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HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

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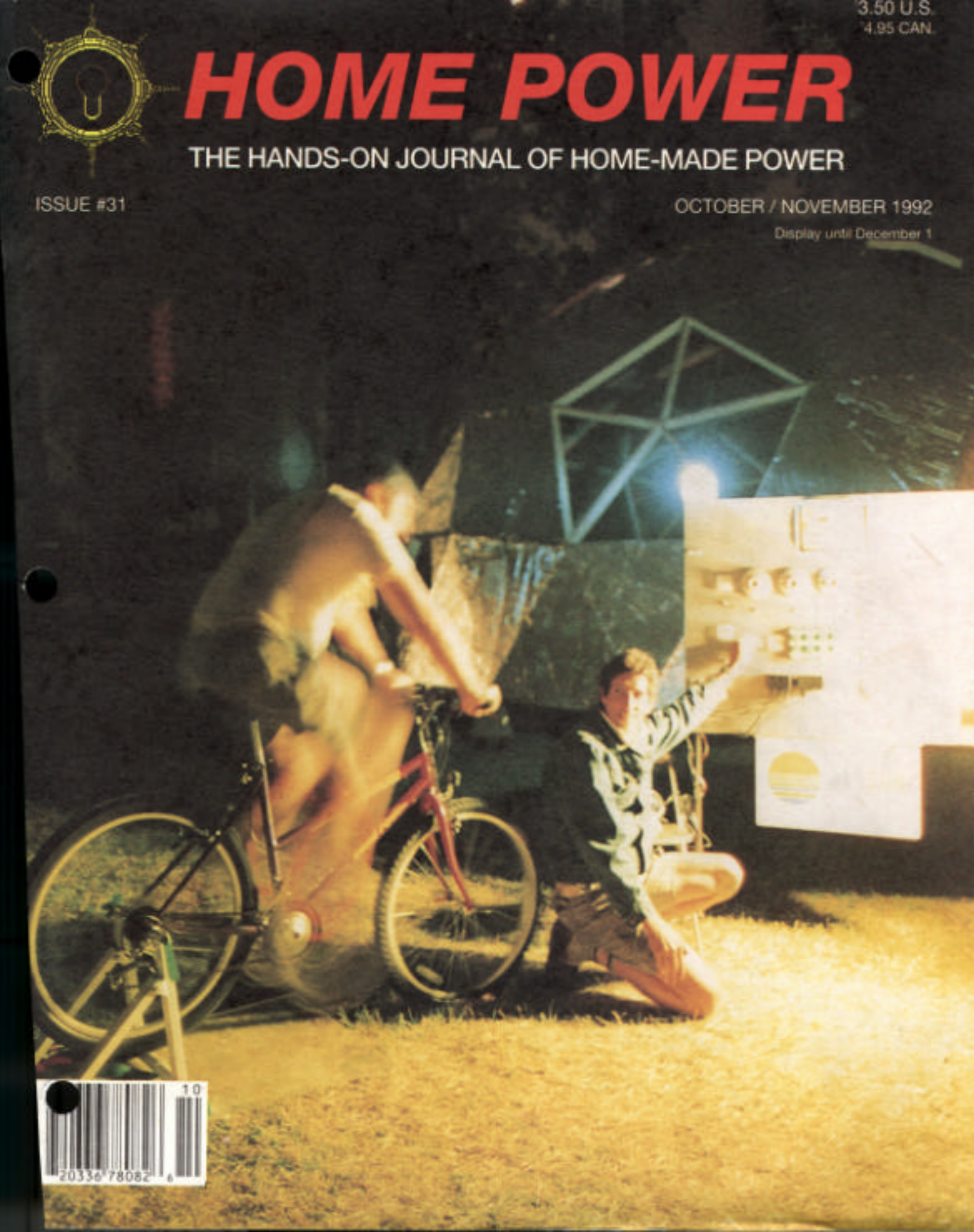

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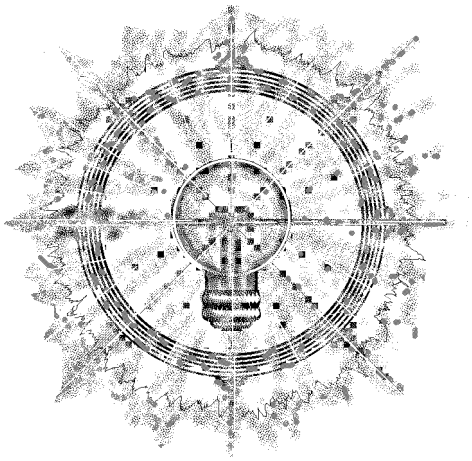

HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

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Think About It

"Everybody is all right really."

Winnie the Pooh—A Bear of Little Brain

Cover

George Hagerman and his bike generator at SEER '92. Bob-O Schultze pumping for power.

Photo by Richard Perez.

From us to YOU

Everybody is all right really

Going around the country this summer has done this crew a whole lot of good. Attending energy fairs, meeting home-powered people, and seeing the energy in everyone's eyes refills and refreshes us.

I sense our attitudes toward energy, environment, politics, and even life in general changing. The folks we meet are hopeful. There is a distinct trend of "we can do it" running through the conversations. Maybe I'm seeing a generation coming of age and assuming its power. Maybe I'm seeing wishful thinking. Maybe I'm delirious…

Maybe the attitude of, "yes we can solve our planet's problems" is tactical. If we don't try, then certainly we will accomplish nothing. If we think we can't, then we certainly won't.

Maybe the "can do" attitude is bred from small successes, our stepping stones into today. We met and talked with many people who are living "a clean solar life". We are all trying very hard, and it's working. We are becoming more free; we are making less waste and pollution. We are making changes. We are making a difference.

We just want to bring this message back from our travels. "Everybody is all right really!" The bear of little brain had it right all along.

— Richard for the Home Power Crew

Above: Five young women in a six legged peace race at the Midwest Renewable Energy Fair are all right, really! Photo by Therese Peffer

People

Kathy Abbott
Barry Brown
Geroge B. Chase
Jay Campbell
Sam Coleman
Michael Diogo
Maria Gonzalez
Ab Greacen
Chris Greacen
David Haaren
Tom Heinrichs
Kathleen Jarschke-Schultze
Kid's Corner Kids
Tom Lane
Dan Lepinski
N. Bleecker Green
Bob Grater
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ELECTRON CONNECTION AD
full page
full color

A Clean Solar Life

George B. Chase

Our trip to energy independence started with a canoe camping trip on the Peace River in southwest Florida. We had such a good time in the wilderness with the alligators, turtles, herons, and hawks that we decided to look for a weekend "get-away" from the fast paced life we lead in the big city.

Small Beginnings

What we found was a small cabin (about 500 square feet) on the river with seven acres of land. The cabin is 1 $^1/_2$ miles from the power line and the previous owner had a car battery to run a few 12 Volt lights and a small fan.

We continued to use the battery and added a gas refrigerator from an old RV. After about a year of switching the batteries in the house and car back and forth, we invested in our first photovoltaic module, an ARCO M65 self-regulating module. Along with a 100 Amp-hour deep cycle battery, we began producing our own power. Now when we arrived for the weekend, the battery was fully charged and ready to go. This one module, one battery system was used for over 6 years as our only power source and is still producing power today, 10 years later!

Building a Home

When we decided to build a home big enough to live in and leave the city for good, our first step was to check with the local electric company. They told us it would cost about $15,000 to bring power to our site! Our budget forced us to find more cost-effective power.

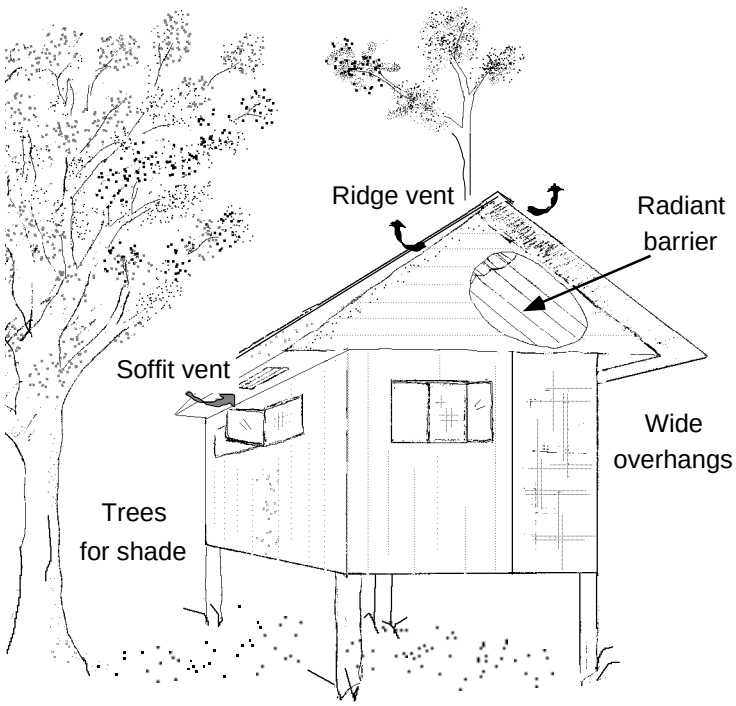
Over the last 6 years we had been doing research on solar power. We were familiar with many products, and had a fairly good idea of what was necessary to go stand-alone solar.

I did my own architectural and electrical plans and had them okayed by the building inspector prior to building. I had great luck with the local building inspectors by going to them early. I told them what I planned to do and asked for help. They knew I was not trying to cut corners on safety and actually asked my opinion on many items. I had to show them areas of the National Electric Code for solar.

Since it gets hot and humid in Florida, and since air-conditioning is not cost effective in a PV home, the basic design of the house had to take advantage of each breath of air. We got information from the Florida Solar Energy Center on any subject we thought might give us a hint on overall planning. The FSEC has a large library of solar publications and the time spent researching saved us money.

In a warm climate radiant barriers are probably the most overlooked yet most easily installed item. They can reduce heat gain tremendously in both roofs and walls. The foil-backed barrier came in three foot rolls. We installed the radiant barrier foil-side down under the rafters in the attic. Heat is reflected from the house and escapes through the ridgevents. Soffit vents under the eaves aid air circulation in the attic.

Large doors and windows carefully located can take advantage of prevailing breezes to keep a house much cooler. Three foot wide overhangs, and shade trees strategically planted help, too. Planning is the key. It can make the difference between a successful project or one you will be redoing for years to come (see drawing below).



Assessing Power Needs

Our next step was to establish our power needs. We knew we wanted to have a normal electrical lifestyle. We first decided what we must have, and what we could do without and still live comfortably. We chose a standard 30 inch gas range and a Sun Frost RF-16 (16 cubic foot) refrigerator/freezer. Since the Sun Frosts are not shaped like a standard 110 volt refrigerator, you must preplan space for it. A regular automatic washer is used for clothes and is powered by our inverter. A 10 gallon RV gas water heater provides our hot water needs. Once we estimated our total electrical needs, we could then start to design our power system.

We have fourteen ARCO M75 photovoltaic modules that produce 47 Watts each. The panels are located on the roof on standard ARCO ground racks. I change the angle of the racks twice a year—a flat angle for summer and a steeper angle for the winter sun.

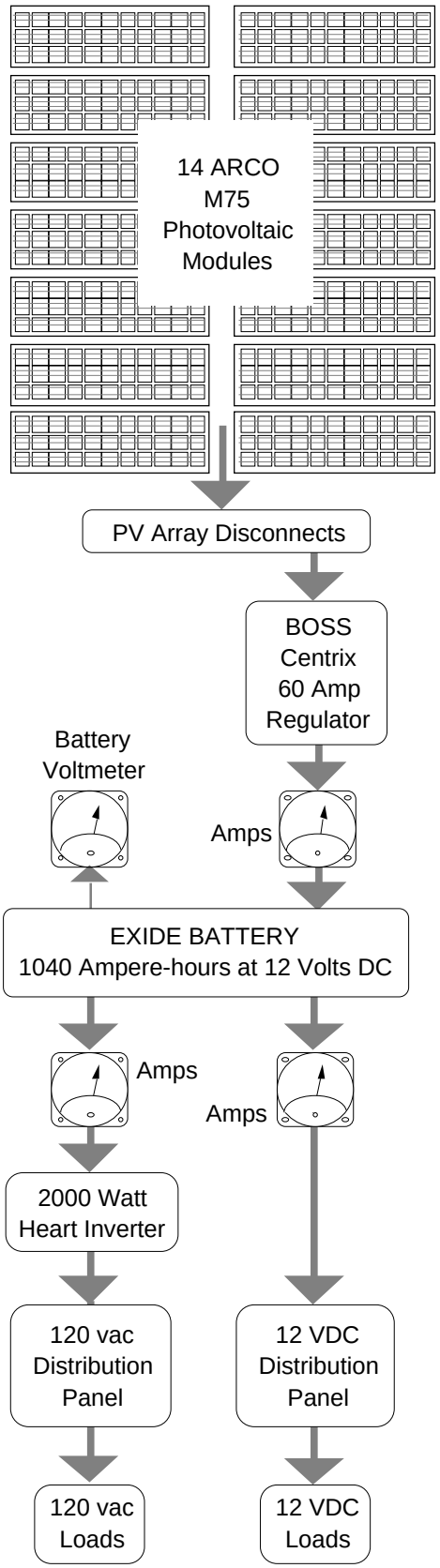
Efficient Design

Building your home yourself allows you to take advantage of efficiency options most contractors disregard. The floor plan should be given special consideration to allow for a centrally located battery room or box. This will cut costs and increase efficiency by keeping wire lengths to a minimum.

Our battery bank is located in a vented box just outside the wall from the control room. We have eight 6 Volt, 260 Amp-hour Exide golf cart batteries, wired in series and parallel for 1040 Amp-hours at 12 Volts. The batteries sit on a strong wooden tray of 2 by 4's and plywood with two sets of refrigerator roller wheels on the bottom. You can easily open the box and roll the batteries out for maintenance and specific gravity checks.

Where the Energy goes in the Chase System

12 Volt DC Loads	Run Watts	Hours/ Day	W-hrs/ Day	%
Sun Frost refrigerator	120.0	6.0	720.0	52.2%
MacDonald water pump	350.0	0.5	175.0	12.7%
lights	9.0	4.0	36.0	2.6%
ceiling fans	18.0	1.4	25.2	1.8%
radio/tape player	3.5	0.2	0.7	0.1%
Subtotal in Watt-hours per day			956.9	69.4%
120 volt ac Loads				
washing machine	1200.0	0.2	252.0	18.3%
13 inch black & white TV	12.0	3.7	44.4	3.2%
microwave	800.0	0.1	56.0	4.1%
vacuum cleaner	600.0	0.1	42.0	3.0%
19 inch color TV	75.0	0.2	15.8	1.1%
ceiling fans	60.0	0.2	12.0	0.9%
Subtotal in Watt-hours per day			422.2	30.6%
Total Energy Consumption in W-hrs/day			1379	



Above: Our solar powered wood frame home stands on 10 foot stilts. Below: Joyce and George.
Photos by George B. Chase

The control room is about 3 x 2 feet with bifold doors. It holds the voltage regulator, quick disconnects for array, both ac and DC breaker boxes, and a Heart inverter. Control gauges show charge current, both ac and DC draw, battery voltage, and temperature. It also houses an alarm system with auto-dialer for police and fire assistance.

Wiring

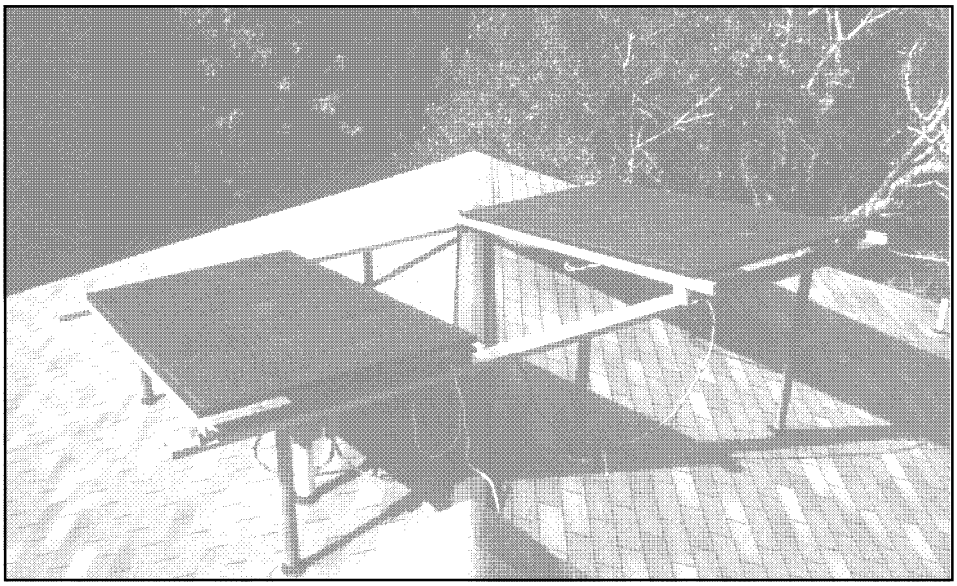
Don't try to save money on the wiring of your DC system. Regular #12 or #14 Romex wire used in conventional home wiring will not do. Larger wire is needed for low voltage DC. Be sure to use a wire chart to arrive at the proper size (see Home Power #18, p. 31).

We divided the house into zones and used large Romex 2-strand wire (#6) under the house to carry the current from the breaker box to each zone. We then stepped down to smaller Romex wire (#12) for short runs from junction boxes to the outlet receptacles. The number of outlets per run were kept at a minimum to keep resistance low. We soldered all connections. A soldered connection

will have less electrical resistance than a wire nut and will seal the wires from corrosion. We installed two different receptacles for 12 Volt and 120 volt appliances.

Maintenance and Backup

Since there are no moving parts to squeak, grind, or suck gas and oil in a PV system, maintenance is minimal. A properly designed system works so well you could easily forget to check it out every now and then. About the only part of your system that will need any regular attention is the battery bank. Specific gravity and water levels should be checked regularly to prolong battery life. *The Complete Battery Book* by R. Perez is a great source of information on all types of batteries.



Above: Fourteen PV modules supply the power for the Chases' home. Photo by George Chase

Since Florida weather includes cloudy days, we decided a back-up battery charger would come in handy. We got a used 12 Volt alternator (60 Amp) from a friend and mounted it to a slab of wood. Then we put a large pulley on the power take-off (PTO) of our tractor. We simply ran a Vee belt from the PTO to the alternator and bingo! 60 Amp output to the battery bank. The diesel tractor will run for about 15 cents per hour and this system will equalize the battery bank. We've installed an ammeter on the output of the alternator and we merely adjust to idle speed of the tractor to change the output current as needed.

Designing a System

If you are thinking of making the move to solar power, talk to as many people as possible and attend an energy fair in your area. The solar industry is no different than any other. There are some people selling equipment who have never used it, and they will tell you what they think you want to hear just to make a sale. Time spent on the phone or writing letters will save you money and aggravation. Each time you talk to a different company you will get a different opinion of how your system should be equipped. Research is the only way to ensure your system will be right for your needs.

A great system doesn't need to be purchased all from the same dealer. Components in solar systems are compatible and expandable. You can easily start with a small system and add to it later. If you choose this route, make sure you buy components that will allow you to expand. If you plan to add more modules at a later date, make sure you buy a regulator that has the capacity to handle the added power.

Cost of the Chases' System

Equipment	Cost	%
14 ARCO M75s (@ 47 Watts)	$3,990	41.6%
Sun Frost RF-16 refrig/freezer	$2,300	24.0%
2000 Watt HEART inverter	$1,800	18.8%
Eight 6 Volt EXIDE batteries	$520	5.4%
Radio Shack security alarm	$400	4.2%
60 Amp CENTRIX volt regulator	$290	3.0%
Support Structure	$200	2.1%
Five Meters	$100	1.0%
Total	$9,600	

Standard and Solar!

If you visit our 2,000 square feet stand alone solar home, you would not think it was any different from a standard utility connected house. Most people we've spoken to think that PV-powered homes are just "cabins" without any creature comforts. All our fixtures and appliances are standard, although some have been modified to run more efficiently. Our home has beautiful tongue & groove pine flooring, a cedar lined walk-in closet, and standard bath fixtures. The kitchen has solid wood hickory cabinets and Corian countertops. Lots of windows and french doors let in air and light.

Our home is proof that you can live a clean solar life and not sacrifice modern convenience or beauty. Our fragile environment needs protection and we feel our home is a small contribution to saving the planet.

Access
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PACIFIC INVERTERS
full page
camera-ready

SEER '92

the *Home Power* Crew

The Solar Energy Expo and Rally (SEER) has grown in the last three years. SEER started out as an experiment relegated by the city fathers to a sun baked parking lot. Now it's a full blown community activity supported by the local chamber of commerce. Here are the *Home Power* Crew's impressions of this nonstop energy extravaganza.

Human Power

George Hagerman from SeaSun Power Systems gets my vote for the best exhibit at SEER '92. Check out the cover of this issue. George has connected a bicycle to a small generator that directly powers a variety of loads like compact fluorescents and regular ole' lightbulbs. It is easy for anyone pedaling the generator to actually feel the difference between efficient and inefficient appliances. George's pedal power exhibit is easily the most fun and informative demonstration of energy efficiency and awareness that I have ever seen. The bike was a screaming success. George actually had children coming up to him and offering to pay to ride the energy education bike!

After SEER closed on Sunday night, a group of us gathered around the bike to photograph this issue's cover. The award for energy production goes to Dave "Third of a Horse" Doty from Gig Harbor, Washington. Dave pedaled four 50 Watt lightbulbs, the blue beacon light, and a fan into life. He pedaled so hard that he fractured a link in the heavy duty industrial chain coupling the bike to the generator. George Hagerman told us that the connecting pins in the chain had sheared off several times, but no one had ever before broken an chain link. We totaled up the wattage that Dave produced and found it to be over $\frac{1}{3}$ horsepower! This led to an demented discussion of exactly which third of a horse Dave is….

SeaSun Power Systems designed this bicycle energy demonstrator as an educational exhibit that can be easily reproduced by schools and community groups. A manual that provides step-by-step building instructions, a parts list, lesson plans, and an educational poster will be available by the end of the year. Contact North Carolina Alternative Energy Corp., c/o Susan Luster, POB 12699, Research Triangle Park, NC 27709 • 919-361-8000, ext. 8031. Parts cost about $500, not including bicycle. Once the manual becomes available, George hopes to hold workshops across the country where teachers actually build the kit for their own schools. — Richard Perez

Communications

Renewable energy works. The big job before us is communicating what natural power can do. To this end, we set up a radiotelephone system at the *Home Power* Booth. Carlson Communications from Garberville, California (800-283-6006), graciously allowed us the use of one of their terrific OptaPhone+ units for SEER. We used this radiotelephone to access the *Home Power* Computer Bulletin Board at Redwood Alliance in Arcata, California. Michael Welch has done a bang-up job of establishing this bulletin board (BB) whose only purpose is energy issues. For example, you may download, from the BB at no charge, the text and art for *Home Power*'s out-of-print issues. There are also message mailboxes on the BB where you can send me, and many other energy people messages. You can access the *Home Power* Bulletin Board at Redwood Alliance by having your modem call 707-822-8640. Michael is just about finished collecting the equipment necessary to place the bulletin board and the entire Redwood Alliance office on solar power. The OptaPhone+ was solar-powered at SEER and performed flawlessly with the computer's modem. The radiotelephone also came in handy for ordering pizza and other essential communications tasks. — Richard Perez

People

While I enjoy the displays, seminars, and electric cars, the best part of SEER for me was the people. Reading the mail and talking to people on the phone doesn't come close to meeting people face to face. SEER was a chance

Photos on page 13.

Left top: The solar cooker contest.

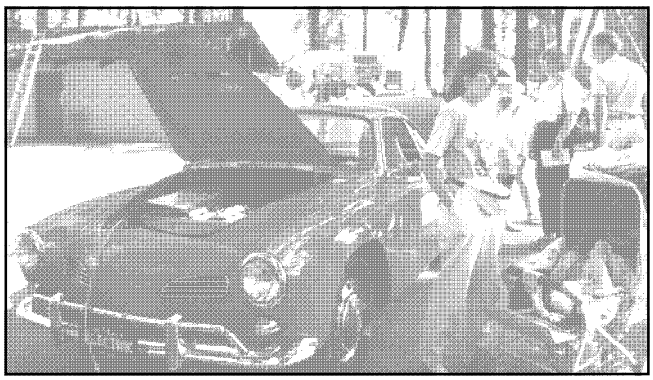
Left center: The main joy of SEER is meeting and talking with people. Here Richard and Karen talk with folks at the *Home Power* booth.

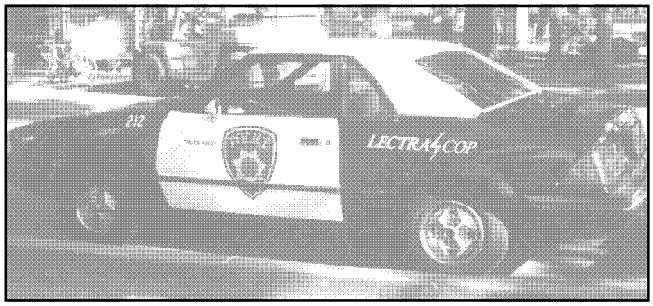
Left lower: George Hagerman's bike powered energy display draws a steady stream of energy conscious pedalers. Norrie Cooper cools off a furious pedaler.

Right top, and below: Electric vehicles for everyone from the Diaper Derby for kids, to Scott Cornell's electric Ghia, to an electric cop car.

Right bottom: Energy fairs can be tiring. Here a wandering Bear takes a nap at the Home Power booth.

Photos by Therese Peffer, Chris Greacen, and Dan Lepinski.

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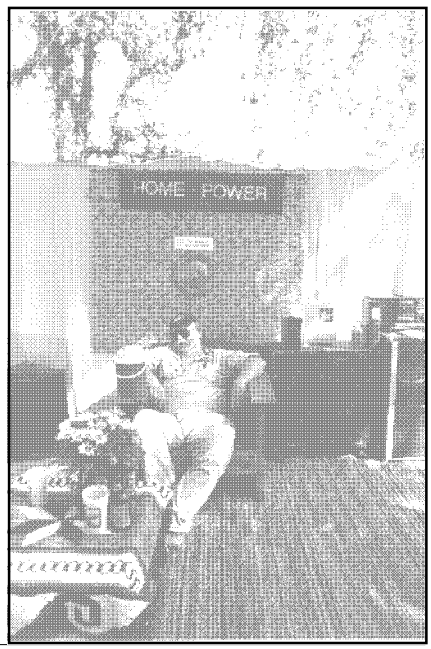
HOME POWER

for some real dialogue, an exchange of opinions, and a great chance for us to get some feedback.

We attempted to bring our home to SEER. We brought a computer and printer, radiotelephone, vacuum—great for the carpets we had laid out—lights, couches, and music. Bob-O had a solar shower set up, and called for more people to take showers as the water got too hot. But it was the people that made it seem like home. Some brought cookies, homebrew beer, and banana bread. Others sat down and read or just rested. Groups gathered around in lively discussions of renewable energy systems or philosophy.

We heard all kinds of feedback. A couple of people had recommendations for the index. Kasha Sanderson suggested we compile a list of efficient appliances. One guy suggested we cover the home businesses that allow people to move to the country and off the utility grid. I talked with folks who were just learning about renewable energy and others who were long time users. I met people who have written for *Home Power*. I spoke with people coming from a walk's distance away to a few thousand miles away. A few readers wanted to know about my toaster oven (mentioned in the system article last issue). Yes, I admit it's not the most efficient appliance, but it only uses about 75 watt-hours (or an hour and a half of sun shining on a photovoltaic module!)

I don't know the final attendance figure for SEER'92, but I know there was a steady stream of people going by the booths both days. It made for wonderful, diverse, educational conversation. These connections make RE come alive and grow—thanks! — Therese Peffer

SEER/Nissan Electrathon

SEER was strong on electric vehicles. The events: the Eco Car Challenge (various electric cars converged on Ukiah, on their own power where possible, then convoyed to Willits over the Ridgewood Summit), the Tour de Mendo (a mileage rally on the back roads around Willits), a number of drag races (including a drag race between an electric vehicle and a police car), and an Electrathon race. "Electric Alley" buzzed with activity — more than forty cars were displayed and participated in SEER activities.

The day before SEER opened to the public, my cousin, Wiggs Greacen, and I skipped out on setting up to go videotape the SEER/Nissan Electrathon race thirty miles away in Ukiah. The electrathon challenge: travel as far as you can in an hour in a vehicle powered by 62 pounds of lead-acid batteries. A dozen entrants came to race. These folks see electrathon racing providing a structure for the development of lightweight electric vehicles which will be applicable to small commuter vehicles. The entrants ranged from Clark Beaseley, the Australian who brought the sport to America in 1990 and won the event last year, to teenager Andy Crice driving a car built by the Willits High School tech-ed class. Dan Parks had a particularly clean and simple vehicle with a leaning suspension and a monocoque chassis. Loy Cloud and her brother-in-law Willy Cloud, fresh from a victory in Bellevue, Washington, entered planning to win in their identical long-nosed, home-made looking cars.

The race was held at the Ukiah speedway. From the start, Loy and Willy Cloud battled it out with Clark Beaseley for the lead. It was neck and neck, as the cars experimented with tight and loose banking to preserve as much momentum as possible in the sloping curves. Before halfway though the race, disaster struck for Willy Cloud in the form of a flat front tire. Loy Cloud, however, lengthened her lead on Clark Beaseley, at one point leading by a full lap. It looked like she might beat Clark but the hot pavement and tight curves struck the same weak point in the car. She too suffered a flat front tire. Clark Beaseley went on to victory, and a new world record, completing 32.5 miles in the allotted hour.

This Electrathon stuff is vivacious and contagious. My cousin, a racing auto mechanic, had never heard of electrathons before. He left with plans to spend the next six months building an electrathon vehicle to compete in the Phoenix race in April 1993. — Chris Greacen

Hot Hardware

The hottest new RE hardware at SEER '92 was sine wave inverters. Both Exeltech and Dynamote were displaying their pure sine wave models. See the "Things that Work!" article in this issue for details. We ran the Home Power booth on a 500 Watt Exeltech, powering lights, music equipment, computers, printers, a modem, and other stuff, while remaining totally quiet in the radiotelephone. The day of pure, RFI quiet power for RE systems has definitely arrived. — Richard Perez

Hydrogen

The all-day Hydrogen Conference at SEER brought us together to discuss the important role that hydrogen will play in our future. Hydrogen makes possible clean, safe storage of energy produced from renewable energy sources. It is easily and efficiently transported to where it is needed. Large scale hydrogen options and problems in their implementation were discussed. Each speaker reiterated that large scale hydrogen could be economical.

One of the main challenges facing hydrogen use is economical production from renewable energy sources.

Roy McAllister of the American Hydrogen Association spoke about converting the organic portion of sewage and garbage into hydrogen and carbon. Professor Peter Lehman, of the Schatz Hydrogen project at Humboldt State University, described electrolyzing water using PV panels and later recombining the hydrogen and oxygen in a fuel cell to produce electricity (see HP #22). Hydrogen could be produced in the sunbelt areas of the U.S., piped to areas that need electricity, and combined with oxygen in a fuel cell (or conventional combustion turbines) to create electricity. Though this system sounds prohibitively expensive, Professor Lehman likened its implementation to first putting in our federal highway system—once the infrastructure is in place the benefits will exceed the cost.

Another challenge facing hydrogen use is the fuel cell. Fuel cells exist today, and are three times more efficient than combustion engines. Currently, however, they are expensive and failure prone. Roger Billings spoke about his work on hydrogen powered cars. His current project is the LaserCell, a hydrogen fuel-cell powered car. He hopes to make the fuel cell available for mass production in time to meet California's zero emission standards of 1998. To put the current state of fuel cells into perspective, Roger Billings asked the welders in the crowd to imagine the cost of making a combustion engine if all the parts weren't readily available.

The interest in hydrogen at SEER was overwhelming. Each presentation was crowded and hydrogen was being discussed everywhere in small circles throughout the weekend. Almost all of the research presented was privately funded. Perhaps all this interest will aid research efforts in overcoming inefficiencies in electrolyzers and the high cost of fuel cells. — Amanda Potter

Solar Cooker Competition

Finding a sunny place in the park for the cooker contest seemed difficult at first. We were supposed to set up the contest at the horseshoe pit so we could dig a hole for one of the cookers, but there wasn't enough sun there. We moved the competition to the park proper (and simulated a hole with a box and newspapers). As the judges tasted the food from each cooker, a small crowd gathered. Not content to just stand by, several onlookers participated in the tasting and commented on the cookers. The crowd looked at the finalists and suggested improvements. I enjoyed the inter-crowd communication —it enriched the contest. See the complete solar cooker contest report on page 38 of this issue. — Kathleen Jarschke-Schultze

Access

Authors: the *Home Power* Crew, POB 520, Ashland, OR 97520 • 916-475-3179

Below: Clan Dyken, a solar powered band, sings songs of sunshine to SEER goers. Photo composite by Bart Orlando

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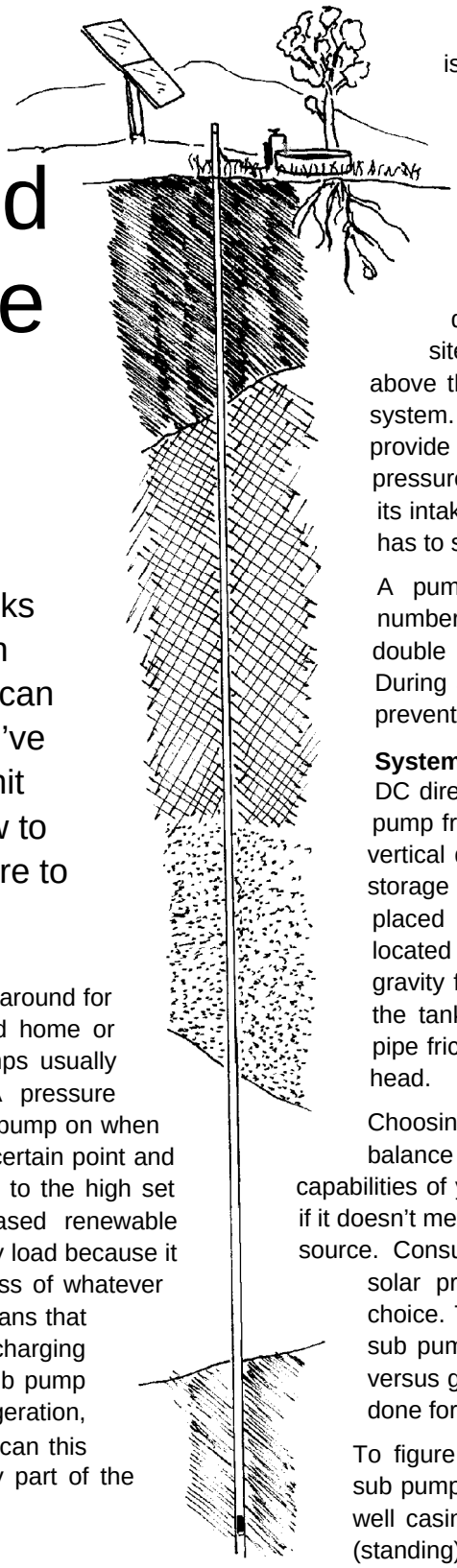
Installing a PV-Powered Submersible Pump

Bob-O Schultze — KG6MM



It is hot and dry. Small creeks and springs that have been flowing as long as anyone can remember are drying up. You've saved up, drilled a well, and hit water. Now what? Here's how to get your water from down there to up here using solar power.

Submersible Pumps

Submersible or "Sub" pumps have been around for a long time. In a typical grid-connected home or farm, these are fairly high volume pumps usually powered by 240 or 120 volts ac. A pressure sensitive switch is employed to turn the pump on when the house water pressure falls below a certain point and turn it back off when the pressure rises to the high set point of the switch. In an inverter-based renewable energy system, this is known as a priority load because it may turn on or off at any time regardless of whatever other loads are being operated. This means that the inverter (and battery bank and charging system) must be sized to handle the sub pump and all other priority loads, like ac refrigeration, and lighting *at the same time*. Not only can this get expensive and inefficient, but if any part of the system fails, you're out of water!

DC Direct Sub Pumps

A more cost-effective and reliable system is to use a dedicated photovoltaic or wind system directly coupled to a sub pump. A water storage tank holds the water until it is actually needed. There are some definite advantages to this type of system. The PVs can be located directly at or nearby the wellhead, saving long wire runs from the inverter, generator, or battery bank. This can be cost-effective even for utility grid-connected folks who want to develop a well in the "back 40". At some sites the water storage tank can be located above the point of use to provide a gravity flow system. Even if the tank's head is insufficient to provide adequate water pressure in the house, a pressure boosting pump with positive pressure at its intake will use far less energy than one which has to suck the water up to the pump intake.

A pump/storage system sized to provide a number of days or weeks of storage will do double duty as a fire protection water source. During a fire, a lot of water is needed quickly to prevent a disaster.

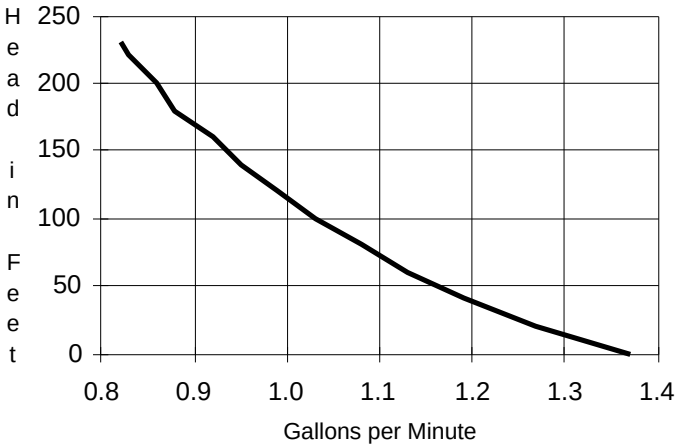
System Sizing and Pump Selection

DC direct sub pumps are now available that will pump from 250 feet total head. Total head is the vertical distance from the pump to outflow at the storage or stock tank. For example, if a pump is placed 150 feet down a well and the tank is located 50 feet vertically up a slope to provide gravity feed, the total head would be 200 feet. If the tank is a long way from the wellhead, any pipe frictional losses incurred will add to the total head.

Choosing the right pump means striking a balance between your water needs and the capabilities of your water source. No pump is a bargain if it doesn't meet your needs or if it overtaxes your water source. Consult the manufacturer's literature or your solar professional to help you make the right choice. The graph on page 18 shows typical DC sub pump performance — dynamic head in feet versus gallons per minute output. This graph was done for a Solarjack SDS-D-228.

To figure out the best depth placement for your sub pump, you'll need to know the diameter of the well casing, the total depth of the well, the static (standing) water level, and, if possible, the recharge rate of the water coming into the well. All the manufacturers of currently available sub pumps make pumps which will fit into 4 inch diameter well

Sub Pump Performance— Head versus Flow



casings. Some of the higher output pumps, however, require a 6 inch casing. As a rule, the deeper the pump is located, the less volume of water will be pumped. If the recharge rate of the well is greater than the pump's capacity, locate the pump 10–20 feet below the static level of the water for greatest output. If the recharge rate is less or unknown, locate the pump deeper in the well and use water level sensors in the well to protect the pump from dry running. *Never* rest the pump on the bottom of the well or cistern as this can cause the pump to fill with mud and sand or reduce the water flow past the pump screens causing overheating. If possible, suspend the pump at least 5 feet above the bottom of the well to reduce water turbidity.

