do with Good and Evil, or is that irrelevant as the 20th Century comes to a close?)

Deep down, I personally feel that high and low tech (with a liberal sprinkling of just plain caring) is the hope of the future. Anything anybody does can have good (positive) or evil (negative) results but caring for others (i.e., people, critters, the planet) can never be irrelevant.

I've raised part of our food and gone from sheep to shirts, both very fulfilling things to do. What do you think? Have the subjects been over worked? We need input here. KP

High Tech Home Power

Got my first Home Power Magazine (#10)! My buddy Mark gave me a subscription form. Feels like Christmas when I was a kid. Your story about Rancho Chatuco was superb reading! Stories like yours and theirs really has convinced me that there is some real live hope for a future here on Spaceship Earth. Your magazine pumped me up so much I spent $200 on some surplus PV panels from the people at Solar Electric Engineering (Rohnert Park, CA) after reading about "Things That Still Work". Watching my first PV generated current go into some nicads was a real treat. I have also enclosed funds to cover the cost of back issues 2-9 and first class mailing status.

My PV application at present is for amateur radio purposes. I eventually want to push for an off grid "home" application. I would be very interested if HP or its readers would like to see some applications of "off the shelf" electronics control applications for solar/PV installations based on readily parts. I am also very aware of the philosophical and technology conflict of what is "appropriate", from completely passive systems all the way to very "high tech". With Bucky Fuller as a role model, I am motivated toward the APPLICATION of technology in order to solve the energy and environmental problems of Spaceship Earth. The ads in Home POwer indicate to me that electronics applications will not offend the readership. Some of my ideas are as follows:

1. simple "constant current" battery charging circuits
2. #1 with some smarts
3. current (amps) sensing techniques for ac and DC systems
4. computer interface for #3 (C64, XT, Mac)
5. PV tracking using auto wrecking yard windshield wiper motors (I have a system already built that works!)

One idea on #3 is to be able to monitor "grid" current into a hot

water tank for data collection purposes in conjunction with a solar pre-heater. Concept #4 could entail a simple and cheap thermistor/computer interface for monitoring what is happening in one or several solar panels (heat) in order to keep track of what is going on. Historical profiles of system performance could be very educational,

Some background: I have a relatively broad background in circuit design. I am comfortable with op amps, discrete and integrated circuit system design in both analog/digital applications. The latter means that I am comfortable with NPN, PNP, and JFET based control/instrumentation circuits, along with off the shelf ICs and how to "glue" them all together. Analog to digital (and A to D) conversation are nothing new. I am familiar with machine code programming with microprocessors and the attendant hardware interfacing to the real world. My present occupation is GaAs IC circuit design. I am very active in amateur radio (WA7MLH) and design/build essentially all my own 12v/24v gear (i.e. SSB/CW transceivers) including instrumentation.

At this point I want to express my intense interest in getting VERY involved with off grid systems and alternative energy applications. I have fond memories of the early days of Mother Earth News. Spending a few years very poor, then six years in college and a few more years getting my career situated has left me out of touch with the present status of AE. What I have been dreaming about for many years is to get off grid. I thought that the idea was a bit far fetched, however realistic. I thought that I was going to to have to do an awful lot of original design/experiments on my own to pull it off. Now I find that many people and companies have done all of the grunt work that I thought was still ahead of me. I am very pleased with how far things have come along in the last ten years. Now I want to see some actual home grown systems. I am also interested in correspondence with people doing off grid/solar systems. What would HP readers like to see for articles? What are their goals? Are there any "dire" missing pieces? maybe the HP back issues will help answer my questions. Maybe I will get some letters. Thank You, Jeff Damm, 18205 NW Bronson Rd Apt 01, Portland, OR 97229

Well, Jeff, Home Power is a reader's publication. If anyone thinks they have something to say, then send it in. Your article on metering is in this issue for example. RP

A Gardening Column for HP?

Dear Home Power, I just had to write congratulating you for a great story on Rancho Chatuco ("God's favorite place on Earth" HP#10). Fascination with hi-tech photovoltaics should not obscure the importance of lo-tech photosynthesis. Victor and Cynthia Rubio have obviously mastered a range of techniques for using their daily income of solar energy.

