Bulk Rate
U.S. Postage Paid
Permit # 166
Klamath Falls, OR

HOME POWER 7

AEE Ad

Trace Ad

Home Power

People

Sam Coleman
Windy Dankoff
Ed Eaton
Dale Glaser
Brian Green
Molly Hoffman
Stan Krute
Jim Longnecker
Mike Mooney
Karen Perez
Richard Perez
Anita Pryor
John Pryor
Daniel Statnekov
Laser Masters by
IMPAC Publications
Ashland, Oregon

Contents

Access

Home Power Magazine
POB 130
Hornbrook, CA 96044-0130
916–475–3179

Think About It

"The whole of science is nothing more than a refinement of everyday thinking."

Albert Einstein

Cover

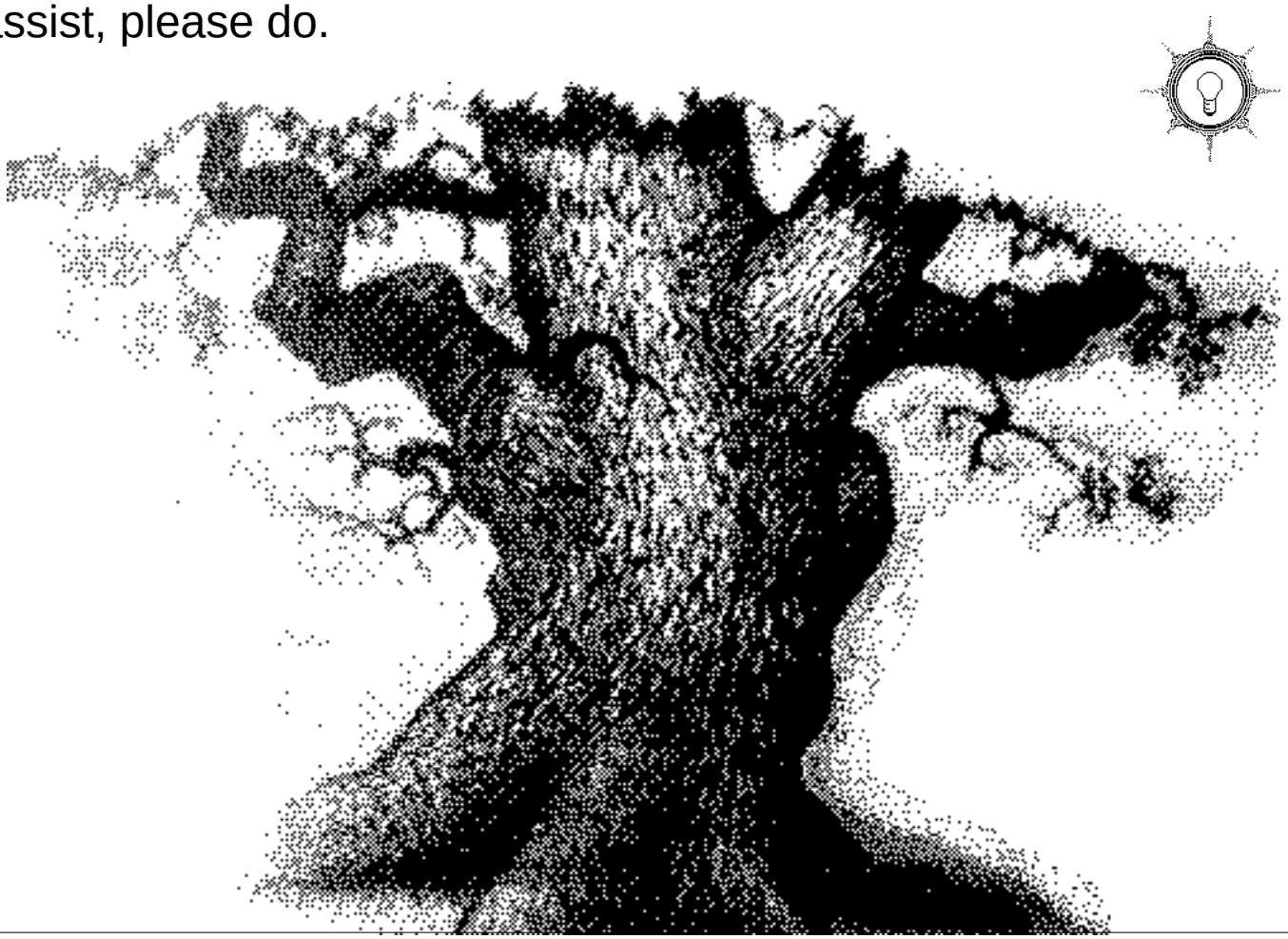
The "Plywood Palace". Home Power at home.

Photo by Brian Green

Home Power Magazine is a year old. We've delivered 7 issues, 10,000 copies each, to you in the last 12 months. Free. Thanks to the support of our far seeing advertisers, the untiring unpaid dedication of the Home Power Crew, and just plain good luck. "It's a sorry duck that doesn't quack in its own pond."

Many thanks to the readers who have contributed information, supported our advertisers, and sent contributions to Home Power to keep things rollin'. We've been real lucky…

We believe in our future. In the future of renewable energy. In a pollution free, healthy world we can all share. To this end we publish Home Power. We can always use your help. So if you can assist, please do.



A Stand-Alone PV System

Molly Hoffman

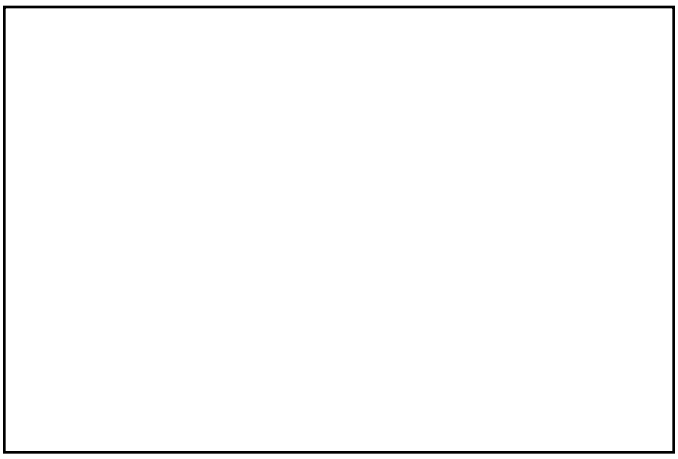
I suspect that Home Power has been overwhelmed by responses from renewable energy (RE) people. Suddenly, there is a publication that speaks directly to those of us who are using RE and to those who have been dreaming of the possibilities. It is exciting to see people responding with helpful information from their own experience. Your articles on system components have been very good down-to-earth stuff: information we can really use. Having been inspired by seeing other peoples' responses, I decided to contribute our experiences.

By way of a brief personal introduction: Ken, my husband, and I have lived in northeast Minnesota for the past 8 years. Ken is a civil engineer, but has worked as a land surveyor most of his professional life. He is registered in MN, and is legally a professional surveyor. That is how we earn our living. We are a company of two people, a very small business. Our house, therefore, is our office. We need electricity to conduct our business, to power calculating equipment, to recharge an electronic distance meter's battery and for lighting drafting work (while I prepare survey drawings). The system we use has been the perfect answer for us. We have always been conservative in our use of any energy. Our system is compatible with our desire to consume less of the world's energy. Nuff said, so at least you know a little of who we are.