Setup

After determining the proper pump depth, cut your safety polypropylene rope and drop-pipe to length. Add (and keep track of) an extra foot or two of safety rope to allow for knots and tie off to your wellhead anchor point.

Next cut your waterproof pump wire to length allowing plenty to get from the wellhead to the pump controller or LCB. You may want to locate the pump deeper in the well at some later time and if the wire is sized so that voltage loss is not a major problem, it's a good idea to cut the wire long and store the extra down the well. If you are using water level sensors, cut the sensor drop wire to the same length as the pump wire.

Splicing the Pump Wire

One of the most common causes of pump failure is water intrusion into the pump via the wire splice. This is a place that pays big dividends later on if you pay attention to detail now. While some pump manufacturers use a waterproof cable connector to insure against water intrusion into the pump motor, most rely on double heat shrink tubing to prevent water intrusion. With any scheme, a well-connected, watertight joint is imperative.

I prefer to use crimped and soldered compression sleeves to connect the short pump cable to the main pump wires. Each wire joint is then covered with glue-filled shrink tubing and all three connections are covered with a larger piece of glue-filled shrink tube. See photos for detail.

Water Level Sensors

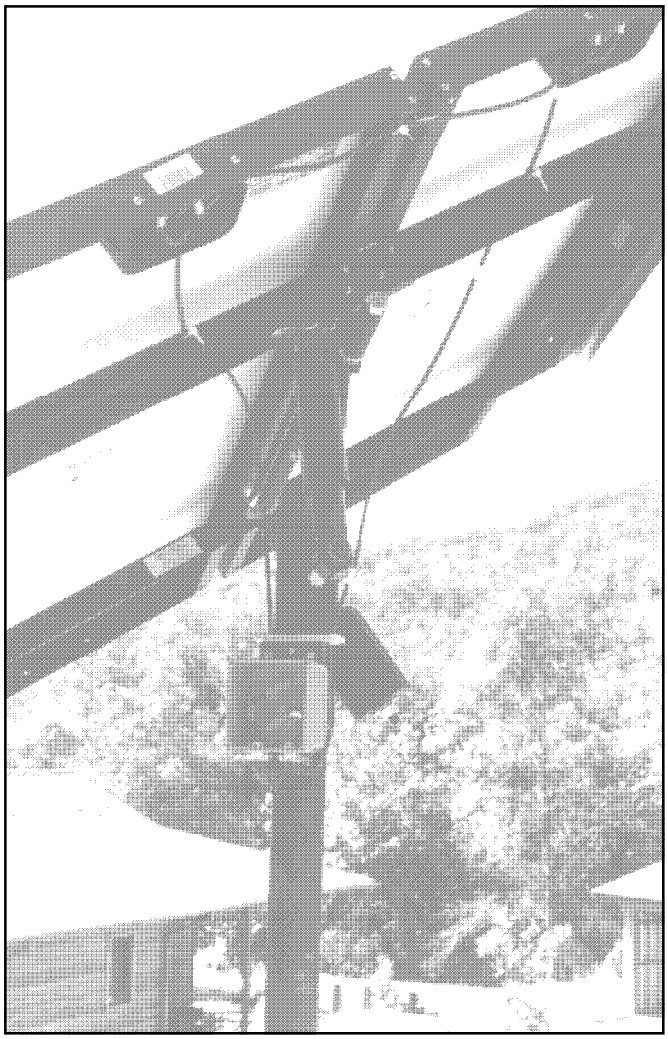
Most pump controllers use three water level sensors or electrodes, although some controls use a single sensor to turn the pump off or on depending upon whether the sensor is immersed. In the three sensor system, the "ground" electrode is the lowest and must be in the water at all times. It is placed within a few inches of the pump. The low-water electrode is placed at the desired "turn-off" point, usually about 6 inches above the ground electrode and the high-water electrode is placed at the desired "turn back on" point. This needs to be well below the static level and no more than 20 feet or so from the low water electrode. For low volume wells, it's usually within 5 feet of the low water electrode. In operation, the controller turns the pump off when the water level falls below the low-water electrode and keeps it off until the water level rises to above the high water electrode. This prevents unnecessary on-off cycling of the pump.

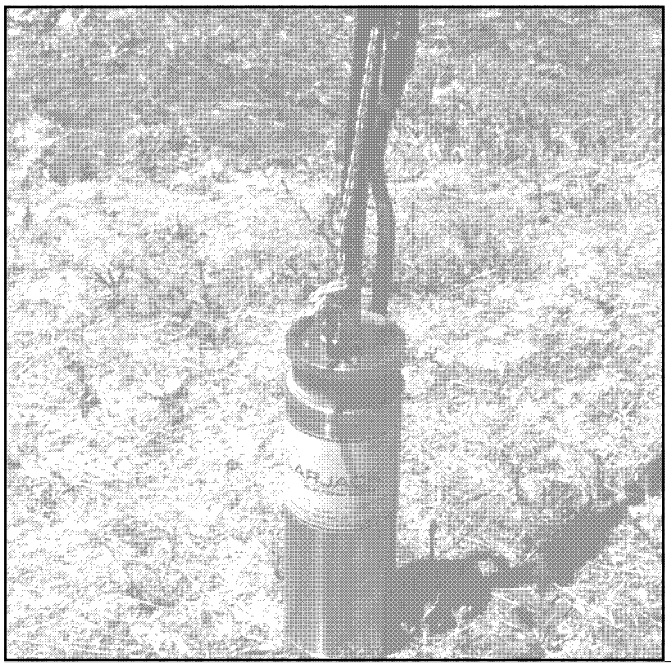
Small gauge waterproof sensor wire is kinda hard to find. On a tip from Wes Edwards of Alternative Energy Engineering, I tried some 3 wire, direct burial sprinkler control cable from a local drip irrigation supply house. It worked well enough, but it's a little fragile. Try rolling a little electrical tape around the wire insulation to "fatten" it up where it goes into the sensor seal.

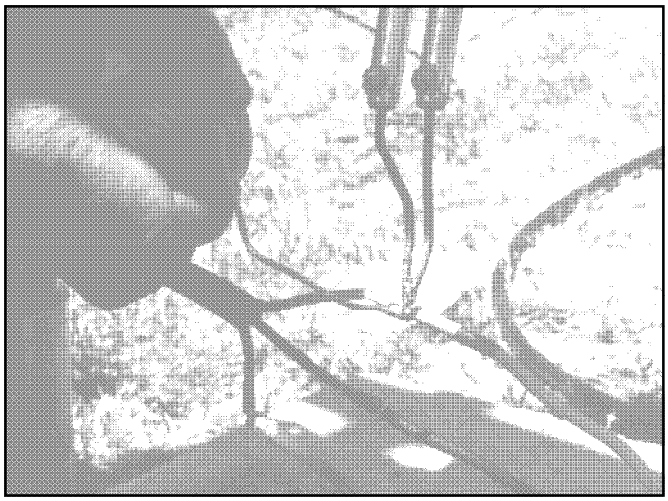
Drop-Pipe

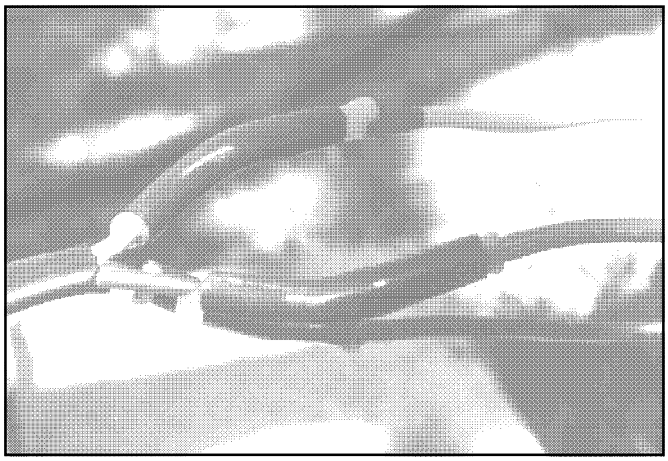
All of the small sub pumps are designed to pump into $^1/_2$ inch poly pipe. The large pumps use $^3/_4$ inch poly pipe. Even though the small diameter pipe can cause some frictional losses in long runs, the velocity of the water in a bigger pipe is not enough to carry sediments to the surface at low flow rates. They tend to settle back into the pump at night and can cause problems.

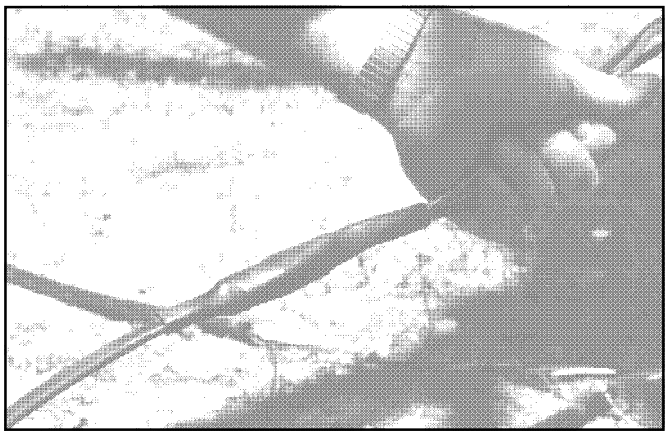
Even though I've never seen it mentioned in any of the manufacturer's literature, I strongly recommend installing a check valve in the pipe at, or just above the wellhead, if you are pumping into the bottom of a storage tank. Here's why: all the sub pumps use a diaphragm-type pump with 2 push-pull check valves. Normally, these valves will seal when the pump stops and hold the water in the drop-pipe. Frequently, however, a grain of sand or small bit of ick will







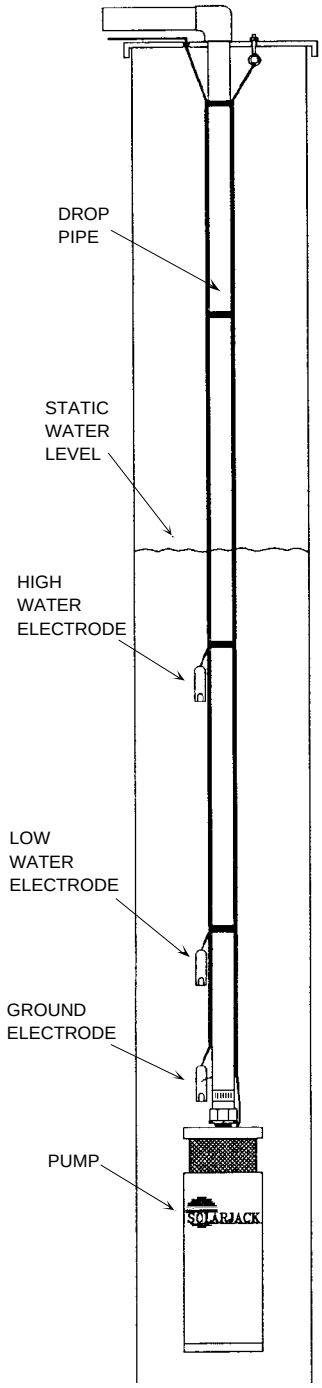




Above: Three photos showing a proper down the well splice. First crimp and solder, then shrink tube and seal, then shrink tube the whole wire bundle. Anything less won't last…

Above left: The power source—two PV modules.

Left: A Solarjack sub pump wired and plumbed, ready to go down the well. Photos by Bob-O Schultze



temporarily lodge under a valve and hold it open. The in-line check valve will prevent draining the tank back into the well.

Installation

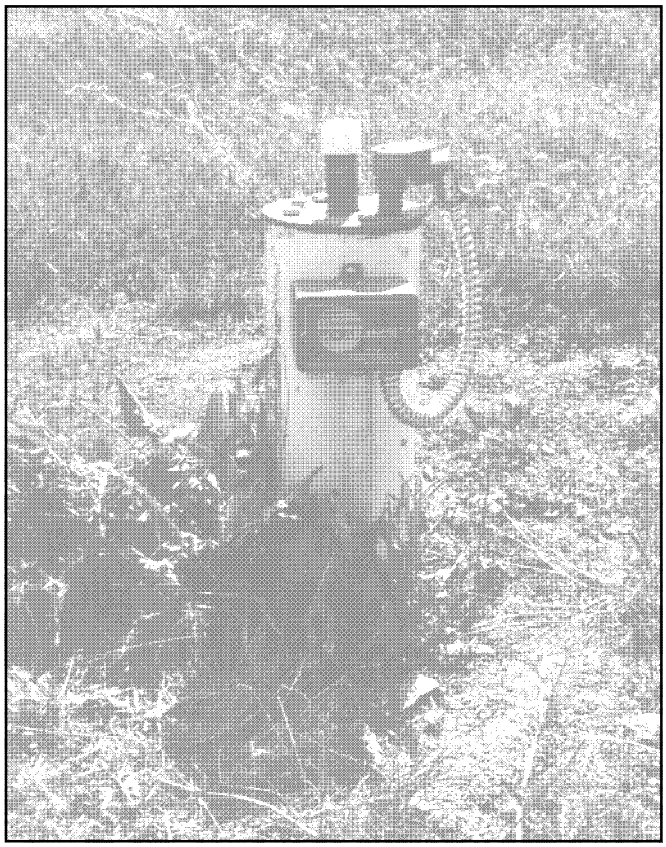
Bundle the drop-pipe, wires, and safety rope together using plastic wire ties or electrical tape every 5–10 feet. If you use tape, use a high quality vinyl PVC tape such as Scotch™ Super 33+, or better, to prevent unraveling. Loose tape is a mess in the bottom of the well. It can even clog the pump's intake!

After making sure that the safety rope is well anchored to the wellhead, GENTLY lower the pump down taking care to keep the bundle centered in the well so as not to nick any of the wires or the drop-pipe. Run the wires through the well seal and connect them to the pump controller. Connect the controller to the PV array through a properly fused disconnect. Pass the drop-pipe out of the well seal or make sure the in-well connection is secure if using a pitless type adapter. Switch the disconnect switch on and you should be pumping water!

Fine Tuning the Pump Controller or LCB

On most controllers, the "factory" settings will provide an adequate flow rate. If you need or want to get the most water out of your sun powered pump, here's how:

If you're using an adjustable LCB or Controller, make the adjustments at mid-day with the PVs at their normal operating temperature, if possible. With the system pumping, turn the array away from the sun or shade the panels until the pump flow rate is reduced about 50%.



Above: The sub pump is happily secure down the well. You don't see any water output pipe because this installation used a "pitless adaptor" which places all the plumbing underground, where it won't freeze.
Photo by Bob-O Schultze

Connect a DC voltmeter to the pump or "load" side of the controller or LCB. Slowly turn the adjusting screw until the maximum voltage is obtained. Uncover or return the PVs to their normal position. The pump should now be operating at its maximum flow rate. Note: this "peaked" LCB setting will change from summer to winter sun conditions. In most installations, a controller peaked out for summer conditions will provide adequate winter flow rates. If you're looking for maximum flow on a yearly basis, however, you'll need to readjust the controller at least twice a year.

Access

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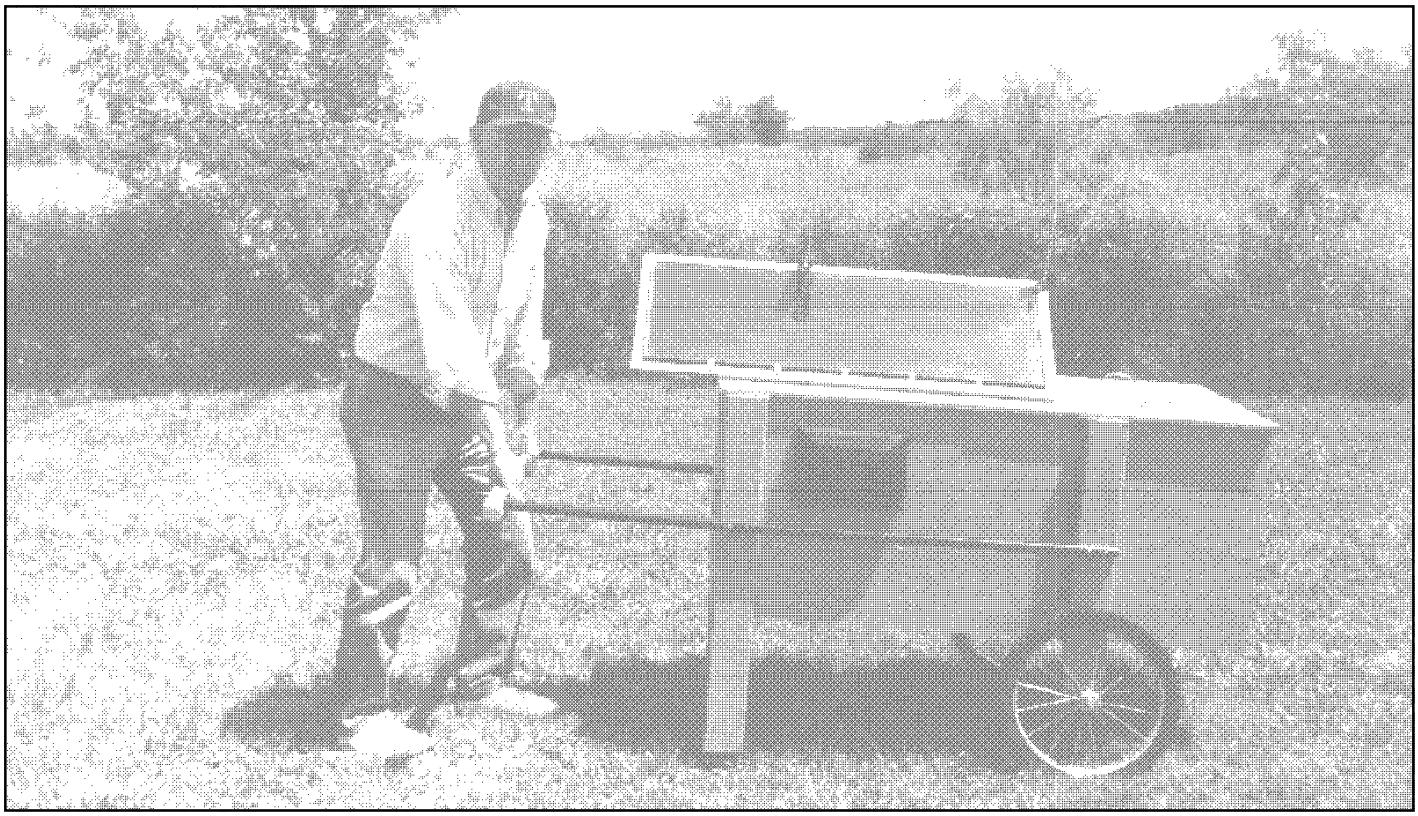
Special thanks to Jim Allen at SolarJack, Wes Edwards at Alternative Energy Engineering, and Bob Maynard at Energy Outfitters for helpful hints and kinks.



Above: N. Bleecker Green with his portable solar power plant. The self-contained unit wheels around the homestead with 12 Volt power for emergency lights, tools, and appliances. Photo by N. Bleecker Green

Portable Solar Power Plant

N. Bleecker Green

Home Power urges readers to try easing off the grid. Richard Perez talks of basics—one person, one module. Think big. Start small. Here is my hands-on account of how I built a portable solar power plant. Not big stuff like a whole house system costing big bucks, but one man's approach to easing off the grid, while working with limited knowledge and funds.

Cooking and Charging

I have been cooking my evening meal in a solar oven for several years. Over a year ago, I switched all my small batteries to rechargable nickel-cadmium batteries (nicads). Solar charged.

Last year I bought a 5 Watt Solarex photovoltaic module. I built a small cart on wheels with a combination back/handle angled at 45 degrees toward the sun. I solar charged a small lawnmower battery for use around the shop. But something was lacking. I wanted more.

Then I came across a 10 Watt Chronar photovoltaic (PV) module in a catalog at a good price. I ordered it and started to work.

I wanted a self-contained unit, a wheeled cart carrying PV module, battery, controls and meters, plus a 12 Volt outlet and a good radio, in-line fuses and soldered connections.

PV Module Starting Point

Since the module was 1 x 3 feet, it was my starting point. I built a box of 1/2 inch plywood, four feet long and about 20 inches square. I mounted the box on 15 inch lawnmower wheels, and added a sturdy handle for easy movement. Partitions divide the box into three sections.

Keeping Cool in Texas

My first concern was the PV module. I did not want a stationary ground mount being plugged and unplugged as the cart was moved around the homestead. I wanted the module riding atop the cart, hooked up and constantly charging the battery.

So I cut a piece of plywood slightly larger than the module. It has five cutouts or openings to allow air to circulate around the back during the hot Texas weather. I then mounted the module (3/8 inches thick) flat on this frame, held in place by plastic mirror holders. The frame was then fastened to the top of the box with three hinges. This allows the module to be pivoted to face squarely into the sun whether facing straight up in the early morning or late evening, or lying almost flat when the sun is overhead. I had learned a lot about facing and tilting with the 5 Watt Solarex module and the shop battery. A short 2 by 4 block helps align the pivoting panel to the sun. Just swing the panel up or down until the shadow disappears. Tinkering was paying off.

Manual Tracking—Erector Set Look

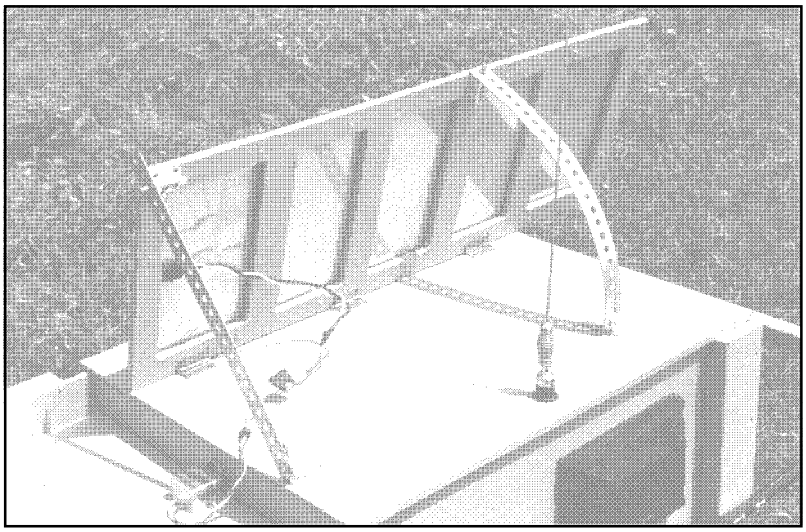
To hold the module at its proper angle, I fastened two perforated metal strips (1 3/8 inch x 1/16 inch) to the top of the box and bolted them to two small angle irons. I then fastened two sliding door latches to the frame. The bolts fit snugly into the perforations, holding the pivoting module securely.

Battery in Center for Balance.

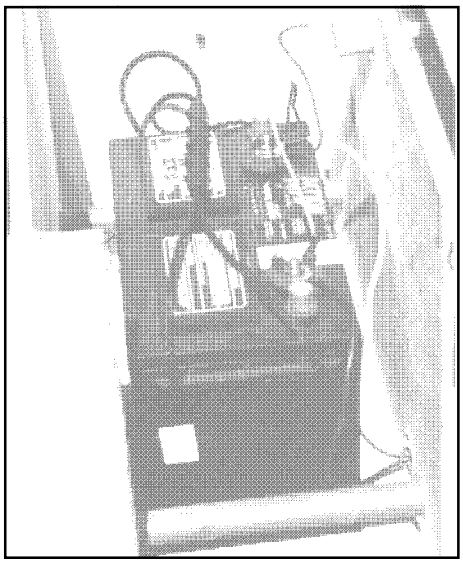
The 115 Amp-hour RV/marine battery is located in the middle compartment. It's heavy, so placing it near the center of the cart makes for better balance and easier wheeling. It is blocked to prevent any tipping or movement as the cart is moved around. I drilled holes for plastic conduit wherever wiring penetrated the plywood partitions.

Right: Control panel at end of cart which holds the controller, AM/FM radio dial, amp and volt meters, and cigarette-type 12 Volt outlet. Surface dropped several inches to allow removeable top to clear controller and radio knobs. Black circular knobs are drawer pulls to lift panel for service.

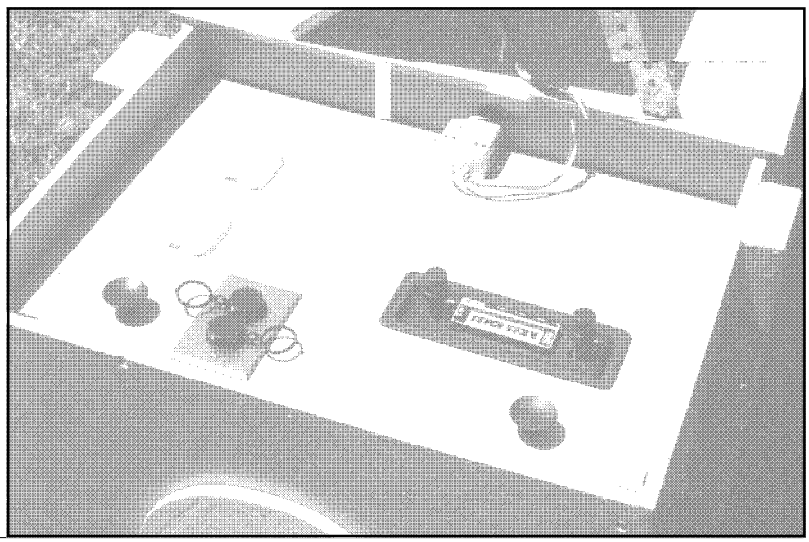
Photos by N. Bleecker Green

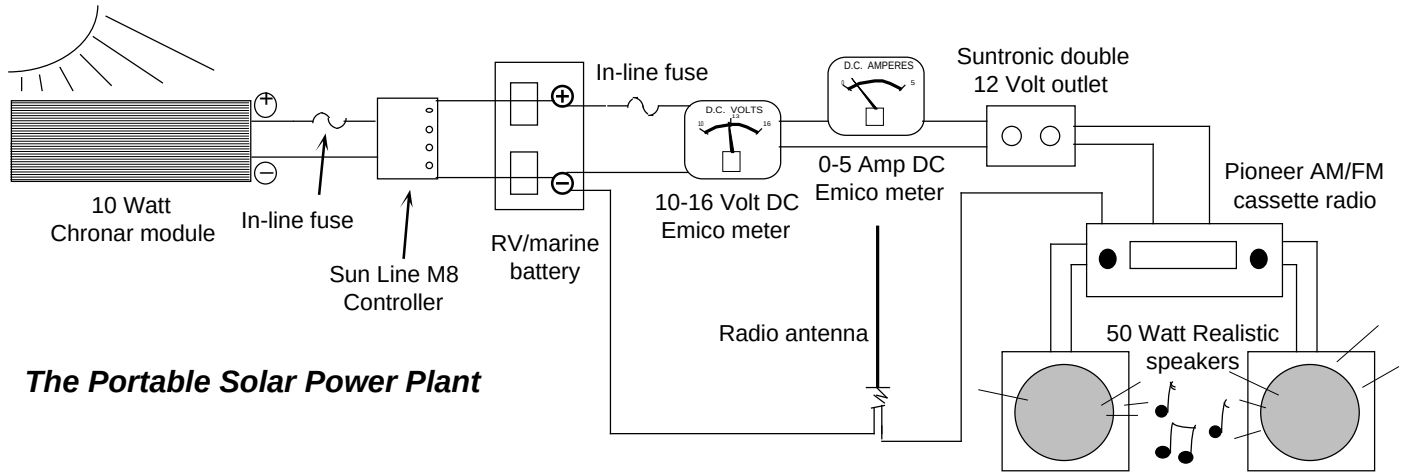


Above: PV module swings on hinges. Perforated metal strips hold module at proper angle to sun. Output from module passes through in-line fuse to controller.



Right: Wiring at top right comes from controller to battery terminals. Output from battery at bottom right goes to in-line fuse and meters. Gray conduit carries wiring from radio on control panel to speakers. Radio antenna is grounded on negative battery terminal.





The Portable Solar Power Plant

Simple Control Panel

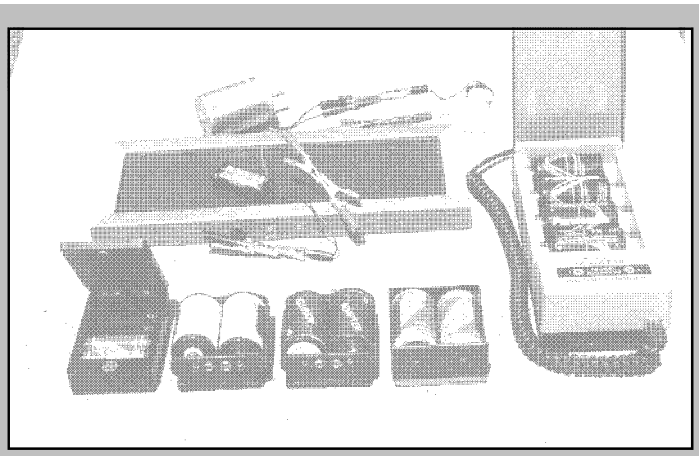
One of my goals was to use some of the basic concepts of large, house-sized solar setups. The polarized plug supplied with the Chronar module serves as an array disconnect. A Sun Selector M8 controller, along with an in-line fuse, is wired between the module and the battery, and prevents the PVs from overcharging the batteries. The fuse protects against overcurrent surges. Another in-line fuse is used on the other side of the battery along with two DC meters for Volts and Amps. Next is a cigarette style double 12 Volt outlet, and finally the Pioneer AM/FM cassette radio from "Old Blue", my retired VW bus. With some paint, the Portable Solar Power Plant was finished and ready for duty.

Charging Small Batteries with the Sun

When I switched to rechargeable nickel-cadmium (nicad) batteries, I tried a variety of solar units. I learned that Radio Shack batteries have low capacity. To get more capacity, it costs more. You get what you pay for. I use high capacity (4400 mAh) D cell nicad batteries in a Panasonic electronic typewriter.

I ended up with a variety of chargers and put them to work for various uses. Battery adapters help pocket-sized solar chargers handle AA, C, and D cells. A DC motor is used with various sized battery holders to discharge nicads down to zero and prevent memory effect.

Photo: Front row chargers: Pocket charger on left takes four AA batteries, but with adapter takes two AA batteries. The remaining three chargers take two D cells, but with adapter, take two C cells (see middle two chargers).



Back row: 1 Watt PV module wired with alligator clips for easy change, here charging two AAA batteries. DC motor at rear with alligator clips for draining batteries down to zero. 12 Volt charger at right takes four batteries of various sizes, plus 9 Volt transistor radio batteries.

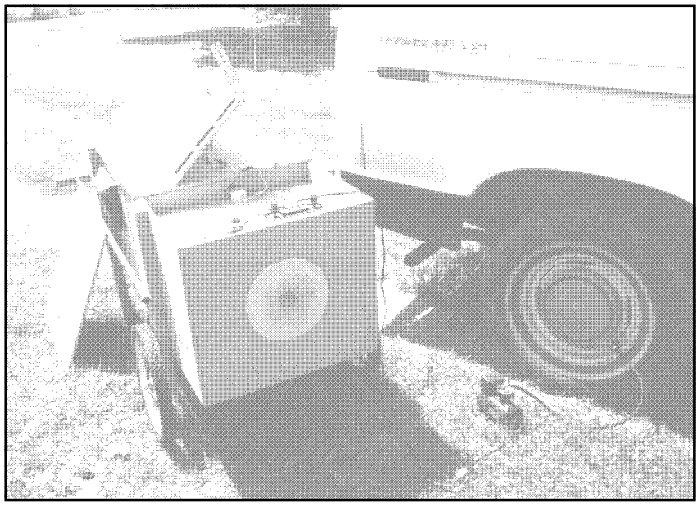
Photo by N. Bleecker Green

Does it Work?
Yes, it certainly does work. It is heavy. Probably more moveable than portable. And the radio gets used the most—puts some rhythm into splitting wood or passes the time when I'm in the garden. The 12 Volt soldering iron has been a help when I could not take work into the house. And the 12 Volt compressor keeps the tires of the van aired for country travel. Other items that work from 12 Volt outlets: an emergency fluorescent light, vacuum cleaner, clip-on and plug-in extensions, nicad battery charger, and dustbuster.

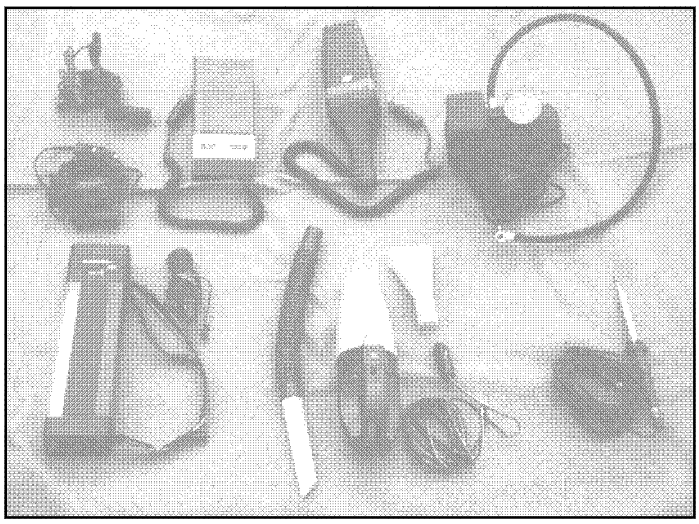
The biggest thrill was testing the emergency lighting. I placed a 12 Volt, 15 Watt Thin Lite fluorescent light above one window in my trailer. I then wheeled the Portable Solar Power Plant under this window and plugged an extension into the double outlet, then snaked it through the open window and into the male plug wired to the light.

I Saw the Light
I turned this light on. Turned the other lights off. And stepped outside into the dark night. Light streamed from the small fluorescent, making a pool of light on the grass outside. I walked to the right. Then to the left. Down the drive a bit. And then back. I was mesmerized by the glow. Real home-made power. Useful, productive and working power. No connections to the power line. No utility bills here. I was hooked right then and there on home produced electricity.

What did it Cost?
When I told a friend what the Portable Solar Power Plant cost, he just shook his head. Said to put a battery in a wheelbarrow and that a transistor radio with throw-away batteries would be cheaper. And just put the 12 Volt battery on a 110 volt charger. If you take a short range look as he does, well.... It may cost me more right now, but down the road I'm way ahead.



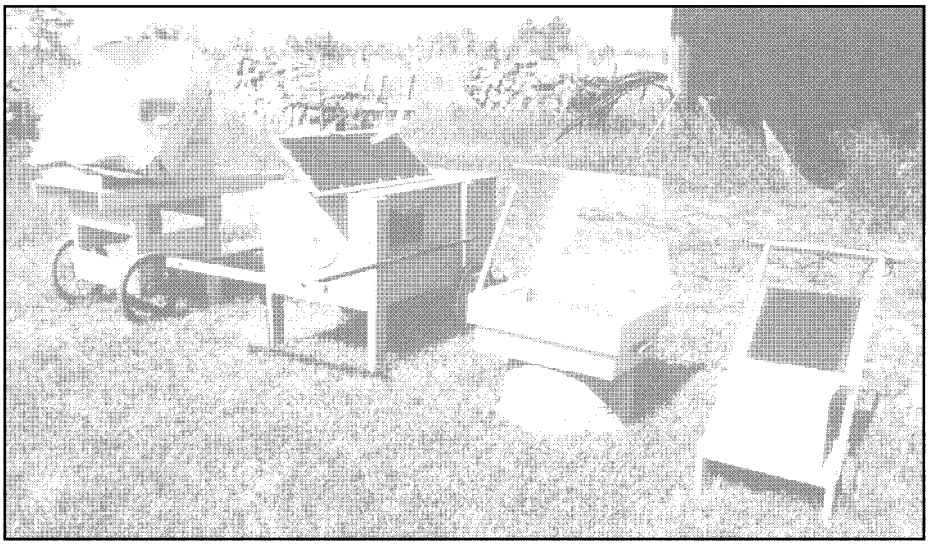
Above:12 Volt compressor inflates van tires.
Below: Some 12 Volt appliances: Front row, left to right: emergency fluorescent light, vacuum cleaner, soldering iron. Back row: Clip-on and plug-in extensions, battery charger, dustbuster, and air compressor. Photos by N. Bleecker Green



Cost of Green's Portable Solar Power Plant

Equipment	cost	%	source
Chronar 10 Watt solar module	$69	19.4%	Real Goods
115 Amp-hr RV/marine battery	$60	16.9%	Walmart
Two Realistic 50 Watt speakers	$50	14.1%	Radio Shack
Two 15 inch lawnmower wheels	$50	14.1%	Home Depot
Sun Line M8 controller	$45	12.7%	Integral Energy Systems
Plywood, hardware, fuses, antenna, paint	$40	11.3%	
Emico DC Volt and Amp meters	$32	9.0%	Alternative Energy Engineering
Suntronic cigarette style double outlet	$9	2.5%	Real Goods
Total	$355		

"I was mesmerized by the glow. Real home-made power."



Above: Solar row soaking up the Texas sunshine. Left to right: slant front solar oven on wheeled cart, Portable Solar Power Plant, flat top solar oven, and 5 Watt panel on small lawnmower battery. Photo by N. Bleecker Green

Another Small Step

Designing and building the Portable Solar Power Plant gave me experience and encouraged me to take another step. Lights, radio and a fan in my trailer. The same for the small toolshed/shop I am building. I'll expand my PV systems: larger module, disconnect switches, load center, and perhaps a small plug-in inverter.

It's been a great learning experience. A miniature PV system: module, battery, controls, meters, fuses, and outlets. Big and small. Practical and theoretical. Watching the ammeter, I learned that a higher volume on the radio does use more current, and I learned which appliances draw the most. I learned that the PV module can push up to 14 Volts. I watched the LEDs on the controller switch from charging to analyzing and back to charging, as if it could think.

Boosted by all this, I am eager to get started on the next home power project. Just ordered a larger, full sized module. When UPS delivers it to my front gate, I'll be off and charging.

Access

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Backwood Solar Electric Systems
Camera-ready

Utility Free
Camera-ready, with paste in corrections

Above: Solar power can mean clean water, lights at night, and better medical care for these children. Photo by Laurie Stone.

Solar Power for El Salvador

Laurie Stone

Travelling in Central America I saw an incredible need for a non-polluting, renewable energy source. Sweating under the hot sun, it was easy to see that the power and reliability of the sun could meet this need.

Many Salvadorans do not have access to basic human rights such as safe drinking water, education, and health care. Solar energy could help bring these basic needs to communities which desperately need them. A simple photovoltaic system could help bring about better education through night classes and better health care through vaccine refrigeration. Solar cookers could replace wood for cooking as well as heat water to temperatures high enough to make it potable (165°F for half an hour).

Many of the Salvadorans who fled the country during the twelve year civil war have recently decided to return home. They have returned, however, with nothing. The government has given them land without homes, water, and crops. Though these newly repatriated Salvadorans have had to start from scratch, this has not deterred them from creating incredibly well-organized and peaceful societies.

Photo by Laurie Stone.