I realize Home Power is not a gardening magazine, but I'd like to put in a plug for an organic garden as an important component of an integrated home energy system. Dependence on imported energy can be greatly reduced by growing food in the backyard. Energy requirements for refrigeration and freezing can be minimized by eating fresh produce. Improved health and happiness reduce expenses for physicians and psychotherapists. Gardening as organically as possible can help us appreciate the essential one-ness of creation. To quote J. Baldwin, Whole Earth Review editor, "It's time for poets and philosophers to get their hands dirty". Pacifically, Larry & Marge Warnberg-Welling, Nahcotta, WA

We've stuck to electricity for two reasons: 1) we figured it was what HP readers were here for, and 2) it's what we know best. If there is interest for other subjects in these pages, then let us know. If someone wants to ride herd on a gardening column, then get together with us. RP

High Tech Horticulture

Dear Folks, First off let me say "AHO" to your fine work in providing a grassroots information source that truly fits the ideals of **FREE** enterprise. I, for one, can do without all of the glitz and slick page, environmentally costly "junk press" of the likes of the Rodale Press and what they have done to THE MOTHER EARTH NEWS.

Second, enclosed are funds in privately owned Federal Reserve Notes, the coin [sic] of the realm, to cover the cost of back issues 2-9, plus some for postage.

Third, I'm looking for information on the hydrogen-enrichment of bio-gas via PV-powered electrolysis and the use of oxygen to oxygenate drinking water (as an anti-bacterial factor) and irrigation water for garden or for organic-hydroponics in or out of one's solar greenhouse.

I am also looking for information on PV-powered Nitrogen production for enriching both bio-gas and hydroponics.

I have done some back-40 experimentation in the past and am doing some research for the design of a fully integrated homestead/farmstead that will be in harmony with the 3rd Sacred Law of the Cherokee, "Maximum effect with minimum energy".

Using several databases and the dynamics of companion planting, I have come up with a "Maxi-Nutrient Gardening system and am currently working on a hydroponic system that is "Bio-dynamically sound", i.e., requires no outside (off farm) inputs. As fertilizers are critical components in any agricultural system, bio-gas is a natural crop that can be harvested with the resulting "crop residue" being a rich, high energy organic fertilizer. Likewise can all grain be sprouted, fermented, distilled (thus concentrated) dried and the crop of alcohol used as a clean burning fuel and the residue is a protein-rich food/feed. We can see the future of the FArmer as an energy harvester who practices real multicropping of diversified crops and completing the link of the cycle so that wastes are returned back to the land and She will want to live. Enough verbiage. Thanks again.

In Service to SPIRIT, Earth and Humankind, White Eagle Wylie, Mars Hill, NC

WOW, the answer to Bill's question on "Food Generation" was right in front of my nose and I didn't even know it. We're willing to do a column on organic gardening, hydroponics, etc. but we need your help. Send us good hands-on info and we'll help spread it around (no manure please). KP

Heaters

Dear Home Power Folks, I am enclosing $20. Please enter me on your 1st class mailing list, it's worth every penny.

Also here is an address you may want to pass on to other readers: Bosler Energy Systems, Inc., 14211 NE 193rd Place, Woodinville, WA 98072

They market hydroponic water heaters in oil//coal/wood combinations or wood only. Although they are not cheap, they look to be heavy duty central heating type units. Thought you might like the info. Keep up the Good Work!

Sincerely, Arnold Zander, Woodinville, WA

P.S. Do you know of anyone who makes a good 12 volt LED clockradio? Just fried my $5.00 junk sale clock radio trying to convert!

Most clock radios that run on batteries can be easily converted to 12 Volt use. If the radio uses less than 10 VDC as a supply voltage, then make a simple regulator from an LM317 or a 78XX type regulator. See HP for schematics. RP

China Diesel Problems?