System Site

Our homesite is located in northeastern Minnesota, 30 miles from Lake Superior, in what is known as lake country, the best known portion of which is the Boundary Waters Canoe Wilderness Area (BWCWA). The altitude, in a state without mountain ranges, is fairly high at 1,900 feet. The forest is boreal and typical of the rather cold climate. Snow arrives permanently in November (sometimes earlier), accumulates from 2 1/2 to 3 feet and melts in March and April (a late snow storm may occur in May). Winters tend to be cloudy and it always seems there is a flake of snow in the air. These climatic conditions have influenced greatly the type of system we have set up. Our system is not typical in many respects. It reflects our personal choices in the way we live. Photovoltaic systems are inherently flexible and seem easy to bend to the character and requirements of their owner.

In the fall and winter of 1986-87 we built a small house (16' x 24' with a 6' x 8' entry). We decided from the first nail pounded that we did not want or need utility line power. Our need for electricity was small. We were in a break-even situation in comparison to the cost of bringing in commercial power versus the cost of our PV system. We decided that we would prefer to take responsibility for producing our own power and adapt, however it was necessary, to be comfortable with this option. We have a 12 VDC system, batteries charged with photovoltaic panels. We decided to run our system without a generator. It was strictly a decision based on our personal preference and not what is usually recommended by most conventional wisdom and experience. We want to create power without the maintenance, noise & fuel dependence of a generator.



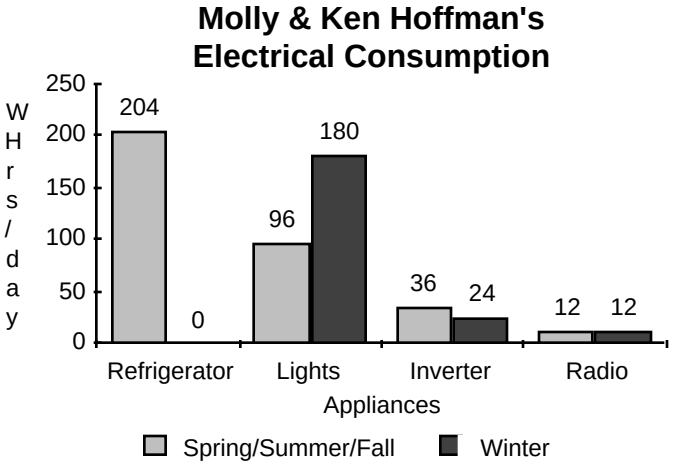
Molly & Ken Hoffman's PV powered home
Photo by Molly Hoffman

Our Present Energy Demands

We meet our heating and cooking needs with wood and LP gas. We built our house with hand tools and therefore do not own power tools. We have not had a TV for the past eight years, our hardwood floors and shakeable–sized rugs do not need a vacuum. All our curtains, chair pads, quilts, bedspreads and some clothing have been sewn on an old, but serviceable, treadle sewing machine. We have no electric well pump, but rather a water storage system inside our house. We have a well equipped with a freeze-proof hand pump and a comfortable outhouse. Since this has been our mode of life for six of the past eight years it has posed no adjustment problems.

We use 12 VDC electricity for refrigeration, lighting, radio (modified to 12 VDC), and powering our inverter for 120 vac production. The 300 Watt inverter supplies a programmable calculator & printer, recharges survey instrument battery packs and 120 vac appliances such as a shaver and toothbrush. By building a set of cabinets on an inside wall of our unheated entry, we are able to turn off our refrigerator during the coldest, darkest winter months and use the cabinets as a passive refrigerator. When the outside temperature occasionally dips below -35°F., we will get partially frozen milk on the lower shelves but for the most part it has been an easy arrangement to manage. The following graph details maximum daily power use.

Power Source- Photovoltaics
We use two 66 Watt Solec and two 48 Watt Kyocera PV panels mounted on aluminum angle frames with 3 adjustment angles for spring/fall, summer and winter. The frames are grounded with 6 gauge copper wire to 8 ft. ground rods driven 7 ft. into the ground. The panels are mounted at the roof peak and even in the flattened summer position, are never close to the hot surface of the roof and have good air flow for cooling.

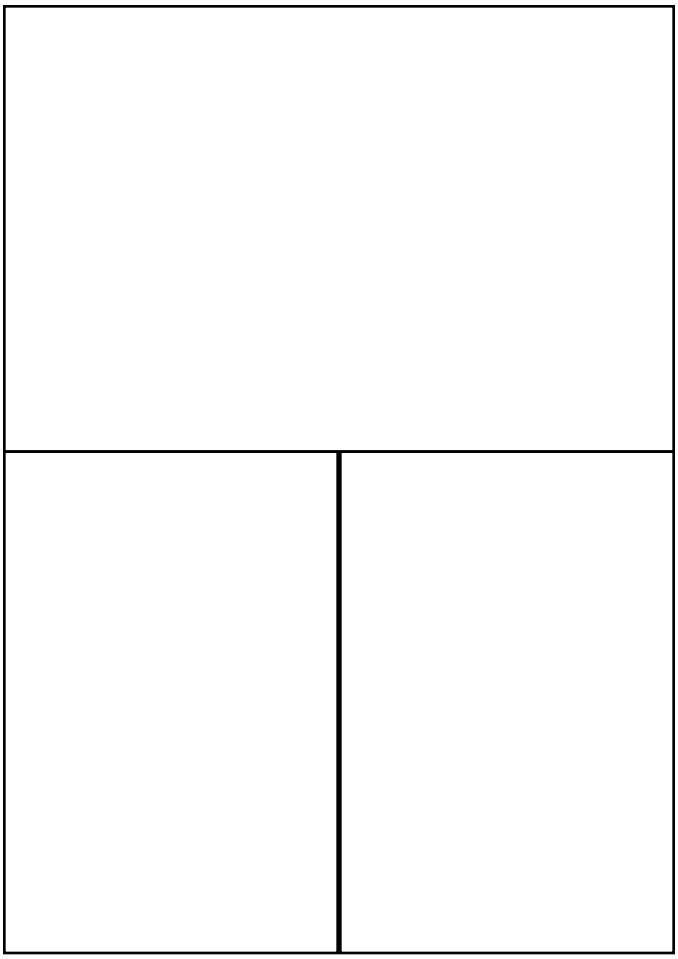


All four panels regularly produce more than their rated capacity.

Regulation & Storage
The power from the PV panels is brought through a wiring center (from Steve Willey of Backwoods Solar Electric Systems, 8530-HP Rapid Lightning Creek Rd., Sandpoint, ID 83864, 208 263-4290) which provides a blocking diode and a charge regulator. The power then flows into two 6 Volt L–16 Trojan batteries (rated 350 Ampere-hours) wired in series to produce a 12 VDC power source. The batteries rest on a hand built dolly with heavy duty wheels and are housed in a cabinet in the house. The cabinet is vented to the outside air. It has a top access lid for regular servicing and a removable side panel so that the batteries can be rolled out on a dolly. The cabinet is large enough to accommodate four L–16 batteries to allow us some future flexibility. All current carrying wires leaving the cabinet are fused for fire protection.