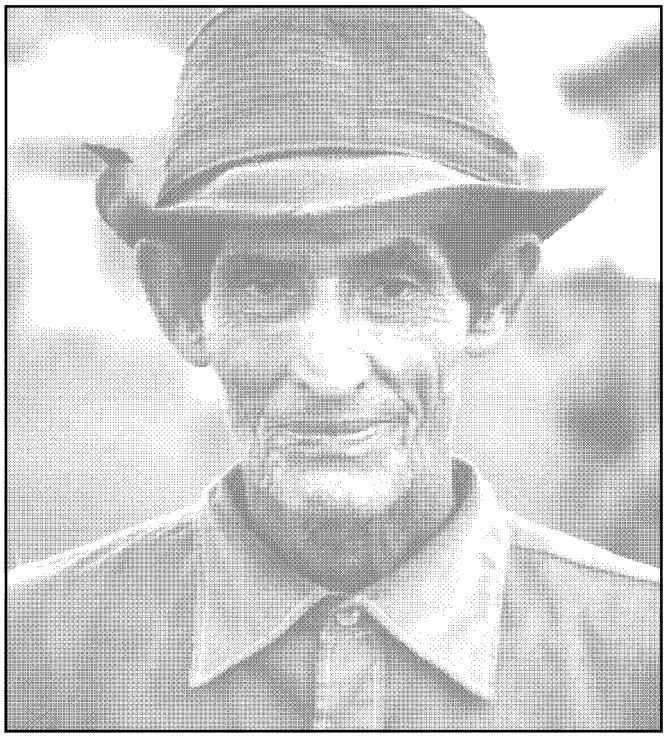
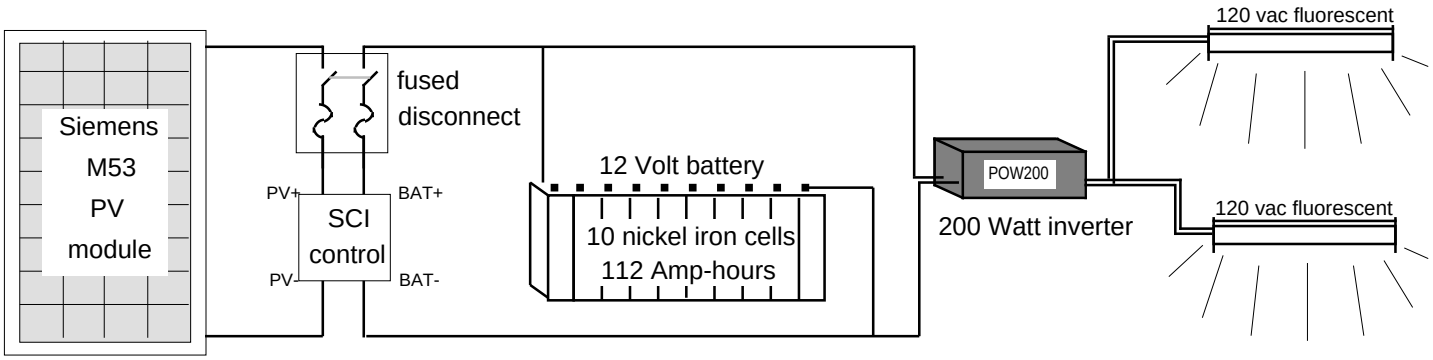


Photo by Ben Scott.

The repatriated communities learned a lot during their years in exile. They learned that they would like to be completely self-sufficient. They do not want to have to rely on their government or other countries for anything. Instead of asking for clothes from international solidarity groups, the refugees asked for fabric and sewing machines. They are teaching themselves to make their own clothes. When international medical groups came to give medical care, the refugees insisted the groups teach them the medical techniques. They've learned the benefits of running their own health clinics over continually receiving medical aid.

The same goes for energy. All of the communities I visited are extremely interested in using solar energy for their electricity needs. They not only want to use solar power but also want to learn how to install the systems themselves. The communities are all in remote regions of the country, and most have no access to the grid. Even organizations in San Salvador, the capitol, which have access to grid power, are interested in photovoltaics, because the grid is very unreliable. Right now the electricity is out eight hours per day with the threat of an increase to twelve hours per day if it does not rain.

Nueva Esperanza, one of the repatriation communities, wants to construct a renewable energy demonstration school. When I visited Nueva Esperanza, I was thrilled by



how enthusiastic the community members are about solar energy. The school would like to incorporate PV systems for lighting and water pumping, solar cookers, self-composting latrines, and a permaculture center. Although the project is only in its planning stages, it has generated interest from all regions of El Salvador and many groups in the United States. The idea is to have a center where members from other communities and organizations can come and learn about renewable energies and get ideas for their own projects. In addition, we are planning on teaching the women there how to build their own solar cookers so that they will be able to teach other women in the future.

There are many communities which need electricity right now. Most of the communities have a community center where classes and meetings are held. Lights would mean that classes and meetings could be held at night, bringing education to many who have no time to study during the day. Seeing the need these people have for electricity, and their incredible desire to learn, it was impossible for me to come back to the States and not do something about it. I decided to try to raise money and equipment to bring as many PV systems to El Salvador as I could.

There are now three of us, Ben Scott, Julia Whelan and I, with enough equipment for four PV systems. The systems consist of one panel, a battery, an inverter, a charge controller and two fluorescent lights. These lights will be enough to provide lighting to the one room community centers. A small inverter is part of the system so they can have an option of ac or DC lights, since it is difficult to know which lights will be most accessible. The panels we are using are ARCO M53 PV modules which were donated by Craig Christensen of Boulder, Colorado. Elliot Josephson of PowerStar donated the inverters for the project, John D'Angelo of Utility Free donated a set of 112 Ampere-hour nickel iron batteries, and Solar Electric Specialties in Willits, California is donating the lighting fixtures. We are trying to raise the rest of the money for the project through private donations.

We plan to travel to the different communities with a Salvadoran organization interested in appropriate technology. This organization can make routine maintenance checks after we leave the country. We will stay in each community to teach the interested community members how to install and maintain the systems. One of the PV lighting systems will be installed in Nueva Esperanza as the first step in the renewable energy demonstration school.

Nueva Esperanza would also like to economically maintain the systems themselves. Eventually they would like to use their systems to generate money, so that they can buy their systems. We plan to help organize a solar battery charging operation. This would generate income for the community and lessen the environmental damage caused by throwing away thousands of batteries.

Solar energy has great potential for the repatriated communities of El Salvador. Photovoltaic lighting systems will enable better education as well as generate interest in other PV applications. Applications include vaccine refrigeration and water pumping. The people of El Salvador need and want to use solar energy. Solar power can bring about a better life for people in the form of education, health care, and even basic needs such as cooking and drinking water. We hope that these four small systems will be the catalyst to bring solar energy to communities where it is desperately needed.

Access

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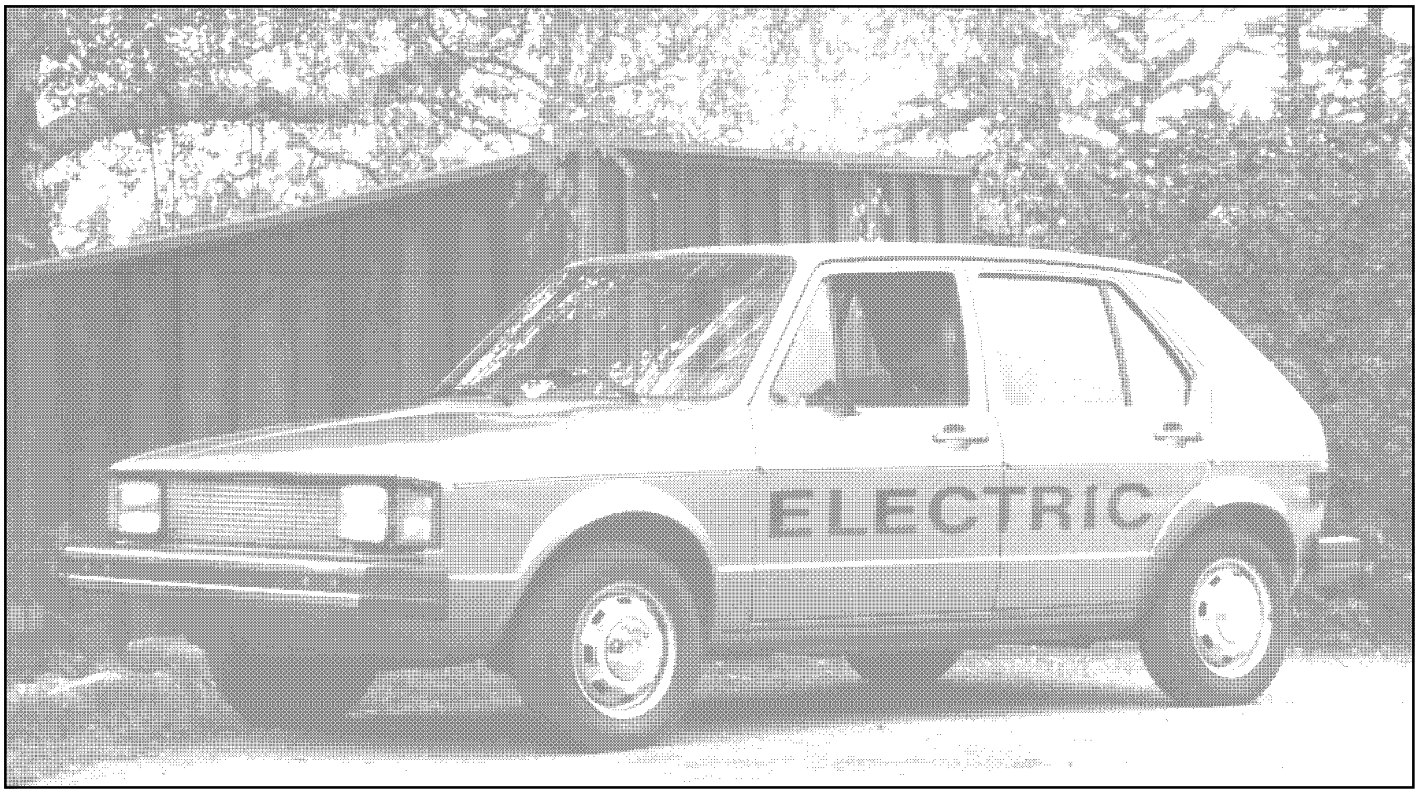
If you would like to help this project, please send donations to Solar Community Projects, c/o Laurie Stone, 5060 Overlook Rd., NW, Washington, DC 20016.



Above: a suitable candidate for electric conversion—the VW Rabbit. Photo by Shari Prange

Choosing a Car for Electric Conversion

Shari Prange

In your fantasies, you cruise silently down the road in an electric dream machine. Not a puff of exhaust comes from the tailpipe—what tailpipe? The only reason to pull into a gas station is to check tire pressures and wash the windshield. Tune-ups and oil changes are fading memories.

Fantasies into Realities

But, now you want to turn your fantasy into a reality. Your first task is choosing a car for this metamorphosis. Making a wise choice at this crucial, first step will ensure that your reality lives up to your fantasy.

Size

Obviously, you won't be converting a Lincoln Continental. The heavy cars that get poor gas mileage will also be poor electric performers. Look for a car that's under 2500 pounds curb weight, if possible. Two thousand pounds or less would be ideal, and 3,000 pounds would be marginally acceptable in a special, low-speed application. Although you'll be removing the engine and miscellaneous other parts, you'll be adding a half ton of batteries. The conversion will probably be 600-800 pounds over its original weight.

To check curb weight on a potential donor car, go to the library and look up *Road & Track Magazine* for the year the car was built. There will probably be a detailed report with all the relevant specs. *Consumer Reports* also carries such information.

On the other end of the spectrum, some wonderfully light cars have other problems. One is limited space for batteries. Even a very light car needs a minimum of 72 Volts (twelve 6 Volt batteries) to be marginally street safe, and 96 Volts (sixteen 6 Volt batteries) is recommended. Another potential problem is the suspension accepting the added battery weight. A very tiny, light car won't have the suspension to accept the added battery weight.

The ideal size is a Rabbit, Civic, Sentra, Escort, or something similar, or a light pick-up truck. Beware of cars, like the Fiero, that are actually much heavier than they look.

Body Style
Look for accessible battery space. Hatchbacks are probably the best choice. Remember that batteries can be sunk into the body, as long as they are enclosed in proper racks. Don't cut through structural members and don't interfere with ground clearance. This means you can have batteries and a backseat, too—and even cargo space in the hatchback, on top of the battery box.

For weight distribution, you will want to put some of the batteries under the hood. Look out for any protrusions into the engine bay, or a low profile nose that reduces vertical clearance.

What about kit cars? Kit cars have the advantage of being very light, since the bodies are fiberglass. They also offer lots of opportunities for modification, since you have to build the car from scratch anyway. On the down side, they are expensive and time consuming to build, so you'd better really love the car. Some kits are very sporty, and don't have much battery room. Battery access is also crucial. Finally, be sure you're dealing with an established, reputable kit car company that will still be there if you need them next year.

Age
The rule of thumb here is to look for a car that is less than ten years old, and the newer the better. There are many reasons for this. Newer cars obviously offer better crash protection and aerodynamics, since much progress has been made in these areas in the past decade. Finally, availability of parts is poorer after ten years, and drops significantly after fifteen years for many cars.

Condition
The ideal donor car has a good body and interior, sound transmission, but a dead engine. For these reasons, the diesel VW Rabbit is an excellent choice. Watch the classified ads for ones that say "Good body, needs engine." Also, talk to local junkyards or independent garages that specialize in the kind of car you want, and tell them to watch for a good candidate for you. Specialty mechanics may be able to recommend a model of a car with a tendency to blow up engines.

If you get a donor that runs, you can recoup some of your investment by selling the engine. This is easier to do while it's still in the car and running. Be sure the buyer knows that you will be keeping some of the parts, such as the clutch and flywheel assembly.

Make & Model
In general terms, it is harder to find a suitable American donor than it is to find a foreign one. This is because American manufacturers have only recently become interested in producing small aerodynamic cars. They are often American in name more than content. Japanese cars seem especially suitable.

Stay away from orphan makes and models. Yes, Aunt Tilly will give you her old Nash for free, or your brother-in-law will give you his Yugo, but where will you find brake cylinders when you need them? Stick to a manufacturer that has a good dealer presence in your area, and a model that was very popular and heavily produced. If there are a lot of them still on the roads, someone will be selling parts for them, and there will be used parts available in the boneyards.

Transmission & Drive Axle
Conversions can be front wheel drive or rear wheel drive. Having the engine and the driving wheels at the same end of the car makes packaging easier, but isn't essential. Four wheel drive is not a practical option at this time.

Automatic transmissions are also not realistic. For one thing, there are energy losses that an electric car can ill afford. For another, an automatic transmission depends on a continuously idling motor to provide fluid pressure. Without it, there is a serious lag in acceleration from a full stop. If you idle the electric motor like a gas engine, you are wasting energy and defeating its efficiency. Adding a separate fluid pump adds one more component and level of complexity to the system. Finally, electric motors have a different torque profile and want shift points that are different from those of a combustion engine.

Options
In general, a "Sally Rand" (stripper) version of a car is preferable to the luxury version. Air conditioning eats almost as much horsepower as it takes to move the car down the road. Power steering is another energy-eater. Also, if the car really needs power steering, perhaps you should look at the curb weight again. Luxury models usually have more sound deadening material, which is unnecessary in an electric.

Power brakes, on the other hand, are easily accommodated with a vacuum pump, and highly recommended, due to the added weight of the batteries. Power windows and stereos don't use enough energy to hurt anything. Enjoy.

The Right Stuff

There are three parts to a good electric vehicle: a good chassis, the right components, and a well-designed and carefully executed installation. Just because a particular car is readily available or cheap does not mean it's suitable, and a poor chassis will give you a poor EV. Making the right choice at the beginning will give you a good start toward getting your electric dream machine out of your fantasies and onto the road.

Access

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Good Manners

Richard Perez

I learned manners from my parents. High on their list of good manners are consideration of others and responsibility for one's actions. Good manners such as these allow us to coexist and cooperate with others. In our relationships with people, critters, and our planet, good manners benefit us all.

Cleaning up our mess

Burning dead dinosaurs have gotten us into big environmental troubles. We have made a global mess. We are sloppy energy eaters with very bad ecological table manners. Good manners dictate that we consider all that lives on our planet and stop making a mess. Then we must clean up after our century-long fossil-fuel feeding frenzy.

Renewable energy sources do not have the pollution of combustion or the deadly legacy of nuclear waste. Nature freely provides us with abundant energy in the form of sunshine, wind, and falling water. We must change our concept of fuel. Instead of waiting for our power to molder underground for eons, we can graciously accept Nature's gifts as and when she offers them. To refuse these energies is the height of bad manners.

Our environment is dependent on the good manners of all living here. We have been unspeakably rude and crude to our planet and all lifeforms on her. We owe our world an apology. We must change our bad energy manners. Using renewable energy sources is no longer a matter of technology and money. It is a matter of changing attitudes and entrenched interests. Of good manners…

Instead of fighting over the mess

Burning dead dinosaurs has gotten us into big political troubles. There's something about concentrated wealth that brings out the worst manners in humans. Contrast the concentrated ownership of fossil and nuclear fuels with sunshine, wind, and water. It is difficult to imagine "cornering the market" on sunlight or going to war over the wind.

Renewable energy sources are free and democratic. If we use these natural power sources, then we have one less reason to make war on each other. War is the worst of all possible manners. War denies all consideration of others and refuses responsibility for despicable actions.

We can be responsible for ourselves!

Living beyond the power lines is what got most of us started. It wasn't until we lived with RE systems, that we appreciated the freedoms associated with good manners. Good manners allowed us to live and work where we wanted, even if it was impossibly distant from the grid.

A renewable energy system now costs less than one-quarter mile of new utility power service. Land without utility service is still less expensive than land that is grid connected. For thousands of home power users, having the good manners to accept Nature's gift has allowed us to afford our homesteads. Many systems also electrify home-based businesses. The types of businesses, their size and profitability, are like any American business. All these home businesses lack is the power bill, the commute bill, and the office rent. Everything from magazines to turbines to soap to flutes is being made with home power systems. It is very good manners to support one's self without harming others.

What we have learned from using these systems makes renewable energy applicable and effective anywhere. Even if you now rent your energy from a utility, you can practice good manners by using power wisely. Efficient appliances like compact fluorescents, efficient refrigerators, and solar hot water heaters give their users lower power bills. They also lessen the pollution produced by nonrenewable energy sources.

Some of the energy wasters we've uncovered are so simple as to be comical and so thoughtless as to be disgusting. Consider the case of phantom loads. Phantom loads are appliances that appear to be off, but instead are really still alive and sucking up electricity 24 hours a day. Check out the clock in the microwave, the instant-on, remote-controlled TV, and the clock in the VCR. Good power manners mean not wasting electricity. I can wait 30 seconds for the TV to warm up, how about you? Want a statistic to show you the insult of phantom loads? Consider that the average American household supports 1.45 kilowatt-hours of phantom loads per day. America's phantom loads waste enough electricity to completely power the countries of Greece and Vietnam with enough left over for Peru. Such is the depth of our insult to others. Good manners at our table are to take all you need, but please don't waste any.

From responsibility comes dependability
Independent renewable energy systems are self-contained, naturally-sourced, energy cells. Each supplies, and is cared for by its users. Natural power sources are harnessed locally. The energy is both site-produced and site-consumed. Renewable energy sources, particularly photovoltaics, are magnitudes more dependable than centralized power generation followed by wide area distribution. Here is, indeed, a formula for responsibility and dependability—both very good manners.

From dependability comes self-sufficiency
Making your own power is the energy equivalent of growing your own food. Life is an inherently vague process. Today one may be in good health and employed. Tomorrow one may be sick and broke. A renewable energy source offers freedom from rising power costs and monthly power bills. Make your own power, become energy independent, and use free, nonpolluting, sustainable, peaceful, and dependable energy sources all at the same time. Good manners include each of us bringing our share to the table.

Good manners allow us freedom
Those with good manners are welcomed and at home anywhere. If we were to improve our manners, then we would find a very different world welcoming us. We would find a world that is cleaner, more peaceful, more free, more dependable, and more self-sufficient. Such a world is a fitting home for generations of well-mannered children to share with multitudes of critters and plants.

Home power people are not rocket scientists or millionaires or Zen masters. If we can practice good manners, then anyone can. Nature is asking us, "Please?" It is good manners for us to reply,

"Thank you!"

Access
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Indigenous Materials Solar Cooker Contest

Kathleen Jarschke-Schultze
and Therese Peffer

Above: The solar cooker cookoff at SEER '92. Front left is Maria Gonzalez's portable cooker, front right is Jay Campbell's "hole-in-the-ground" cooker, center is Lu Yoder's parabolic cooker, and further back is Michael Diogo's carrizo- mud-and-tin can box cooker.
Photo by Therese Peffer

The sun shines on the rich and poor, hungry and well-fed alike. In the United States, a growing number use the sun's energy to cook food, with solar cookers built from scrap and low cost materials, such as cardboard, foil, and glass. What are some low cost or scrap materials in other countries that could be used to make solar cookers? In *Home Power* issue #28, we asked readers to design and build a solar cooker using materials readily available in a developing country of their choice.

We received numerous phone calls; eight entries made their way to HP Central. Alan Nichols sent his design for a tracking solar cooker. Another reader sent a sample of fiber cement that could be formed into walls for a cooker. Philip Hodes' simple waterproof cooker required a plastic milk crate, plastic mirrors for reflectors, and foil-backed foam for insulation.

We chose four cooker designs to build for the cookoff Saturday at the Solar Energy Expo and Rally 1992 in Willits, California. The four finalists were chosen based on their use of simple, "low tech" materials and included a bamboo-type box cooker, a hole-in-the-ground model, a parabolic design, and a foldable cooker.

Judgment Day

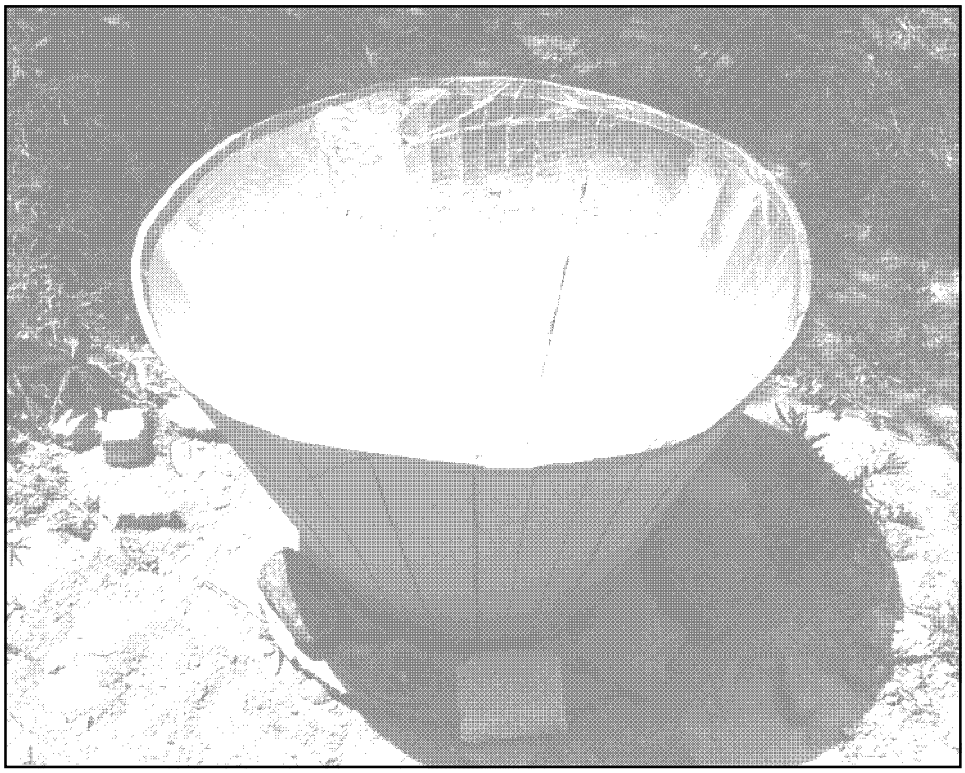
We built the four finalists' models from their instructions.The top four designs were judged on validity of materials, ease of assembly, clear instructions, ruggedness, beauty of design, and ability to cook food. Each cooker held a yam, and equal amounts of black beans and brown rice cooked in black painted jars. The cookers were placed in the sun at 10:30 am and adjusted throughout the day until 3:00 pm.

Our four judges were Paul Mellersh, Board of Directors SBCI; Johnny Weiss and Felicia Trevor of Solar Technology Institute; and Kathleen Jarschke-Schultze. C. Jay Campbell's hole-in-the-ground design took 1st place, winning a Solarex MSX-60 solar panel. Michael Diogo placed 2nd with his carrizo cooker, winning a PowerStar

200 inverter. Maria Gonzalez's foldable design won 3rd place, and Lu Yoder's frustum-based model placed 4th; they chose either an Osram compact fluorescent light or a Kyocera Jetski PV module as their prize.

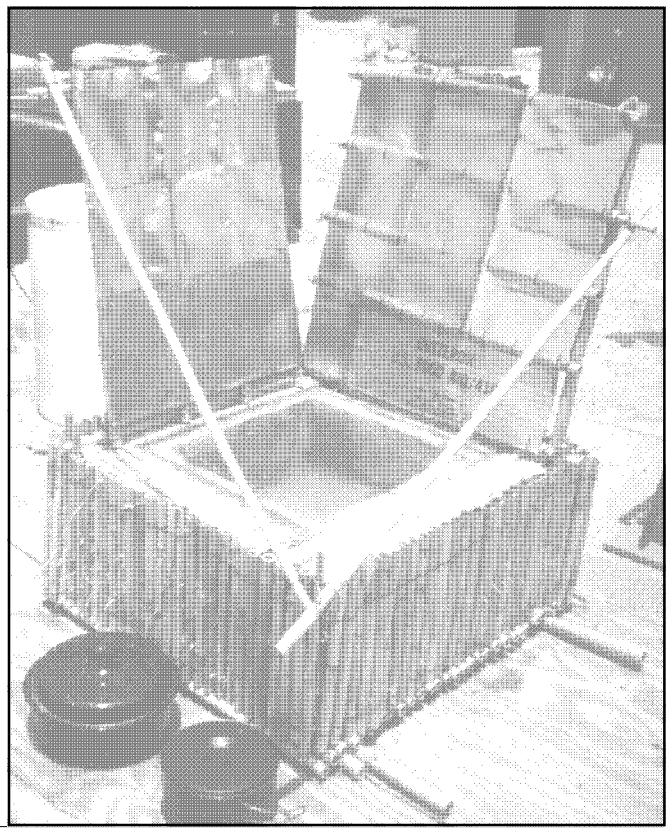
The Top Four

Jay Campbell's design, targeted for Guatemala, was beautifully simple. His cooker required a hole in the ground insulated with newspaper, and a conical reflector to concentrate the sun's rays onto the black plastic pan holding the cooking pot. Jay used a junked car's side window for glazing and fashioned reflectors from cardboard and aluminum foil. Jay's design scored high on all criteria; the lowest scores were for ruggedness, because of the cardboard. We couldn't dig a hole at SEER, so we used a cardboard box filled with newspaper. Judges' comments, "Good instructions, could be totally pictorial, maintained heat well." Overall score: 258.5

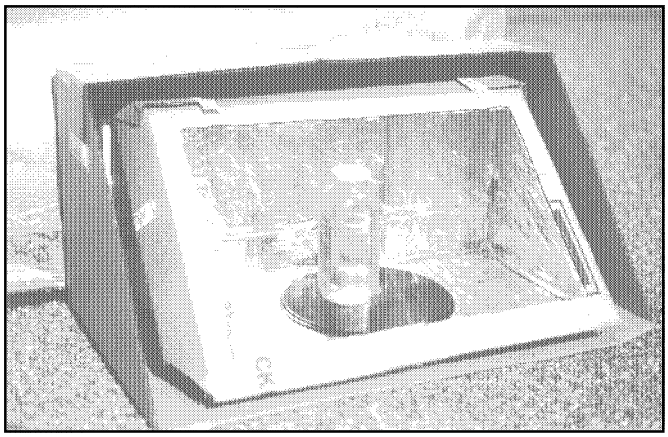


Above: Jay Campbell's cooker won first place. Photo by Jay Campbell

Below: The weather-proof carrizo cooker from Michael Diogo took second place. Photo by Michael Diogo



Michael Diogo, from Baja California, Mexico, scored high in material use, ruggedness and clear instructions with his box cooker built from carrizo (a native plant similar to bamboo). He wired lengths of carrizo to make the walls and floor of the interior and exterior box. Dried grass was stuffed between the boxes for insulation. The interior box was daubed with mud and black magnetic sand was poured on the bottom. Michael removed the bottoms of over 100 bottles before finally succumbing to sheet glass for glazing. For reflectors, he cut open rectangular tin cans and banged them flat. Michael wrote that two years ago, 300 cardboard and foil cookers were donated to the Baja natives, but not one is left today. "No time was spent training the people to use the oven and adapt it to the traditional methods of preparing foods." He mentioned that the little huts people live in are "made of cardboard and plastic wrap, leak like sieves and there is no room inside for a solar oven to take up precious space." Michael designed his cooker with native materials to survive outdoors. Building the cooker was labor intensive. Judges' comments, "Very imaginative and elegant in design." Overall score: 202.5

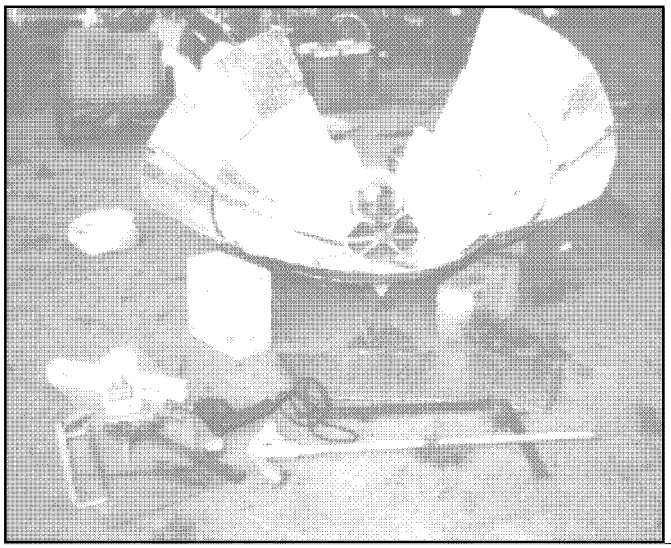


Top: Maria Gonzalez's foldable cooker placed third.
Photo by Maria Gonzalez

Maria Gonzales' triangular cooker uses velcro straps so it unfolds flat for travel or storage. She uses cardboard for the interior and exterior boxes, and adds foil and glass to the interior box which holds the cooking pot. The insulation between the boxes can be a blanket, newspapers, or whatever is on hand. Maria's cooker consistently scored high on ruggedness and beauty of design. Judge's comments, "Great idea, may need to be tilted back in countries close to the equator. Clean design." Overall score: 185.5

Lu Yoder wrote that since he'd never been to a developing country, his Liberation Technology: "no weld" solar cooker design was made from materials readily scavenged from an Albuquerque, New Mexico barrio. Tools were bartered or bought at the local flea market. He used three frustums, or cone reflectors, to approximate a parabola. A metal conduit frame supports the aluminum foil and cardboard reflectors. Lu wrote that there are rich and poor in all countries of the world. "The poor in both countries stand to benefit very much from technology which partly frees them from the toil of gathering fuel and destroying their own ecosystems...." He pointed out that the world's resources would be most affected if we changed our cooking habits in the U.S. "Solar cookers made from secondary and low cost materials have the potential to help people in all parts of the world struggle for economic justice." While scoring high on most criteria, Lu's design scored low on ease of assembly and clear instructions. Judges' comments, "Attained highest temperature, instructions hard to understand." Overall score: 161

Below: Lu Yoder's parabolic cooker came in fourth place.
Photo by Lu Yoder



The Winning Design

As promised, here are the plans of the winning design by Jay Campbell. Jay has travelled extensively to Guatemala. "On my recent visits, however, I have become very disturbed by the ever rising tree line around the cities. The hills are literally bald up to a certain altitude. As heating is only an issue in the highlands, much of the tree loss is due to cooking.

"Guatemala has a pleasant, springlike climate year round....Even during the rainy season, the sun shines most of the day, with about 3 hours of cloud cover. This pattern is typical throughout the interior of Mexico and Central America.

"Guatemala has a well developed plastics manufacturing sector. All types of plastic containers, bags, toys and household items are available at low prices in the many village markets. One of the most ubiquitous items is known as a PALANGANA (pronounced just like it looks, accent on the PA). It resembles a common oil change pan here, but is far more than that. Bathing, food preparation, laundry, storage, and coffee picking are typical uses. Two small ones suspended from either end of a stick forms the standard market scale. They come in a variety of sizes, cost from $0.50 to $2.50 U.S., and are used in every household. The palangana is truly an indigenous part of Guatemalan life.

"Construction time for the prototype was 6 hours. Total cost as built was $2.75. Maximum temperature witnessed was 150°C (300°F), but the temperature was still climbing at this point. Time to bring 1 liter of 20°C water to a full boil was 61 minutes. As designed, there is a maximum 4:1 ratio concentration of incoming radiation. When pointed at the sun, this would provide over 1000 BTU's per hour. Based on the boil test, about a third of that

actually gets into the food. In actual use, 1 1/2 liters of black beans (the staple food in Guatemala) cook nicely when left unattended for the workday.

Rationale

"The heart of this cooker is a black palangana. The oil drain pan I bought in the U.S. is a little thinner and shallower than standard, but worked well with a cardboard heat shield in the bottom. In country, I would use a larger version to increase the volume. The glass used is from the side window on a junked car, another common item in the country. Standard window glass would work fine, but would probably cost more. All other materials—cardboard, foil, glue, string, and newspapers—are readily available in any population center in the country, for a low total cost. There is no hardware required, as the glass slides in and out of the cardboard frame like a drawer.

"The conical reflector captures just as much energy as the same sized parabolic reflector. The difference is that where the cone reflects all light into a relatively wide area, the parabola reflects it all into a single point. For food preparation, the wider area is preferable. An inclined base is used to correct for both latitude and seasonal changes. For anywhere out of the equatorial region (±10°), the tilting spacer is worth the effort. It can double the amount of incident radiation, and allows for tracking the sun. The tilt angle in the photo on the next page (22°) was built for my latitude (34° N), and should work well in Willits in August. For use in Guatemala, the tilt angle should be needed only during October–March, and would be 26°.

"Geometrically, a circle is the most efficient shape for a container, having the maximum possible area inside for a given amount of perimeter. What this means for cooker designs is that a maximum of sunlight will enter the oven while a minimum of heat will be lost through the sides. Also, the circular reflector is a good concentrator—by doubling the diameter, the energy input is quadrupled. The circular geometry maximizes the energy input for a given quantity of materials.

"I must justify the use of 'high tech' foil. It is widely available, and used in such small quantity that a single roll can make 9–10 reflectors. Split open aluminum cans (also widely available) worked about as well, but are very labor intensive to prepare. They are available for free, however. The stated goal of this contest is to use local materials. For Guatemala, foil is such an item.

"Another feature is the outer box—just a hole in the ground. Some siting considerations must be made (shading, local elevation, drainage), but no more than for other types of solar cookers. The main advantage is that almost anybody can afford a hole in the ground. A lining would be recommended for long term use, but is not essential. Tightly crumpled newspaper provides the insulation between the palangana and the ground. Newspaper may not be the best insulator, but by making the hole a little bigger and adding more paper, it can have a competitive R value with any insulated box.

Materials and Tools

Materials include: a palangana or shallow plastic pan, cardboard, foil, glue, string, glass, and newspapers. Tools: Sharp stout knife, sharp stick, straight edge, pencil, shovel, and instructions.

Construction

"Obtain palangana and a piece of glass which will completely cover it.... I recommend an 18–24 inch diameter pan for sufficient volume. Directions are given based on whatever sized parts you can acquire.

Cone

"Get a large piece of cardboard, or make one out of several smaller pieces. Lay out a [string] as long as 4 diameters of the tub. See Figure 1. Draw an arc from the center of the line, connecting the two ends, and cut out. Lay out a similar arc [1 diameter smaller], and cut it.

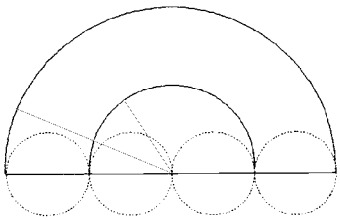


Figure 1

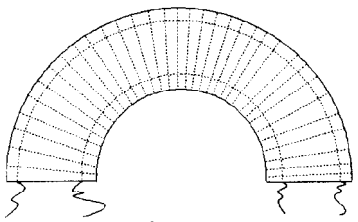


Figure 2

"Cut (score) the surface layer of the arc as shown in Figure 2 so that it can be rolled into a faceted cone. On the same side, score an arc near the two edges, and push a string into this cut. By pulling the strings tight, the cone will cinch up like a barrel. Paste foil completely over the unscored side and edges, and trim off excess.

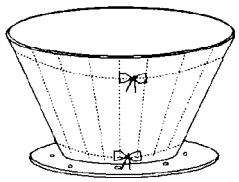


Figure 3

"Now pull up the strings and tie them off. Cut a ring to fit around the small end of the cone, as shown in Figure 3. Glue this in place. Punch 8 small holes spaced evenly around the ring. The cone is now done. This simple geometric layout produces a perfect 60° cone for any sized palangana, which will give a 4:1 concentration of incoming radiation. A 60° cone is not the optimal angle, but is close. Due to its simple pattern, however, it cries out to be used for this application.

Tilt Angle

"Lay out another line 4 diameters long. Cut and fold the pattern shown below, then glue into a square (a little tab helps). The tilt angle should optimally be the latitude of the site, for year round use. Two different ones could be used to improve the efficiency, one for March 21–September 20 (Latitude minus 12°) and one for September 21–March 20 (Latitude plus 12°). Punch 2 small holes at the bottom of each side, as shown below.

"Turn the cone upside down and set the angle on top. Thread a string through the holes in both the cone and the base to tie them firmly together (see Figure 5).

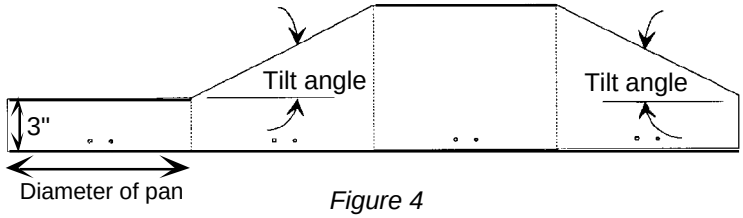


Figure 4

Frame

"[This is] a drawer slide. The glass will go in and out one edge, and seal on the top, bottom, and other edges. It must be made for a specific piece of glass in order to seal well. In a large piece of cardboard, cut a hole to the size of the palangana body. The [pan] should fit completely inside, with the lip seated well on the cardboard. See Figure 6. Stack up cardboard to be slightly above the lip. Set the glass on top of this buildup, centered over the palangana. Cut strips of cardboard to outline the glass. Cut a final piece to cover the whole stack. Cut a round hole the size of the palangana in the top piece. Once all pieces have been dry fit, glue them together as assembled. The glass should slide freely, but should not be loose. Use one of the cutout holes as a heat shield at the bottom of the palangana. This will help diffuse the concentrated energy which could damage the plastic. Also, the piece just below the glass can be made to any thickness, making the cooking volume larger.