Hello: Our family has been living an alternative life style for over a dozen years. We have a fair amount of acreage up at the 5,000 ft. level on the south side of Mt. Shasta in Northern Calif. A year or two ago we put in an 8,000 watt diesel generator. This unit was advertised through "China Diesel" out of Southern Calif. So far we

have had no major problems with it, but have heard a number of "horror" stories concerned with people who have theirs break and need parts. We'd appreciate a card from you folks who have had some problem with your CHINA DIESEL unit telling us what the breakage was and where you finally found parts for it. Please indicate what model the engine was so that we may collate the data into a form that we could later send into Home Power to inform other people of the findings.

Another concern of ours is to develop a small group of families who would get together in developing a working model of a small community. This group of families would be devoted to an interactive, peaceful, alternative energy oriented sufficiency. We already have the land, the tools, and the knowledge, but have yet to find practical hardworking families with similar spiritual goals. We are vegetarians who recognize the essential Truths in all religious dogmas, and yet are attached to no dogma. Mystic dreamers need not apply. We are looking for families who will build the reality by their own responsible work.

Sincerely, M. Riener, POB 739, Mt. Shasta, CA 96067

A system in Vermont

Hi, Aren't you folks busy! I just read HP#11 cover to cover (woops - I'm s'posed to be cooking dinner...) and had such a GREAT time - full of inspiration with lots of great easily accessible ideas. Thanks for all the work! Well, I had so much fun - I wonder if you'd please send a copy of each of your back issues, 2-9. I hope they're all available. The HP index is SO handy, too.

Thanks Again, K. DeCelle, Walcott, VT

P.S. Last year, when we built our house, we said no to electricity (power co. generated) at an estimate of $5000+ just to get it into our woods. Well, we fished 3 circuits up the walls last week, and as soon as partner returns with a little longer breaker-box-to battery cable, (1 hour drive), we will plug in and turn on a lamp and music! Our Trojan L-16's arrived yesterday and fit in nicely with our living room "decor"! Thanks to you folks, I've written for some Hydrocaps, too - they seem just the thing. Next month, on to the PV panels.....

(Thank heaven for "Basic Home Wiring" and David Palumbo at Independent Power & Light; we've been able to do a great deal of work for the beginner - and learn a tremendous amount as well & I'm so glad HP is around...!)

Wire Loss and Wood Fired Hot Water

Dear Home Power: My solar panels are located about 600 ft. from my cabin at the highest point on my property. Because of this distance all of my electricity is 117 volts as provided by a Trace Inverter located in a "powerhouse" constructed close to the panels.

As wire sizes larger than 12 gauge are extremely expensive, I have met my wire needs by using multiple passes with standard 12/2 house wire. Thus, between the breaker boxes in my cabin and the above "powerhouse", I placed 5 cables of this 12/2 wire.

Connecting these wires in the standard manner would give me 5 ground wires, 5 neutral wires and 5 hot wires. I know of no reason to be concerned about voltage drop on the ground wires, thus I modified things somewhat.

I wrapped both ends of two 12/2 cables with white tape, thus all three strands in each cable serve as a neutral wire. The ends of two cables are wrapped with black tape and all of the wires in each cable serve as a hot wire. The fifth cable is wired in the usual manner. I thus have 7 hot wires, 7 neutral wires and a single ground wire. All of the underground connections are soldered and enclosed in heat shrink tubing.

Based on my electrical tables, using 21 total amps (2500 watts) or 3 amps per 12 gauge wire, will result in a 5.1% voltage drop over 600 ft. (one way). As my normal consumption is at a much smaller rate than this, the 5.1% loss is the most I should sustain.

600 ft. of trench is a lot of digging (my well is 500 ft. in another direction). Also, it is much cheaper to use standard 12/2 wire as opposed to 12/2 wire which is rated for UV exposure and burial. To allow for relatively shallow burial and the burial of standard house wire, I have placed the wiring inside of 1" plastic water pipe. (With the use of this pipe it would probably be OK to simply wrap all underground connections in regular electrical tape and forego use of the heat shrink tubing.)