Distribution
Cables and wires to and from the battery cabinet are run in an interior house wall which has a removable panel for complete access. Power from the batteries is supplied to fused 12 VDC house circuits on the wiring center board and to our Heart 300X inverter.

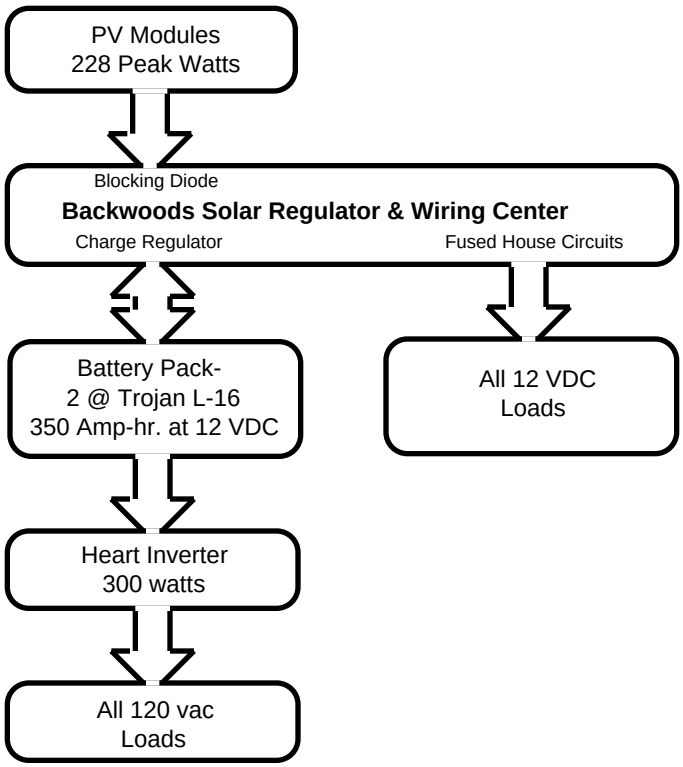
12 VDC House Circuits & Appliances
We have wired 12 VDC house circuits so that we have outlets and overhead lights on switches, two swag lamps modified for 12 VDC use with compact fluorescent bulbs, a radio also modified for use with 12 VDC and two small 12 VDC fixtures for reading lights by our bed. We used standard 120 vac grounded outlets on the 12 VDC system and wired them so that accidents with ac appliances are impossible. We used switches rated for higher current than most ac switches, they are the "loud" clicking type. We used ivory colored switches, outlets and cover plates for all these 12 VDC circuits. For refrigeration we have a SUNFROST, 10 cubic foot, 12 VDC refrigerator without a freezer. It is wired on its own circuit from the wiring center. We do not operate the refrigerator during the winter months as previously noted.



Top: the inverter rides over the wiring center. Left:battery compartment exterior. Right: battery compartment interior. Photos by Molly Hoffman

120 vac Circuit & Inverter
Our only 120 vac circuit consists of four grounded outlets located where 120 vac is needed. These outlets are wired in the usual ac convention. To distinguish these outlets from the 12 VDC outlets, brown colored receptacles & cover plates were used. We wired grounded plugs on both ends of heavy flexible wire. This is our connection from the plug receptacle on the inverter to an outlet in our 120 vac circuit. This 120 vac circuit is energized by the small Heart inverter only when ac power is needed. The inverter could be left on continuously, but we switch it off when ac is not being used. Some of our 120 vac loads are too small to cause the Heart to switch from idle mode to the operating 120 vac mode. We found it necessary to use a small night light, which is just enough load to activate the Heart. The inverter is grounded with a copper wire attached to an 8 ft. ground rod driven 7 ft. into the ground.

System Costs
The total cost of the basic system was $3,027. Additional



Flow Chart of the Hoffman's system

costs which complete the system are:
• $169 for 4 overhead 12 VDC fluorescent fixtures and bulbs, modifications to two swag lamps, modifications to radio and 2 12 VDC Osram co-pilot lamps.
• $191 for refrigerator cable, house wiring, outlets, switches, cover plates, conduit, miscellaneous nuts and bolts.
• $33 for System instrumentation - hydrometer & multimeter.
• $1,553 for a SUNFROST 10 cubic foot 12VDC refrigerator ($1,395 + $158 shipping). Without this refrigerator our system would be very difficult to manage. It is attractive, quiet and remarkably efficient.

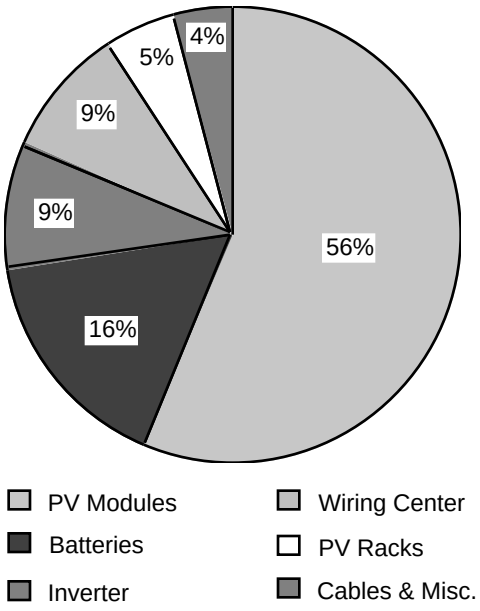
That's it, including all the nuts and bolts. It doesn't work out well to calculate our cost per kiloWatt–hour because we are not yet fully using all the power generated by our panels. At present we have no maintenance costs and do not anticipate any in the near future.

System Operation

Without the benefits of a generator to "even out the low spots", we opted for a system where the PVs are our greatest expense. We need to generate power at all times, especially when only limited solar insolation is available. Partly cloudy days are frequent because of our altitude and proximity to Lake Superior. It has worked out well so far (with only one year experience to speak from) and we seldom use more than 20% of our battery's capacity. We have alot of excess power generated both summer and winter and intend to use some of this power in the future. An option on our wiring center makes it possible to take off and use this excess electricity as it is available. It is possible to power such things as a slow pump for water, a small water heating element, a fan, etc.....

Our wiring center has expanded scale analog meters to

Hoffman System Cost



monitor battery voltage, house power use and power produced by the PV panels. We use rechargeable batteries to keep flashlights and other battery operated devices functioning. These small batteries are recharged from our wiring center. Maintenance of the system consists of changing the panel angle seasonally, occasionally washing the panels and checking the battery's electrolyte. We hope that with shallow cycling, the life of our batteries will be long.

Ours is not a conventional set-up. But then the whole idea of a system to supply electric power demands without utility assistance is not conventional either. Because of the excess power generated & not used, our system does not figure well in the present methods of cost analysis, but then we feel it doesn't have to. It is something we could afford and has worked wonderfully well for us and that is what counts.

Molly & Ken Hoffman, Gunflint Trail, Box 30, Grand Marais, MN 55604 or call 218-388-4455.