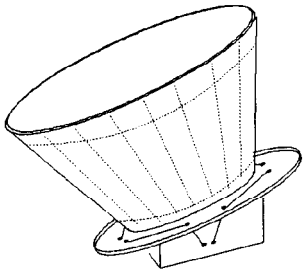
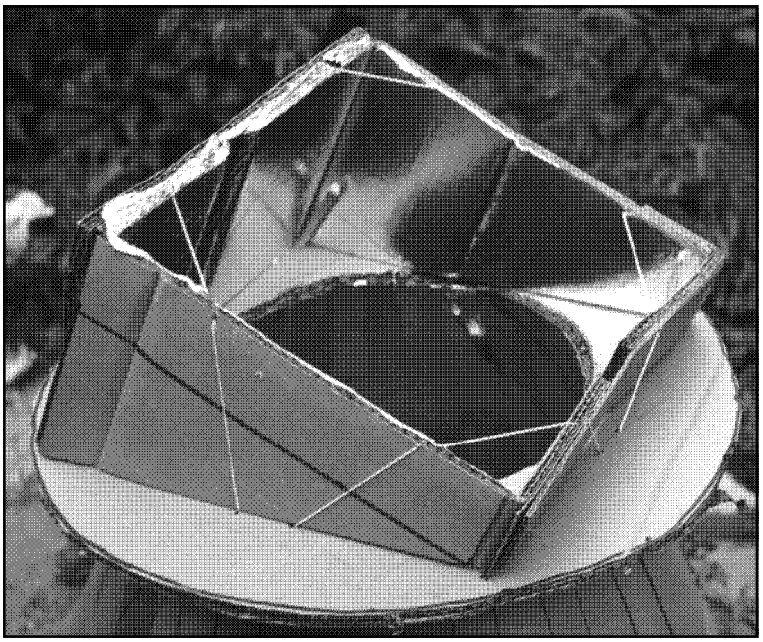


Figure 5



Above: The tilt angle installed on the cone. Photo by Jay Campbell

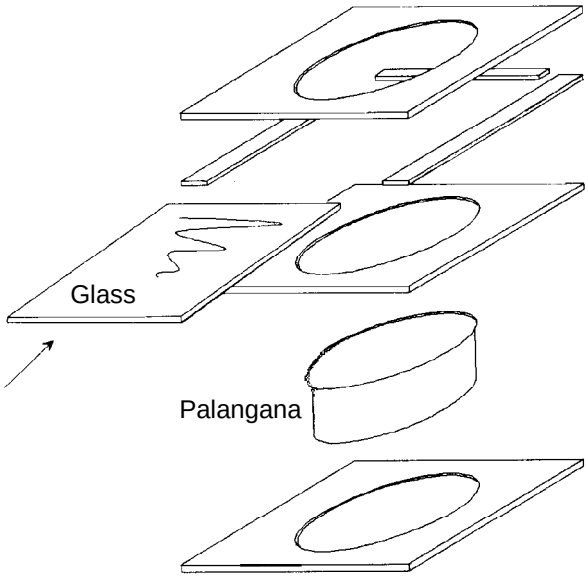


Figure 6

Assembly

"Dig a round hole, about 10 inches larger in diameter than the palangana. Level out the ground around the hole. Place frame over hole, without glass or palangana. Pack newspaper around the inside of the hole, stepping on it and stuffing as much as possible without interfering with the palangana. Place in palangana, slide in glass and set cone assembly on top (see Figure 7). The reflector can be weighted down with rocks around the base, or by tying 3 tethers to stakes in the ground. High winds are not a real problem in the interior of Guatemala, so only rocks were used during testing.

Above: After the hole is dug and lined with crumpled newspapers, the pan is placed in the hole. The frame with the glass is placed over the hole and the cooker is ready to have the cone placed on top. Now we're cookin'!
Photo by Jay Campbell

Use

"Tip the reflector onto its side. Slide the glass back and put in the food. Slide glass back snugly into frame, and replace the reflector. The reflector can be rotated to follow the sun without disturbing the food or cooker. It's important to tip the reflector for access, to avoid looking straight into the cone. To fully utilize the volume advantages of this design, round cookware should be used.

Conclusion

"This is a simple, inexpensive, rugged cooker, easily constructed of local materials. It can meet the cooking needs of a typical family in Guatemala throughout much of the year.

"This has been a very educational project. I appreciate your posing this problem as a challenge, and getting the creative juices flowing. Win, lose or draw, I am a confirmed solar cooker, and will continue to develop the concept and promote its use. Hopefully, this contest had the same effect on others.

"I claim no financial interest in this design. Anyone is free to duplicate, distribute or modify it at will. Covering expenses is reasonable, but I only request that it not be produced for a profit."

Contest Conclusions

Jay Campbell's cooker was taken to an Earth Stewards/Peace Tree gathering and shared with people from fourteen different countries. The plans will be made available to all who wish to help spread the design to indigenous people everywhere.

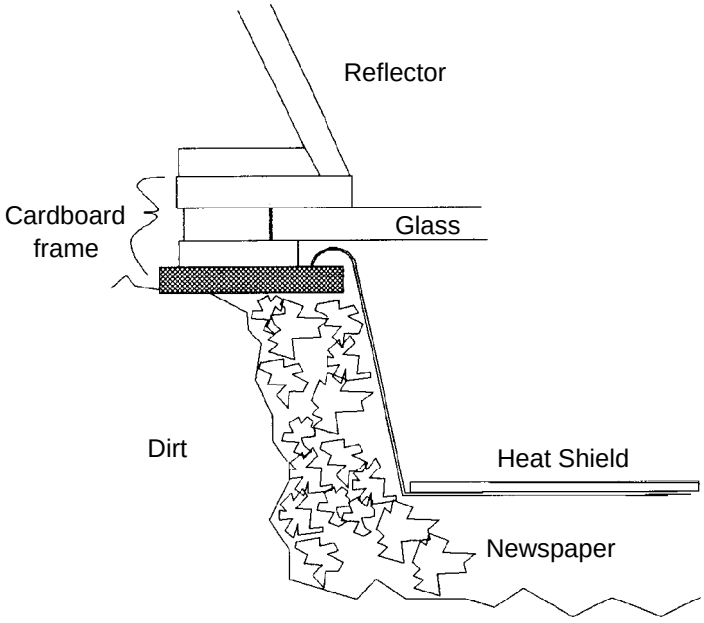


Figure 7

Congratulations to all of our entrants for your time and creativity! For you readers who had an idea for a solar cooker, but did not think you had enough time to develop one, there is always next year's competition. Look for the details in the next issue of Home Power. Go for it.

Access

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Milk crate oven: H. Philip Hodes, 3137 Capri Rd., Palm Beach Garden, FL 33410

Tracking solar oven (plans available for $2): Alan Nichols, 4220 N. Bear Canyon Rd., Tucson, AZ 85749

Presidential Material

Michael Welch

These are interesting and scary times we live in. We, the American public, are about to decide who will be elected to one of the most powerful positions in the world. *Home Power* readers can now make ENERGY a campaign issue. The media and the candidates have already decided that the issues in this campaign are to be abortion, family values, health care, and political change. Now, I have my opinions about all these things (just ask me), but I feel that our energy interests will be better served by leaving those other opinions alone. It will be up to us to force into open debate the energy issues which are so important to our country and this entire Earth's peace and well-being.

Our candidates

Our viable choices for President leave much to be desired, even though there is a world of difference between them. George Bush inherited the Presidency on the coattails of an accomplished orator who specialized in placating the masses with hollow rhetoric.

Ross Perot was catapulted into viability by the media because they thought he might have enough personal finances to make it. However, he seemed to self-destruct as the going got rough... or is he trying to be tricky by waiting for the right moment to jump-start his candidacy? The core of his political machine remains in place.

Bill Clinton is a practiced and successful power broker who was able to pull together his party's bigwigs, and in turn, enough party members to sew up his nomination.

One thing is certain: none of these men is likely to make energy policy an issue until the public insists on it. Unless, of course, you consider further military action for Persian Gulf oil to be energy policy.

Questions asked

We, at *Home Power*, wrote and sent a list of pertinent questions to the candidates that they decided to ignore. The list is long but you might imagine the things we were looking for: the use of various energy sources, research and development (R & D) appropriations, energy efficiency, renewable energy business support, and awareness of public sentiment about energy. We also sent them complimentary copies of *Home Power Magazine*. To my knowledge, none have chosen to subscribe, unless you consider the CIA's subscription as going to George Bush.

Anyway, after countless phone calls, letters, and faxes, we finally received position papers from both Bush and Clinton. Though we had specific questions, the most we could get out of the position papers were "pat" answers. The papers do provide insight into the candidates' energy positions, even if they don't help us with our questions about the home energy industry.

Bush answers

You can probably guess how things turned out. George Bush's literature reveals that he wants to drill for oil in and near environmentally sensitive parks and preserves and to rely on a massive increase in the building of nuclear power plants to meet our future needs. He opposes increased automobile fuel efficiency and pays little more than lip service to the ideas of energy efficiency and conservation.

Bush says that he wants an expansion of electric vehicle technology and an increased budget for solar and renewables R&D. But his words don't ring true when you compare his plan with both his past actions and what the last Democrat administration wanted for renewables. Bush said that his funding request "for solar and renewables is up by 67 percent" but closer scrutiny shows that his proposed 1993 budget of $247 million for renewables is only a third of Jimmy Carter's 1980 budget of $718 million. Bush's funding request for nuclear programs alone is about double the amount he has requested for all renewable energy and conservation

programs combined. His basic premise behind his proposed energy strategy is one that has kept solar and renewables out of the mainstream and on the back burner for many years: If it's not good for the oil and nuclear industries, then it's not good for America.

In the major speech about his National Energy Strategy, Bush intoned, his National Energy Strategy "relies on the power of the marketplace, the common sense of the American People and the responsible leadership of industry and government." A quick reality check reveals this statement to be what it truly is: baloney. In truth, the "power of the marketplace" should not have to rely on huge subsidies to give unfair advantage to oil and nuclear power. Further, polls show that "the common sense of the American people" calls for meeting increased electricity demand through energy efficiency (63%), renewable resources and conservation as top energy funding priorities (76%), and no increase in nuclear power (65%). Finally, most people are painfully aware of what the "responsible leadership of industry" really means to the well-being of our planet.

Clinton answers

Bill Clinton, on the other hand, is harder to pin down, since there is no past Presidential performance to go on. He has had some success as Arkansas Governor by forming a state Department of Energy to develop renewable energy resources, grant funds for solar energy projects and promote energy conservation.

Clinton campaign literature claims that he is strongly for just about everything that an energy activist like myself could want. He is obviously aware of the direction that public sentiment has taken. My fear is that politicians say whatever they need to get elected, then water down their actions to suit the special interests that got them elected.

Clinton is pushing very hard for natural gas as a replacement for oil and coal. While it's true that natural gas is cleaner burning, cheaper, and more abundant than oil or coal, it is also a non-renewable fossil fuel. Natural gas still produces carbon dioxide when it is burned. Carbon dioxide (CO_2) is a greenhouse gas which contributes to climate change. Clinton needs to be educated about the value of decentralized energy sources. His push appears to be toward large scale renewable energy projects.

In contrast to Bush, Clinton's literature claims he opposes increased reliance on nuclear power, opposes oil drilling in the Arctic National Wildlife Refuge, wants to create a civilian advanced research agency to support R & D on renewables, wants to increase fuel economies, and wants to create tax incentives for renewable energy use. While Bush holds on to the archaic belief that "the relationship between greenhouse gas emissions and global climate change is not yet well understood," Clinton has called for an international climate change treaty and wants to "Limit U.S. carbon dioxide emissions to 1990 levels by the year 2000 and accelerate the phase-out of CFCs." ChloroFluroCarbons (CFCs) are greatly responsible for holes now appearing in the Earth's protective ozone layer.

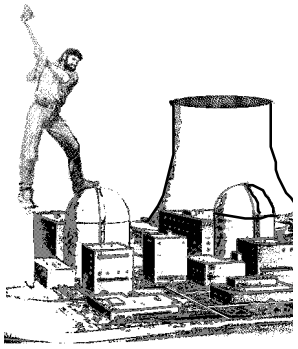
Perot shines us on

As for Ross Perot, should he reappear, my research has not turned up anything, nor was his campaign willing to send anything. Nobody knows what this guy stands for on this and many other issues. He says that he's not for doing it like anyone else. The fear among energy and environmental activists is that his free market tendencies would turn into favoring big business at the expense of important environmental and safety regulations.

Make a choice and then VOTE!

The choice seems obvious to me, but my personal opinion favors voting for the acceptable candidate who at least has a chance of winning. However, many people feel disenfranchised by our two party system and its marginal choices. For some, it is difficult to compromise by voting for someone that does not represent all of their principles. For example, it is troublesome to vote for someone who on one hand offers good prospects for our energy future, yet on the other appears willing to support military action for oil.

For these people, there may be other choices. Ralph Nader, the ultimate energy activist, has had his name bantered about in circles seeking a reasonable write-in candidate. Jerry Brown is still campaigning for changes in the Democratic Party. He has published a book with some right-on energy strategy called "Platform in Progress", to help "fashion a blueprint for America." A newly formed Natural Law Party is offering a ticket composed of two PhDs to "bring the light of science into politics." This new party claims to have fulfilled ballot access requirements in 18 states and, at least at first glance, their energy platform looks good. Then, of course, there's the Peace & Freedom candidate, Ron Daniels, who you can darn sure bet won't be starting more oil and resource wars.



The main point is that we can make a difference in energy policy in the November election. We can further make a difference by insisting that the media *make energy policy a campaign issue*. If the media takes up this cause, then our elected officials will more likely be held to their promises and to do what the public really wants.

Write a letter to the editor about energy policy. Call the major broadcasters and tell them that you will make up your mind based in part on how the candidate reacts to public energy opinion. Go out there and volunteer for your favorite candidates, being sure to tell them how important renewable energy is to you. But most important, register and *vote*. It's easy to vote, even in the sticks. You can request an absentee ballot from your local elections office, as long as you do it far enough in advance of election day. Just DO IT!

Access

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Sources

Polling and other campaign information: Safe Energy Communications Council, 1717 Massachusetts Ave. NW Suite LL215, Washington, DC 20036

Candidate questionnaire: Energy America, PO Box 114, Warner, NH 03278

"Platform in Progress": We the People (Brown for President), 801 N. Fairfax Suite 211, Alexandria, VA 22314

Clinton & Bush campaign literature.

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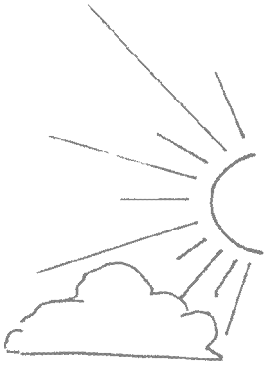

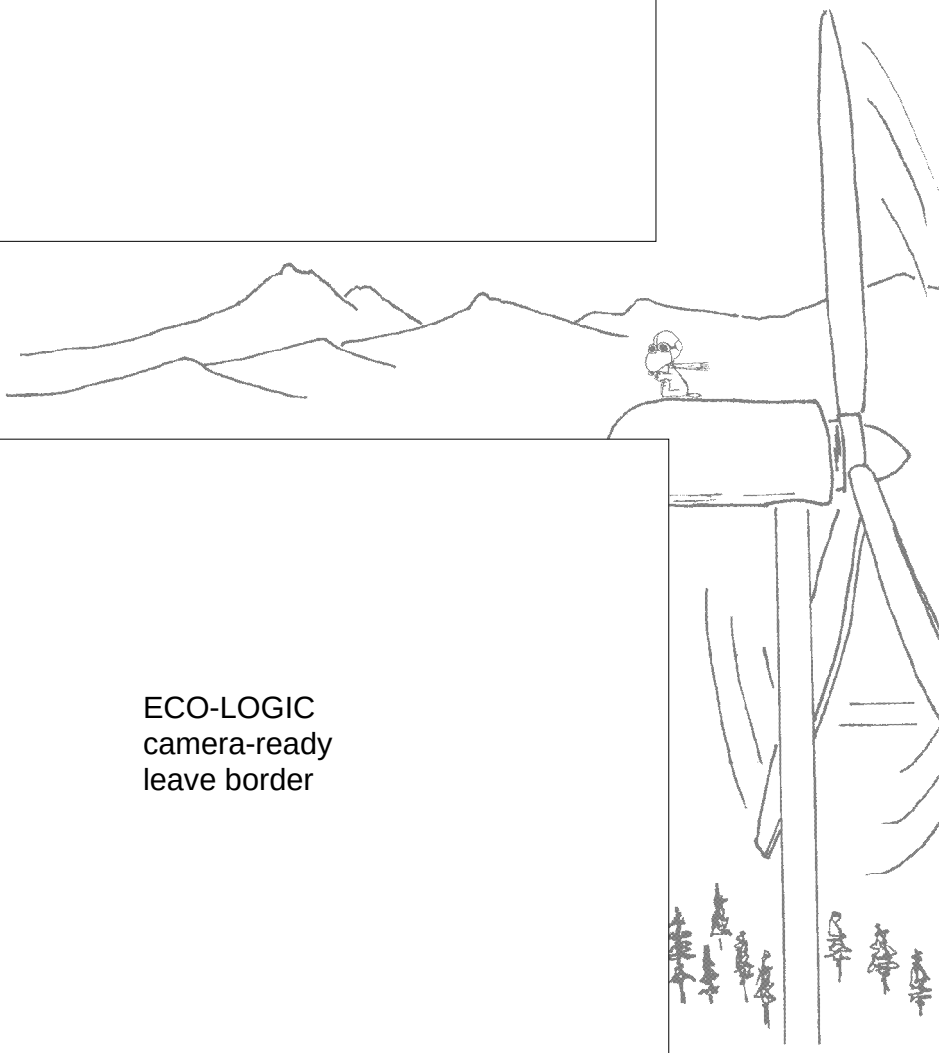

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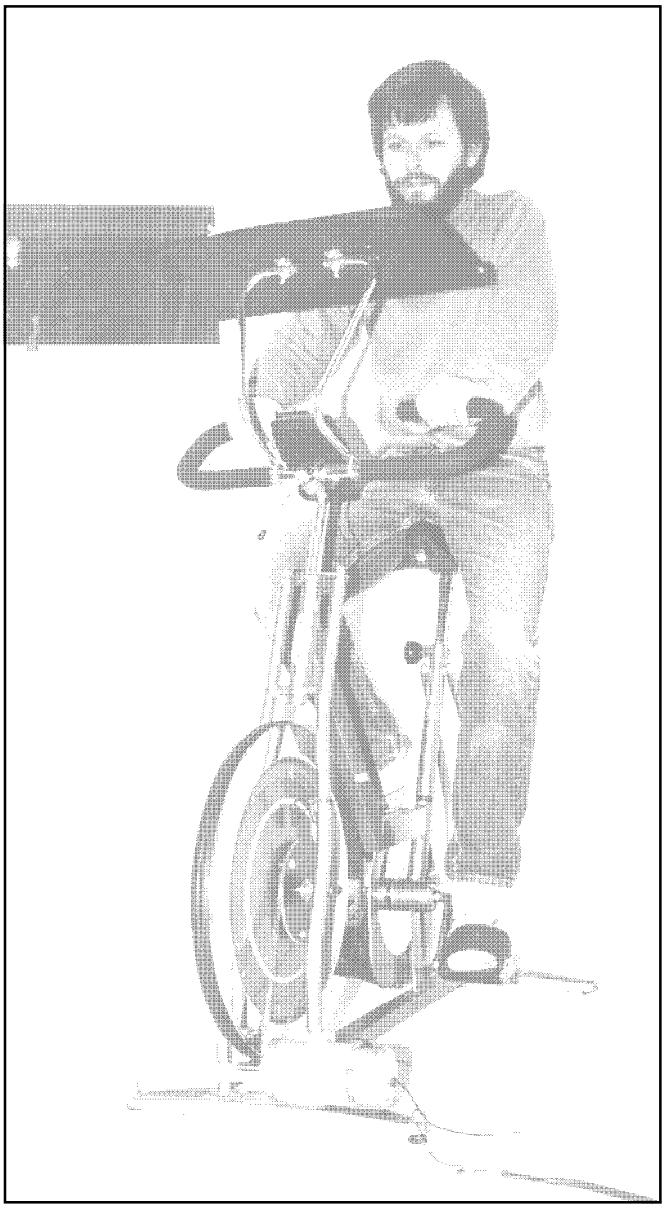
See product review (page 54)

Pushing Pedals

David Haaren

One simple way to make electricity is to push pedals. The pedals turn a dynamo that charges a battery. To some the idea might sound as practical as trying to catch their dinner with their bare hands. Others who have tried it are enjoying the benefits of indoor exercise and free electricity.

My wife, Kathy, and I have been riding the system shown here for several years to supplement photovoltaic power. We are making the system as a kit that specifically adapts the Schwinn DX 900 exercise bike. It uses a Thermax 5 Ampere DC permanent magnet generator. Power is transmitted from the flywheel to the motor using Berg sprockets and a self-lubricating, steel-reinforced plastic chain. We typically charge our two 12 Volt deep-cycle, lead-acid batteries in the 3 to 6 Ampere range, while reading, strumming the mandolin, or just pedaling. We find we only need to pedal in the winter. I get motivated when I see our battery voltage getting low. Our time on the bike varies, but we may average about 30 minutes a day between us when required. Thanks to all the work done with efficient appliances, even an extra 2 Amp-hours really can brighten our electrical outlook.



Above: David Haaren makes electricity by pushing pedals on an exercise bike harnessed to a generator. Photo by Kathy Abbott

Where Do The Watts Come From?

Our bodies produce mechanical power in our muscle cells using food or stored fat as fuel. This conversion is about 20 to 30% efficient. Some of the losses are due to our creaking joints and when one muscle contracts against another. The rest of the energy manifests itself as body heat or is used to maintain vital functions. One food Calorie contains about 4000 Watt-seconds or about 1000 Watt-seconds of mechanical energy assuming 25% efficiency of the human engine. The 150 Calories in one large banana should be good for about 42 Watt-hours of energy and about 430 BTUs of body heat.

Our muscles can produce power over a wide range of forces and speeds. We can push with a force exceeding our body weight (if we pull down on handlebars or push against a recumbent seat) or we can push lightly. We can pedal slowly or spin very fast. The experts recommend a high number of revolutions per minute (70 to 90 rpm), when bicycling to reduce the forces and strain on the muscles and bones. Pedaling slower may be vastly more tolerable. What's the hurry? Everyone has their own preference. Here are some typical values for the human body's ability to produce Watts of mechanical power:

Human Mechanical Power

Watts	rpm	comment
14	50	a bare minimum of effort
51	60	easy to read etc., no sweat
136	80	breathing harder, but can maintain
283	100	going all out and not for long
33	100	geared too low, spinning too fast

These numbers agree with other literature. The average factory worker will work at a rate of 75 Watts. World-class bicyclists can maintain over 300 Watts for races that last for over an hour. Thus we can expect our pedal power to be in this range. Our muscles are easily trained and made stronger. The more we pedal the easier it is to pedal.

Gearing Up

Gearing determines what amount of force is required at what rpm. The simplest approach is to use a single gear. The gear must be carefully chosen for a suitable force and a suitable rpm. With a constant force applied to the pedals, the power produced is proportional to the square of the rpm. Increasing the crank length is a way to decrease the force required for a given power output at a given rpm. At the end of the day, our legs will tell us if we've found the right crank-length and gear to use.

Where Do the Watts Go?

We should anticipate a smaller electrical yield per banana than the mechanical Watts we produce because of the inevitable losses in converting mechanical power at the pedals into electricity. There are losses due to friction at every bearing, including the pivoting links of the bicycle chain. There is even resistance from the air. Fortunately if you use positive-drive transmission (chains or gears), these frictional losses can be kept very low. Rollers and smooth belts are generally very inefficient and should be avoided. A blocking diode introduces electrical losses because of the voltage drop across it (at half a Volt that's 4% of the power at 14 Volts). The major source of losses in the system, however, is dynamo heat.

Dynamo Heat

A dynamos is a type of generator that uses magnets and motion to induce voltage and current in a conductor. AC current is produced in a closed circuit conductor when the conductor is rotated in a magnetic field (or is stationary in a rotating magnetic field). The phenomena can be witnessed by moving a magnet near a TV and watching the stream of electrons deflect. The magnets can be electro- or permanent magnets. The latter are preferable because they do not require current to maintain their field. They are easily magnetized materials which maintain a magnetic field for a long time. The conductor generally needs to be coiled in windings to build up a useful voltage. Any conductor has some resistance and that resistance is responsible for the unpleasant, but inevitable, dynamo heat. These winding losses can be calculated by multiplying the winding resistance in Ohms by the amperage squared. For instance, with a winding resistance of one Ohm there is one Watt of dynamo heat at one Ampere and 100 Watts of dynamo heat at 10 Amperes. Thus the losses to dynamo heat increase from 7% at one Ampere to 42% at 10 Amperes (assuming a 14 Volt charging voltage).

Here's how it's figured: if you're pedaling enough to put one Ampere of current into the battery, the battery is getting 14 Watts (1 Amp x 14 Volts), while 1 Watt ([1 Amp]^2 x 1 Ohm) is wasted as heat. You produce 15 Watts, but only 14 Watts go to the battery, while 7% (1 Watt/15 Watts) is lost. Ten Amperes into the battery is 140 Watts, with 100 Watts ([10 Amp]^2 x 1 Ohm) or 42% (100 Watts/240 Watts) wasted as heat. This decrease in efficiency will actually be even worse when the increase in the resistance of the wire windings with temperature is taken into account. One nice side effect of this decrease in efficiency is that it justifies not pedaling too hard. Multiply the dynamo efficiency by the mechanical Watts to calculate the electrical Watts into the battery.

Dynamo Dementia

Two curved, ceramic permanent magnets in a steel tube form the body of the dynamo. The tube completes and thus strengthens the magnetic field in which the rotor rotates. The windings on the rotor transfer current to the external circuit via carbon-copper brushes at the commutator. The commutator produces DC current by reversing the connections to the circuit at the same instant the direction of the induced current reverses in the loop. The brushes should last over ten years in this application as they last two or three years on a windmill. The brushes do not seem to add much mechanical friction. The winding resistance of the dynamo measures over one Ohm when at rest and varies with the rotor orientation. The actual working winding resistance when the machine is in motion is not known. I have briefly measured a maximum of 15 Amps at about 15 Volts going into our batteries. I can't maintain even 10 Amps for long, and the dynamo just heats up, so I don't bother. We think the system represents a good compromise between efficiency and cost for this application.

The Ultimate Hand-built Dynamo

I recently purchased an amazing book from New Zealand called *The Homebuilt Dynamo*, by Alfred T. Forbes.

Words and hundreds of photos show how to build the ideal dynamo for pedal power from scratch! The author charges a 65 Ampere-hour, lead acid, 12 Volt battery for about an hour a day (two in winter) at 8 Amps to provide all the fluorescent lights needed for his home. The dynamo is large, the parts are not cheap, and the construction looks like a challenge. But the winding losses are low right on up to 10 Amps of charge. You can get the book for $65, shipping included, from Todd-Forbes Publishing, P.O. Box 3919, Auckland, New Zealand.

It's Only Natural

Pushing pedals can make the difference for a battery-based alternative energy system. Typical residential transformers are always using about 28 watts of electricity. Pedaling into the utility grid seems futile. Alternative energy enthusiasts spend large amounts of money in efficient appliances, PV panels, and other hardware. A few weeks of cloudy weather doesn't have to spoil that investment. We want to keep our batteries charged so they will last a long time and be ready with power. When the sun is gone, we have reason to pedal. I strongly recommend this type of battery charger. Without any sun, it's often more pleasant indoors anyway, and pushing pedals can help to push both morale and battery voltage a little higher.

Access

Author: David Haaren, POB 6, Westminster Station, VT 05159 • 802-722-4122. Kits: Pedal Systems, same address

Reference

Bicycling Science by Frank Rowland Whitt and David Gordon Wilson. The MIT Press. Second Edition. 1982. This book is an interesting look at the physics of bicycling and body power.

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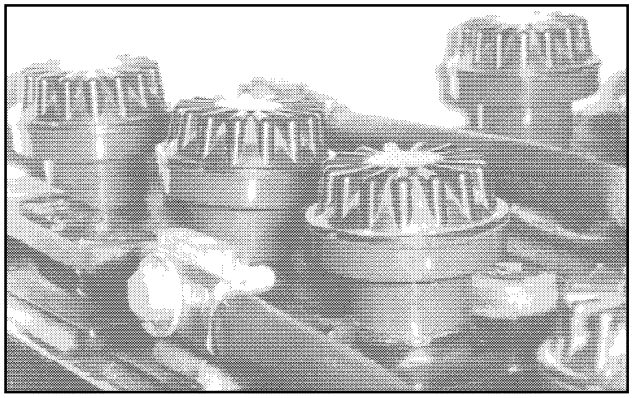

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Things that Work! Dynamote's "Brutus" a 2400 Watt Sine Wave Inverter

Things that Work!
tested by Home Power

Tested by Richard Perez, Chris Greacen, and George Patterson

Brutus makes 2,400 watts of pure sine wave power. This large inverter's 120 vac output remains stable under brutally inductive loads like 3/4 horsepower electric motors. At 96¢ a watt, Brutus is affordable by those whose work requires ultrastable sine wave electricity.

Shipping Container and Documentation

Brutus arrived in fine shape. The shipping box is rugged enough to support Brutus's 65 pound bulk (8 inches high, by 15 inches wide by 15 inches deep). The documentation is straightforward and gives enough data for proper installation and operation of Brutus. Dynamote builds Brutus for use in vehicles. The manual reflects Brutus's mobile heritage and could use wiring diagrams for photovoltaic, wind, and microhydro systems. The manual contains sections on batteries, power cables, and even a list of required tools. We had no trouble installing the inverter.

Brutus's Specifications

Brutus converts 12 Volt DC power into 120 vac, 60 Hz., sine wave power. Dynamote specifies output at 20 amperes at 120 vac. Output surge amperage is rated at 90 amperes at 120 vac. Brutus is rated for 2400 watts continuous operation and 10,800 watts under surge. This is a large inverter.

Dynamote rates power purity at less than 3% total harmonic distortion (THD), and places *NO* limitations on the power factor of loads. In nontechie terms, this means that the output power is a constant peak, pure sine wave—the same as utility power. No limitation on power factor means that Brutus will power big inductive loads like electric motors and still maintain this pure sine wave output. This is a feat that utilities have yet to accomplish.

With specs like these, we couldn't wait to test Brutus.

The Test System

We installed Brutus in *Home Power*'s inverter room. Brutus is connected via 6 feet of 0000 gauge cable to a fused disconnect and then to the power center. We used a 500 Ampere, 50 mV shunt for measuring current into the inverter. The battery is composed of 150 pocket-plate nicad cells yielding a capacity of 1,500 Ampere-hours at 12 VDC (18 kiloWatt-hours of storage).

We connected Brutus to our home/office's power distribution grid. This gave the inverter access to all the appliances in the home and office. We used three Fluke 87 DMMs and one Beckman 2020 DMM for true rms voltage and current measurements. We installed an oscilloscope to watch the inverter's power output.

We then proceeded to operate our household and business using Brutus power.

Brutus's Performance

The first stage of our testing was 3 months of just plain ole' user type testing. We immediately noticed that all our problem appliances stopped buzzing. We had become so used to hearing the buzz in the computers, the printers, the microwave, and the swamp cooler, that their silence was deafening.

We noticed other distinct performance improvements in our large appliances. Our swamp cooler uses a 1/3 horsepower, shaded pole, electric motor to turn the fan. This motor barely ran on slow speed when plugged into any modified sine wave inverter. On Brutus's sine wave power, we can use the slow speed on this blower and it spins just like downtown. The 800 watt microwave oven cooks about 30% faster. All the computer equipment (and there lots of it) runs silently and much cooler. Performance on our video and audio systems is flawless. There is no sign of hash and trash on sound, and no dark lines marring the video displays. Brutus also worked

speed-controlled tools, like a Milwaukee 1/2 hp. drill flawlessly. This inverter is large enough to run a rock band, and clean enough to run any laser printer!

Brutus is powerful enough and stable enough that we can do things we never dared to do before. Operating all the computers and the microwave oven and a power saw on the same inverter at the same time is no problem. We really had to work to get Brutus to shut itself off from overloading, which it did at about 3,000 watts output.

Brutus protected itself against output overcurrent, overtemperature, and low battery voltage. All these fault modes are manually reset by turning Brutus off and then on again. We have operated Brutus at 16.3 VDC input, which makes this inverter compatible with alkaline battery systems.

Brutus is very radio quiet. It is the only large inverter we have ever used that is not audible on our VHF FM radiotelephone. Karen spends half her life on the phone and loves Brutus for its silence alone. It is also quiet on AM radio, FM stereo, 2 m Ham FM, and broadcast VHF TV bands.

Brutus is a large sine wave inverter. It extracts a price for its power and purity. The price is efficiency. Brutus does have an effective sleep circuit that reduces its no load power consumption to 0.7 Watts. But once up and running, Brutus requires about eight Amperes at 12 VDC (96 Watts). This means that when we use Brutus, we should have a real job for it to do.

After user testing, we took data on Brutus's performance. Here is a sample of our measurements of Brutus as it operated in our system.

The table shows a variety of primarily resistive loads being powered by Brutus. From our data, Brutus meets Dynamote's specification for ±5% rms voltage regulation. Frequency was a rock solid 60.00 Hz on our Fluke 87. Even under full rated load, the waveform's peak voltage never fell below 160 volts. We also plugged a variety of large and nasty inductive loads into Brutus. We tried motors, transformers, and the switching power supplies used in computers. We watched the oscilloscope in fascination—the inverter never deviated from a smooth and regular sine wave. This inverter didn't care what we plugged into it!

Efficiency below 300 watts is low, but between 300 watts and 2000 watts power output efficiency is well above 80% by our measurements. This is about 12% less efficient than modified sine wave inverters because Brutus makes sine wave power. Our actual measured peak efficiency is higher than the 83% claimed by Dynamote for Brutus.

The rms voltage, peak voltage, and frequency data we collected from Brutus far exceeded our expectations. We checked the instruments and did the tests again. We could still not measure any deviation from the pure sine wave. We doubted our instruments until…

Brutus meets the BMI Powerscope at SEER '92

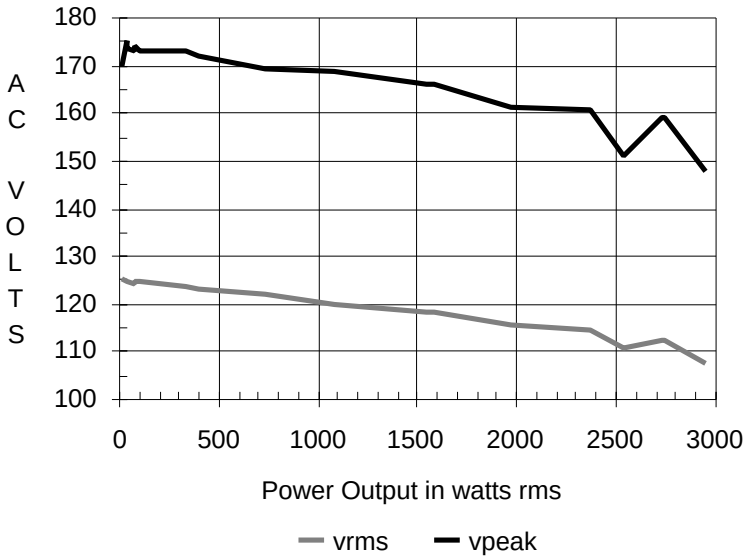
George Patterson, an electron wizard and long-time home power fellow, showed up at SEER with a BMI

Dynamote's "Brutus" Sine Wave Inverter

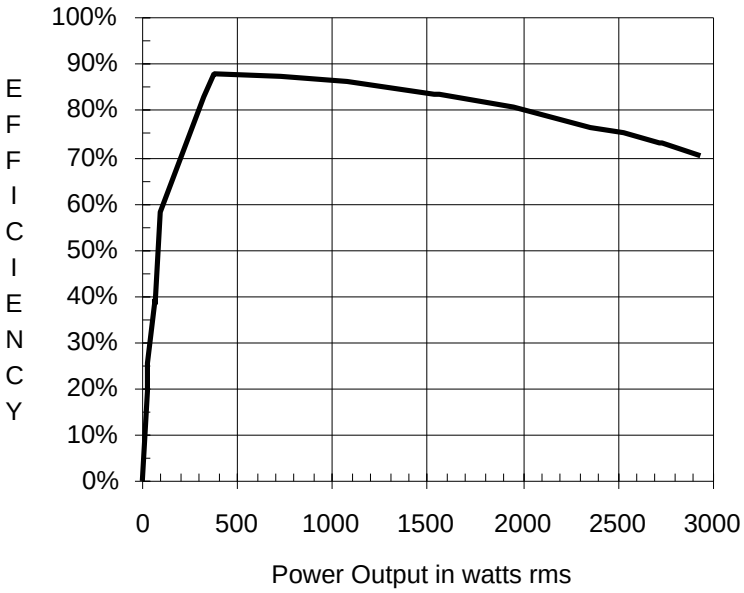
Rated output: 2,400 watts Test date: 3 August 1992

INPUT POWER 12 VDC			OUTPUT POWER 120 vac					
Volts	Amps	Watts	volts rms	amps rms	watts rms	Vpeak+	Vpeak-	Effic.
14.40	0.1	0.7	125.6	0.000	0.0	167.2	-173.2	0.0%
14.70	9.0	132.3	125.2	0.202	25.3	174.8	-176.4	19.1%
13.75	8.5	116.9	125.0	0.240	30.0	173.6	-174.8	25.7%
13.82	12.2	168.6	124.5	0.530	66.0	172.8	-174.8	39.1%
14.77	11.8	174.3	125.1	0.532	66.6	174.0	-175.6	38.2%
13.87	11.1	154.0	125.0	0.716	89.5	172.8	-174.4	58.1%
14.64	26.5	388.0	124.1	2.600	322.7	172.8	-174.0	83.2%
13.73	31.6	433.9	123.4	3.100	382.5	171.6	-173.2	88.2%
14.27	57.7	823.4	122.3	5.900	721.6	168.8	-170.4	87.6%
13.70	90.9	1245.3	120.6	8.900	1073.3	168.4	-170.0	86.2%
13.37	137.1	1833.0	118.7	12.900	1531.2	165.6	-167.2	83.5%
13.47	139.5	1879.1	118.7	13.200	1566.8	166.0	-167.2	83.4%
13.19	183.4	2419.0	116.3	16.800	1953.8	161.2	-162.8	80.8%
13.13	235.3	3089.5	115.0	20.500	2357.5	160.8	-161.6	76.3%
13.00	259.2	3369.6	111.4	22.700	2528.8	152.0	-151.2	75.0%
12.96	287.6	3727.3	112.8	24.100	2718.5	158.8	-160.0	72.9%
12.98	287.6	3733.0	112.9	24.200	2732.2	158.9	-160.4	73.2%
12.88	324.4	4178.3	108.2	27.100	2932.2	149.2	-147.2	70.2%
		Averages	119.4			166.0	-167.1	

Voltage versus Power Output for Dynamote's 2.4kw "Brutus" Sine Wave Inverter



Efficiency versus Power Output for Dynamote's 2.4 kw "Brutus" Sine Wave Inverter



Powerscope. This 25 kiloBuck instrument has only one mission in life: measuring electric power. Consider it a computerized connoisseur of commercial power (see sidebar). George hooked the BMI Powerscope to Dynamote's Brutus and started taking data. We at Home Power Central work very hard to collect accurate data with affordable instruments. Never in our wildest dreams have we ever been able to sic an instrument like the Powerscope on an inverter.

The Powerscope verified Dynamote's claim of less than 3% total harmonic distortion (THD). The Powerscope measured less than 1% THD on most data runs, with a high of 2% THD when Brutus was running a 3/4 horsepower electric motor on an almost discharged pair of car batteries.