Five cables of 12/2 wire pretty much fill the 1" water pipe. In order to prevent problems in getting the wire through the pipe, 1) use the lightest gauge of water pipe available, 2) keep the soldered connections as compact as possible and 3) stagger the connections so that there is only a single connection per 20 ft. section of pipe. I have also placed rocks on top of the burial trenches to mark them and will keep these lanes free of trees in future years.

The good folks at the Wizard Works - Bob & Jane Thompson - produce an excellent wood burning hot water heater. Call them at (509) 486-2654 or write to Wizard Works. 32156 N Hwy 97, Tonasket, WA 98855 for information.

Best Wishes, Mason Hess, Tonasket, WA

Data Acquisition

Dear Home Power: Enclosed is $2.00 - please send me issue #2, which will complete my collection - I think you have a classic underway, with much info otherwise unavailable.

I am interested in a Data Acquisition System for home energy systems - specifically, a way to collect and store information as to daily amp-hour consumption and production by more than one circuit: PV, generator/charger, refrigerator, washing machine, water pump, inverter, balance of household circuits. The currently available amp-hour meters are to expensive to buy 6 or more of, and they don't store daily totals.

There is a design mentioned in HP#9 which uses a single chip computer with an on-board 8-bit A/D. But without a programmable gain amplifier, I wouldn't think you'll get enough dynamic range. Also there is a relationship between accuracy, sampling rate and maximum rate-of-charge of the signal (current) being measured (I believe it's called the Nyquist criterion) which should be considered.

I've put a great deal of thought into various design concepts for such a Data Acquisition System, but haven't had enough time/commitment to get past the schematic stage. I'd like to hear from others who might want to engage in a joint venture to develop something, possibly leading to a marketable product. I would especially like to hear from anyone who thinks he/she might have a feel for the marketing potential of such a system. I would be happy to write up a proposed specification and cost estimate; if someone could convince me that there is some sales potential, perhaps I'd be more motivated to get on with constructing a prototype.

By the way, my home electrical system consists of 30 peak amps (at 14 volts) worth of miscellaneous PV panels on a fixed, 60° tilt roof mount, gasoline generator with 60 amp homemade charger, 1075 amp hour 12 volt GNB Absolyte II battery (6 cells), 550 watt inverter (not used much), Slo-Pump water pump, Dometic 12 volt refrigerator (runs 8 hr/day in winter, 12-14 Hrs/day in summer, drawing 5.5 amps), Kenmore washer converted to fully-automatic 12 volt use, drill press and bandsaw converted to 12 volts. I assume I produce/consume about 60-80 amp hours per day in winter and 80-100 amp hours per day in summer. Incidentally, I'm only 200 feet from the end of the power line, though it was 1400 feet when I built my house. But I still have no plans to hook-up, though my wife and I have 2 youngsters and wash a lot of diapers!

Keep up the good work - your publication is (especially) an inspiration to those of us who use home produced power by choice rather than necessity.

Sincerely, Peter Domenicali, RR3 Box 186, Montpelier, VT 05602

Q&A

We try our best to answer all your questions. Please remember that we are limited by our own experiences. If we don't have the direct personal experience to answer your question, we won't. We'll print the question anyway and hope that a Home Power Reader will have the experience to answer it. So this column is not only for questions , but also for answers from readers. Thanks for your patience-- Richard

Answers

Here's a letter that Steve Willey of Backwoods Solar sent to Diane Paget, adding to her question on ovens & pilot lights.

Good Diane Paget, I would like to add to the answer given your letter in Home Power Magazine. It is possible that you have one of the ovens without pilot lights, which uses a spark to ignite the burner each time it needs more heat during cooking. I have come upon several of these recently. Occasionally with the proper service diagrams these spark ignitions can be converted to DC operation or substitute a DC sparker from a camper heater (Duotherm brand). More likely, an inverter is the best option here. Fortunately these do no take a lot of power and so a small inverter should work, such as a 100 watt Tripplite or a Statpower. They would have to be left on all the time the oven is in use, which is a bit of wasted power, but not much with inverters like Statpower and the unit could be used for other things when not cooking. The clock in these stoves is enough to keep the Statpower running, so that it is on and ready when additional heat is called for in the oven. IF YOU USE A TRIPPLITE, WHICH IS MANUAL SWITCH ON AND OFF, THEN THE CLOCK WIRES SHOULD BE DISCONNECTED to avoid using even more power. Careful, because some ovens will not work at all if more than the motor wires are cut to the clock.