The PV/Engine System that produces Home Power Magazine

Richard & Karen Perez

Many have asked about the energy system that produces this magazine. Well, I've been hesitant about writing about our system. It is less than optimum for our needs. It wasn't really planned, it just grew. But, here it goes— warts and all…

System Location

We are located on a plateau, called Agate Flat, in the Siskiyou Mountains of SW Oregon. At an altitude of 3,300 feet, we are dwarfed by the 6,000+ ridge of mountains NE of us. This site was a lakebed where mastodons once lunched on lush grasses at the end the last ice age. We are not the first humans to live here. We have discovered stone tools and arrowheads here that date back over 2,000 years. You can locate us on a map, our coordinates are 42° 01' 02" North and 122° 23' 19" West.

The nearest paved roads are 8 & 11 miles away. Unimproved dirt tracks run everywhere; it is common to be "snowed-in" or "mudded-in" in the winter. After days of rain, the ground's consistency resembles pudding. This sticky mud coats vehicle tires and makes driving difficult. On a good day, the nearest town is about 1.5 hours away. On a bad day, we don't even make it to the paved road. We walk home returning to the stuck truck with jacks, shovels and a comealong.

We are 8.5 mi. from the nearest commercial power hookup. At a going rate of $5.25 per foot, this amounts to around $235,000. The irony is that there are two 60kV+ power lines within 3/4 of a mile of this location. The power company got a good chuckle out of my suggestion of a substation. From the very beginning we realized if we wanted electricity, then we had to make our own.

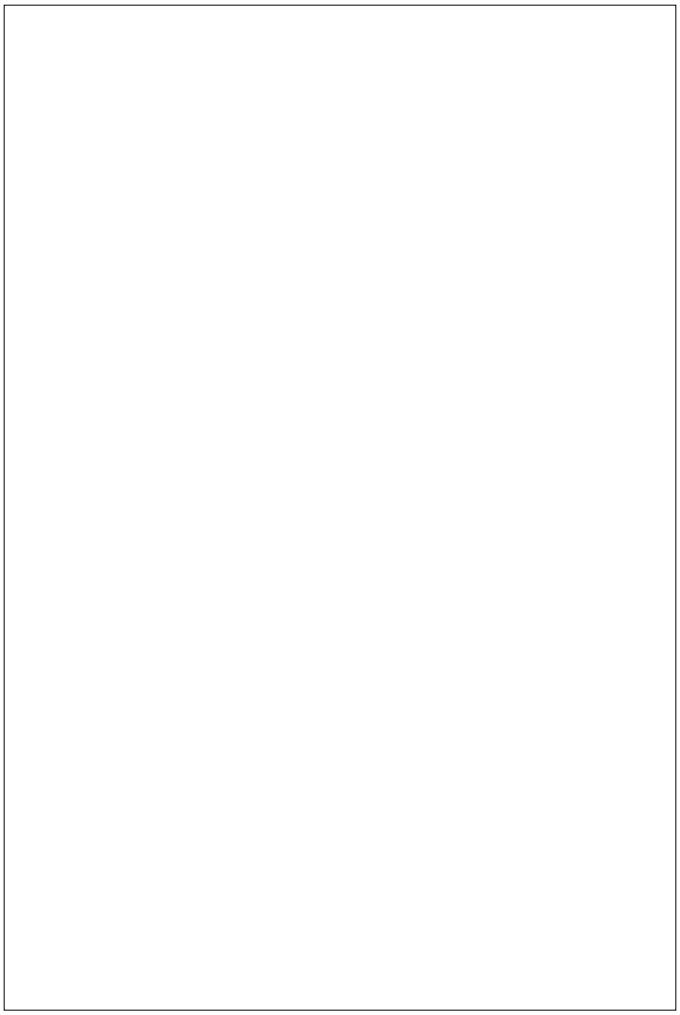
The building where we produce Home Power Magazine is a two story, 16 ft. by 16 ft. "Plywood Palace". It uses passive solar hot air for heating, backed up by a wood stove. Our friends say this building exists only to support the 9 radio antennas growing on its exterior.

System History

The electrical power system here was not planned, it grew. And in 18 years of growth we made many mistakes. This article is as much about what not to do as what worked. We learned these lessons the hard way because information wasn't available to help us.

We started using electricity the first day we arrived. We powered a small 12 VDC cassette recorder/player from the battery in our truck. This arrangement provided music, while we used kerosene lamps for lighting. We had a lot of romantic notions about country living. For example, we planned to cut all our firewood using hand saws. We cut for 2 months before it became obvious that we couldn't cut enough wood before winter. Fortunately a neighbor lent us a chainsaw and we didn't freeze our first winter.

By 1976 we had developed a rudimentary stand-alone electrical system. It employed a 100 Amp-hr car battery and a home made engine/12 VDC charger. The DC charger used a 3.5 HP Tecumseh horizontal shaft gas engine driving a 35 Amp Delco car alternator via a pulley/belt arrangement. We learned several valuable facts from this system. One, car batteries don't last very long (less than 2 years) in deep cycle service. Two, inexpensive gas engines have short lifetimes (about 500 to 1,000 hours of operation). Since we were putting over 1,000 hours on the DC powerplant yearly, we were using up an engine every year.



The "Plywood Palace". Photo by Brian Green

With power production on site, our electrical consumption soared. We were using about 300 Watt-hours daily. We added 12 VDC car tail lights, several radios including Ham & CB units, and a 5" B&W TV. Even with the increased utility of the system, we were far from satisfied. The entire system depended on gasoline as a power input. We hauled over $30. worth of gas from town monthly. The generator was noisy & required constant maintenance.

Electrical Power Requirements
Here is a description of our system as it exists now. We use electricity only when & where necessary. When we are finished using an appliance we turn it off. Our total electrical consumption now averages about 1,130 Watt-hours per day. This is about 10% of the energy consumed by the average US household daily. This is a daily AVERAGE. We often "binge" on electricity. Some days we use less than our average, while on others (like during magazine production) we use over twice as much as our daily average. Just before Home Power goes to press, both computers and lights are running all night.

Inverter Powered Appliances
We use about 660 W-hrs/day as 120 vac from our inverter. The majority (over 50% of our total consumption) of this energy is consumed by our two Macintosh computers and their printer. The remainder of the 120 vac is consumed by various motorized household appliances.

12 VDC Powered Appliances
We use about 480 W-hrs/day as 12 VDC directly from the batteries. Our system grew up when efficient inverters that lasted where a fantasy. As such, we have wired the "Plywood Palace" extensively for 12 VDC usage, and have accumulated many specialized DC appliances.

The major consumer of 12 VDC is a 28 Watt (measured by us) fluorescent light made by the Solar Retrofit Consortium (see their Mercantile ad in this issue). This light is on the ceiling of our main work room and operates an average of 4 hours daily. Before we had this fluorescent we used several incandescent car tail lights. Changing to fluorescent lights significantly reduced our power consumption. For a report on this fluorescent see our "Things that Work!" review of it in Home Power #4.