The Powerscope also agreed with our measurements regarding rms stability, peak voltage stability, and frequency stability. George commented that Brutus delivers power which is more stable and better regulated than the grid…

Putting Brutus to work

Brutus is best for serious work in large systems. If you load this inverter to 400 watts or more, then the efficiency loss for using sine wave power is small. If you use Brutus to power a couple of 11 watt compact fluorescents, then the efficiency penalty is severe. Brutus consumes 90 Watts once operating, so you'd best have work for it to do.

Use Brutus for large jobs that require clean, sine wave power. For example, the combined wattage of all our computers is about 500 watts. These computer operate just about all day every day. In the morning, we plug our home/office into Brutus for clean, silent power all day. After work is done, we plug ourselves into a modified sine wave inverter to run lighting and small appliances more efficiently all night. Brutus would be at home powering communications businesses, recording studios, video editors, computer based businesses, wood shops, and metal shops. Brutus will power loads like laser printers, laser based copy machines, and thyristor controlled appliances that will not function on modified sine wave power.

Cost

A modified sine wave inverter costs about 70¢ per continuous output watt. The Brutus inverter costs 96¢ per continuous output watt. List price of a Brutus 2400 is $2295 with a one year warranty. Making a pure and stable sine wave at this high output power level involves electronic design compromises that lower the inverter's efficiency. We, at HP Central, have been using about 3,800 watt-hours of power out of Brutus each day. The efficiency penalty paid is 12%, or 580 watt-hours per day in our case. This is the amount of power produced by 2.5 standard 50 Watt PV modules. For us, the additional cost and power consumption is far outweighed by increased performance.

Conclusions
Brutus is a large, super stable, pure sine wave inverter that really works. Dynamote gets thumbs up for making downtown power possible and affordable for home power systems. The quality of Brutus's power is superb, better than the grid can deliver.

Access
Author: Richard Perez, c/o Home Power, POB 520, Ashland, OR 97520 • 916-475-3179. Test assistance by Chris Greacen and George Patterson.

Maker: Dynamote Corporation, 1200 West Nickerson, Seattle, WA 98119 • 800-426-2838 • 206-282-1000

The BMI Model 4800 PowerScope

The PowerScope is a portable instrument that detects power line disturbances, and analyzes them. The 4800 PowerScope combines 16 digital oscilloscopes, 32 true RMS voltmeters, 4 frequency meters, 4 noise meters, and a strip-chart recorder in a portable instrument. All of the front panel controls set triggering thresholds and instrument configuration. There are six Z-80 microprocessors in each 4800 PowerScope being driven by 30,000 lines of code along with four custom high-speed processors.

At SEER '92, we looked at several inverters using the PowerScope. The sine wave inverters exhibit excellent frequency stability and low total harmonic distortion (THD), typically <1.5% THD. I measured my PG&E power in Santa Rosa. The THD was 3.1%. One must understand that with the entire grid connected, this is excellent. In the home system there is no large scale grid, with loads of various types randomly operating, to consider. For this and many other reasons, the electricity in a home power system is more controlled than power supplied by a utility.

Access
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PowerScope Maker: BMI Basic Measuring Instruments, 335 Lakeside Drive, Foster City, CA 94404-1147 • 415-570-5355

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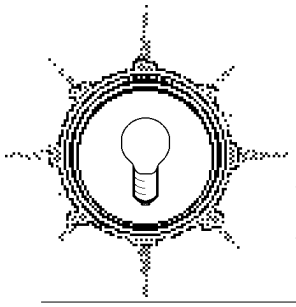

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☐ **As my primary power source**
☐ **As my backup power source**
☐ **As a recreational power source (RVs)**

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

My site has the following alternative energy potentials (check all that apply).

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☐ **Water power**
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HP#31

I now use OR plan to use the following alternative energy equipment (check all that apply).

NOW	FUTURE		NOW	FUTURE	
☐	☐	**Photovoltaic cells**	☐	☐	**Gas/Diesel generator**
☐	☐	**Wind generator**	☐	☐	**Batteries**
☐	☐	**Water power generator**	☐	☐	**Inverter**
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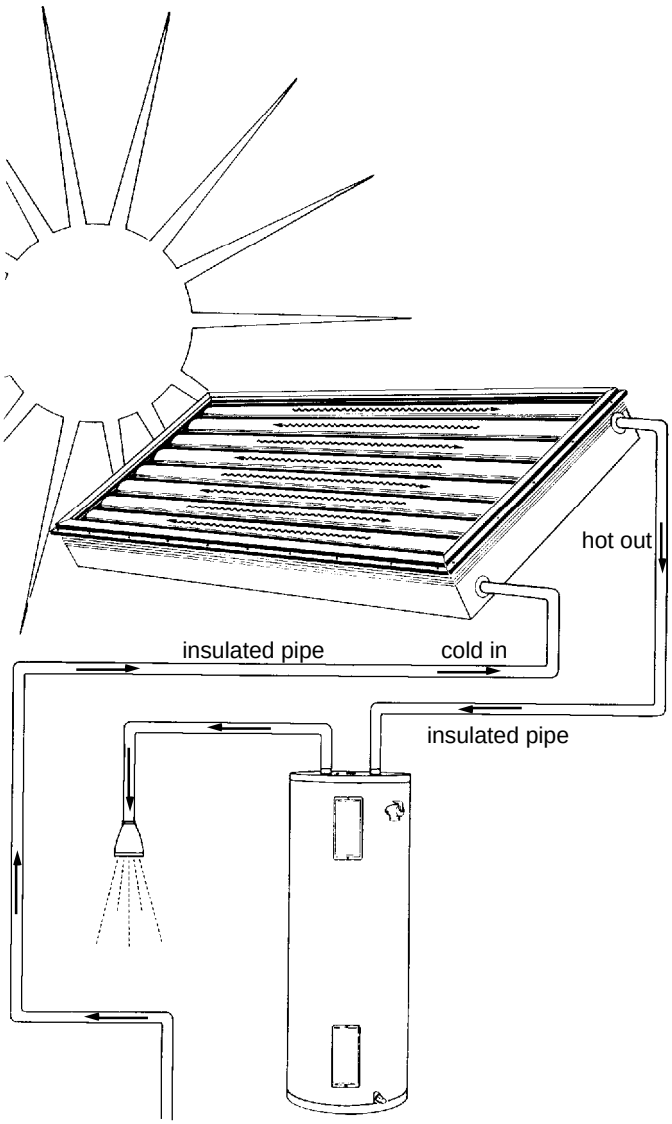
Batch Solar Water Heaters

Tom Lane

The simplest type of solar water heater is a "batch" heater, so called because the collector is the storage tank—water is heated and stored a batch at a time. Batch heaters are used as preheaters for conventional or instantaneous water heaters. When hot water is used in the household, solar-preheated water is drawn into the conventional water heater. Since the water has already been heated by the sun, this reduces energy consumption. A batch solar water heater is a low cost alternative to an active solar hot water system, offering no moving parts, low maintenance, and zero operational cost. The acronym for a batch type solar water heater is ICS, meaning Integrated Collector and Storage.

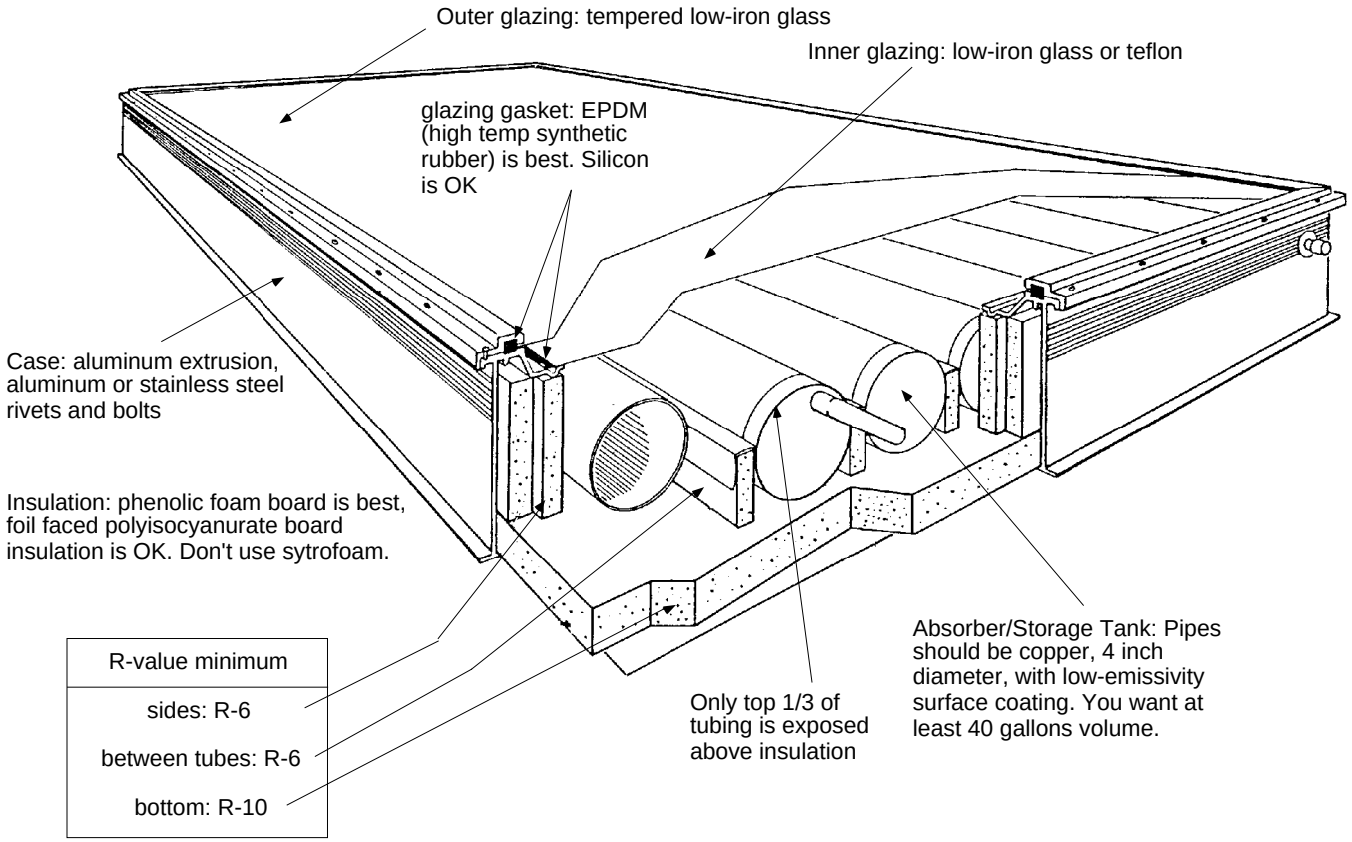


Good Freeze Protection for Mild Freezes

Thermosiphon units (with separate tank and collectors) have serious problems with their collectors freezing and bursting, even in areas with only one or two mild freezes a year. Thermosiphon solar heaters depend on electrical power and/or water pressure (for freeze dribble valves) for freeze protection, so woe to you and your solar water heater if the power goes out during a freeze. An ICS unit avoids freeze damage by using 4 inch or larger copper tubing in a double glazed, insulated enclosure. Quite simply, the volume of water in an ICS unit is too large to freeze and burst in a mild freeze. Thermosiphon systems also have problems in hard water areas that batch heaters do not.

What to Look for in a Batch Heater

ICS units can be a good low cost investment for heating water for 2 to 4 people. Beware: some ICS units are not good value due to design flaws. They may even cause your bill to go up instead of down, from late fall to early spring. Since an ICS holds your hot water storage on the roof overnight, it is absolutely essential that 1) it be double glazed 2) it have a selective, low emissivity, surface coating (like black chrome) instead of black paint 3) only 1/3 of the tubing be exposed above the insulation. It must be sealed off to prevent convection (see diagram—insulation here extends 2/3 up around each tube). I have seen single glazed ICS units with the tubing above the insulation returning water to the tank at 45°F, while sending water to the house at 70°F. This occurred in central Florida after a night in the low thirties!



Unless you live in the tropics, an ICS unit must be double glazed. The upper glazing should be low iron, tempered glass—*NEVER* any plastic, Teflon, or fiberglass glazing. The second layer, about 1 inch to 1 1/2 inches below the first, can be glass or Teflon film, since it won't be exposed to corrosive air pollution, acid rain, hail, pollen, and bird excrement.

Phenolic foam board is the best insulation for batch heaters. A second choice might be foil faced polyisocyanurate board. Fiberglass will soak up moisture and lose its insulating properties. Don't buy a fiberglass insulated batch heater unless you live in the desert. Styrofoam is not a good high-temperature insulation—it will outgas.

Volumetric capacity is also critical on ICS units. You should have at least 40 gallons to justify your investment. I hope a manufacturer will soon bring out a 4 foot x 10 foot unit that will heat 50 or 60 gallons.

S.R.R.C. and Batch Barracudas

The blackest mark on the solar industry is the solar tax credit era of the early eighties. The most common solar system sold then was a single glazed 20 to 30 gallon ICS unit that was mass marketed by high pressure, direct marketing outfits. They used suede shoe barracudas that could convince an unknowledgeable person that sugar on a cowflop was gold.

The Solar Rating & Certification Committee's (S.R.R.C.) testing procedures are pretty weak; they do not take into account the higher performance of a well-designed ICS unit. You will want a batch heater that holds heat at night much better than the S.R.R.C. ratings. Poorly designed ICS units—those without double glazing—will have good results by official standards, but will not compete with well designed batch heaters in the real world. Unfortunately, some of these poorly designed units are still being sold.

I understand that the European solar water heater test does not include a daytime water draw. Such a test, which records results at the end of the day and measures overnight losses, is a much better indicator of performance of a solar system. I hope the S.R.C.C. will come to its senses and adopt the European model, since most homeowners are not able to use hot water during the middle of the day.

Choose Copper

The ICS tubing should be made of copper. During the early eighties, a lot of ICS units were made from stainless

steel. Manufacturer after manufacturer either went out of business or changed to copper. This was due to the massive leaking problems seen after a few years, through the welds of stainless tubes. Historically, all the ICS units made out of type L copper have had no problems and will probably last 100 years or longer. If you don't get a full ten year warranty that includes both parts, shipping, and labor, then look for another company.

Make sure your run to and from the batch heater is all in 3/4 inch soft type L copper. Unlike hard copper, soft type L copper can expand about twice its diameter. Insulate the pipe with 3/4 inch elastomeric insulation (Rubatex or Armaflex) available at heating and air conditioning supply outfits. Specify 7/8 inch inner diameter with 3/4 inch or 1 inch wall thickness. Do not use polyethylene insulation—it will melt. Wrap all exterior lines in aluminum tape and spray with a can of automotive undercoating paint. You can tee or branch off the solar return leg of a ICS unit in the attic and go to a second or even a third water heater in the home.

Freeze Protection

My major concern about ICS system in the extreme north is that the water in the lines going to and from the unit will freeze and burst in the winter. The Dole corporation makes a thermally activated dribble valve that goes on the exit from the ICS unit (available at most solar water distributors). Currently, there is nothing available to protect the pipe that supplies water to the ICS unit.

Batch heaters can be cost effective in northern climates if you are careful to drain the batch heater during the cold season whenever there is a chance of the pipes freezing. Don't worry about mild freezes. You could use a stove or fireplace heat exchanger during that period for heating your hot water. You need to adapt your lifestyle to get the most out of an ICS unit when the weather is cool.

In the Sunbelt, during the winter, it is important to use most of your water from 10:00 am to 8:00 pm to take advantage of the time that the water is hottest. Try to do laundry and dish washing between 10:00 am and 2:00 pm.

Cost & Installation

You can purchase a 40 gallon, double glazed ICS unit for around $1,600 with mounting hardware or have one completely installed for $2,500 or less by a contractor. ICS units are heavy. They are about 250 pounds dry, and need two ladders and four men or a sign company crane to get them on the roof. However, they are not too heavy for the roof as the weight is distributed over a minimum of 32 square feet spread out over two trusses or rafters.

Summary

An ICS unit can be a good investment. However, do not rely on the S.R.C.C. BTU ratings alone if you do not want to get "sunburned." You need to make sure you get a well designed, double glazed unit of at least 40 gallons. You must also realize the special limitations of these solar batch water heaters. More than active systems, the total contribution is dependent upon your hot water consumption patterns and daily weather conditions. Batch heaters offer an economical alternative for homeowners with limited budgets and/or small demands on hot water.

Access

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The Forces for Good Will Organize Around the Sun!

Allan Sindelar

The 1992 World Conference on Solar Cooking, sponsored by Solar Box Cookers International (SBCI), was held at the University of the Pacific in Stockton, California in June. The conference brought together solar cooker developers and users from around the world to share designs and strategies for the U.S. and the developing world.

Above: The SK 12 solar cooker at work on ratatouille. Note the haybox basket used to keep the food hot while the next pot is placed in the cooker.
Photo by Allan Sindelar.

SBCI began five years ago to spread knowledge of solar cookers worldwide. Don Metcalf, president of SBCI, was at the Earth Summit in Rio de Janeiro and reported that 99 out of 100 people there didn't know that you can cook with the sun!

Problems and Solutions

In some African countries, 80–90% of the total energy supply comes from firewood. In Central America, women look for wood on average between nine and forty hours a week. The wood is rapidly disappearing. Solar cooking can play a major role in easing peoples' lives, slowing deforestation, and reducing CO_2 emissions into the atmosphere.

Solar cookers must be carefully tailored to a particular culture to be accepted. For many of us in the U.S., the first time we see a solar cooker or eat hot, delicious food fresh out of one, our reaction is to see the cooker as a cure-all. We see a wondrously simple solution to problems of fuel cost and deforestation, and fail to understand the complexities for the developing world. For example, what can be simpler than an insulated oven made from cardboard boxes nested together? Yet one member of the audience at the conference spoke of spending four months in his home country to gather enough cardboard to make a single box cooker. What is abundant scrap to us may be a scarce and valuable commodity to others.

The keys to a cooker's acceptance are many. Design and materials must be simple, the design must be adaptable to the available materials in a particular country, and the design must be easily taught and replicated by a local populace. Also, a cooker must be reliable. In the United States, if a meal fails to cook properly, we pop it in our gas or electric oven; for people in developing countries, a failure may mean going hungry. Cultural attitudes are also extremely important. In Botswana, one attempt at promoting solar cooking failed simply because the solar cooker is not used in the energy-guzzling industrialized world. In Ladakh, India, solar box cookers were used half-heartedly, but the people, especially young folk, were excited by a parabolic cooker design. "It looks like a satellite dish!" In a village in rural Guatemala, a year after being given solar cookers, the people were not using them. The reason was that fuel gathering was done by groups of women. Solar cookers isolated the women by denying them the socializing involved in wood gathering.

Some Favorites

Many box cookers were displayed at the conference. Examples included SBCI's own cardboard unit which can

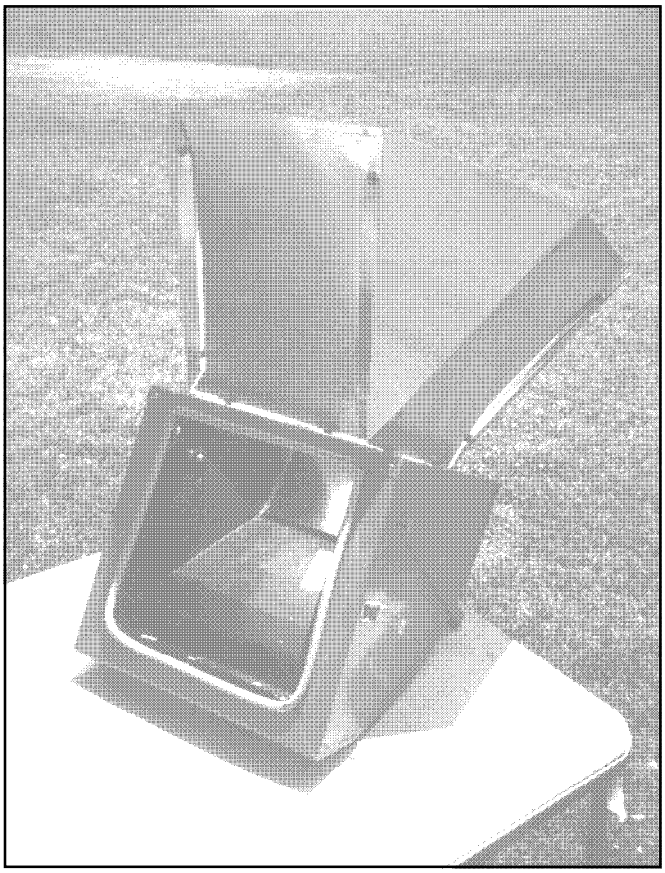
be shipped worldwide and John Morearty's cabinetmaker's model. The *Heaven's Flame* cooker developed by Joe Radabaugh attracted much attention from both the public and media. Made from cardboard boxes, white glue, aluminum foil, black paint, and scrap glass, it is a prime example of what can be done with low-cost and free materials. It also works exceptionally well, achieving temperatures well over 300°F. Joe identifies himself as a homeless person, and promotes his cooker as an essential survival tool for a simple, nomadic life.

One of the designs that attracted the most interest was not a box cooker, but a reflective dish called the SK 12 that focuses the sun's energy on a cooking pot. Developed at the State Technical College in Altötting, Germany, this cooker is used with several haybox baskets to cook for twenty people. A pot of food is brought quickly to cooking temperature. Then the pot is placed in a haybox, an insulated basket made from local materials, that lets the food continue to cook by its own heat. Then another dish is cooked in the same way, until an entire meal is ready. The dish is powerful enough to bring three quarts of water to boil in half an hour, and even to allow frying.

The SK 12 is well designed. The cooking pot sits in the bowl of the dish, so both the sun's glare and the chance of starting a fire are minimized. The dish rotates on a horizontal axis around the cooking pot. This allows the pot to be shaded while it is being handled to protect one's eyes from the sun's glare. The cooker may be turned away from the sun and left outside when it is not in use. The cooker is designed to be manufactured by local craft workers using standard materials and simple cutting, bending, and punching tools. The demonstration model of this cooker was given away at the conference and is now being used in Nigeria as a cooker and as a model for the local development of additional cookers.

Personal Impressions

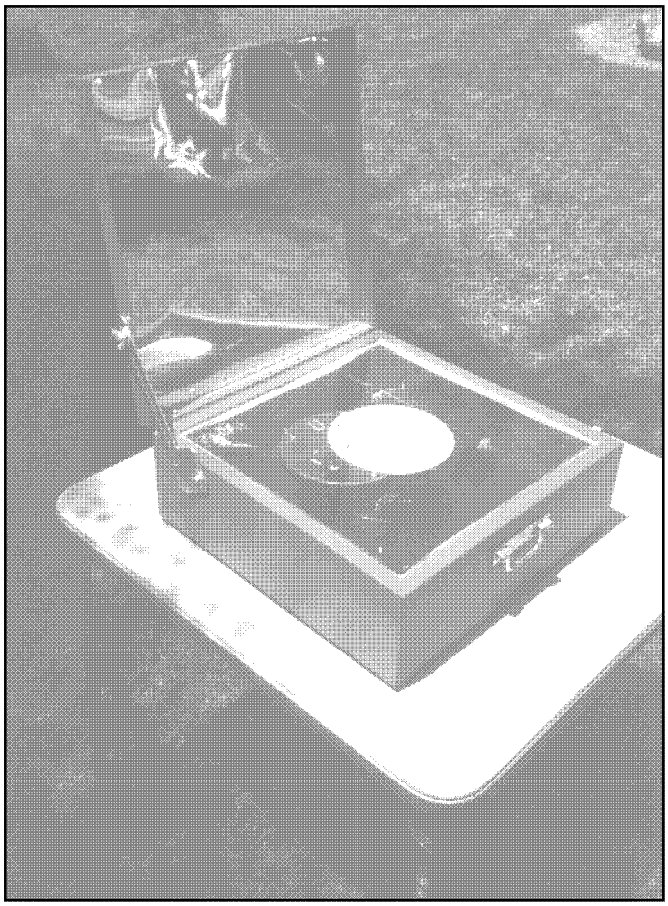
I was struck by the diversity of people at the conference, women and men of all ages and colors and nationalities. Many of the speakers focused on the roles that women play. The keynote speaker, Waafas Ofosu-Amaah of Kenya, stressed that women are managers of both production and reproduction, as well as community life. She maintained that environmental management is the management of scarce resources, such as food, water, and cooking fuel. All of these things are handled by women on a daily basis. She concluded that women must therefore be integrally involved in any programs to promote solar cooking. I liked hearing this grassroots approach, which was echoed frequently by other speakers.



Above: The tray on which the pot rests is suspended, so that the pot always stays level. This design also allows access to the food from the back.
Photo by Allan Sindelar

I learned that among users of solar cookers in the United States, the main reason for their continued use was not cost or environmental benefit. Rather, solar cooking saves time. The cooker may take longer to cook the food, but it doesn't require constant attention. In the morning, food is placed in the oven and it is oriented toward the afternoon sun. At day's end the meal is ready to eat, with no burning and no hot kitchen in the summer. As one man told me, "You come home to eat, not to cook!"

I was excited by Eleanor Shimeall of SBCI, who uses her box cooker for home canning. She cuts and places fruit and high-acid foods like tomatoes in a canning jar, with water up to the jar's neck. She puts one to six jars at a time into her cooker. The food begins to bubble up in about half an hour. At day's end when the jar cools, it seals. The color is much better than with standard boiling, and the flavor is true. Also, the rubber lid seals aren't



Above: This variation of the Kerr-Cole design allows access to the food without opening the box and allowing heat to escape.
Photo by Allan Sindelar

destroyed by the heat, so they can be used again. Eleanor Shimeall said that any jars that don't seal by the end of the day can be returned to the cooker the next day. She was careful to caution, however, that this method is not to be used for meats, vegetables other than tomatoes, or any foods that would normally be canned under pressure in order to kill botulism spores. Her favorite solar canned foods were plums and peaches. She offers a solar cookbook with many recipes and detailed canning instructions for $10.

Besides solar cooking and canning, beer brewing showed another use for solar cookers. Andrew Pejack demonstrated his Solarbrau—delicious solar-brewed beer, brewed in a solar box cooker.

The conference was a major success for those who attended and for SBCI, and there will be more to come. The next one may be held in India or a country other than the U.S. I learned a tremendous amount in two days, and was very glad I went.

Access

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SK 12 dish cooker: Gerhard Jobst, Karl-Valentin-Str. 20, 8265 Neotting, Germany • 08671-20523, fax 08671-73114

Joe Radabaugh, POB 1296, Mt. Shasta, CA 96067

Heaven's Flame: Home Power, Inc., POB 275, Ashland, OR 97520 • 916-475-3179

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Writing for *Home Power Magazine*

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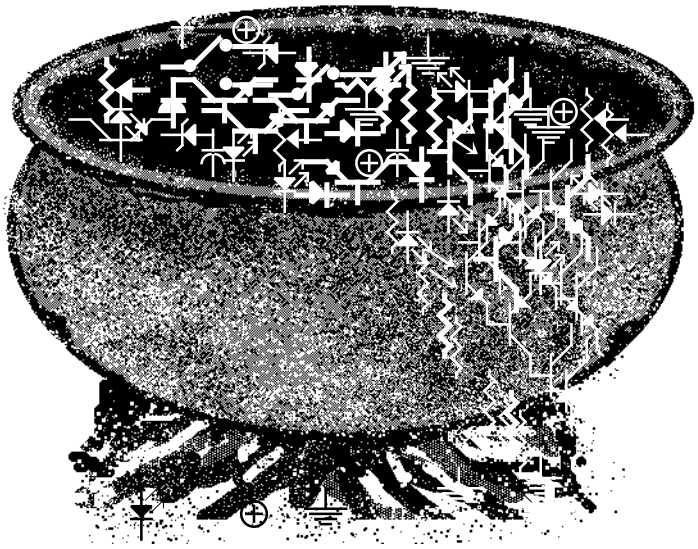


You Can Teach Old Inverters New Tricks

Bob Grater K6SUB

In these days of super efficient modified sine-wave inverters, the old power hungry square-wave inverters that we started off with have all but been forgotten. Yet there must be a lot of them out there sitting in corners gathering dust or being sold at flea markets and garage sales for ridiculous prices. Tripp-Lite still manufactures square wave inverters ranging from 100 watt to 2000 watt output. These reasonably priced, well-built units can take a lot of abuse and keep on ticking, and there are probably others that I am not aware of.

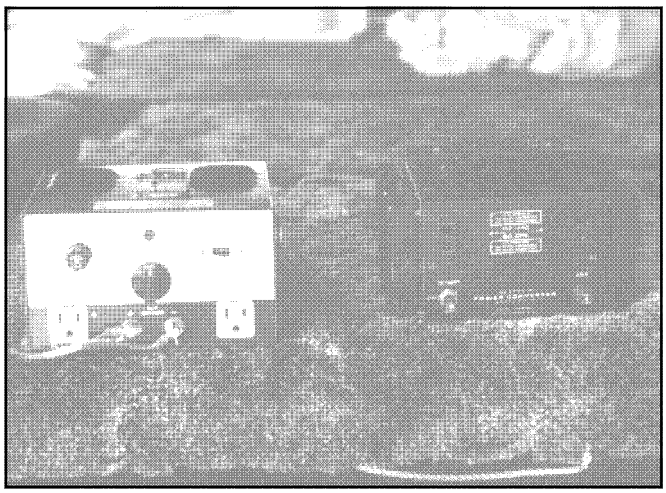
Just because these older style inverters aren't as efficient and can't stand the surge loads the new Whiz-Bang, Gyro-Stabilized, Talking inverters can doesn't make them useless. As a matter of fact, they can come very close to matching the newer inverters in efficiency in a lot of applications — and for a lot less money. Don't get me wrong, the new high efficiency inverters are great. I have a Powerstar™ UPG-1300 and consider it one of the best things to happen since sliced bread. But even these new inverters can stand to benefit from a couple of tricks.

Trick Number One: DC Output for Universal Motors

Trick number one is an old trick, used first on the Knightkit™ KG-662 and KG-666 inverters made by Allied Radio in the late ‘70s. These square wave inverters put out 120 watts or 240 watts — your choice by flipping a HI-LO switch. They also had a built-in battery charger using the same HI-LO switch. Their “trick” was a 120 Volt DC outlet as well as the 120 volt square wave ac outlet. Why 120 Volts DC? Just try and run a hand drill on the square-wave output — you might be able to drill through soft butter. Plug the same drill into the DC outlet and you have a full power, full speed hand drill.

Let's borrow Allied Radio's 120 Volt DC outlet idea and take it a step further to the point where, with a large enough square wave inverter, it will start and run a brush type power hand saw. A full wave rectifier is all that’s needed to change the square wave into a sloppy 120 VDC. But wait — we can do better.

Did you ever notice when you pull the trigger on your portable hand saw the lights momentarily dim? It takes a lot of current for a short period of time to get that motor turning. This momentary high current drain will stop an older square-wave inverter in its tracks. Fortunately the solution is easy: add a couple of hefty capacitors to store the extra energy for the motor start up. Capacitors are a lot like a battery in that they can be charged and

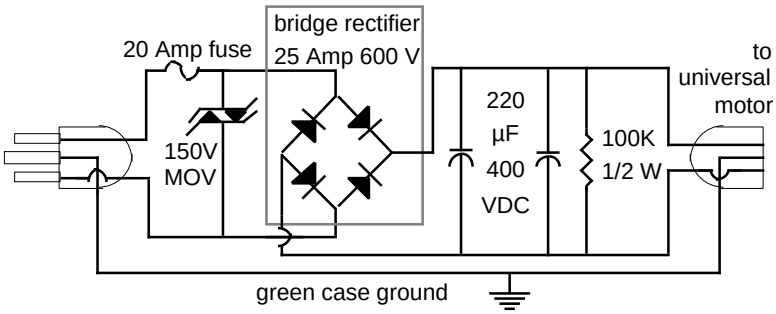


Above: a venerable collection of old, but still useful inverters, KnightKit on the right and HeathKit on the left.
Photo by Bob Grater

discharged. In this circuit they get charged up when the inverter is turned on, and then when the motor is turned on, they add their stored energy to the inverter's energy, giving the required boost. They also smooth out the pulsating DC coming out of the rectifier.

Direct Current Caveats

Be careful. Direct current can only be used on "universal" or brush type motors, resistive loads, and incandescent lighting. It cannot be used on induction motors, or any equipment that uses transformers (most consumer electronics, microwave ovens, etc.), or a lot of other things. Most variable-speed power tools will handle DC but run at full speed (you lose the variable speed feature). If your saw or drill runs backwards, simply reverse the plus and minus leads at the output receptacle. Any device using a thermostat such as a crock pot should not be used on DC. This is because DC tends to prolong arcing when contacts open and close and reduces the life of the contacts.



Building the Circuit

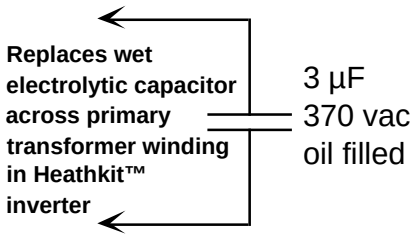
The values of components I specified for this circuit are super conservative since I expect things I build to last about as long as I do. I took a small metal box that would contain all the components and mounted a fuse holder, the bridge rectifier (using the metal box as a heat sink), and the two capacitors with some tie-wrap to keep them from flopping around. A hole was drilled in each end of the box to accommodate grommets for a short extension cord that I cut in half for the input and output to the unit. The MOV (metal oxide varistor or surge protector) is optional but a good idea — see Trick Number Three. The 100 kΩ bleeder resistor bleeds off the charge in the capacitors slowly when the unit is shut off and is an inexpensive safety item. Make sure you observe the correct polarity when wiring the capacitors in parallel and to the bridge rectifier.

This handy little box can then be plugged into different inverters or even used with standard house current if you have a long extension cord run and you need an extra starting boost to your power saw.

Trick Number Two: Buzz Buster Capacitor

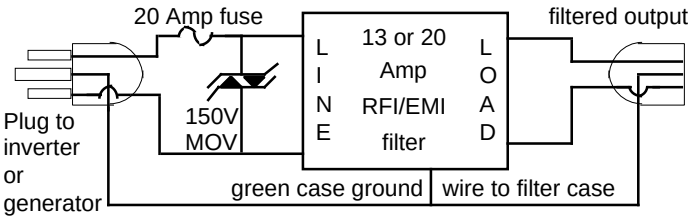
Square wave inverters and the appliances they run can make an annoying buzzing sound. You can get rid of some of that buzz by wiring a 3 µF ac oil-filled motor start capacitor across the secondary or output of the inverter. This rounds the edges of the square wave. This is referred to as the "brute force" method of buzz removal, and there is a price to pay in the form of added power consumption. The sharp edges of the square wave see the capacitor as a very heavy, momentary load.

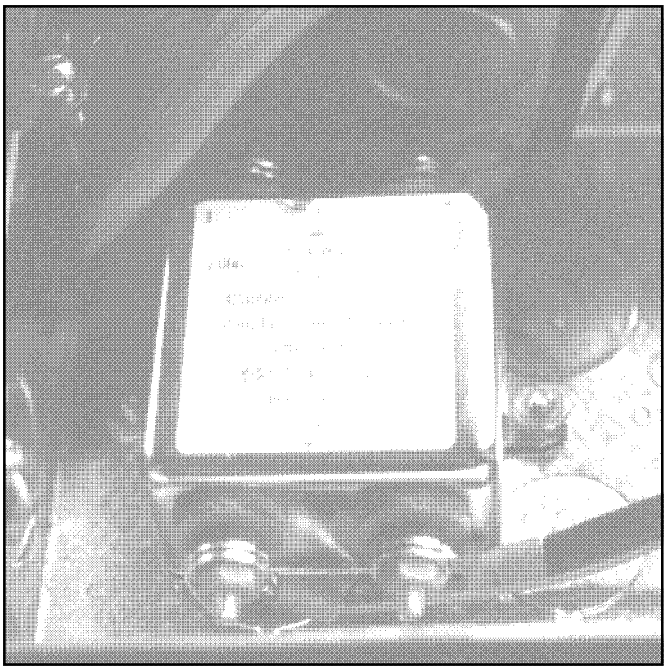
The Heathkit model MP-10 uses a 5 µF ac electrolytic capacitor across the transformer primary to smooth out the edges of the square wave somewhat. This wet electrolytic capacitor often dries out and blows up (literally) or shorts out, making the inverter inoperative. Remove or replace this electrolytic capacitor with an oil filled motor starting capacitor which will essentially last forever. It will have to be mounted externally since it is much larger than the original small electrolytic capacitor.



Trick Number Three: the Surge Suppressor

Surge suppressors protect sensitive electronic equipment from high voltage pulses and radio frequency interference (RFI). High voltage spikes are more common on utility power lines than in home RE systems. But they can be a problem with poorly designed inverters or voltages induced by lighting strikes. RFI, on the other hand, is a fact of life with all square wave and modified sine wave inverters. Abruptly switching current creates high frequency harmonics which can interfere with radios, TV, etc. You can buy a surge suppressor from your local electronic outlet store, or you can build a better one for roughly a tenth the price. The schematic below shows how.





Above: RFI / EMI Filter installed in a steel wall box.
Photo by Bob Grater

Incoming line voltage goes through a fuse or circuit breaker, directly across the MOV, and into the line side of the RFI/EMI (Radio Frequency Interference / Electro-Magnetic Interference) filter. The MOV is basically two wires stuck in a ground-up semiconductor and wrapped up in a little package. It acts like an insulator until the voltage rises above a level determined by the distance between the wires, and the semiconductor used. At voltages above this level, the MOV quickly becomes a conductor. In this circuit the MOV starts conducting at 150 volts, and draws more and more current as the voltage goes up. This is approximately the peak voltage that comes out of your wall plug or modified sine wave inverter. The 120 volt figure you are normally familiar with is actually the rms (root mean square) voltage. Another way of putting it is, the 120 volt figure is the average effective voltage of the sine wave coming out of the wall.

The MOV is designed to handle very short duration, high voltage spikes that can ruin most electronic equipment. If such a spike of any significant duration occurs, the fuse will blow, protecting the equipment. MOVs will take a lot of punishment, but if you live in lightning country I would suggest getting a spare or two. They will short themselves out when really hit hard. If the MOV is shorted, the fuse will simply blow again when you replace it. *(Don't leave the surge suppressor plugged in permanently to an idling inverter. Idling peak to peak voltages can rise higher than the MOV's threshold causing them to conduct and, after a while, blow. This exact scenario happened to me with a POW200 inverter and a computer surge suppressor. The POW200 did not survive the experience — CG).*

Don't pay retail price for your RFI/EMI filter; you can get it much cheaper as surplus. Also, get the highest-current filter available. The RFI/EMI filter consists of a network of capacitors and inductors designed to remove electronic noise from the power lines. Both sides of the power line are worked against the case ground so it is important to have a good ground. Ground the grounding prong of your input plug or have the case tied to a grounding rod through your system ground.

This combination of items can be put into a box much in the same manner that Trick Number One was except no heat sinking is required, just good grounding.

If you are plugged into the grid no matter where, from FPL (Florida Power & Light) to PG&E (Pacific Gas & Electric), there is an unbelievable amount of trash coming in on those power lines. The closer you are to an industrial center or the farther out you are in a rural area, the worse it is. The suburbanites seem to have the cleanest power except in hot weather when the air conditioners are switching on and off. Part of a project I was on at one time had me taking pictures of what comes into your home on those power lines — suffice to say it's a great argument for getting off the grid!