I hope this fulfills your needs. Write or call if we can help you further and please let us know it all goes.

Sincerely, Steve Willey, Backwoods Solar Electric, 8530 Rapid Lightening Creek Rd, Sandpoint, ID 83864, (208) 263-4290

More on Wood Fired Hot Water Heaters

HP is Great - Keep on rolling!

Have some information on wood fired hot water heaters. Used to see them advertised in The Mother Earth News. (Try New Atlantis Enterprises, 535 Cordova Rd Ste. 244, Santa Fe, NM 87501, Phone (505) 983-5902. This came from an ad in TMEN#76. There is an article describing a test of the heater in TMEN#57. There is another article in TMEN#77 describing how to convert a salvaged gas-fired water heater into a wood burning water heater for do-it-yourselfers.

Wilbur Loyet, Olmstead, IL

DC Rated Goodies

Dear Home Power, I was reading your Q & A and Patricia Ganyard asked about a Mexican wood burning water heater that worked on a handful of kindling. I was reading through a copy of Whole Earth Catalog printed in 1980 and there was a wood burning water heater advertised in there that would heat 14 gallons in 15 minutes with a handful of kindling. It is made in Mexico, in 1980 it cost $119.50 and for more info you could write to Appropriate Technologies Importers Inc., POB 5, El Rito, NM 87530

I hope this info will help Patricia Ganyard.

Now for my question, in HP#8 Code Systems, DC rated fused disconnects are mentioned in the Code Book. Were do you get DC rated equipment, it is easy to obtain ac equipment, but I don't know were to find the DC goodies.

Any help would be greatly appreciated. Thank You, Clyde Gress, Portsmouth, VA

P.S. Great article on the gasifer. I can't wait until you have more info on the subject. How about steam engines to run a generator set, anyone working in this direction?

DC Goodies are available form a number of HP advertisers. Dave Katz at Alternative Energy Engineering stocks one of the largest selections of fuses, connectors, terminals and wiring parts. RP

Wood fired hot water heaters

I've written before telling you just how much I admire your efforts. Keep up the great work.

Someone asked about wood burning water heaters in Q & A. Answers given were expensive. The Megamex (made in Mexico) is available in any hardware store in any city in Mexico for about US$35. A VW beattle could haul it, although it might be a cramped ride. They are available in pressure and gravity fed styles.

Enjoyed your article on Nicaragua. I spent the winter working there and my experience was quite different. I saw a lot of inappropriate technology being bestowed on the people by well meaning Internationalists.

My wife is a Holistic therapist and I am a carpenter with considerable experience with indigenous materials. We would be interested in helping others that are in need of help. Networking is important. We travel in a '61 VW Bus, which doubles as are sometime home.

Good Luck to All, Bruce & Cheryl Valois, POB 252, Osage, MN 56570

Next is another letter that a Q & A'er (Loren Amelang, Philo, CA) received from Loren Impson on solar flues! KP

Dear Loren, Nice name! You wanted a solution to the solar flue. Use expanded metal lathe and cement. It is very easy to nail on directly over the scraped off sheetrock. You might want to shoot a coat of lacquer over the sheetrock to seal the cement moisture out during the process or just cover with plastic. Make a batch of cement with a ratio of 8 sand (blasting works well or masonry if you have access to it) 5 cement and 2 lime. I use an acrylic polymer to make the mix more creamy, if you can't find acrylic then use Elmer's Glue, a handful to a five gallon bucket will work. Put the glue in first then blast it with water to disperse. I'm told you can buy plaster pre-mixed dry. You might look into this depending on the amount you need, it could be cheaper.

Thanks for your letter to Home Power. It's becoming a great network.