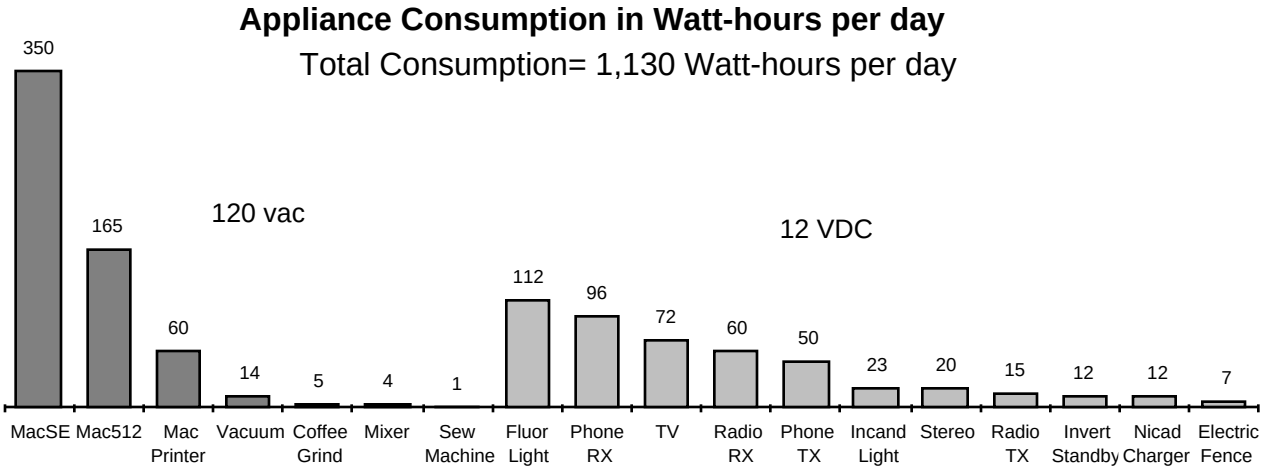
We power a number of electronic devices directly from our batteries. A full duplex UHF radiotelephone, 9 inch color TV, cassette/FM stereo, 2 meter FM ham radio, HF ham radio, a nicad recharger (see Home Power #5), and an electronic field fence charger are some of the specialized 12 VDC appliances. Below is a chart of our appliances' power consumption.

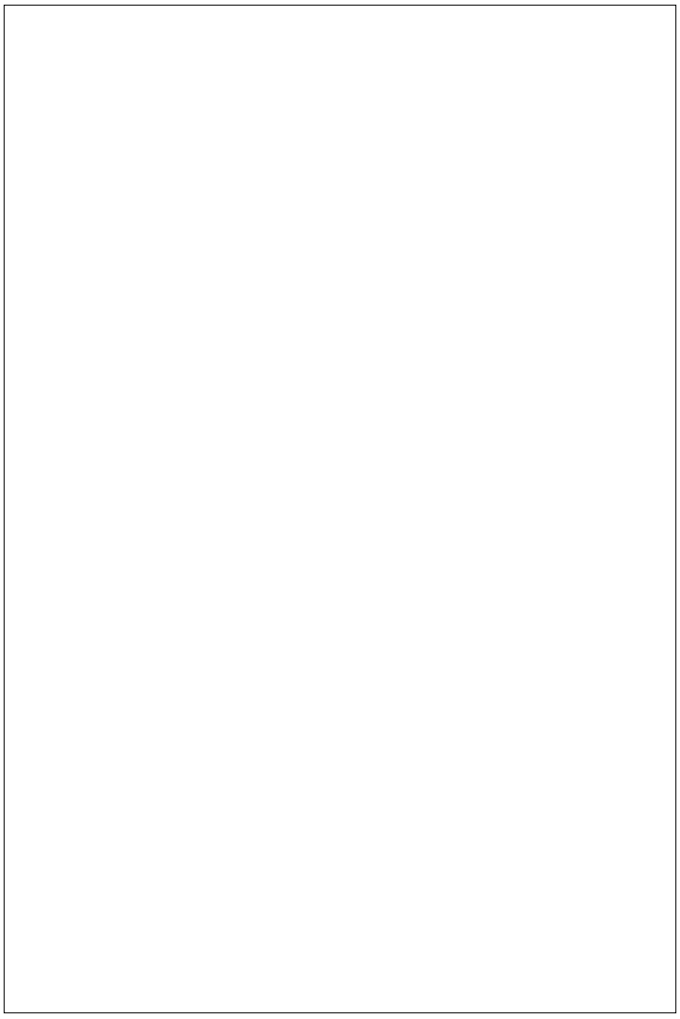
System Components
The hardware in our system reflects its organic growth. If we were to specify this system today, it would be very different. We've used what we had…

Power Source- Photovoltaics
The main input to our system is 3 Kyocera PV modules. We now use two 48 W and one 59 W module. We purchased the 59 W module to test its performance against the lower voltage 48 W module. The modules are made of the same PV cells, but differ in number of series PV cells. Our experience shows that the 48 Watt modules are more cost effective in 12 VDC systems such as ours. For a discussion of the relative merits of the different sized modules please see Home Power #3, page 9.

We are now about 70% solar powered. We (with extensive help from George Patterson of Santa Rosa, CA) installed a cumulative Ampere-hour meter on the PV array. Our PV array of 3 modules produces a maximum of 63 Amp-hrs daily. Currently we are not using any regulation on the array. This is possible because the array's output is less than our average consumption and overcharging the batteries via the PVs just doesn't happen. When we add more PV modules, then we will have to add regulation to keep from overcharging the batteries. Due to our altitude & clear skys, our PV modules outperform Kyocera's specifications. The PV array has sunshine from dawn to about 4 PM daily. We have been keeping records of solar insolation at our site since 1985. Our records indicate an average of 242 full sun days yearly. This data is interesting when compared to the US Weather Bureau's records for our area. The official records show much lower solar insolation. Consider where the solar insolation data for your neighborhood is taken. It is most often at a site that is convenient for the weather bureau. If you are at a higher altitude, then there is less atmosphere to absorb the sunlight, and your solar insolation may be greater than the official figures.

Power Source- Engine/12 VDC Alternator
When it's cloudy, or when we need extra power, we fall back on our gasoline generator. This generator uses a 5 HP, single cylinder, Honda engine driving a 70 Amp Chrysler automotive





The PV Array. Photo by Brian Green

alternator. The engine is coupled to the alternator via a 6 in. pulley on the engine, a 1/2 in. Vee belt, and the stock alternator pulley. A Mark VI Field Controller regulates both the amperage output of the alternator and its maximum voltage output. For a complete discussion, with photos, of this engine/generator & its control system see Home Power #2, pgs 23-26. Before we had PVs, this generator was our only power input. We have used a variety of engines & the Honda engines are the best. The one now on our generator has operated for 7,343 hours (we have an hour meter). The only failure was in its ignition system. We made an electronic ignition to replace the stock magneto (see the engine article in this issue). Our Honda still doesn't consume ANY oil between changes.

With the 3 PV modules, we are running our engine about 980 hours yearly. Most of this occurs in the winter. In the summer we may go for over a month without using the generator at all. Operation of the engine/generator now costs us about $19 a month. Without the PVs, we would be running our engine about 2,000 hours per year, and spending some $40. per month. The addition of 2 more PV modules will reduce our engine/generator operating time to less than 475 hours a year. And you can believe we are saving our bucks for these additional PV modules.

Energy Storage- Batteries

In 1980 we purchased 2 Trojan L-16W batteries. We are still using this battery pack, which has a capacity of 350 Amp-hrs at 12 VDC. This pack gives us about 3 days of energy storage. The energy supplied by the PVs extends the average storage period to almost 6 days. With 5 PVs in our array the average storage in this battery pack would be 11 days.