Parts available from All Electronics Corp.

Description	Catalogue #	Price
Fuse holder (3AG)	FHPM-7	$1.00
13 Amp RFI/EMI filter	RFI-13	$7.50
20 Amp RFI/EMI filter	RFI-201	$8.50
220 µF 400VDC capacitor	EC-2240	$2.00
3 µF 370 vac capacitor	MRC-337	$3.00
25 Amp 600 PIV bridge rectifier	FWB-256	$3.50
150V Metal Oxide Varistor (MOV)	MOV-150-20	$1.25

Fun to Run

These old timers (meaning the inverters not the author) are practical! I keep the Knightkit in the camper shell on the pickup, wired in and ready to go. The Heathkits have been moved from car to car over the years. The only requirements are heavy wiring to the battery or fused ignition line (size depends on distance) and plenty of ventilation, especially around the transistor heatsinks. Did you ever want to drill a hole to mount a new gadget in the car, or solder it in without draping extension cords all over

the place? Want to check out a small appliance at a yard sale? Just plug it in, then complain about the terrible buzzing but accept it anyway at half price.

These old square waves will run a computer without any problem because of the switching power supplies used in computers. Some printers don't like square waves and a few video displays have problems with them. Generally they can be used in an application where you don't need them to idle for long periods. Just turn it on, use it, and turn it off. Out buildings and remote sites are handy places to have them.

The Crock Connection

I get the feeling that whoever designed the crock pot had inverters and long auto trips in mind. The power drawn by a crock pot sits right about on the peak efficiency curve of these small, older inverters. While you're cruising down the road, your alternator is putting out all the power needed to run the inverter. There aren't any worries about draining your battery and it would take an awful long rest stop to cause any kind of battery problems.

In the meantime, dinner is slowly cooking and will be hot and ready to eat when you arrive at your destination. You can put that New England boiled dinner together and start it in the pot a few hours before you leave and then just move the pot to the car. Or, you can plug the pot in after you arrive to continue cooking and eat after you're settled. A crock pot gives you a lot of leeway in cooking times.

Making the pot carproof is simplicity in itself. Drill two small holes, one in each handle, large enough to accept the hooks on a bungee cord. Insert one side of a short bungee cord in one handle, take a quick wrap around the knob on the lid, and attach the other hook to the opposite handle. That lid is now guaranteed not to go anyplace! I had this idea many years ago when the pots were small and I elected to mount mine on a plate with rubber underneath so it wouldn't go anywhere. The new larger pots have a much bigger footprint. Just gluing some faucet washers on the feet pretty much guarantees it won't go anywhere unless you are on some really rough roads. The pot is still just as useful at home as it is in the car.

I appreciate it being back in the camper shell with the animals since I can get awfully hungry toward the end of a long drive. The smell drives the dogs bananas! The Cocker/Retriever has to alternate between watching the bird and the crock pot, the Beagle/Whippet stays glued to the pot, and the cats just wander around and pounce on one of the dog's tails now and then to raise a little excitement. In the station wagon I must admit I've been forced to test how tender the corned beef was long before we arrived.

Be sure to look at the wattage on your crock pot verses the wattage of inverter. We usually cook everything on low, saving the high setting until we get where we are going and just can't wait.

I hope this has resurrected some of those old inverters and started some fun ideas working along with them.

Access

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All Electronics Corp., P.O. Box 567, Van Nuys, CA 91408-0567 • Order Phone: 1-800-826-5432 • FAX 1-818-781-2653 (Minimum Order $10.00 + $3.50 S&H)

Errata

The book review in HP#29 page 78 on Finding & Buying Your Place in the Country by Les Scher listed the wrong ISBN number. The correct ISBN number for the third revision is 0-79310-395-9.

The Homebrew in HP#30 page 68, left out the resistance of the potentiometer. On the schematic on page 69, the potentiometer (R2) is 5kΩ.

ECS
camera-ready

Conductors and The Code

John Wiles

It is sometimes difficult to find a suitable conductor with the proper insulation that can be installed using a method outlined in the National Electrical Code that will satisfy the electrical inspector. Numerous types of cables are available from sources as diverse as auto supply stores, welding shops, hardware stores, marine equipment stores, electrical supply houses, and building supply stores. The information presented below will assist in selecting the proper cable.

Interior wiring for load circuits, ac and DC, was addressed by David Doty in *Home Power* #27. He covered the use of non-metallic, sheathed cable (NM - Romex) rather completely. PV installers frequently use large cables to minimize voltage drop. If NM cable with number 10 AWG conductors (i.e. NM 10-2 w/gnd) protected with a 30 Amp fuse or circuit breaker is used, then 30 Amp receptacles are required. Fifteen and 20 Amp receptacles may be used only on branch circuits protected at 20 Amps or less.

Module Wiring

Inspectors usually have questions about exterior wiring. Section 690-31 of the 1990 National Electrical Code (NEC) allows the use of single conductor cable that is identified as sunlight resistant for PV module interconnections. UF (Underground Feeder) is identified as sunlight resistant. USE and SE cable are generally not marked sunlight resistant, but they have passed the sunlight resistance tests. The 1993 NEC will allow not only UF, but SE and USE cables as well. Most UF cables are made with PVC insulation. Problems have been identified with PVC insulation when used in direct current circuits where moisture is present. Under these conditions, the insulation turns to goo. It is unknown whether PV module wiring in wet climates provides the conditions necessary for PVC insulation failure. It might be wise to use another type of cable in locations where the cables are in contact with standing water. Furthermore, although passing the Underwriters Laboratories (UL) standards for sunlight resistance, UF cable has shown signs of deterioration after only four years in hot, sunlight-exposed installations. If USE or SE cable is available, it is preferred.

Most inspectors are familiar with the use of USE and SE cables outdoors in exposed locations. If the USE or SE cable has cross-linked polyethylene (marked XLPE or XLP) and is further marked RHW and RHH or RHW-2, it is one of the best commonly available cables. Standard USE cable has only 75°C insulation. The RHW designation indicates rubber 75°C insulation for use in wet conditions. RHH indicates rubber insulation, with 90°C insulation when dry. The new RHW-2 designation (1990 NEC) indicates rubber insulation with a 90°C rating even when wet. SE cable has a slight advantage over USE in that it has flame resistant additives. The Underwriters Laboratories label (UL) will ensure that the cable meets the highest quality standards and will be the most durable product.

Exposed, single conductor cable is only allowed for module connections. At some point near the modules, the wiring method must be changed to one of the other methods that meet the requirements of the NEC. The exposed, single conductor cables could be routed to a weather head and into conduit and then into the building and to the PV disconnect switch. Another alternative is to route the single conductor cables to a junction box where the cables can be spliced to a jacketed, multiple conductor cable like NM (Romex) or UF (Underground Feeder). These jacketed cables must then be installed with the required physical protection, and routed to the disconnect switch. NM cable, of course, can only be installed in indoor locations. UF cable has sunlight resistance and, with appropriate protection from physical damage, can be installed in outdoor locations.

Tray Cable (TC) is generally marked sunlight resistant. Some inspectors object to its use based on the NEC requirement in Section 340-4 that it is mechanically supported by a cable tray or other means. Section 340-5 prohibits the use of tray cable as open cable on brackets or cleats.

Temperature Derating

Modules in direct sunlight can get significantly hotter than

ambient air temperatures. The backs of the modules, the module junction boxes, and other nearby areas where the conductors must operate can have temperatures as high as 65°C to 75°C. The ampacity of the cables used to connect the modules must be derated for these higher temperatures.

After determining the temperature ratings of the module terminals (75°C or 90°C — marked on the back of UL-listed modules or from the manufacturer), the appropriate temperature derating factor can be selected from Table 310-16 or 310-17 in the NEC. Cable with 90°C insulation must use a 75°C conductor rating for the ampacity calculations, if the terminals are rated for only 75°C. The temperature derating must then be applied to this ampacity. Most installations should use a temperature of 65°C to derate the conductors. In hot locations, with no ventilation provided for the back of the modules (e.g. mounted directly on a roof), a 75°C temperature should be used.

An Example

A particular PV module has junction box terminals rated at 75°C. Single conductor, number 10 AWG USE cable has been ordered with XLPE, RHW-2, and UL markings which indicate a 90°C temperature rating. The modules are mounted on a rack on a brown shingled roof, but for esthetic reasons, the spacing is only two inches. The wiring is to be in free air (not in conduit) so Table 310-17 in the NEC may be used. In this table, the 75°C temperature rating of the conductor must be used because the module terminals are rated at this temperature. If the 90°C rating was used, which matches the USE/RHH wire temperature rating, then the module terminals would operate at a higher than designed temperature and/or current.

According to Table 310-17, number 10 AWG cable with 75°C insulation has an ampacity (current carrying capacity) of 50 Amps at ambient temperatures of 30°C. A footnote to the table states that number 10 AWG conductors must not have an overcurrent device rated at more than 30 Amps. Because the modules have little ventilation space and the roof is brown, the area between the modules and the roof and in the module junction boxes can be expected to be as high as 75°C on hot, sunny days. The ampacity of the conductor must be derated for this temperature, which is the ambient temperature in which the conductors operate. Ampacity Correction Factors are presented in the lower section of Table 310-17. For conductors rated at 75°C, there is no correction factor because a 75°C cable operating at 75°C has no ability to carry current. Back to the drawing board.

If the modules were spaced six or more inches from the roof, the maximum operating temperature would drop to about 65°C on hot, sunny days. In this case, the derating factor is 0.33 which, when multiplied by the 50 Amp rating of the cable at 30°C, gives a derated ampacity of 16.5 Amps.

Furthermore, Section 690-8 requires that a 25% safety factor be used when sizing conductors. This calculation indicates that the maximum short-circuit current that this conductor can handle is 13.2 Amps. The sum of all short-circuit currents for all of the modules connected in parallel on this number 10 AWG USE cable should not exceed 13.2 Amps.

Flexible Cables

The NEC does not address the need for flexible cables for use with tracking module mounts or concentrating PV modules. The highly flexible cables such as rubber-covered SO and SOJ cables described in Article 400 of the NEC are to be used only in portable installations. They may not be used for fixed PV installations. Furthermore, they do not have the necessary temperature derating data that is presented for the more common cable types found in Article 310 of the NEC, and in many cases they may not be sunlight resistant. If flexible cables must be used, UL-listed cables that are type SEOO, SJOO, and SJEOO "hard-service cables", and identified as sunlight resistant, appear to be the most appropriate. The ampacity tables given in Section 400-5 of the NEC derated for temperature, according to Table 310-17, *might* be used to determine the ampacity of these cables. The electrical inspector will have to issue a waiver on the use of these flexible cables in fixed PV installations.

Battery and Inverter Cables

Large conductors such as 2/0–4/0 AWG cables used to connect batteries and inverters are very stiff if made with building wire, such as THHN or USE, with 19 strands of copper. The inspector may require the use of such cable because the NEC requires it to be used in fixed installations and the inspector frequently sees electricians using these stiff cables in standard ac power installations. The NEC also requires that space be allocated for wire bending and connection areas when installing equipment using these large cables. Use of these cables requires the proper tools to deal with the stiffness, which are available from electrical supply houses.

Most PV installers use either battery cable (controlled by SAE Standards) or welding cable for the larger cables. These cables have numerous small strands that provide a

degree of flexibility not found in more rigid building cables. Stand-alone inverters and large battery cells are being manufactured with flexible cables attached, but these products are generally designed for mobile applications or industrial applications, which do not fall under the NEC. The flexibility makes for ease of installation, but the NEC (in the same manner as outlined for flexible cables) does not make definite provisions for their use in fixed installations. If the flexible cables are used, they should be UL-listed and acid resistant, and installed in conduit. Flexible, Type W single conductor cables are available and identified for extra hard usage, but they still fall under Article 400 of the NEC.

There are restrictions in Section 400-8 that prohibit flexible cables from being run through walls or attached to building surfaces. Section 400-10 of the NEC also requires that strain relief be used wherever flexible cables are connected. This would indicate that if the inspector approves their use, it will most likely be for short runs to a nearby junction box where the flexible cables are connected to a standard, stiff cable.

Manufacturers of inverters and large battery cells might also consider the use of junction boxes and terminals that allow the use of the more rigid standard building cables. Underwriters Laboratories will address the cable and cable termination requirements as the standards are developed for the inverters and battery systems used in residential and commercial systems falling under the NEC.

Summary

Cables are available that can be used for PV installations. In some cases, waivers by the electrical inspector may be required. In other instances, new (to the PV installer) installation techniques may have to be used to deal with the existing, required cables.

Access

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National Electrical Code - 1990, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269

Underwriters Laboratories, 333 Pfingsten Road, Northbrook, IL 60062

Electricity for the Absolute Beginner

Chris Greacen

In *Home Power* articles, volts and amps are everyday words. Circuit schematics are nearly as common as photos. If these are mysteries to you, here are some conceptual tools to see how all this electricity stuff fits together.

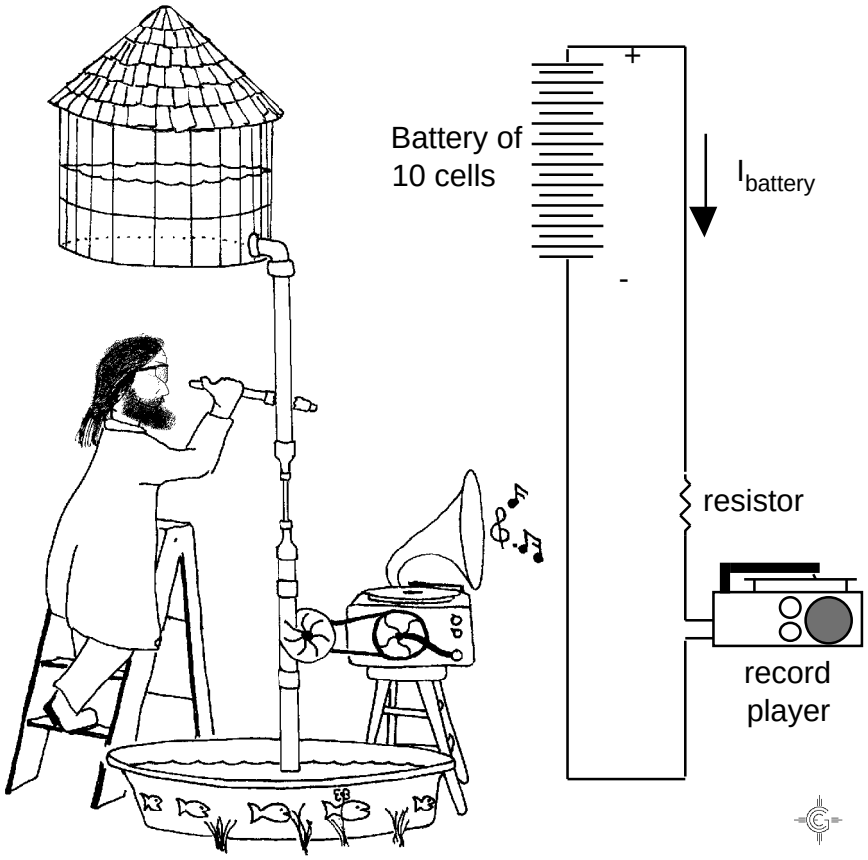


Fig. 1: Right: a schematic of a series electrical circuit powering a record player. Left: Dr. Klüge puts the final touches on an analagous plumbing "circuit".

So what is electricity anyway? If you've ever been shocked by a live wire or static electricity, you've had about the most direct experience of electricity of anyone. Beyond this, no one really knows what electricity is. On the other hand, we do know a lot of ways to make electricity, and even more ways to use it. All of these involve circuits.

Electrical Current ~ Water Current

A good way to think about electricity flowing in a circuit is to think of water in plumbing. Water flows through pipes. Electrical current flows in wires. A water current is a flow of water molecules; an electrical current is a flow of electrons. Pipes and wires can both be connected together into networks. Figure 1 above shows a schematic of an electrical circuit that uses a battery to power a record player. To the left is Dr. Klüge's plumbing "circuit", which uses water to do the same thing.

Voltage ~ Pressure

Electricity for this circuit comes from a battery. In the plumbing network, water under pressure is supplied by the storage tank. The higher the storage tank is placed above the rest of the plumbing "circuit", the greater the water pressure in the pipes. In the electrical circuit the analogue for pressure is the voltage. Voltage is raised by adding more cells to the battery.

Resistance

In the plumbing case the water flows out of the storage tank and through a very narrow (small inner diameter) section of pipe. A narrow pipe presents more resistance to water flowing than a larger pipe. Thick copper wires carry lots of electricity easily, while thinner wires resist the flow of electricity. The property of an object to resist the flow of electrical current is called resistance. A resistor is an electrical part which has a known (usually large) resistance.

Water loses pressure if it flows though a pipe, and loses more if the pipe is narrow. Water loses pressure in the process of powering a turbine. The same thing happens with electricity. If a current flows through something with electrical resistance, then the voltage is reduced.

Mathematically: V = IR; the voltage drop (V) is equal to the current (I) times the resistance (R). This is called Ohm's law, and is used everywhere.

Frequently, resistance is not desired. With this in mind, electrical people take care to use big enough wires and make good connections between wires. Bad connections and corroded connections have high resistance.

The record player itself has resistance, just as Dr. Klüge's turbine powering the old phonograph resists the flow of water more than if it weren't there. Even the battery has a resistance, but don't worry about it if it hurts your head. Let's assume the wiring and the battery have negligible resistance.

Kirchhoff's Laws

How much current flows in the circuit? Two laws discovered by Gustav Kirchhoff in the mid-1800s are the only tools we need. The first seems so silly it's surprising that it gets a name.

Kirchhoff's Law #1: At any point the current going in must equal the current going out.

Think about this in plumbing terms: If water flows in the top part of the pipe, it will flow out the bottom part too. In plumbing there might be a delay as water fills up an empty pipe. There is no delay (actually a negligible delay that moves at the speed of light) for electricity. The wire is always "full" of electrons. The important part here is that current is not lost in the circuit. Voltage is lost, but never current. Every electron that starts the circuit finishes it.

Figure 1 is a series circuit, meaning the components follow each other in a series, one after another, like the links on a chain. In this series circuit there are only three components: the battery, the resistor, and the record player (analagous to the storage tank, the thin pipe, and the record player). For a series circuit, Kirchhoff's law tells us even more: that the current at any point in the circuit must be equal to the current at every other point. Digest this point for a second; find out why this is true.

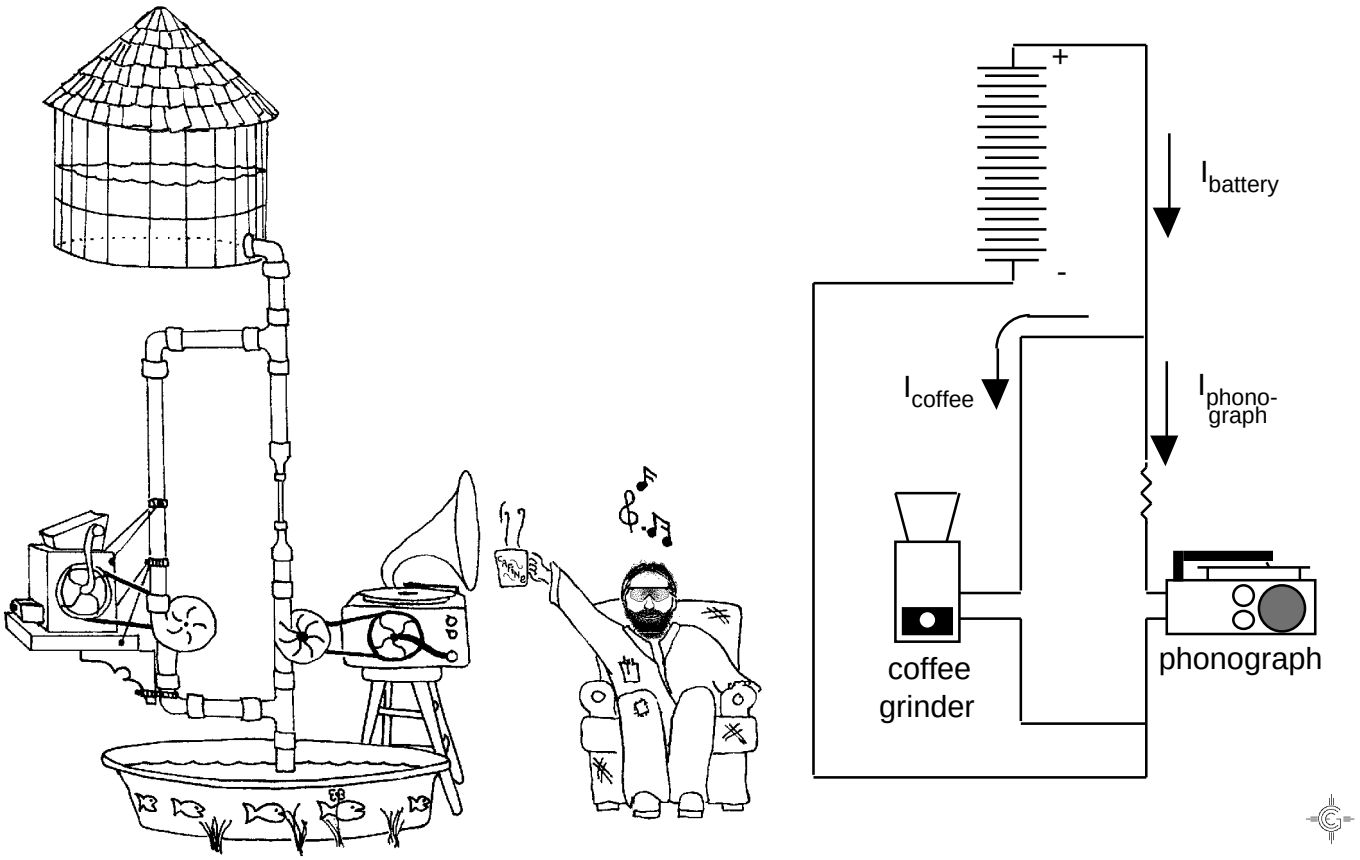


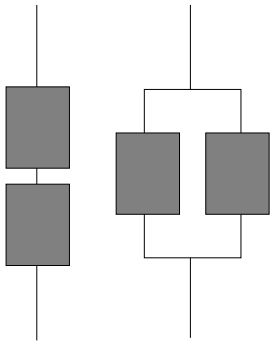
Figure 2: The parallel circuit provides Dr. Klüge with fresh ground coffee and music at the same time.

Kirchhoff's Law #2: For any closed circuit, the total voltage drop across all the components is equal to the voltage of the power source.

Remember Ohm's Law: when current flows though a component, there's a voltage drop across that component equal to the current times the resistance of the component. Kirchhoff's Law #2 says that the battery will supply more and more current until the sum of the voltage drops across the components is equal to the battery voltage; and it will sustain current at this level until the resistance of the circuit or the voltage of the battery changes. A bit of nomenclature here: the voltage of the power source is often called the electromotive force (emf) designated by the letter "E".

A Parallel Circuit

In order to enjoy a cup of fresh ground coffee while he listens to his phonograph, Dr. Klüge adds a coffee grinder to the circuit. The grinder takes more current than the phonograph. If Klüge put the grinder in series, its current would be restricted by the phonograph turbine and the bit of narrow pipe. The doctor decides to install a parallel circuit to bypass these components (see Figure 2).



Series Parallel

The Electrons Aren't Confused!

The current in the circuit now has a choice: go left to the coffee grinder, or right to the old series circuit. In the electric circuit, Kirchhoff's first law has a slightly deeper meaning if we choose the intersection as our point to inspect. Current-in equals current-out, and here current-out is current in the coffee loop plus current in the phonograph loop. $I_{battery} = I_{coffee} + I_{phonograph}$.

Kirchhoff's second law says that the voltage drop in each conductor equals the battery voltage. In the phonograph loop the same amount of current will flow as before. The resistance of this part of the circuit hasn't changed, and it is resistance that governs how much current flows. Electrons who choose this path will have it just as easy as before. But there will also be an alternate route — through the coffee grinder loop. In the coffee grinder loop the battery pushes current to maintain a voltage drop across the coffee grinder equal to the battery voltage. It's the same scenario as in the phonograph loop, only here the resistance is probably different (lets say it's less — Klüge has a powerful coffee grinder). Lower resistance means more current will flow so that I_{coffee} times R_{coffee} equals $V_{battery}$.

In this way, figure out the current in each loop separately, then add them up to get the total current, just like you would do for water flowing in parallel pipes.

Limitations of the Plumbing Analogy

You'll find the plumbing analogy for circuits is far from perfect. For one thing, water sometimes leaks, electricity doesn't. In the plumbing klüge, water flows from storage tank down to a kiddie pool. Electrical current only flows if the circuit is closed — if the "bottom" of the circuit is hooked to the battery negative

Bag O' Tools

There you have it. These tools will allow you to find the current in all parts of any direct current circuit. There's a lot of information packed into this article, and it will take a while to get comfortable with it if you've never seen this stuff before. To summarize: 1) every electron that starts the circuit finishes it; and 2) the charging source supplies more and more current until the voltage drop across the circuit equals the EMF.

The best way to get a feeling for voltage in circuits is to get a volt meter and start measuring. As long as you stay away from household currents (110 ac or higher) and you keep the meter in voltmeter mode, you've got little to fear.

Access:

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For What It's Worth: a Renewable Energy Parable

Mick Sagrillo

Once upon a time, there was a fellow in need of a wind/PV hybrid system. He contacted his local renewable energy dealer to discuss his needs and size his system. Over the course of a dozen long distance phone calls, the dealer gathered all the necessary data and put together a complete package for his client. The package, consisting of wind generator and tower, PV array and tracker, inverter, battery bank, and standby generator, totaled almost $9000.

The dealer, figuring that he would also be installing and maintaining this system, decided to split the retail mark-up with the client. He knew he could make some money on the sale of the equipment and some money on the installation. The dealer offered the client a $700 discount on the entire package. This brought the package down to $8300. The dealer then offered to do the installation for what appeared to be a very reasonable price. The client accepted the installation, too. He was very happy with the package deal.

On a whim, however, the fellow called a "renewable energy department store", you know, the ones who sell everything from major pieces of equipment to solar key rings. The fellow explained all of the specifications of the package that was put together by the dealer, including the price quoted. The man at the RE department store commented on what a good deal the fellow was getting. He then offered the fellow the same package, but priced $50 less than what was quoted by the local dealer. The only stipulation was that the fellow had to accept the offer before hanging up the phone. The fellow, seeing a small but additional savings, took the bait. Four weeks later, all of the equipment was delivered to the client.

Now the fellow had no idea how to properly install the system, so he called the local dealer back and explained the situation. He offered the installation to the dealer, but said that he only expected to pay the installation costs from the original price quote. The dealer balked. From his perspective, the dealer had already done a great deal of work for an apparently unappreciative client. He had developed the package price thinking that he would be doing the installation as well as making the equipment sale. But with the equipment already bought, he would be losing money on the installation. The cream, he thought, had been skimmed. He felt that he had been somewhat burned in the deal, and was not interested in being taken advantage of again. The dealer declined the offer to do the installation at the original price.

Angry at having the dealer refuse to do the installation at the original price and not willing to pay the real cost of the installation, the fellow told the dealer that he would find someone else to install the system, or do it himself. The fellow tried to get others to install the system for what was originally quoted by the dealer, but was repeatedly turned down. Two years later, all of the equipment is still in the original crates.

So, what can be gleaned from this story? Mistakes were made by both the dealer and the client. Let's take a look at those mistakes and their "why's".

The Dealer

The dealer painted himself into a corner by quoting prices as he did. He assumed that he would land both deals, the sale of the equipment as well as the installation. I have a sign above my desk that "assumption is the mother of all screw-ups." In retrospect, that sign has serve me well many times. Dealers must never take customers or their needs for granted.

What the dealer should have done was quote three prices, not two. Quoting separate prices on the equipment and on the installation, followed by a significantly discounted installed system price would have left no doubt in the client's mind as to where the money could be saved. If the client decided to buy the equipment somewhere else and hire the dealer for the installation only, the dealer would still be covered for his time and effort. If the dealer felt that he should be compensated for his time in designing and sizing the system, then he should have specified that to the client up front. These choices should belong to the client, not the dealer. I never liked playing "mystery speed limit" or enjoyed getting hit

with surprise bills. Why should my customers be treated differently than I want to be treated?!

The Customer

The major mistake that the customer made was to underrate the value of his local dealer. The large "RE department stores" may be able to offer great prices sometimes, but they will never replace the local dealer. Local dealers not only sell and install equipment, but they offer something far more valuable to the customer: their expertise and their service. They sell, install, do maintenance, troubleshoot, and answer question. But most importantly, they are readily available and are close at hand. The "RE department stores" may occasionally offer slightly better prices, but they cannot offer the helping hand of the local dealer that comes only with years of experience working in the field.

Some system owners do not need a local dealer. They are fully capable of installing and maintaining their own renewable energy systems. Many of these folks even evolve into renewable energy dealers, but occasionally even they need to kick ideas around with someone who has been around the block a few times.

Some customers try to bypass the local dealer and buy directly from the manufacturer. Most manufacturers will sell directly to end users. However, no money is saved by purchasing equipment from a manufacturer rather than through a dealer. Manufacturers would rather not deal directly with the public, answering detailed questions or troubleshooting over the telephone. This is why they have developed a dealer network in the first place. Dealers almost always have better access to the manufacturer than an end-user for answers to those tough questions.

The Relationship

Customers and dealers need each other. A dealer needs customers: access to manufacturers, expertise, and experience are worthless without clients that need these things.

But customers need the dealers, too. Their product is not just hardware, but also the expertise and service that comes from years of experience. Hardware is worthless without the knowledge of how to install it, make it function properly, and keep it working for many years into the future. Dealers have invested hard-earned dollars in tools and equipment. They have considerable sweat equity built up from the "college of hard knocks." Most are very small businesses, sole proprietorships or family-run businesses. Just like a mechanic or furnace repairer or even the customer, they have a right to earn a living, too. Customers should not expect dealers to spend long hours on the phone out of the goodness of their heart explaining how to install some piece of equipment that was not even purchased from them.

We're all in renewable energy together, customers and dealers. The dealer should not be interested in getting rich from every sale or installation. First, it's not fair to the customer, and second, you'll soon drive away all of your prospective clients. Put yourself in your customer's shoes. They want the best value for their dollar and, as a good businessperson, it's your responsibility to give it to them.

The customer, on the other hand, should not try to squeeze the dealer for every last penny. Our customer may have saved $50 on an $8300 order (which, by the way, was only 0.6%!!!), but he wasted $8250 on equipment that was never installed. Again, and I can't emphasize this enough, dealers have a right to earn a living, just as you do. Put yourself in the dealer's position. What you do if your boss treated you that way?!

I recently saw a sign on a repair truck that read, "The bitterness of a poor installation or repair remains long after the sweetness of low price is forgotten." That's a good moral to the opening story.

Access

Author: Mick Sagrillo deals AND consumes at Lake Michigan Wind & Sun, E3971 Bluebird Rd., Forestville, WI 54213 • 414-837-2267

Getting into Hot Water

Therese Peffer

I first learned about thermosiphon solar hot water systems several months ago, and the whole concept really piqued my interest. What a simple and clever system! I found a simple plan to build such a system in Renewables are Ready, a pamphlet with Renewable Energy projects for Junior and Senior High Schools, and I decided to try it.

I learned in grammar school that hot air rises. Hot water rises, too. In a tank full of water, the warmest water will be at the top, while the cold water sinks to the bottom. In a thermosiphon solar hot water system, the solar collector sits below the storage tank, so as the water warms, it rises and enters the tank. Since it is a siphon system, this pulls cold water at the bottom of the tank down to the collector.

Materials and Tools

The materials are quite simple:

- a shallow rectangular cardboard box (I noted that photovoltaic module boxes would work quite nicely!). The booklet says “at least 45 x 30 cm (18 x 12 inches), no higher than 10 cm (4 inches).”
- approximately 3 meters (10 feet) of plastic tubing, approximately 2 mm thick and 1.2 cm (0.5 inch) in diameter
- black paint and a brush (I used spray paint)
- a bucket that holds at least 2 gallons of water
- a thermometer
- plastic wrap, glass, or Plexiglas the same size or larger than the box
- aluminum foil
- extra cardboard
- tape

Tools needed: knife or razor blade to cut cardboard. We also used a glass cutter, but is not necessary if you use plastic wrap or get glass to fit.

Making the Collector

Amanda Potter, a new member of the HP crew, and I found a shallow corrugated cardboard box, approximately 20 x 30 x 4 inches. Luckily we had a piece of glass (1/8 inch thick plate glass) that was just a couple inches too big in one dimension. We cut the glass to the proper size. We had enough corrugated cardboard around that we decided to insulate the box. We used my Swiss army knife to cut cardboard and taped 3 layers of double thickness cardboard to the bottom and sides.

The next step was to glue aluminum foil on the inside of the box and paint the box black inside. At first I just painted the box black inside, but after talking with Richard, I realized that the aluminum foil acts as a radiant barrier to prevent heat escape. I mixed Elmer’s white glue with water (the 1:1 mixture is easier to spread and doesn’t dry as fast) and glued aluminum foil to the bottom of the box, and then spray painted the box black.

The tubing caused the most problems. I had a 16 foot piece of 1/2 inch black plastic tubing that I had bought for irrigating the garden, but never used. It turned out to be too stiff. We cut a small hole through the side of the box towards the bottom and snaked one end of the tube through. Amanda and I tried to loop the tubing back and forth. It kinked in a couple places. We let the plastic tubing warm up in the sun, and used 2 inch pieces of wire to hold the curves into place. I cut a hole in the opposite side of the box near the top and put the other end of the tubing through. Eventually we gave up on this tubing and tried flexible rubber tubing.

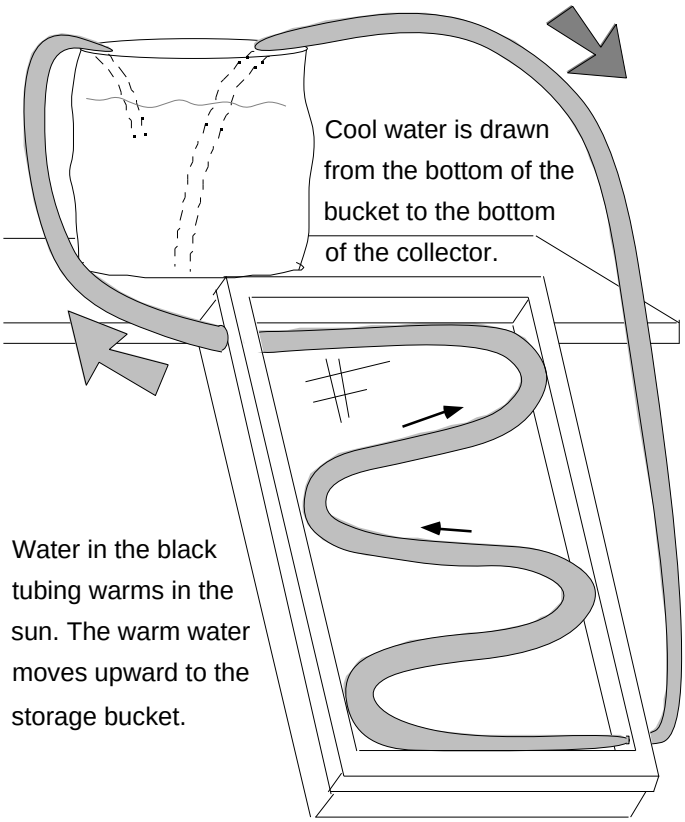
We placed the glass on top of the box. I cut a cardboard frame for the glass and taped this to the sides of the box.

The Storage Tank

We wrapped newspaper and bubblewrap around the sides and bottom of a 5 gallon white plastic bucket. Since it did not have a cover, we cut a circle of cardboard for a lid. The directions recommend cutting two holes in the cardboard for the two ends of tubing. I tried that, but found it easier to tape the tubing to the sides of the bucket, and cut the edges of the lid to fit around them.

We set the collector at a slant (about 45°); the top of the box was supported by a shelf. As per directions we put the bucket on the shelf “completely above the level of the collector.” We filled the bucket about three-quarters full of water. We stuck the two ends of tubing into the bucket. The end that goes down to the bottom of the box goes down to the bottom of the bucket. The end that comes off the top of the collector sticks just under the surface of the water (see diagram).

A Thermosiphon Solar Water Heater Model



The other problem we had was filling the tubing with water. The directions recommend sucking on the higher end of the tubing. "Make sure there is no air in the pipe when you insert it back in the water." This was the hard part. I tried but couldn't get all the air out the tubing. The thermosiphon did not work very well, at first, although the tube coming from the top of the collector was much warmer than the tube going to the bottom of the collector.

I finally took the garden hose and filled the tubing under water in the bucket. Then it worked great! The temperature of the water went from 65°F to 85°F in two hours, and climbed to 105°F when checked about two hours later.

So What Next?

I'm already thinking about changes. I don't recommend rubber tubing. When I mouth-siphoned the water through the rubber tubing, it tasted absolutely horrible! I imagine there are other types of plastic or vinyl tubing that I could paint black. I'd like to try making a larger collector with more tubing to increase the water temperature. I wonder if reflectors, like those on a solar cooker, would help increase the temperature. I could try using thicker glass or use two layers of glass.

This project is not meant to serve all my hot water needs, but to learn about thermosiphoning solar water heaters. I use the hot water for dishes, and it supplements our 5 gallon solar shower. But I learned a lot. I'm anxious to see how it works in the winter time!

On the Home Front

Part of the work going on at HP Central includes redoing the kitchen. We needed to replace the 1960 propane range that had served Karen and Richard for 12 years, but was showing its age.

We looked around for propane ranges (we'd like to convert to hydrogen eventually). Sealed burners are so much easier to clean, but these come with the fancy models with clocks and buzzers. We didn't want any phantom loads—our term for appliances, such as my radio/cassette player, which draw a small amount of electricity when plugged into an outlet, even when off. We brought home a Magic Chef range with sealed burners, piezoelectric ignition, and a clock/timer. We figured that we could save electricity by connecting it to a plugstrip (a multi-outlet strip with an on/off switch). That way the range would not draw electricity all the time, but could be turned on when we needed to heat or cook food.

Then someone used the oven while Richard was in the battery room—he measured 600 watts! We discovered a 600 watt glow bar ignition that lights the burner. Then we thought that the glow bar was just used to start the oven, but actually 600 watts is drawn the whole time the oven burner is on! After several phone calls, we discovered that in the state of Oregon, gas appliance dealers cannot sell pilot light ignition systems for gas appliances—the new models are all electronic ignition. The rationale? Because they are more energy efficient!!

So we ended up with a restaurant propane range with pilot light—no sealed burners, but no electricity required. This was a real lesson for us. If you are looking to buy propane appliances, watch out for those with electric power needs!