Let the Sun Shine, The Wind Blow and The Water Flow Clean, Loren Impson, Sanger,TX

Both 12 and 24 Volts

I would like to share some information which might help folks with a 24V system. Let me give a brief review of my system. I have 12 Trojan L-16 batteries, wired in series-parallel to give me 24V. Pulling 12V off is a Vanner 60-20 Voltmaster Equilizer (I don't have an inverter). Now the problem is with my answering machine, lightening destroyed my one year old Panasonic KX-T1423 AS. When I hooked up my brand new one and picked up my receiver there was so much interference I could not hear the dial tone. I brought it back thinking it was defective, the new one did the same thing. A call to Dave at Alternative Energy Engineering let me know I was not alone. He informed me that he had a customer with the same system as mine whose answering machine did the same thing. He also told me that Panasonic had changed the circuitry in their new models. He couldn't tell me what was causing my interference and I must admit that after much experimentation I

don't know what is causing it either. But I do know that my old Panasonic (which had no interference) had an "A" with a circle around it on the bottom and the new one had a "2" with a circle around it. So I marched back to the local Service Merchandise Store and asked to see the answering machine in their display case. What I was hoping was that they had not taken the time to change it when when they got the new shipment in, I was right. On the bottom there was an "A" circled. As you may have guessed I bought the one from the display case, took it home and it worked great. So al you folks with a 24V system that are having trouble with your answering machine the Panosonic with an "A" is what you need.

If anyone could tell me what is causing my system to produce that buzz I would be indebted to you for life. The system is grounded and the PV array and the batteries share a common ground.

Thanks, Joseph Berube, RFD 1, Frankfort, ME

The buzz is probably from the voltmaster as it's a switching type unit. Try adding a choke (wind several turns of wire around a ferrite core) or a capacitor to the buzzing device. This will smooth out the noise on the DC bus. RP

More on Inverter Hum

I would like to know how to get rid of inverter (Heart 300) hum on my stereo, TV, and VCR. It's really annoying especially at low volume. I've tried all the easy fixes and none work. Is there something I can buy and install between the two?

Anyway thanks for the great magazine. It makes my day when I find it in the mailbox.

Paul Lavoie, Carmel Valley, CA

The power supplies on most consumer entertainment electronics are designed for sinusoidal power input. When fed from the "modified sine" wave inverters, they buzz. We have modified many of these appliances for quiet operation from inverters by adding additional filtration to the device's power supply. Add several thousand microfarads of capacitance to the low voltage side of the ac/DC supply in the TV, VCR, Stereo or other offender. If you are not comfortable with a soldering iron, then go see your local techie for help. RP

Gas Reefer - Help Needed!

Not much for writing letters but wanted to tell you folks at HP - Right On! Keep it going.

I also have a Servel gas reefer problem. The gas man is eating me alive. I have a smaller model Servel and I'm averaging only 16 days per 100 lb. tank of gas - this after installing a new burner. The nearest AE small businessman installed it and adjusted it. The thermostat seems to be OK because you can freeze ice cubes and not the milk and veggies. The baffle is in place in the chimney. I have what someone in HP10 called the "classic blue flame". But this unit seems to never switch between high and low flame despite the new burner. My neighbors all run larger model Servel's and get almost 2 months from a 100 lb tank. Anybody out there got any info that could point me in a direction before the gas man gets the deed???

Thank You, David Prusator, RT2 Box 456F, Stonelake, WI 54876

Build your own 12 VDC refrigerator

Hi People; Your magazine is great!

By way of introduction, I'm 70 now and practically retired. I've been in heating, refrigeration & air conditioning since 1947 and I hold an FCC ticket 1st phone, with radar endorsement. I've also been active in the marine field among the Alaska fishing fleet, radar, loran and ship board refig.

After 30 years in Alaska I want to find out if it's more energy efficient to go where its warm or keep warm where I am. I intend to outfit a bus with living quarters and a small shop and try to be independent of an extension cord or shore power.

Most fixtures will be custom built i/.e. refer, freezer, stove, etc. In particular, I want to do some work with "holding plates" in refer & refig. work. I need a source for 12V DC reefer compressors and solar cells to build an array to fit space available, perhaps you could help.