We need more battery capacity in our system. The addition of 2 or 4 more L-16Ws would be cost effective. It would reduce our generator operating time, saving us money. We have not added more batteries because our batteries are so old. In our experience, it is not effective to assemble packs of dissimilar batteries. Age and size are such dissimilarities. An efficient battery pack should be composed only of cells that are of the same type, size and age. Batteries that differ in age by over two years should not be assembled into packs, even if they are of the same type and capacity. With 8 years of service on the pack, we should get another 2 years use before replacing it.

This expected 10 year lifetime reflects very careful cycling and maintenance. We NEVER withdraw more than 80% of the pack's energy. An advantage of the engine/generator is we can recharge our pack at will. We don't let the batteries languish at low states of charge; this courts sulphation and premature cell failure. Use only DISTILLED WATER to replace lost electrolyte. We keep our batteries and their electrical connections clean. The thin film of acid that collects on the batteries is an electrical conductor. Since the L-16s have external inter–cell connections, this electrolyte forms short circuits between the cells. This increases self-discharge, and state of charge inequalities between the cells. We are careful to do regular equalizing charges. About once a month, we completely recharge our batteries and then give them a controlled overcharge at the C/20 rate for at least six hours. A C/20 rate for our 350 Amp-hr pack is 17.5 Amps (350 Amp-hrs/20 hrs = 17.5 Amps). The secrets of battery longevity are: 1) proper cycling, 2) regular equalizing charges, & 3) regular maintenance.

Energy Conversion- Inverter

Our first computer (1984) led us to install an inverter. Over the years we used several inverters. Some self-destructed rapidly for no apparent reason, and some lasted. The inverter is a critical link in an RE system. It allows the low voltage PV energy to be used as 120 vac. Two inverters we have used are worthy of mention- the Trace 1512 (now the 2012) and Heliotrope PSTT inverter. These inverters not only work and are very efficient, but they LAST. The Heliotrope currently powers our computer equipment beautifully- no additional heat is generated within the computer's power supplies..

The Batteries and Inverter. Photo by Brian Green

The Heliotrope has an output power of 2,300 watts continuous, surge to over 6,000 watts. The WF 12-2300 has enough power that we haven't used our 120 vac powerplant for months. This inverter runs all of our shop tools, such as our circular saw, drills, soldering irons and our monster, 1/2 HP split-phase bench grinder. I doubt that we will outgrow this inverter within the next few years. For info on the Heliotrope, please see Home Power #3, pgs 29-31. For info on the Trace, please see Home Power #2, pgs 29-30.

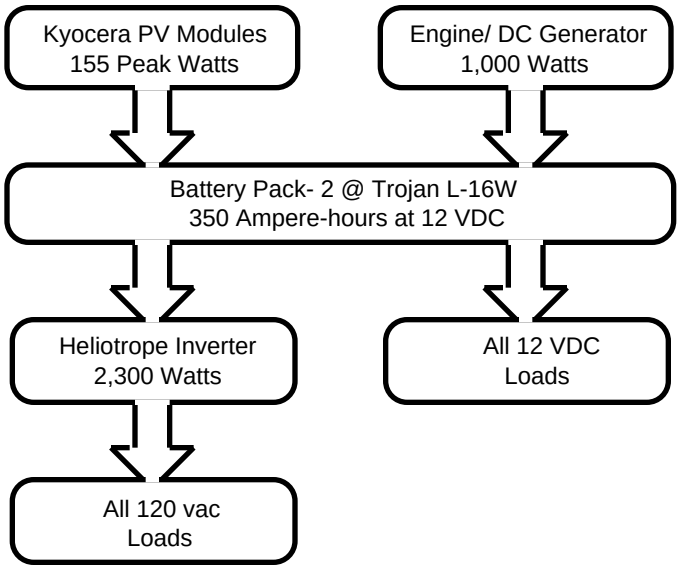
The inverter is wired to our batteries via short, 0 gauge, copper cables with homemade, soldered, copper connectors. It is essential that any inverter have a very low resistance path to

the battery's energy. On surges, a powerful inverter can draw over 500 Amperes from the batteries. Our cable ends are filled with solder to resist the inevitable corrosion involved with battery connection. See the battery article in this issue.

System Cost

We have invested about $4,500 in hardware. The three PV panels cost $1,068, the Trojan L-16W batteries cost $490, the engine/generator cost about $1,100 to construct, and the Heliotrope inverter cost $1,720. All these prices include shipping to our site. This hardware cost info is presented as a pie chart below.

If the engine/generator operating expenses are figured into our system's cost, we will spend about $6,800. to both buy and operate this system over 10 years. This power cost, right now, is $1.64 per kiloWatt-hour (kWH). While this may not look so swell when compared with our local utility's rate of 7¢ per kWH, consider the $235,000 that the Power Co. wants just to run the lines. The way I look at it, we've got all the electricity we need and saved some $228,000. If there were no PVs making electricity for us we could expect to pay $8,121 over 10 years to run this system, or $1.96 per kWH. With 5 PVs in our array, the 10 year cost would be $6,366, or $1.53 per kWH. If you're making your own electricity, PVs can really save you money.



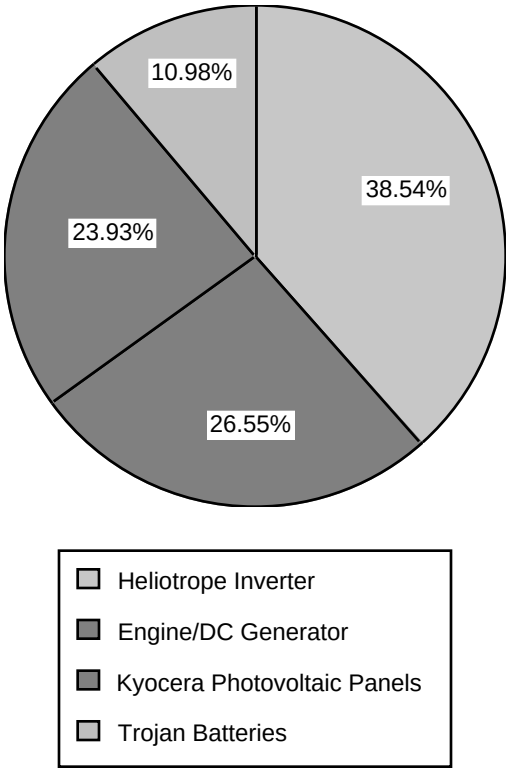
The graph below shows how PVs financially impact our system.

Some Valuable Lessons

This article is a chronicle of experience, not an optimum way to design a system. We've had to learn the hard way- by making mistakes. We are still living with some of our mistakes. You can profit from our errors. So here are some suggestions.

• Plan well ahead when you design your system. Do a comprehensive, accurate, long-term estimate of your needs before you buy any system components. We were short-sighted. For example, we purchased too few batteries. This has caused us to spend much more money on generator operation. Look well ahead to your energy needs not only next year, but for at least five to ten years.