Access

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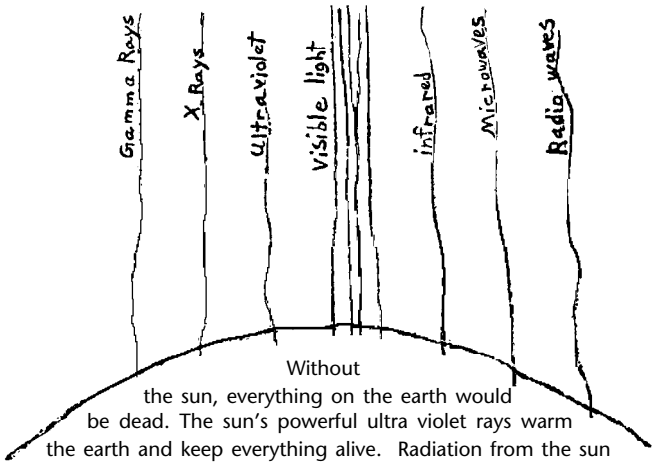
Renewables are Ready: A Guide to Teaching Renewable Energy in Junior and Senior High School Classrooms, available for $10 from the Union of Concerned Scientists, 26 Church Street, Cambridge, MA 02238 • 617-547-5552

Kids Corner

Thanks Todd King & students from Humboldt County, Jennifer, and Allen! Kid's Corner is for you kids—send us your drawings and thoughts about solar, wind, or water energy, or the environment. We'll print as many as we can! –Therese & Crew



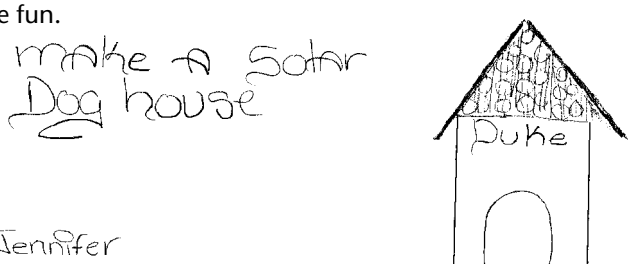
Without the sun, everything on the earth would be dead. The sun's powerful ultra violet rays warm the earth and keep everything alive. Radiation from the sun travels in waves. Seven kinds of radiation waves come from the sun.

SOLAR CONCENTRATORS

My name is Steven Popenoe. I'm eleven and in the fifth grade. I did a science project about solar concentrators for the county science fair. A solar concentrator is a device that collects sunlight and reflects it onto one spot to increase the heat. In my experiment I got four black tubes and left them out in the sun. One was just by itself, one was on top of a piece of tin foil, one was in the middle of a parabolic shaped reflector, and the last one was placed in the center of a funnel shaped reflector.

I put three tablespoons of 60°F water in each tube and left the concentrators out in the sun for half of an hour. After that I put a thermometer in each tube to see how hot the water inside was. The parabolic concentrator and the funnel shaped concentrator got the hottest. The highest temperature was 170° F.

I'm thinking about seeing how hot I can get the water by leaving the concentrators out in the sun for a longer time and measuring the temperature every ten to fifteen minutes. I'd also like to try cooking hot dogs. That might be fun.



Hi! My name is Ethan Fleener. I am 13 years old and in the seventh grade at Big Lagoon School. I live on the north coast of California in a small community. Most of the people in this area are concerned about the environment. For our school science fair, I chose to do a project on solar heating in the home. The reason I did this project is to learn more about solar energy, and to inspire young minds for the future.

Here are some of the highlights of my project—The Sun-Heated House:

Hypothesis: I am doing this experiment to find out which side your house's windows should be on in order to get the most heat from the sun. If your windows are facing in the direction in which they will get heated the most by the sun, you will be using solar energy instead of wasting electricity. The sun won't run out for a long time, but coal and fossil fuels will.

I started building the miniature sun-heated house. I then tested it by facing it north, east, south, and west. Then I was ready to type my data and other information.

By using my experiment you and millions of other people, can help stop pollution by using energy from the sun, instead of burning coal or fossil fuels for heating.

I am glad I did this project. I hope some day my dreams about saving the earth will be fulfilled.

❋ ❋ ❋ SEER '92 by Allen Schultze ❋ ❋ ❋

Willits is a great place to go. And for 3 magical days in August the Largest Solar Fair in the World is held. This solar capital is the most awesomest place with its spaceage looking solar, hydrogen and battery powered cars and nifty crafty and spendy booths.

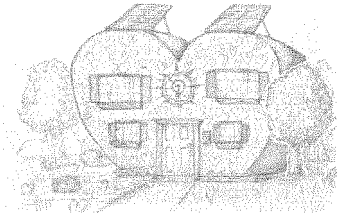
At SEER this year was band that played Rock & Roll at night along with plenty of day activities such as workshops like Rammed Earth, showing how to make cement out of dirts and clays. Then there were Hydro, Solar, and Wind power conferences in the Boy Scout building. Another cool thing was they had daily performances for kids like a juggler and kids folk songs.

They had food stands with vegeburgers and Shave ice and all the way down to Sushi, lemonade and fruit yogurt, Ice-cream bars. A country and western radio station was there giving away two tickets to an Oakland A's game and two tickets to Sea World. There was also two Electric Scooters raffled off along with a few mountain bikes. There was a solar cooking contest where people sent in instructions on how to build them, and some models came out in the finals.

There were major businesses such a Real Goods, Power Star inverters, Trace inverters, and SES and many more.

I would like to thank the whole staff of SEER'92.

Home & Heart



Kathleen Jarschke-Schultze

SEER Surprise

While at SEER '92 I had the pleasure of meeting Amy Shadwell. She uses a solar oven to help her create beads, pins, earrings and barrettes from a polymer material called FIMO. She works the vivid hues into amazing flowers and incredible beads. She was at a party when a friend of hers set the FIMO down on the table in front of her and said, "Here, this will set you free. You can make it at home and you can sell your art."

That was two years ago, and time has proved her friend right. She worked with the material about two weeks trying to maintain the low temperatures needed in her kitchen stove. Then she found all she needed to do was to place the pieces in a box out in the sun and place a piece of glass over it. It worked perfectly. She now owns and operates Skywater Ridge Beaderyie, Box 184, Redway, CA 95560.

Appropriate Appliances

I recently received a letter from Larisa Walk (and here I apologize for spelling her name wrong in issue #29). She suggested an article on antique hand powered kitchen tools and their modern counterparts. She uses a few all the time and is always on the lookout for more at junk shops. She has an old hand cranked pea sheller that shells pods as fast as she can shove them into it. It also converts to a bean frencher which she uses to cut up beans for dehydrating.

I have a Moulinex hand grater that I use for dry cheeses and chocolate. It must be fifty years old but the design is very clever. It can be changed for right or left handed use, is easily cleaned and will last forever. I think it had other sized grating wheels at one time, but when I bought it for 25¢ at a flea market it only had one wheel.

As for modern tools, Larisa uses a steam juicer and steam canner. When she makes tomato juice with the steam juicer, she puts the pulp through a Victorio strainer and has a thick sauce that needs no cooking down. This saves her hours of hot kitchen work. I have a Squeezo hand cranked strainer that is immensely helpful when making apple butter or tomato sauce.

Larisa also uses a cone shredder. They are hand cranked and come with different cutter cones. She told me she had used a Vegematic that she got for a dollar at a rummage sale. After hearing this, I have been looking for one. She says it is great for cutting up veggies for dehydrating or making sliced pickles.

I'd like to hear about other appliances that use no electricity but can ease the work of homemaking. Probably all our modern electric devices had some earlier counterpart that was used in the home.

Applied Appliances

While attending MREF, I was asked if I had ever heard of a bicycle powered grinding machine. A woman wanted to grind soybeans to make tofu. Well, I have not heard of one, but this certainly got me thinking. Then at SEER, I saw George Hagerman's bicycle generator make electrical power. I asked him about a power take off (PTO) bike-grinder. He was confident that the end result could be achieved by the right use of belts and gears. I am looking for a used Corona mill to convert. We have one, but Bob-O grinds the morning's coffee beans in it and would frown on any experimentation that would deprive him of it. More on this later.

Water Wishing

We were intrigued by Stu Ward's 1 pint flush toilet (see HP #30). One of Bob-O's customers ordered two for his new house and this gave us the impetus to order one for ourselves—this and the fact that water is at a premium in our neighborhood. The creek dried up long ago and our spring is down to a trickle. I have started doing laundry in town and watering perennials with dishwater. This is the seventh year of drought in this area of the country and it is worse each year.

We received the Sealand 510 Traveler model. It can be used with composting toilets, as the customer will do, or with septic systems, as we will do, or in an RV or trailer. It is a "trap door" set up, and reminds me of the toilets on a train. We were afraid one pint of water wouldn't flush all the way to the septic tank. The lever you step on to flush the toilet can also be raised with your foot to add as much water as you want or need. We have been using the Sealand for a month now and it has performed flawlessly. The savings in water is admirable. Instead of five gallons every time we flush, we use only one pint to one quart.

It took a little while to get used to the look of the thing. There is no holding tank on the back so it looks very small. The 510 model is slightly smaller than a regular toilet whereas the 910 model is the same size. Both models are made of china so they don't seem shoddy or

temporary. I am used to it now, so I don't notice it except for having to find another place for the silk flower arrangement that used to sit on the holding tank.

Sun Mar, the manufacturer, recommends 2 gallons per minute for the rim and bowl wash to work properly. This has not been a problem for us. There is an option I am considering. You can retrofit either the 910 or the 510 with an optional hand spray attachment. This attachment allows the user to better direct and control the flow of water into the bowl under varying water pressures. It looks like one of those hand sprayers that come with some sinks and attaches to a holder on the side of the toilet.

There was a nice owner's manual that came with it. It has an exploded view to identify parts (I really like that) and a troubleshooting guide. Most toilet manufacturers aren't so accommodating.

Co-op Conundrum
I received a fax from Stu Fleischhaker of the Speerville Mill Co-op in Quebec. Stu feels that food co-ops are a good idea and give one a semblance of control over their food. However, in the same way that home power people use alternative energy sources as a means to reduce their use of fossil fuels, he feels the co-ops need to be responsible for the energy requirements of what they sell.

Just the FAX
He states, "The average distance food travels before it reaches us these days is around 1500 miles. Given that the average transport truck gets 5–6 miles per gallon, and 30% of the trucks on the road carry food, this should be of concern to us all. Food co-ops could be part of the solution if the priority is not just *cheap* food, but include a higher level of consciousness about where our food comes from.

"As we strive to return to some semblance of harmony with the earth, growing our own food is obviously the highest priority. Food co-ops could be the way to extend our self-reliance and earth consciousness further to foods we do not grow. The fact that they usually are not is a failure. I'm not sure if it's a failure of the process or one of consciousness. My recommendation: take control and educate yourselves on where the food you are not connected to comes from.

"There are potential issues surrounding most anything we purchase when we give over responsibility to some organization or company. Much harm has already been done to this planet by 'unconscious consumption'. Although it may not be possible for everyone to take personal care for every transaction, we should learn to be aware of as many as we can, and to recognize that when we disconnect from our actions, the results can be devastating. In something as important as food and its effect on the earth—it becomes critical."

Food for Thought
This started me thinking. How much energy is used to transport and process our food—imported, domestic, processed, unprocessed, or homegrown? Is the energy supplied by renewable energy sources, human or animal energy, or plant and fossil fuels? How much does a cookie cost in energy spent? I wonder.

Access
Kathleen Jarschke-Schultze, c/o Home Power, POB 520, Ashland, OR 97520 • 916-475-3401

Everything has an end but a sausage has two.
Check you mailing label!

HAPPENINGS

NATIONAL

Sun Day 1992 – Public Citizen and nearly 200 citizen groups (including Midwest RE Assoc., Great Lakes RE Assoc., Redwood Alliance, & just about every RE Assoc. and environmental group you can think of), businesses (including Jordan College, Snowbelt Solar, Lake MI Wind & Sun, Integral Energy, Solsource & *Home Power*), government officials and others are sponsoring SUN DAY 1992: A Campaign for a Sustainable Energy Future. SUN DAY advocates a national energy policy that, at a minimum, reduces the total energy use by 10 percent and triples the current contribution of renewable energy (RE) technologies by the year 2010. SUN DAY sponsored Earth Day renewable energy events throughout the U.S. on April 22, 1992. The focus of SUN DAY 1992's sponsors will be developing local and state-level coalitions to advocate for policies supportive of SUN DAY 1992's goals. Participating organizations will provide information, encourage model programs, lobby for RE friendly legislation, hold conferences, and distribute information to grammar schools, high schools, and colleges. For more information contact: Public Citizen, attn. SUN DAY 1992, 215 Pennsylvania Ave SE, Washington, DC 20003 • 202-546-4996

The Union of Concerned Scientists (UCS) has announced a year-long campaign to change the public perception of solar power, wind power, and other renewable energy sources. UCS will help interested people to plan and carry out educational activities and political actions that promote greater use of renewable energy. Although the public likes the idea of using renewable energy most people, including industry leaders, utility planners, and government officials, think of renewables as futuristic, backyard novelties. In actuality, RE technologies could provide a much greater share of the nation's energy supply. However, current energy policies have prevented renewables from penetrating energy markets in a significant way.

Public education will be a major focus of the "Renewables are Ready" campaign. UCS activists will also focus attention on policy-makers and work on changing the regulatory climate to encourage the growth of renewables. A set of eight posters is available covering solar architecture, electricity from renewables, and alternative-fuel vehicles. All 8 posters sell for $14 plus 20% shipping. For more information, contact the Union of Concerned Scientists, 26 Church St., Cambridge, MA 02238 • 617-547-5552

Electric Vehicle Safety Survey: In order to establish meaningful standards, the Electric Vehicle Industry Assoc. is seeking data on the safety of EVs already in actual use. Anyone who has had any experience with EV accidents is invited to share their information. The survey takes 10 minutes to complete. Final data will be made available for publication. To participate, contact Shari Prange, Electro Automotive, POB 1113, Felton, CA 95018-1113 • 408-429-1989

Renewable Energies/Conservation Directory will be a listing of folks who have implemented conservation and renewables in their homes, and are willing to share their stories with others and at the same time help answer individual questions. Categories: 1) USERS: those employing a particular technology; 2) Providers: businesses who deal in renewables/conservation. Providers will be charged $25 to defray the cost of the directory; 3) Networkers: users or aspiring users interested in getting together to knock a few ideas around; 4) Homegrowns: those who are using a renewable system that they have built from scratch; 5) Owner-installed: those who purchased a system but installed it themselves; 6) Educators: those who know enough about a topic that they are willing to share their knowledge in a lecture, slide presentation, or forum with school or community groups (this is a most needed category!). If you're interested, send your name and address (phone optional) and category(s) to Julie Weier, Midwest Renewable Energy Assoc., POB 249, 116 Cross St., Amherst, WI 54406 • 715-824-5166

Elfin Permaculture is holding a number of workshops ranging from one day to three weeks in locations around the U.S. and Canada. Contact Cynthia Hemenway, 7781 Lenox Ave., Jacksonville, FL 32221

Audubon Solar Brigade – If you pay an electric bill every month, let them know you'd like to see more utility solar power. The National Audubon Society's (NAS) Solar Brigade is an effort to coordinate a million people nationwide to demand 10% solar in ten years. Send a SASE to the NAS, 950 Third Ave, Dept. AB, New York, NY 10022 or call 212-759-6354 for more information, or to become a Solar Brigade leader. A roving video/slide show and free Audubon Technical Guide on energy efficiency are available by calling 212-546-9195.

The Conservation and Renewable Energy Inquiry and Referral Service (CAREIRS) is offering three free insulation publications. "Insulation" (FS142) discusses the types and forms, and includes a table for determining how much insulation is economical to add for your climate. "Cellulose and Fiberglass Loose-Fill Insulation" (BF1*) and "Wet-Spray Insulation and Similar Products" (EE6*) offer the pluses and minuses of these insulation forms. To receive these publications or others contact CAREIRS, POB 8900, Silver Springs, MD 20907, or call 800-523-2929

CANADA

SW Alberta Renewable Energy Initiative Information Centre – This group provides Canadians with information and workshops on renewable energy. Contact Mary Ellen Jones, Information Centre Manager at POB 2068, Pincher Creek, Alberta, Canada, T0K 1W0

CALIFORNIA

North San Francisco Bay Chapter of the Electric Auto Assoc. (EAA) holds meetings on the second Saturday of each month at the PG&E Business Center, 111 Stony Cir, Santa Rosa, CA from 9:30 AM–Noon. For information on the EAA and the chapter nearest you, send an SASE to 1249 Lane St, Belmont, CA 94002, or call 415-591-6698 (10 to 5 on weekdays).

The American Hydrogen Association's Silicon Valley Chapter is now offering access to a bulletin board system with information on solar cells, hydrolyzers, gensets, windmills, hydropower, ocean thermal energy, converters (OTRCs), bio ponds, thermal cracking and other means of converting solar energy in Hydrogen. Learn about technologies for transporting hydrogen by pipeline, storage of hydrogen as a liquid, a gas, and a hydride, combustion of hydrogen with air and by catalytic burning and how hydrogen is electrochemically combusted to produce electricity within fuel cells. Contact: The American Hydrogen Association – Silicon Valley Chapter Headquarters, 1401 Pointe Claire Ct., Sunnyvale, CA 94087, BBS@408-738-4014 Voice@408-235-1177

The first annual Santa Cruz Solar Art & Bike Earthquake Festival will be held at the Santa Cruz town clocktower on Oct. 17 & 18 from 11:00 AM to 5:30 PM, admission is free. Booth space is limited to 25 art, food, solar and bike units. Parking is not available because of downtown construction except on Sunday, exclusively for electric vehicles. For more information contact James, at 408-454-9610

COLORADO

Solar Home Workshops will be held at the Solar Technology Institute (STI). These workshops are for owner builders and persons seeking careers as solar professionals.

• Micro-Hydro Electric Systems – Oct. 5–8. • Solar Home Design & Construction – Oct. 12–22. • Advanced Passive Solar Design – Oct. 26–Nov. 5. See ad on page 95. For a detailed description of SOLAR HOME PROGRAM WORKSHOPS, costs and scholarship information, write STI, POB 1115, Carbondale, CO 81623-1115 • 303-963-0715

FLORIDA

FSEC Photovoltaic System Design Workshop, Dec. 9–11, 1992 at the Florida Solar Energy Center (FSEC), 300 State Road 401, Cape Canaveral, FL 32920. The registration fee is $300; target audience: solar industry, engineers, government agency reps and interested individuals. Call JoAnn Stirling at 407-783-0300, ext. 116.

The Florida House Foundation is building two model homes incorporating passive solar architecture, energy and water efficient appliances, solar electricity and hot water, and edible landscaping. Contact The Florida House Foundation, POB 21583, Sarasota, FL 34276 • 813-924-6833

IOWA

Iowa Renewable Energy Fair (I-RENEW) presented by the Iowa Renewable Energy Assn., October 17 1992, Cedar Rapids, Iowa. Workshops on wind, PV, solar thermal, biomass, batteries, energy efficiency, farm applications, legislative issues, electric cars, eco-entrepreneuring and more. Working demonstrations of wind, photovoltaics, hydrogen, solar thermal, electric cars, solar cars, and water pumping. Exhibits and vendor booths, music, food and Fun! Contact: Tom Deves, 3863 Short St, Dubuque, IA 52002 • 319-556-4765 or Jim Sievers, 1857 Edgewood Dr NW, Cedar Rapids, IA 52405 • 319-396-6576.

MAINE

Hands-On Workshops will include: solar air heating, solar water heating, solar cookers and ovens, solar electric home, passive architecture, greenhouses and sun spaces, and the immensely popular photovoltaics workshop. The fee for each of these workshops is $25.00, which includes lunch. For information on sites and dates contact Richard Komp, Maine Solar Energy Assoc., RFD Box 751, Addison, ME 04606 • 207-497-2204

MASSACHUSETTS

Solar and Electric Vehicle Symposium (S/EV'92) Boston, October 9–10, 1992, sponsored by the Northeast Sustainable Energy Assoc. (NESEA). "With clean air

legislation currently passed in the Northeast, the EV market is about to explode, and new EV and components for EVs are announced monthly," says Nancy Hazard of NESEA. The S/EV'92 will be a forum for advancing the electric vehicle market, infrastructure, and technology. Interested parties include NESCAUM, Electric Edison Institute, the DOE, GM, Ford, Trojan Batteries, the E.P.A., and Unique Mobility. Call 413-774-6051

NEVADA

Solar Electric Classes in Nevada taught at remote solar home sites. Maximum of four students for two day classes, held on the third weekend in October and November. Classes on weekdays & other weekends upon request, minimum of 2 students; $75 per person. Call 702-645-6571 or write Solar Advantage, 4410 N. Rancho Dr. #418, Las Vegas, NV 89130

OREGON

The Appropriate Technology Group is a grassroots and hands-on group formed to explore how to educate, demonstrate projects, provide a community resource for designers and builders, do experimental projects involving energy, transportation, sewage, hazardous and solid waste, etc. The group meets once a month in Portland, Oregon. For more information call 503-232-9329 (evenings).

TENNESSEE

On October 2–4 1992, The Farm School in Summertown, Tennessee is hosting The Alternatives Fair: energy conservation and economic conversion for the 90's. Educational presentations, product demonstrations, and experts from across the Southeast. Issues covered include sustainable energy practices, least toxic pest management, biodiversity, passive solar design, midwifery, vegetarian nutrition, permaculture, group economics, the impact of chip mills, water testing, and solar electric vehicles. Sponsored by Global Village Institute, Tennessee Solar Assoc., and The Farm School. For registration, camping information, and travel directions, send SASE to Mary Ellen Bowen, 51 The Farm, Summertown, TN 38483. For exhibitor information call 615-385-2123 or 615-964-2637

VERMONT

Sunnyside Solar Workshops are one day workshops on photovoltaic home electric systems: the remaining 1992 dates are: Oct. 3 and Oct. 24. The workshops are limited to 8 persons, fee $95/person. $35 advance registration required. For more info contact: Sunnyside Solar, RD4 Box 808 Green River Rd, Brattleboro, VT 05301 • 802-257-1482.

Good Books

Pocket Ref

Complied by Thomas J. Glover

Reviewed by Chris Greacen

Want to know how many BTUs in a kilowatt-hour? What cement/sand/gravel ratio to use for a waterproof basement wall? Wonder where to look to find what XHHW wire is? Want to know the code for "backspace" for a HP Laserjet printer? How about the area code for Lubbock, Texas? What is the windspeed in a 10 force gale? The length of a 20d nail? How many BTUs in a gallon of propane? What's the specific gravity of oyster shells?

You can find these and about 25,000 benchmark values, codes, and conversion factors in *Pocket Ref* compiled by Thomas J. Glover. Ten dollars is a bit of a hefty price for a 480 page book so small (3.2 inch by 5.4 inch by 0.7 inch), but having this information in one package will quickly save you $10 of your time. The index in the back could use another twenty pages, but it is sufficient enough to find what you need: if the info is in the book, you'll find it. Around Home Power Galactic Central, *Pocket Ref* is the book of choice for on-the-fly calculations. *The CRC Handbook of Chemistry and Physics* now hunkers unused on shelf for all but the most esoteric information. If you ever find yourself needing assorted benchmark engineering information, buy this book and keep it easily accessible.

Access

Pocket Ref compiled by Thomas J. Glover, (ISBN#0-9622359-0-3), Sequoia Publishing Inc., Department 101, P.O. Box 620820, Littleton, CO 80162-0820. This book is available from Real Goods (see ad on page 31 of this issue) or from Forestry Suppliers Inc., 205 Ranklin St., Jackson, MS 39201 • 601-354-3505

Reviewer: Chris Greacen, c/o Home Power, POB 520, Ashland, OR 97520 • 916-475-3179

the Wizard Speaks…

Information Sources

Many of you want to know more about the free energy movement. Here are some sources of information about the theory and technology of free energy devices.

Tesla Book Co., 1580 Magnolia St., Millbrae, CA 94030. A bookstore dedicated generally to the work of Tesla and his successors.

Bedin Electronics, POB 769, San Fernando, CA 91341, 818-367-7762. Books, tapes, and videos on their own work and the work of others in the field.

H & A Industries, Rt. 2 Box E-35, Bowling Green, MO 63334. Books and papers on free energy, alternative energy, and energy savings.

Space Energy Association (SEA), POB 396, Clearwater, FL 34615, 813-442-3923. *Space Energy News Letter*: A quarterly newsletter edited by Donald A. Kelly, $35 annually.

I would like to invite all inventors of free energy devices who feel that they have a working free energy machine to send a prototype to Home Power for testing. Please include all specifications and instructions necessary for the proper testing of your device. Let's get the ball rolling.

To the unknown SEER goer: Thanks for the Cabbage Patch Wizard!

Letters to Home Power

Selected & Entered by
Kathleen Jarschke-Schultze

Tombstone Territory

Dear Home Power; We really appreciate the information in your magazine as well as the inspiration it provides here in the "outback" area of southeastern Arizona. We live in the mountains amongst oak trees, mesquite and manzanita, in an old ghost mining town with only 11 residents — 13 miles of dirt road from Tombstone.

We have been solar freaks for a long time, cooking almost daily with three home-made solar ovens for over 13 years. However we are new to this area and into being totally solar so would like to get in touch with other off-the-grid folks in Cochise County. Ironically enough, although this part of Arizona is a solar paradise, going solar doesn't appear to be that widespread.

We have a 24 Volt system with 4 Solec S-53 panels mounted in a Wattsun tracker, 8 Trojan T-105 batteries, a Trace 2524 inverter and an old Samson windmill to pump our water. The only problem we have had is with the controller or "brains" of the Wattsun tracker which had to be replaced 3 times. The Wattsun folks were very good about sending out the part quickly and even up-graded our "brain." However our experience does make us wonder about the reliability of the Wattsun tracker as we were warned by two different solar experts here about their bad experiences, recommending we go with a Zomeworks tracker.

Right now we are looking for an evaporative cooler to cool our 12 foot by 60 foot trailer house for those few days a year when it gets a little too warm even here at 5,000 feet. You mentioned that you use one at Agate Flat. Are there any energy efficient coolers on the market? Something in between the small, one-room coolers such as Essick-Air or the small 12 V RV Recair and the standard, high volume, large coolers?

Thank you for doing such a good job and for helping us to feel less isolated. Sincerely, Dave Leib and Valerie McCaffrey, Star Route Box 12A, Gleeson, AZ 85610

Thanks for the flowers, Dave and Valerie. Our eight module Wattsun tracker has been running for well over a year now without failure. Check the installation of the tracker, especially the operation of the limit switches. The reports we get from readers indicate that the Wattsun is very reliable, with few failures (yours makes the third reported out of scores of reports). Many "solar experts" are very conservative about new products and prefer to sell what they already have in stock. Wattsun is a new product. Failures are bound to happen with new products. All I ask is that the companies involved make it right by the consumer. I am gratified to hear that Wattsun is taking care of their customers.

We are currently running an 8 module Zomeworks against an 8 module Wattsun against 8 modules static mounted. In about a year we will have some real data about performance. We will publish this data.

The evaporative cooler we use is called "MiniCool" and it does one room OK. Most of the 12 Volt evap coolers are underpowered and won't cool an entire house. Consider replacing the motor in your cooler with a more efficient type. Jim Forgette at Wattevr Works! has been replacing the motors in evap coolers with great success. See his ad in this issue or contact him at POB 207, San Andreas, CA 95249 • 209-754-3627 — Richard

One Circuit at a Time

Dear Home Power; Your magazine is great and performs a service in providing information on AE. I took some elementary steps and converted most of my home's incandescent lighting to fluorescent lighting. Many 75 watt spots got replaced with the Osram EL Series 15 watt replacement. That made a very visible difference in the monthly bill! In just one room alone, the lighting load went from 375 watts to 75 watts. I recommend the Osram EL series to anybody. I have had them about a year now and they provide better lighting than regular yellowish incandescent lights.

The second thing I did was add solar hot water. I was paying $65 per month in propane costs just to heat water! In HP#25, Tom Lane wrote an article on a closed loop DHW system. That seemed just right for Grass Valley as it can freeze in the winter. I called Tom and ordered most of what I needed from him. Tom spent a lot of time on the phone with me and was very helpful. Well, I got the system installed and it has been performing beautifully. I recently had 8 people in the house for Memorial Day weekend, and we had plenty of hot water with everybody taking showers.

Although I am currently grid connected, I read with great interest the article in HP#25 on First Year PV Basics. Your recommendation for us grid-connected folks was to

take a circuit at a time. I thought this was a good idea. I went to the Photocomm folks located here in Grass Valley. I told them I wanted to put my refrigerator on PV. It was one of my larger energy users, and I thought this was a good place to start. The people at Photocomm were taken aback by my request. I was told (and correctly I believe) that it would require a rather large PV system to run my refrigerator (not a SunFrost). I checked the plate on the 'fridge and found out it drew a "nominal" 350 watts. It would draw more during defrost. My thought was to put in a PV system with an inverter that would switch back to grid power if the batteries went low. In this way, I could keep the 'fridge running, and add PV panels as I got the money. It was my feeling that any power I could generate by PVs would be that much less fossil fuel I would consume on the grid!

In addition, I wanted to use nicads as it's my understanding that I could add batteries as time went on since nicads seem to be less fussy than lead-acid batteries. I wanted to install a PV system that was extendable. Am I barking up the wrong tree here?

My proposed system would be a Trace 2024SB, eight Kyocera 50W (approx.) panels, about 200 A-h of nicads, appropriate controller, and instrumentation. I did not want to have to buy parts again as the system grew which is the reason for the rather large inverter. This was to be my beginner system to which I would add PV panels and batteries. Any suggestions?

Thanks again for your work in providing us grid-connected folks with food for thought and providing a great magazine! Sincerely Yours, Jim Gallops, 14838 Christopher's Place, Grass Valley, CA 95945

Hello, Jim. I estimate that putting your current refrigerator on PVs will require a large system, at least 16 modules. This is why we urge grid connected folks to replace their appliances with efficient types before considering putting the appliance on renewable energy. Consider that a comparable Sun Frost will save you the cost of 12 modules (almost $4000), not to mention the enlarged battery required. Your concept of a grid supplied inverter/charger is excellent. The Trace is the best unit for this job because it transfers automatically to the grid when the battery is low, recharges the battery, and then returns to being an inverter. Nicads are the technology for growing battery packs. You can add cells to the battery at any time, whereas you have at most two years to add cells to a lead-acid battery pack. Be sure to get a charge controller with enough current capacity to allow you to expand without replacing the controller. — Richard

Kiwi Concepts

Dear Richard; A brief note from an admiring reader some 6,600 miles to your southwest.

Home Power Magazine is dead-on the target audience; this from an individual with some 15+ years experience creating vertical interest slick, semi-slick and newsletter publications. An excellent job for an obviously expanding, info-hungry marketplace. It does not hurt that you and your family are so enmeshed in the topic matter as well, just as (several decades ago) the founders of Mother Earth News once also were. The core of the interest is well served by pieces such as All Things Connected (HP #28) and by your recognition that each issue brings in new enthusiasts who start off from ground zero excited by, but unprepared for the text (i.e. On Being Confused in your Back to Basics segment HP# 27). The ultimate success of the home power movement, while neither assured nor predictable, will best be nurtured by a continuing/on-going examination of the flaws inherent in a wired grid system, and analysis of the REAL advantages of being your own grid.

As with any non-standard technology, offering problem solutions which do not fit the accepted techniques, you will for some time yet be walking a very thin rail separating those whom society labels "quacks" and those who society accepts as "forward future thinkers". Balancing your editorial viewpoint on the imaginary rail line will be a constant battle you must endure.

With the advantage of physical separation, being a "Yank" living in a country which shares many "Americanisms" but shuns many more, it does occur to me that if Home Power could be faulted (not easily, I assure you) it would be in the area of NIH; i.e. Not Invented Here. Your market is North America of course (not a statement of fact, simply a statement of observation) and the solutions offered to problems and challenges have an American bias. Yet there are technologists throughout the world with elegant solutions peculiar to their own societies or raw materials who have much to offer to the world of home power. In my own reading, correspondence and traveling, I see wonderfully simple, low-cost technology solutions to the very problems you address from Israel to Mother Russia, Japan to the Australian outback. In my amateur radio hobby which has the advantage of instant info exchange on a global basis, we still suffer from the same NIH syndrome; i.e. American amateur press laments problems for years after their solutions have been offered in obscure foreign press. With this sort of worldwide information exchange, one runs the real risk of inventing, reinventing, and re-reinventing the same or a similar

solution over decades in earth time. Not the most efficient system, you would agree.

Such bottlenecks could be widened if not eliminated by adopting a wider stance and encouraging an exchange of data at least on the professional journal level. I have been exploring a similar approach to the assimilation and marriage of data in several fields of interest; the mechanics of routinely surveying all the globe has to offer in a given field, reorganizing that data (into the common language; English) is a task of some magnitude, but do-able.

To a pair of specific questions which initially prompted this unsolicited letter: 1) In HP#28, page 10, the Ciotti's mention the RIFE hydraulic ram. Might you have a company address for Rife? 2) In HP#27, page 53 Things That Work you review the Exeltech SI-250 sine-wave inverter. All you say about inverters vis-a-vis "sensitive" electronic equipment is true of course. What you do not tell me is whether the sine wave from the inverter is accurate to 60 Hertz. And if yes, how accurate short and long term. Reason for asking: Many VCR products, especially in the 3/4" tape size field, reference their frame (video image) timing system to the alternating current field frequency, i.e. 60 Hertz. The timing system which determines how the tape plays back (smoothly or in electronic jerks) must see a +/- 0.1 to 0.2 Hertz accuracy of the 60 Hertz cycle or it will not function. I have been searching for a reasonable-cost solution to playing back (here in New Zealand) 3/4" tapes which were originally mastered in a 60 Hertz world (Kiwi being a 50 Hertz world. Obtaining 120 vac is no problem; 60 Hertz is). Bob Cooper Jr., POB 330, Mangonui, Far North, New Zealand

I agree with your assessment that the success of the home power movement rests on a "continuing or on-going examination of the flaws inherent in a wired grid system, and an analysis of the REAL advantages of being your own grid..." There is lots that can be written about the evils of current large scale electricity generation methods. Perhaps writing about it could win over even more converts to home-sized renewable energy. But already magazines like The Ecologist, World Watch, Third World Resurgence, groups like Greenpeace, and hundreds of recent books have done a good job educating the public about the problems. We think our limited staff, time, and pages in the magazine are best spent talking about the nuts and bolts behind solutions which each of us can do.

On being ignorant of inventions elsewhere: for goodness sake, let us know what's going on in other places! We're serious about increasing our readership in other countries in large part so we can be informed about what they're doing.

Answers to your inquiries: (1) Rife Hydraulic Engine Manufacturing Co., P.O. Box 857 Montgomerville, Pennsylvania 19401 USA • 215-699-8870. Also consider Folk Ram Pumps 2770 White Court, N.E. Conyers, GA 30207 USA • 404-922-4918. (2) The Exeltech 250 maintains 60.0 Hz ± a couple of hundredths of a Hz. This is true of all contemporary, crystal-controlled FET inverters. — Chris

No Ground Required for 50 Volts DC

Dear Home Power: Trying to get useful information out of the National Electric Code book can be tricky. The jargon is a mixture of technical and legal mumbo jumbo. The answer to a simple question can take hours of research as the reader is bounced around the book by referrals from one baffling section to the next.

Many are of the opinion that the Code is composed of Druidic riddles from which only vague, esoteric answers may be gleaned. After many years of study, I no longer believe this to be true. At the bottom of this giant heap of convoluted verbiage appear traceable threads.

Some sections, in fact, jump off the page with such astounding clarity that they seem to violate the basic principle of befuddlement under which the document appears to have been created. The reader may wonder if it is safe to accept straight forward sounding information at face value. Perhaps it is more appropriate to view such statements with suspicion and paranoia.

One area where considerable confusion seems to reside is in the issue of grounding low voltage DC installations. Many believe that it is necessary to ground both the system and circuit to a ground rod, regardless of voltage. This usually means bonding the negative wire to the ground rod. A separate equipment ground would be run with the circuit wires, also bonded to the rod.

This issue is of importance in wind generation systems. Many in the industry report that a grounded circuit wire can damage the reliability of the system.

According to my reading of the NEC, this grounding isn't necessary for two wire DC systems under 50 Volts.

If you thumb through the Code book to Article 250 (B), section 3 (a), you find a remarkably straight forward set of dictates. The passage is in the form of a general rule, with listed exceptions to that rule. Leaving out the non-applicable parts, we can simplify the section as follows.

Article 250 GROUNDING B. Circuit and System Grounding 250-3 Direct Current Systems. (a) Two-Wire Direct Current Systems. Two-wire DC systems supplying premises wiring shall be grounded. Exception #2 A system operating at 50 volts or less between conductors.

In plain English, two wire DC systems need to be grounded unless they operate at 50 Volts or less. If they are kept to 50 Volts, grounding is not required.

In some instances, it is necessary to ground exposed metal on equipment regardless of voltage. This does not require grounding any circuit wiring, only the metal frames of equipment. In this category are motor operated water pumps and a number of cord and plug connected appliances.

Cord and plug connected equipment which need to be grounded include refrigerators, air conditioners, clothes washers and other appliances. The rules differ slightly between residential and non-residential occupancies. Sections 250-45 (c) and (d) give the complete listing. For equipment fastened in place, see section 250-43.

The bottom line appears to be that for a two-wire DC system under 50 Volts, we may float the ground if we want. In some cases an equipment ground is required for conductive metal frames.

This conclusion assumes that the NEC is truly written in English rather than ancient Celtic. It also assumes that there are no secret interpretations lurking in the catacombs which are rumored to underlie the NEC's offices in Batterymarch Park, Quincy, Massachusetts. Thanks, D. Chamberlin, DC Wiring, 12788 New England Rd., Amesville, OH 45711 • 614-448-4894

Downstrike in Stafford

Our system was destroyed by lightning about a year ago. We suffered a $4,500+ loss. There is some question as to where the lightning struck. The telephone interface box on the house was literally disintegrated. Some people feel that the strike came in the telephone line. Some people feel that the tower was the target of the strike, yet I can find no evidence of a hit on the wind AE system. We are rebuilding the system and are very thankful there was no fire damage to our home. Richard D. Smith, 8445 RT 237, Stafford, NY 14143

Sorry to hear about your loss, Richard. Every wire going into a system is a potential path for lightning. The phone companies in our neighborhood install a lightning arrestor at each line termination. There is no sure way to protect a system from lightning damage. All we can do is minimize the probability of a direct strike, or damage caused by a near strike, by properly grounding the towers, arrays, and other equipment. — Richard

Grid Resistance

As a 51 year old former submariner (yes, for real) and electrical engineer who has been living "off the grid" (terms that didn't exist when I started designing the system 17 years ago) I want to caution you about jumping too soon on the "code bandwagon".

At 12–24 Volts your system should easily be thoroughly insulated against any conceivable short circuit. Not a single car starter cable has a fusible link at the battery terminals. Lock or protect the battery room against kids as you would any other hazard. Don't run #00 wires to appliances drawing only 10 Amps. Incidentally, submarine batteries do not have fusible links in the well!

Why does this bother me so much? Because I watch all the hassles for anybody who wants to do something like install a composting toilet for instance.

In fact, now that I've read that last statement, I have to ask you to leave off my name and address!

Pumping up the enthusiasm is great - but standardization ain't here yet. Your AVERAGE county building inspector does not care and he does not want to be educated by you. What he does is tag along behind the grid and anything else he finds gets tagged out.

As for Bob-O telling us that streams are important so go tell someone about your hydro-system, La-La land isn't the word for it! And I did not start off with an "attitude". Too many of us are STILL bareknuckling it with the bureaucrats.

That all sounds like a lot of criticism — you're still doing great — but the AVERAGE person out there still does not believe we're FOR REAL and losing that frontier attitude too soon could lead to some really ridiculous future hassles. Name and Address Withheld by Request

Dear Name and Address Withheld by Request, Being a "Question Authority" kinda guy myself, I can sure appreciate your viewpoints — especially about composting toilets. My county requires a full septic & greywater system to be in place as a "back-up" before allowing a composting toilet to be installed. This in a place that's been parched by a drought for the last 6 years. Makes you wonder who's running the zoo, eh? On the other hand, FOR THE SAKE OF THE PLANET, I'm willing to put up with a lot to see RE go mainstream, for the same reasons that I'll pay a little extra to get recycled paper products, I'll pay a little extra to install safety equipment where it may or may not be totally necessary.