Have tried some tests with solid state thermo-electric heat pumps, they depend on very efficient heat sinks which don't work with high ambient levels - also expensive. Am enclosing a small contribution to keep the coffee pot going.

Keep'em Flying, Frank Worcesto, Kenai, AK

For reefer parts and kits see Alternative Power & Light's ad on page 30 of this issue. Our experience with thermo-electric modules is similar to yours- limited heat moving capabilities and very dependent on ambient temperature. RP

Silicone RTV

I find Home Power Magazine very interesting and informative.

I enjoyed the article in Home Power 10, pg. 31 "Things That Still Work" about solar panels. In fact, I was so interested that I ordered four panels and am using them, at present, to charge the batteries for my 2 meter handheld transceiver. I plan to make a modification to convert each panel to have added capability of 12 volts, then I intend to have switches to give me versatility by wiring these panels in series, parallel and series parallel. I do not want to do this until I can obtain the silicon RTV compound to restore the panels to their original cosmetic state after modification. Perhaps one of your readers or you can help me by informing me what to ask for and where to obtain it.

I have always been interested in alternative energy, in fact, I constructed a wind generator during my high school days and would like to continue my projects but I really don't have the space. Keep up the good work.

Sincerely, E.S. Spiak, Hacienda Heights, CA

Small Scale Steam

Just saw #11 and am happy with HP, hence subscribing.

I recently acquired a house in Colorado, 5 miles from the nearest utilities, at 10,300' in a deep valley, close to the continental divide. Although I have full sun in summer, I get less than 2 hours in winter on the rare days it's not clouded in. Wind has strong gusts which makes reliance in it difficult.

What I do have is bountiful firewood. Does anyone make a small scale steam generator which can be run on wood. 1kw is adequate. Steam engines are inherently less efficient than internal combustion engines for small scale operations but since I can use heat even in summer, this is OK. I am surrounded by Mother Nature's beautiful green solar collectors and can go for years before I have to fell a live one.

Paramananda Sarawati, Nederalnd, CO

Try Peter Carlich of the Reliable Steam Engine Co., POB 671, Waldport, OR 97394 or call 503-563-2535. Peter builds ultrafine, 5 to 40 hp., steam engines. He does his own casting out of recycled metals. RP

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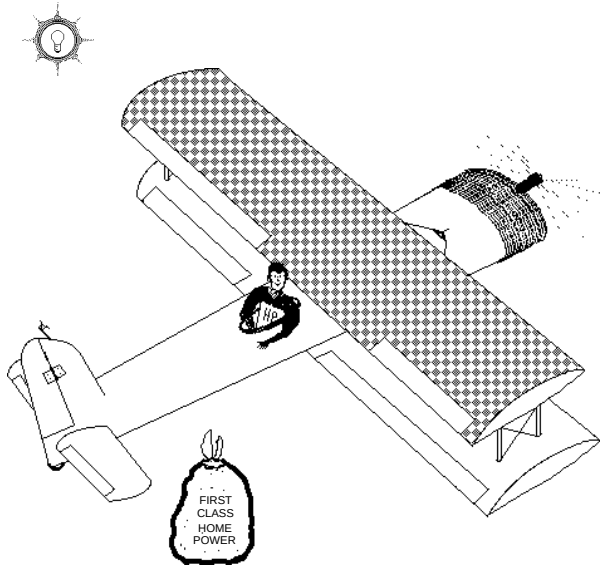

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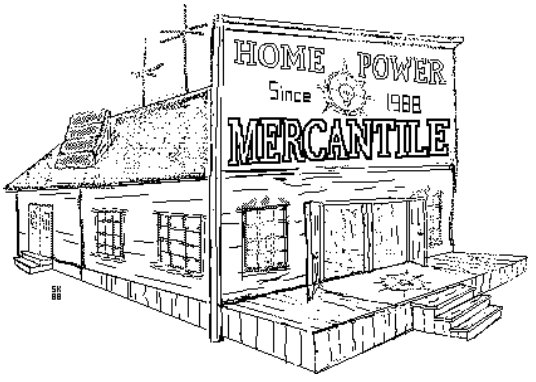

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