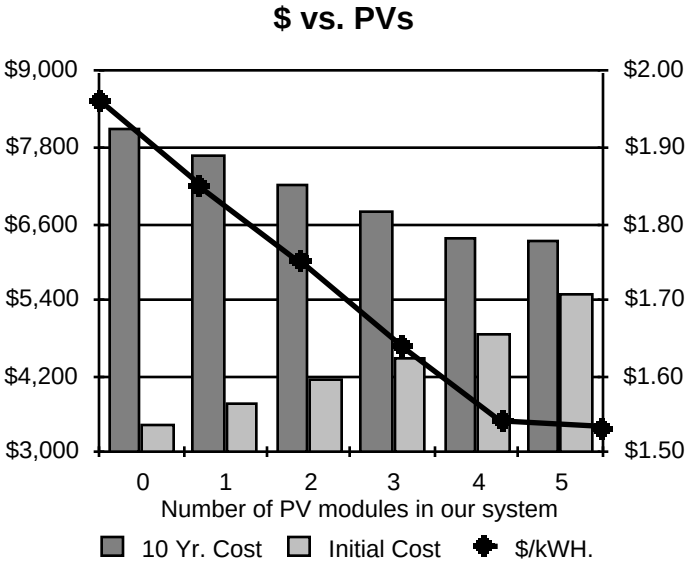
• Don't think twice about purchasing PVs. Money spent on PVs rapidly comes back. There is no comparison between using gasoline or sunlight as power inputs. With fossil fuels we get noise, pollution and the way things **were** done. With PVs, we get silence, freedom and the way things are going to be. Let the future into your life & use the Sun's power.



• Don't be tempted to buy the least expensive system components. Your home power system should last for at least 10 years. System components designed with cost as their primary criteria are not going to last. Stick with equipment that has documented longevity, it will be cheaper over time, eventhough it costs more to initially buy.

• Seek help from experienced people when you specify & purchase your components. Details such as how many batteries, system voltage, how many PV modules, and what

size inverter are critical to system efficiency and cost effectiveness. If you are in ANY doubt about the equipment you require, enlist the aid of those with the experience necessary to specify a system that meets your needs at the minimum cost.



• Learn all you can about your system and how to operate it. You are your own power company. The longevity and performance of your system depends on your involvement in its operation and maintenance. You'll have no one to blame, but yourself, if the lights go out.

• Consider the appliances that use or will use energy in your system. In home power systems, it is ALWAYS more cost effective to buy the most energy efficient appliances available. Appliances like RE refrigerators & fluorescent lighting will pay for themselves because of reduced power consumption.

• Feel good about your system. Through the use of renewable energy, you show the way to a clean & sane future we can all share. Give the Earth a break & use renewable energy!

The Home Power Crew in Action

Left: Richard & Duppy at the controls of Home Power Central.
Bottom Left: Karen uses a PV powered Mac to enter articles, edit and maintain Home Power's data bases.
Below Center: The Wiz handles the severe nerding at Home Power.
Below Right: Brian, the Home Power Photographer, at the radios.
Right: Everyone gets in the act. "Patience",Karen's horse, keeps cool with an AEE PV powered hat.

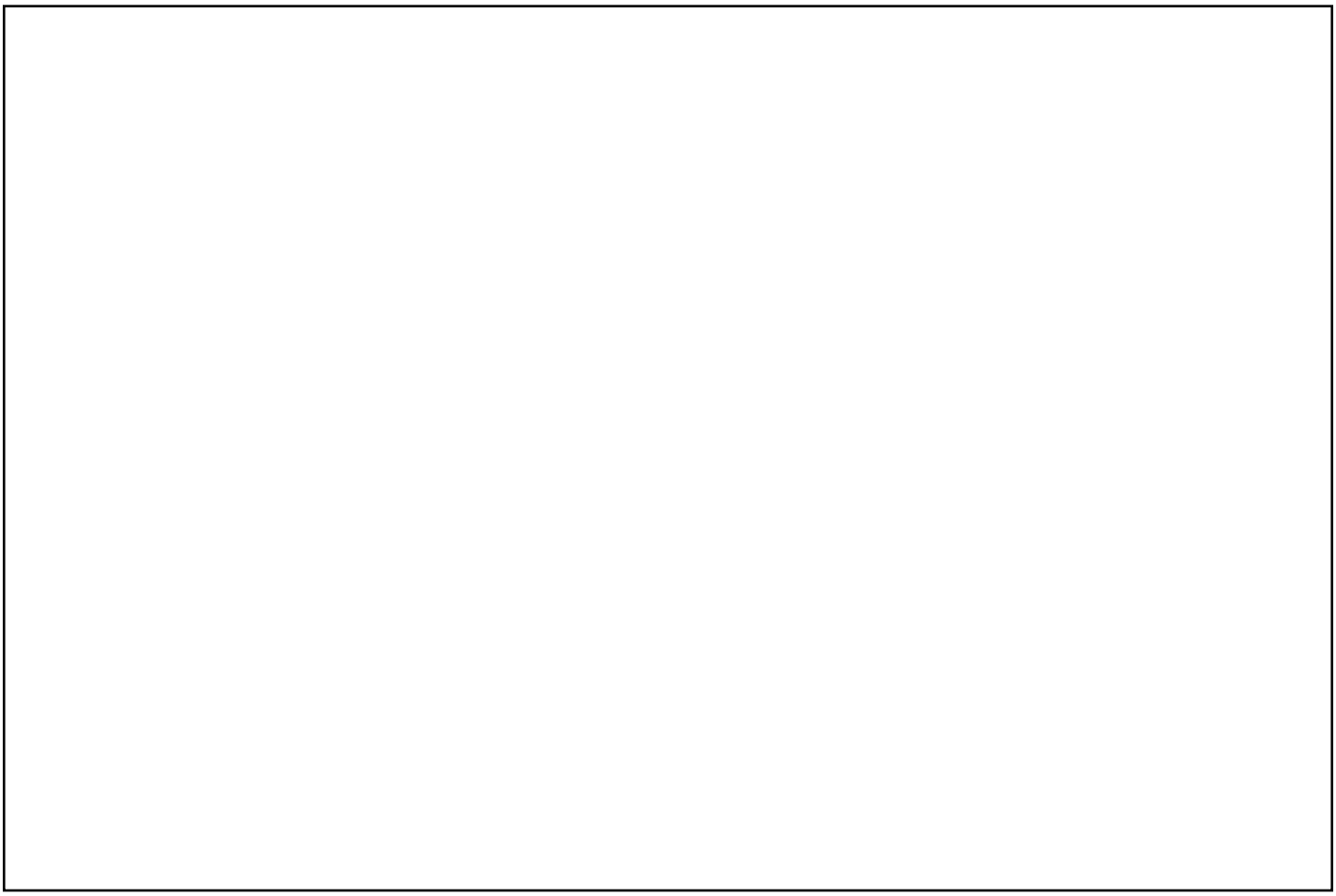
Photos by Brian Geen & Richard Perez

Support HP Advertisers!

Cookin' with Sunshine

Ed Eaton

In just a few days, the sun showers us with energy equal to all the earth's fossil fuels. Consider our environment and its condition; using solar energy seems only logical. One way to use the sun is to cook with the energy. We can bake, fry, steam, or even solarque our favorite dish right in our own backyard.



Three styles of solar ovens and a solar cooker. Note the cast iron skillet in the cooker (left) for size reference. The large oven on the right uses mirrors as does the smaller oven at top. The cooker on the left and the oven below use metal reflectors to concentrate solar energy. Photo by Ed Eaton

Brief History

Successful solar cookers were reported in Europe and India as early as the 18th century. The increased use of glass during that period helped inventors to trap heat & hot air. In 1870, Augustine Mouchot invented a fairly portable oven for the French Foreign Legion. It could bake a pound of bread in 45 minutes or 2 pounds of potatoes in one hour.