Never mind the inspector, people pay me (and others like me) their hard-earned bucks to install or recommend safe, reliable systems. The words "I'm sorry" just won't cut it to someone looking at the ashes of their home, ya know? Bob-O

Alaskan Assessment

Dear Karen and Richard; Issue #30 was — aw shucks, I"ll say it — just "swell". Yep, it has been a long strange trip. Jenasy and I were sitting around the dining table this morning analyzing our energy prospects for the day..."Well, I can see the mountain waves setting up (lenticular clouds), so we're gonna get a lot more wind than solar"..."OK, so we can do laundry and garden (water pumping) any time..." We both then marvelled at how, unlike our neighbors who are constantly trying to insulate themselves from the vagaries of nature with large generator systems or commercial power, we are literally going with, and getting into, the flow. Most Alaskans are anti-environmentalist because they perceive the environment up here as so harsh that it must be conquered and so vast that it can be plundered with impunity. Our Home Power inspired and guided systems are causing quite a local stir because we are SHOWING that its not necessary to have polluting power production or endless-struggle, environment raping jobs like gold and coal mining, and oil plundering, to live comfortable, healthy, guilt free lives. Meanwhile, Patrick and Zachary are absorbing the message in a way that will maybe even stand up to their future adolescent, hypocrisy-piercing, gaze!

As for price increase: $2.50/issue is fine. Back Home charges this, and in comparison, they have nowhere near the meat; their articles are so "lifestylish", which is better than People Magazine, or The Enquirer (actually, what else would we do in the check-out line?), but nowhere near the value of answering a practical question like, "I wonder if an LCB would help my wind turbine put out more?"

Mike Welch's "Power Politics" article of course doesn't fit the "How-To" mode, but one of these per issue is great. I would like to see some more stuff on hot-water heating how-to. Actual systems that integrate with wood burning stoves, etc. This is our last big energy-hog problem to tackle. The new index format was good and these indices ('though, I imagine, a pain-in-the-ass to compile) are very important, making HP truly a Hands-On manual..

Therese, your Next Generation article was great. Jenasy was very interested and is going to use her school board position and your great references to build up a district-wide alternate energy curriculum. It seems that education and reference are your emerging speciality.

Kathleen, your writing continues to be top-notch and lend an invigorating different creativity. Your use of packing materials and other "junk" is impressive, and redolent of early Mother-Earth-News type innovation, in an otherwise high tech (and inevitably, expensive) field. Your 2+2 Systems article was wonderful. I have shown it to two neighbors who are intimidated by our whiz-bang system, which they could never afford. Your article shows that 90% of the lifestyle improvement comes with the first 10% of the cost. The large catalog type advertisers may not like this message, but what are we trying to do here, anyway? We would like to know your opinion of parabolic reflector-type cookers, such as that shown on Kansas Wind Power ad., HP#30, p. 67. I'm afraid we might need a little more solar concentrating up, here than is possible with the regular cooking box style. Jenasy is enthusiastic about dehydration, because our garden is so bountiful this year.

To The Wizard: Thanks for the good "10% probability" argument. I have incorporated it into my spiel. All in all, HP crew, a sterling effort. Keep up the Big Mo! Your Alaska buddies, John, Jenasy, Patrick and Zach Dailey, HC 1 Box 3102a, Healy, AK 99743-9604

The model you refer to certainly looks interesting, John. All the principles of solar cooking seem to be intact. I have never seen one or know anyone who has used one. I have seen parabolic cookers demonstrated and they do attain very high temperatures. Frying and popcorn is possible. In your letter you mentioned wind power. If you get a parabolic cooker, or make one, you need to be able to secure it very well as I have read of fires started by cookers falling over. I have often wondered what one could do with an old satellite dish in terms of solar cooking. Jenasy, I am trying to figure out how to suspend my dryer box over the woodstove, remove the bottom and keep the solar fan for ventilation to keep drying food in the winter. It works so well I don't want to give it up in the wet weather. — Kathleen

Don't be left hanging

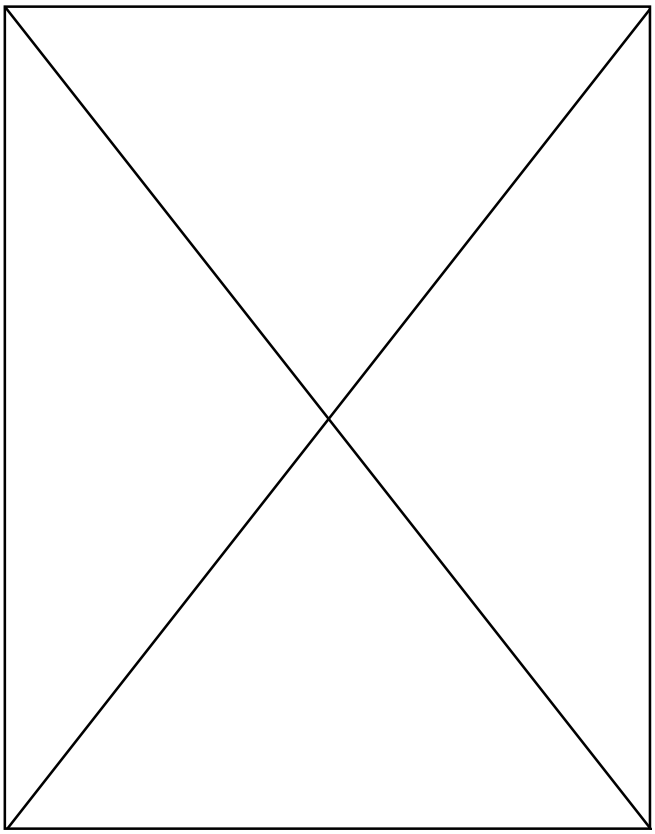
Dear Home Power Crew, I think it's time for you to move beyond your "animals with mailing labels" tradition and branch out into the broader range of possibilities of "Home Power address labels in compromised positions." I took one myself of my buddies pointing to the label in an especially absurd location. They are one rope length from the top of the Nose route on El Capitan in Yosemite Valley, California. They're hanging above 3000 feet of granite which took us five days to climb.

By the way, I appreciate your practice of not sending renewal notices. Take care, Tom Heinrichs, POB 84411, Fairbanks, AK 99708-4411 • 907-457-4090

Thanks for the photo, Tom. We liked it so much we are running it in color on this page. You guys are my kind of maniacs! We hope other readers will take up the challenge and send in photos of Home Power in strange and wonderful places. — Richard

Solar Cooker Coverage

It has been an unusually cloudy spring and summer so far, dampening the spirits of us solar enthusiasts slightly. Still, there have been some sunny days and no doubt they will become plentiful again. The less than perfect conditions are spurring me on to keep developing more efficient solar ovens and to keep in contact with the larger solar cooking community so we can share valuable information. A very large international conference was recently held in California and I hope to obtain a report of the proceedings. I have a lot of the $160.00 ovens available (medium size). I have just begun work on a bunch of large $250 ovens, and a higher efficiency medium size oven priced at $200. More consideration is being given to aesthetics these days. Offer a free trial period before purchase and partial barter payment, especially to those belonging to the Local Employment and Trading System. I don't mind explaining solar cooking over the phone or by letter. I have long since promised new build-your-own plans to many people, but due to the time involved, I have not yet produced these. If somebody would like to take this on, give me a call. There has been some talk of making solar oven production into more of a co-op effort. I am happy about this and hope this eventually happens. Solar cooking seems to be inherently grassroots and well suited to the cooperative approach. The Habitat Re-Store in Winnipeg has plans to begin producing solar ovens using salvaged materials. This seems like a wonderful idea! I have declined a position to spearhead their project, but perhaps somebody else would like to learn this easy trade and apply for the job. Experiments with water distilling using a solar oven have shown it to be quite workable. However, I believe the better approach is to build a separate unit for this purpose. My next attempt will be a very simple hot-box in which evaporating water will condense on the window glass and collect in in a trough. I have had several letters and a phone call from (Solar) Joe Froese. He is in the Montreal area and scheduled to be in Africa by September. The Eritrean Solar Oven Project is receiving incredible support from both the Canadian-Eritrean



Don't be left hanging!

Check your mailing label!

It tells you when your Home Power sub expires!

Left: Tom Carter (in red) and Peter Coward (in blue) dangle from the 3000 foot height of El Capitan while holding a copy of Home Power. Tom Hendrichs shot the photo.

community and from many others. You may have heard Joe on CBC Radio. If not, you may in the future, as CBC has requested Joe to keep in contact, even to call collect from Africa! How nice to hear of Joe and the Eritrean Project's success, so far! Howard Boldt, Box 152 RR4, Saskatoon, Saskatchewan, Canada, S7K 3J7 • 306-239-4742

It is good to hear from you again, Howard. It sounds like Canada is really taking off with solar cooking. The Eritrean Solar Oven Project sounds really great. There is an article by Allan Sindelar on the Solar Cooking Conference in this issue. Keep up the good work. — Kathleen

Northern Composure

Dear Home Power; Enclosed is a check of $15 for my subscription renewal. Although my primary residence is very urban (NYC), I spend as much time as possible at a small (600 square foot) house that my wife and I built about 2 hours northwest of the city. I expect that, especially in the Northeast, there are many folks in this situation, needing power just for some lighting, a water pump and possibly a TV or small fridge (we use ice).

One issue relevant to our situation are concerns that develop from leaving an alternative energy setup unattended for weeks, and occasionally in the winter, for months. What needs should be attended to, what are the risks, etc. Another interest of ours, that I'm sure would be shared by others, would be the possibility of establishing an extremely low-head (2–3 feet) hydroelectric power unit that would only need to put out 2–3 Amps at 12 Volts to keep a small battery pack fully charged. I have almost got working a small (30 inch) water wheel attached to a geared up DC motor, but I expect there is a more efficient approach. Although extremely low-head situations are obviously much more limited than sites where you have a real drop, there are many people who might build a small summer cabin (like us) by a relatively flat but swiftly flowing stream, if they could easily get 20–30 Watts, 24 hours a day, without major dam construction. Because we live in a narrow, heavily wooded valley, solar is really not an option.

I realize that the magazine's main focus is energy, but I also wondered whether you, or any of your readers, would have any info about electric or propane incinerating toilets. Our deep valley location, 20 feet from a trout stream, makes both septic and composting toilets unacceptable. As waste water treatment is probably the other key issue of living in harmony with nature, and with neighbors downstream, I thought that others might have some ideas. Anyway, keep up the good work. Jon Rubin, 121 N. 5th St., Brooklyn, NY 11211

Hello, Jon. Try Incinolet, Research Products/ Blankenship, 2639 Andjon Dept SS, Dallas, TX 75220 • 800-527-5551. This is the only incinerating toilet that I know of. — Kathleen

Ultra low-head hydro is do-able if you've got lots of water to work with.(see HP#23) Without considerable dam construction, your 30 inch wheel (overshot? undershot?) and a fairly large diameter pipe are as good as you're going to get. Let us know how it turns out! — Bob-O

Earthship Rising

I feel truly and deeply inspired!! I recently completed devouring The New Solar Electric Home Book and now I am writing to subscribe to your incredibly powerful and electric magazine! (Just found "you" yesterday.) I am in the process of generating ideas to an "Earthship" home which will be completely off-the-grid and will incorporate sun, mass, wind, and gravity for electric power and heating. I look forward to my first copy with much anticipation! Any readers out there, especially other women or newcomers, who would like to network, please write to me. Thanks, Home Power! Susan Slatky, c/o Morrison, 12421 K Hickory Tree Way, Germantown, MD 20874

Such enthusiasm from our readers is vitalizing. I refer you to George Chase's article in this issue, A Clean Solar Life, to help you outline your plans. — Kathleen

Ozonal Notes

How to move and stay in the same place
Home Power has a new mailing address even though we haven't moved. Our physical location here in Oregon is the same as it's been for the last 22 years. We are so remote that even our legal street address is on a road four miles east of where we are really located.

Why
For a wide variety of legal reasons our address needed to reflect our true state of origin, Oregon. We started using the P.O. Box in Hornbrook, California as a convenience way back when we started five years ago. We live and work eight miles up a four wheel drive road, 3/4 of a mile into the state of Oregon. The only year round access is south, which takes us through Hornbrook, a two hour round trip, on our way into the Rogue Valley in Oregon. The trip into Oregon takes about three and a half hours in the summer. In the winter that same trip can take anywhere from four to twenty-four hours, depending on the weather.

For Real? Yup!
Over a year and a half ago Home Power applied for second class mail privileges with the U.S. Postal Service. Second class mail service is only available to periodical publications on approval of the post office.

On August 17,1992 our second class permit was approved. So I guess that means Home Power is now a Real Publication.

What a long, hard road it's been! It's the same long road for us. Even though our mailing address has changed, we're still in the same old place.

Delivery Dementia
Those of you who received two first class copies of HP #30 are the beneficiaries of a computerized hiccup. Our mailing service, who prints and affixes the labels, omitted the street address line on all of the first class labels. The majority of these issues were returned and reshipped. Those of you who got the first shipment, *sans* street address, have on-the-job postal workers. To those who received their first class issue late because of this snafu, our apologies.

Access
Authors: Karen & Richard Perez, c/o Home Power, POB 520, Ashland, OR 97520 • 916-475-3179

Q&A

Battery Containment

Dear Home Power People; Thanks very much for answering my previous letter in HP #29. I guess I didn't make it clear that I wanted information about specific materials that are unaffected by battery acid. Fiberglass, PVC, ABS? I would hesitate to put batteries in Tupperware containers, as you suggested, without being absolutely certain that the plastic was in fact completely resistant to battery acid.

My system has only two golf cart batteries which I have since put in plastic boxes made for boat batteries (cost $7 each at K-Mart). Seems safe to assume that these boxes are acid resistant. The golf cart batteries are taller than what these battery boxes were made for, but the boxes will at least contain possible leakage and the covers keep dust off the battery tops. Admittedly, battery gassing is not externally vented. Perhaps external venting would not be necessary with Hydrocaps? My maximum charge rate is 6 or 7 Amps on the 220 Amp-hour batteries.

People with larger batteries indoors may want to make battery boxes from scratch. Perhaps you could discuss chemical properties and reactions regarding battery acid and different materials. Clive Ellis, 2039 Manzanita St., Klamath Falls, OR 97601

OK, Clive, here is a table showing the chemical resistance to electrolytes (both acid and alkaline) for various commercially plastics (info courtesy of The Handbook of Chemistry and Physics). It looks to me like the best and most obtainable plastics to use are polyethylene or polystyrene. — Richard.

Auto Charging

Dear H.P. Crew; I have run the full gamut of trial and error as far as AA to D nicads go. First, I bought "el cheapo" with too small a capacity to last very long. Then I fried a couple of good ones in a solar charger.

I forgot! Now I'm reading with great interest how you folks use them all of the time and have their recharging down to a science. You even give detailed specs on how I can build my own that will make them last longer. Well I don't want to build my own! I don't have the time or desire. I'm a craftsman/artist. I don't do electronics.

I have been using 9.2 Volt nicads in portable tools for years, and they're great. I think the problem with the smaller ones is that I haven't yet found the perfect auto shut off charger. So.....Who makes the best, idiot proof charger for the non-techies out there. I know I'm not alone. Look forward to your reply. Gratefully yours, Paul Christopher Prelitz, POB 5024, Laguna Beach, CA 92652 • 714-494-6353

Well, Paul, the reason we build our own chargers is that every commercial model under $200 is less than perfect.

Commercial Plastics and their Chemical Resistance to Electrolytes

Plastic Type	Weak Acids	Strong Acids	Weak Alkalies	Strong Alkalies
Cellulose Acetate, soft	Fair to Good	Poor	Poor	Very Poor
Cellulose Acetate, hard	Fair to Good	Poor	Poor	Very Poor
Cellulose Acetate Butyrate, soft	Good	Fair to Good	Good	Poor
Cellulose Acetate Butyrate, hard	Good	Fair to Good	Good	Poor
Nylon, 6/6	Very Good	Poor	No effect	No effect
Polycarbonates, unfilled	Excellent	Fair	Poor	Poor
Polyethylene, low density	Good	Good	Good	Good
Polyethylene, medium density	Excellent	Excellent	Excellent	Excellent
Polyethylene, high density	Excellent	Excellent	Excellent	Excellent
Methylmethacrylate	Good	Fair to Poor	Good	Poor
Polypropylene, unmodified	Excellent	Excellent	Excellent	Excellent
Polypropylene, copolymer	Excellent	Excellent	Excellent	Good
Polystyrene	Excellent	Excellent	Excellent	Excellent
Polystyrene-acrylonitrile	Excellent	Good	Excellent	Good
Polytetrafluoro ethylene	Excellent	Excellent	Excellent	Excellent
Polytrifluorochloro ethylene	Excellent	Excellent	Excellent	Excellent
Polyvinylchloride acetate, rigid	Excellent	Good	Excellent	Good
Polyvinylchloride acetate, nonrigid	Fair to Good	Fair to Good	Fair to Good	Fair to Good
Epoxy	Excellent	Fair to Good	Excellent	Excellent
Melamine-Formaldehyde, cellulose	Good	Poor	Good	Poor
Melamine-Formaldehyde, mineral	Fair	Poor	Fair	Poor
Phenol-Formaldehyde, cordfilled	Variable	Poor	Variable	Poor
Phenol-Formaldehyde, cellulose	Variable	Poor	Variable	Poor
Phenol-Formaldehyde, phenolic	Fair to Good	Poor to Good	Poor to Good	Poor
Polyester	Good	Poor	Good	Poor
Silicones	Fair to Good	Poor to Good	Fair	Poor
Urea Formaldehyde	Poor	Poor	Fair	Poor
Acrylonitrile-Butadiene-Styrene ABS	Good	Good	Good	Good
Acetal, homopolymer	Fair	Poor	Poor	Poor
Alkyd Resins, fiber filled	Good	Fair	Good	Fair

The nicad pulsar we featured in HP#30 is cheap and simple to build. It will run rings around any commercial charger. If you don't want to build it, then find a techie and pay him to build it for you. How about it techie readers, anyone want to build a pulsar and sell it to Paul? — Richard

Concept Clarification

Dear People; Right now I'm struggling to educate myself about AE and many of the articles are a bit over my head — but you do have a good mix of articles explaining the fundamentals too.

I have a question. I know that contrary to popular belief current flows from the negative terminal of a battery to the positive. How then does current flow in a negative ground system such as a car battery? Why is the negative terminal grounded? It appears to the novice that devices are hooked up in a manner more consistent with electricity flowing from + (positive) to – (negative). This simple concept somehow continues to confuse me. Charles Polenick, 6175 Ventura Lane, Central Point, OR 97502

Well, Charles, you aren't the only one who is confused. We can blame this confusion on Ben Franklin who first formed the convention that electrons flowed from positive to negative. Ben had a fifty-fifty chance of being right and he came up wrong… Bottom line is that electrons only need a complete electrical circuit to flow. The direction of the flow is really immaterial in both electronic and electric circuits. Electrons are negative charged particles and they actually originate at the negative pole of a battery. The convention of current flow from the positive pole remains even today. If you went to college in an Electrical Engineering program, you would be taught that current flows from positive to negative. It is a tribute to the versatility of electrons that we can specify their motion backwards and they will still do our bidding. In terms of wiring and actual use, it matters not which pole of the battery is grounded to the vehicle's frame. Consider the old British cars which grounded the positive pole of the battery to the frame. What really counts is having a complete circuit. If the circuit is complete, then the electrons will flow without regard to our understanding of the direction of their flow. — Richard

Electric Mower

Dear Richard Perez: In Home Power #30, reader Noel Perrin asks for a source for battery-powered electric lawnmowers.

Here is a source: Kansas Wind Power, Route 1, Holton, KS 66436. They sell various models of Elec-Trak lawn and garden tractors, new and used, in prices ranging from $750 to $3200. Any of these small garden tractors can be used as a rider-mower.

I should point out that these Elec-Trak tractors are apparently manufactured by General Electric. I strongly urge Home Power readers to respect the ongoing boycott of G.E., which has been heavily involved for years in all kinds of weapons production, especially the production of nuclear weapons. Nuclear weapons continue to threaten all life on earth, in spite of the end of the Cold War. Sincerely, Martin Holladay, POB 72, Sheffield, VT 05866

Battery Housing

Gentlemen: One of the things that bothers me concerns batteries for PV panels. On one hand, batteries need good ventilation and separation from the house. On the other hand, batteries must not be allowed to freeze, or to get too hot. These requirements seem to me to be contradictory. Can you help me on these questions? Our home will be at 5300 feet and 33° N. latitude. John Gordon, 2828 Quay Loop, Holloman AFB, NM 88330 • 505-479-9043

Hi, John. Zomeworks Corp builds a temperature controlled box for batteries called "Cool Cell". This box is a passive device and requires no electricity. While I've not tested one, I hear good reports from users in hot climates. The box will keep batteries form overheating in the summer and from freezing in moderate climates during the winter. — Richard

Sun & Suds

Dear Home Power; Please send me one copy of Joseph Radabaugh's *Heaven's Flame*. Our new "Sun Oven" really cooks, even here in the cloudy great Lakes region. The book is for my mother, who became an instant convert to solar cooking after a Sun Oven demo.

One question: do you — or any readers out there — know of a Canadian source for the James washer? Could you possibly print this question, including the address below in your mag? Thanks. Wendy & Wolfgang Weiss, RR #3, Parry Sound, Ontario, P2A 2W9 CANADA

OK, readers, can anyone help Wendy and Wolfgang out?

How & Why

My friend has been generous in lending me his back issues of Home Power, The problem is that they're so handy to have as reference that I hate to give them back - hence my large purchase of back issues.

I have 24 Arco M-53s, Trace 24 V inverter, Heliotrope CC 60-C controller, Cruising Equipment Amp meter, Exide lead acid battery bank, Flowlight slow pump — good stuff. But none of these manufacturers offers more than a

description of how their equipment is supposed to work. For real insight into the quirks and actual performance of these things, your magazine is excellent. A good example is the manual for my Heliotrope CC 60-C. It provides no real detail on how the device actually works. They describe how the controller regulates the "energy" and "output" of my PV modules. Kind of vague! I'd like to know what the controller is doing to the voltage and amperage of my PVs. What kind of readings should I expect to see on the volt/amp meter at various times in the charge cycle?

The Trace manual, though very good, only hints at the limitations of a modified square wave inverter in the operation of things like fan motors. I have a nice propane furnace that I'd like to use, but the blower motors and transformer say "no way" when asked to run on inverter power, any suggestions? Sincerely, Eric Mellen, 11500 W Sinagua Rd., Tucson, AZ 85743 • 602-449-4072

Hello, Eric. The Heliotrope controller works by rapidly switching the array on and off. There is a transistor (or two) in series between the PVs and the battery. This transistor is rapidly activated to provide the battery with a regulated voltage when the voltage set point of the controller is reached. Your voltmeter will show whatever voltage you have set on the controller when it is regulating. The current (Amps) from the array will vary depending on what the battery wants to accept at that specific voltage set point. As the battery fills, the amount of current delivered by the control decreases. This basic scheme is called Pulse Width Modulation (PWM) and has been proven to be the most effective way of controlling PVs that are recharging a battery. With regards to the furnace motors, contact Jim Forgette at Wattevr Works! about a replacement motor that will run on your inverter. Or replace your mod sine wave inverter with a pure sine wave type like Dynamote's Brutus reviewed in this issue. — Richard.

"Pulsar" Recharge

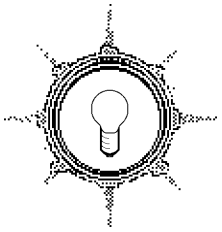
Dear Chris; I just read issue #30 and read the article on "Pulsar". Could you advise how a similar unit could be used to recharge a battery bank? I think this current train may be useful in eliminating similar problems in recharging small nicads as well as larger batteries. If you could supply any additional info I would greatly appreciate it. Thanks, Chris McKay, POB 991, Maywood, NJ 07607

Dear Chris: Using pulses to charge big battery banks is not a bad idea, but to do it through the whole charging cycle without wasting precious energy from your renewable energy system would be difficult. Besides, lead acid batteries and pocket plate nicads don't suffer from the memory effect and dendrites that sintered plate "flashlight" nicads suffer from, so charging with pulses really doesn't buy you much.

The Pulsar uses high frequency switching to lessen the current from a big battery bank to charge "flashlight" batteries. Lots of current flows when the switch is on, nothing flows when it is off. The average - the current your flashlight batteries receive - is somewhere in between. With the Pulsar, when the switch is off the electricity stays inside your house battery bank. If you wanted to use high frequency switching to charge your house-size battery bank, you would be rejecting power from your solar panels or wind machine. In this case rejected power is lost power. It doesn't stay around in the solar panels or the wind machine, it's gone if you don't let the battery absorb it.

In the bulk of the charging process you want all the power you can get from your renewable energy system. But when the battery is nearing full, reducing the current, even if it means rejecting the rest, is not a bad idea. Indeed many available charge controllers use high frequency switching for controlling the charge on house sized battery banks. Brand names include: Heliotrope CC20, CC60, and CC120, the Enermaxer, and the Bobier ECM1 unit for their LCB. — Chris

Home Power's Business



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Sir Thomas Lipton — 1870

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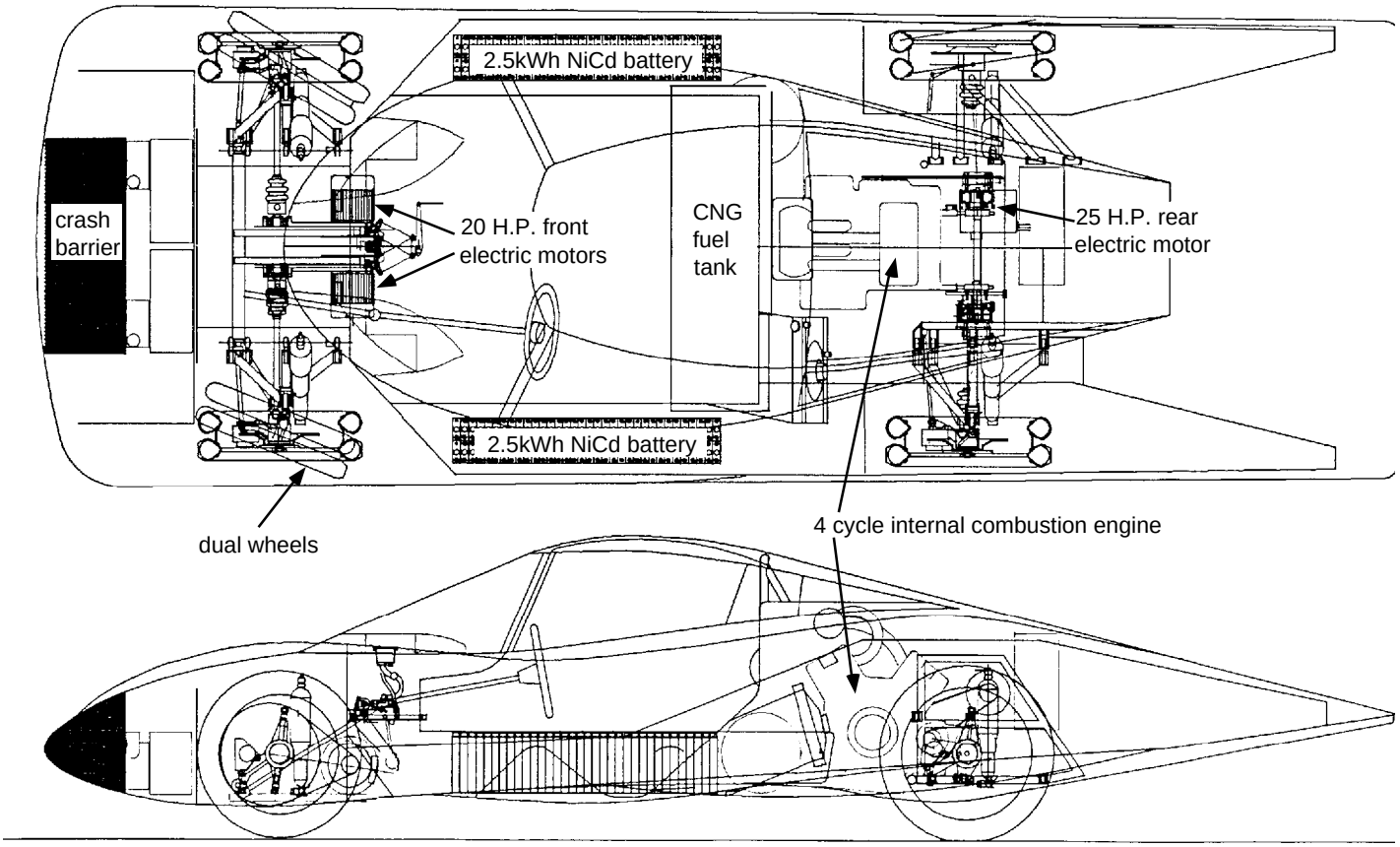


Viking 21: A Vehicle for the End of the Fossil Age

Chris Greacen

There's a place for inexpensive conversions of existing cars to electric cars — see Shari Prang's article in this issue. There's also a place for wiping the slate clean and entirely re-thinking the automobile. That's what the Viking 21 program is about. Once the public is aware that more environmentally benign alternatives are within the grasp of current technology, we can hope for a market, and some pressure on Detroit to mass produce clean vehicles.

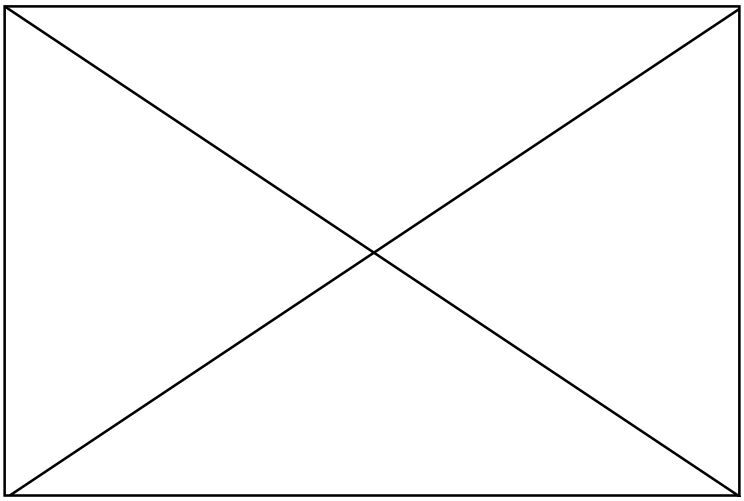
In many areas we are already running out of clean air. Clean air laws require that by 1998, 2% of all new cars sold in Southern California be "zero emissions vehicles". Michael Seal, director of the Vehicle Research Institute (VRI) at Western Washington University in Bellingham, Washington, sees this as part of a growing trend leading to banning internal combustion engines in many cities. Public transportation and bicycles will help reduce urban pollution and our reliance on fossil fuels. Michael Seal says, however, that the current structure of our lives and cities in industrialized countries requires the continued use of the family/personal automobile. With some good design choices, it is possible to make a vehicle which is much more environmentally benign than today's cars, yet has the performance and range industrialized humans have come to believe they need.

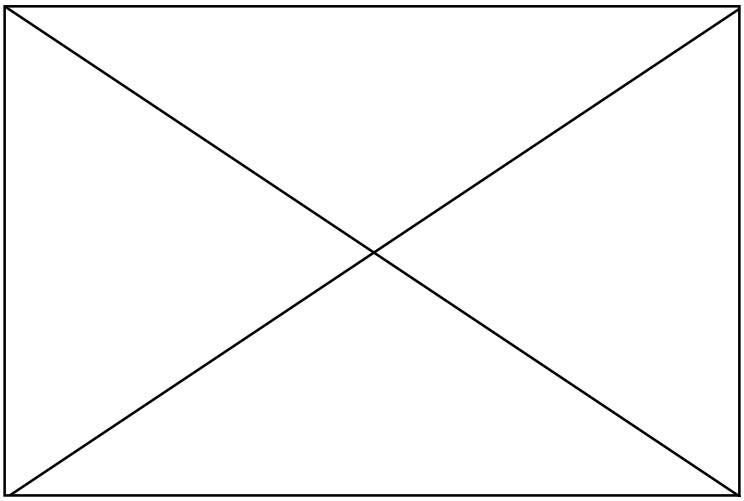
Michael Seal and his students at VRI are building a “solar electric/natural gas parallel hybrid car” from the ground up as a response to this challenge. They have a quarter of a million dollar budget from the Washington State Department of Ecology, the Bonneville Power Administration, Puget Power and Light Co., and interested individuals. Their goal: to demonstrate to the world’s auto makers a quick, responsive, safe car with 100 miles range in “zero emissions” mode, and 300 miles with the addition of a small natural gas powered internal combustion engine. They call the car the Viking 21.

The Viking Cars

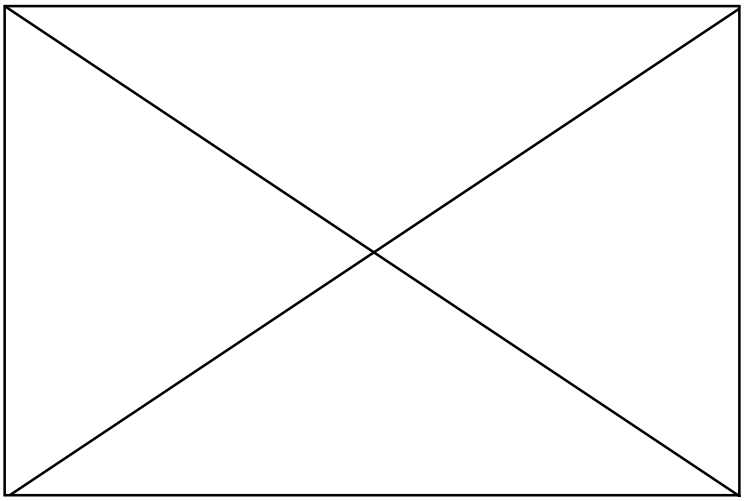
In two visits to VRI, I got a sense of the car they’re building, and a little of what is involved in designing and building a prototype energy-efficient car from the ground up. VRI is housed in several rooms of the bottom floor of WWU’s Technology Center, a space a little larger than a basketball court. On benches on the concrete floors are lathes, a computer numeric control milling machine, welding equipment, and work-in-progress: motors, disc brakes, linkages, suspension arms. In one room is a dynamometer, and other emissions measuring equipment. Another room reeks of tools and supplies for fiber glass, and carbon fiber construction.

VRI built its first car, the Viking I, to compete in the 1972 Urban Vehicle Design Competition, held at the GM Proving Grounds in Michigan. It featured a propane converted Toyota engine and extreme steering for ease in parallel parking. Later Viking cars were to concentrate largely on low emissions and fuel efficiency. In the late 1970s Viking cars were approaching 100 mpg. The Viking VI, built in 1978, successfully demonstrated that a low-emissions, fuel efficient car could meet or exceed federal crashworthiness standards. This car, with a more recent engine, gets 118 mpg at 50 mph. The Viking XX is a two person solar car, built like a catamaran with a tilted PV array between the pods. It placed second in the 1990 GM Sunrayce USA from Orlando to Detroit and fifth in the 1990 World Solar Challenge across Australia, beating cars with higher budgets. VRI also prototypes internal combustion engines, including the twin-cam, four-valve Subaru Legacy engine. (See the August ‘92 issue of *Alternative Transportation News* for a more detailed history of VRI).





Two pictures above: the chassis of the Viking 21 showing motor controllers, electronics, battery storage, and internal combustion engine (rear). Hydraulic cylinders push all eight tires in contact with the road during braking and acceleartion.
Below: Viking 21 shell. In the final version it will be covered with high-efficiency silicon solar cells. Photos by Eileen Seal



The Viking 21

The day I visited VRI a few students were making modifications to a welded steel "mule" chassis for the Viking 21. The car is drivable with this chassis but the final chassis will be composite monocoque. This will bring the Viking 21's curb weight to less than 1,400 pounds. Building the "mule" first enables the design to evolve flexibly. Welded steel beams can be fairly easily cut and moved, composite monocoque cannot. A 20 horsepower, brushless DC permanent magnet motor powers each of the front wheels, and another 25 hp motor powers the rear axle, with no clutch. The motors and their controllers are made by Unique Mobility. They are about the size of a coffee can, weigh 26 pounds, are 95% efficient, but also cost $8,200 each (the rear motor is $14,000). Michael Seal says similar motors in the near future will be available for a fraction of this price — right now there's no economy of scale. Power for the motors comes from 5 kWh of sintered plate NiCd batteries, giving an expected range of 100 miles. British Petroleum's 17.5% efficient laser-grooved silicon solar cells on the upper portion of the carbon fiber body will charge the batteries through one or more Australian-made maximum power point trackers.

For extended range outside the city, a 16 valve, 1200 cc motorcycle engine modified to run on natural gas will power the rear axle through a five speed transmission without a differential. Natural gas burns the cleanest of fossil fuels, and is in greater supply than liquid fossil fuels. Over-running clutches will provide for differences between inner and outer wheel speeds during vehicle turning. The internal combustion engine will add about 200 miles to the vehicle's range with mileage over 100 mpg (gasoline BTU equivalent).

The range and fuel efficiency is made possible by reducing friction and weight. The car has a drag coefficient of around 0.2, achieved through preliminary wind tunnel tests of 1/10th scale models. Rolling friction is reduced by mounting two tires on each carbon fiber rim, much like a dual truck tire assembly. The inner tire has a hard compound rubber and round section giving a small contact patch. The outer tire has a wider tread patch and uses soft high-grip rubber. The wheels normally run at negative camber so the outer tire does not quite touch the road. During cornering the normal chassis roll causes the outer wheel to contact the road surface, increasing cornering power. During hard braking, hydraulic cylinders push all eight tires in contact with the road.

While VRI tries to use stock components, many of the parts must be built from scratch. When I visited first, Michael Seal and a student were working on adapting a motorcycle disc brake for the car. In the end this was not satisfactory and the disc brake was hand built. I was shown several attempts at a custom cam used in the four wheel steering the car will incorporate. In the end the part was redesigned. Steel rims weighed in at around 17 pounds. This was unacceptable. The students built carbon fiber wheels weighing 4.75 pounds. If you want to start messing around with carbon fiber, Michael Seal recommends starting with the "Aircraft Spruce Catalog".

One student explained to me that a reason VRI is successful is that once someone knows how to use a particular tool, he or she is free to use it. There is a minimum of red tape. It's a place where environmentally minded young technically inclined folks can test their mettle making ideas into metal. Transportation breakthroughs emerge.

The car's first event will be the Pike's Peak Challenge on 8 October at Pike's Peak Colorado.

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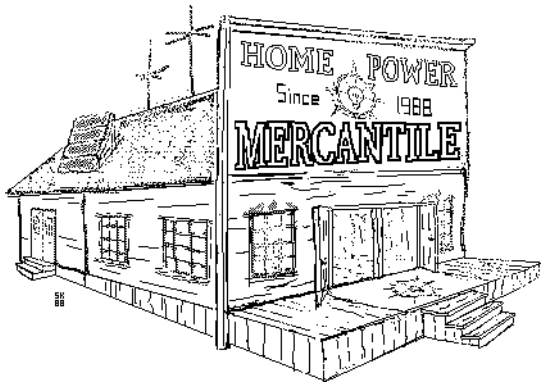

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