Around the same time, W. A. Adams developed an eight-sided mirrored oven which reflected light through a glass cone located in the center of the oven. This oven could cook a 12 pound turkey in 4 to 5 hours. This is still a popular design today. We actually use a large model, very similar to Adam's oven. In this oven we can cook 60 pounds of food at a time.

Present Times

Heat

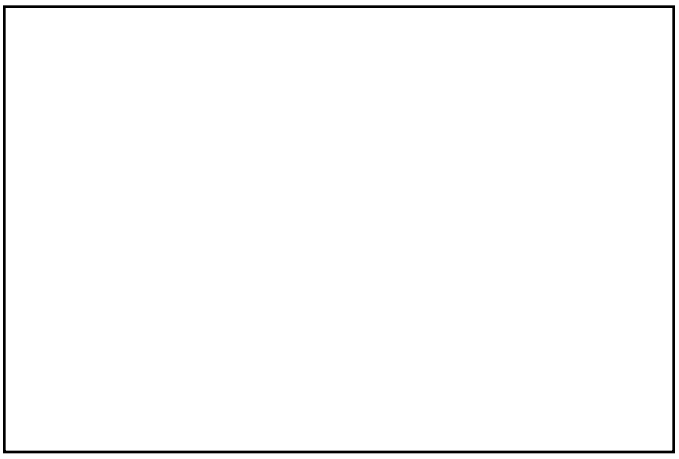
Interest in solar energy seems to fluctuate along with the price of fuels (oil in particular). We feel a new awareness is blooming. It is due to the ever growing concerns about OUR planet EARTH and our desire to help Earth out! Solar cooking enables us to contribute in a small, simple way.

How It Works
Sunlight is concentrated in a cooking area by using mirrors or any reflective surface. Consider a car parked in the sun with all the windows up. The sunlight is absorbed as heat by the car's interior. The rolled up windows help keep the heat and hot air within the car. In a solar oven heat is captured inside an enclosed area and is absorbed by the food and pots or pans. This is called the greenhouse effect and applies to cars, solar cookers and planets. In solar ovens, temperatures as high as 425°F can be achieved.

Solar Ovens
Ovens come in may shapes and sizes. For example there are: box ovens • slant-faced • multi-mirrored • four sided pyramids..... This list could go on forever.

Designs vary, but all OVENS trap heat in some form of insulated compartment. In most of these designs the sun actually strikes the food. It is pleasing that the sun's energy is absorbed by the food we eat.

Our Favorite Oven
The Slant-Faced Oven. We use 3 of these, along with other designs. One nice feature of this oven is that it works in the



Ed Eaton with Our Sun's new 1988 Solar Oven.
The mirrors are backed with steel; this slant faced oven

winter. For the avid solar cooker, this is essential to roast the Christmas turkey! Its ease of construction is nice too. You can vary from the design readily, so you can use available materials. The oven is fairly portable and very durable. The compartment size can be nice and big too. This design is capable of exceeding 400°F. They generally cook at 325°F to 350°F.

Solar Cookers & Steamers
Cookers or hot-plates concentrate light on a focal point. They are used for frying or by holding the food in the focal point (like a hot dog on a stick). Use caution with a cooker, especially when children are around. Intensified light can cause fires, burns and be harmful to the eyes.

Steamers work just like they sound. The cooker's heat boils water to make steam, which cooks the food. I have seen designs that are just a solar hot water collector. Simply directing steam to a box with a relief valve on it. Just like a pressure cooker, except the sun provides the power.

Facts on Constructing Solar Ovens & Cookers
There are some important facts to know when building a solar oven. One is to: GO FOR IT. Don't be afraid to experiment. That is how progress is made.

A Solar Cooker focuses light on the frypan to cook the food. Note the simple construction. Photo by Ed Eaton

• When choosing insulation, be sure to use insulation that will not out-gas. Ask your supplier if the insulation can handle high temperatures. Some will actually break down at 250°F and lose their insulation capability. Stay away from ALL foam type insulation. We recommend duct-board insulation. It's made of pressed fiberglass with strong, waffle-like foil on one side. Regular fiberglass insulation works fine also. Just be sure to cover it some how, insulation tastes horrible.

• Paint the inside of your oven black with non-toxic, lead free paint. A good paint is equal parts of black tempera powder, white glue and water. Simply mix together and brush on.

• Use dark cooking containers. Stay away from shiny pots & pans which reflect light instead of absorbing it. We use cast iron pots with glass lids. Cast iron cooks well and retains heat. With the glass top, you actually have an oven inside of an oven and you can see your food cooking.

• Cooking bags can be used for those bigger foods, such as turkeys, roasts, etc. They are very durable and can be purchased at most markets. Be sure not to tie these real tight as they expand when the heat can't escape.

• Good reflectors are very important. Make your reflector surface as large as the area you are reflecting into. Reflectors can be made out of aluminum foil, reflective mylar, glass mirror, polished aluminum, stainless steel or any item that reflects light well. We use mirrors because you can clean glass easily and repeatedly. This is a strong point, although

they are cumbersome for portable ovens.

• Try to use at least double strength glass. Lighter glass seems to crack when cooling down. Leave room for the expansion of your glass.

• A metal liner for the inside of your oven is a good idea, it retains heat and keep spills in check. Our first oven had cardboard reflectors with aluminum foil glued on. This worked fine until it got wet. But by that time we had saved up for some mirrors.

• Our reflectors here in the southwest work very well when set 120° from the surface of the front glass. You might want to make a cheap cardboard reflector, like mentioned above, and see what fits your needs.

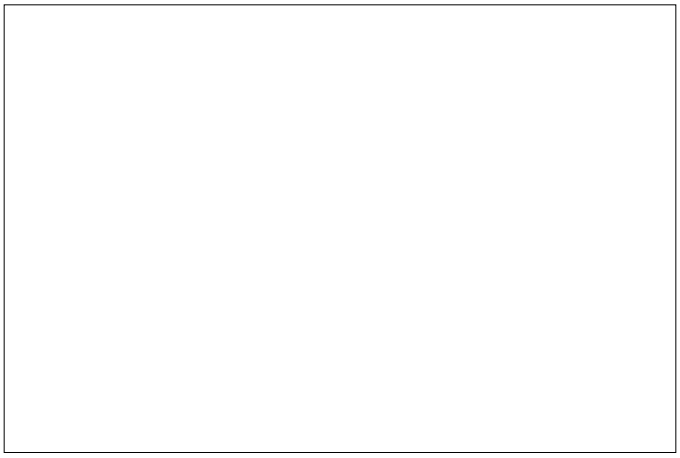
•The front angle of your oven will differ according to your latitude. To be quite honest, I don't know how critical this is. I'm sure it does apply if your latitude is very far north or south. We in Tucson have great success with angles of 30° to 50°, and in winter we use 60°.

Quick Tips

• Clear sunshine is essential for cooking. You can cook on partly cloudy days but it will take longer. On very cloudy days, FORGET IT!

• The outside temperature is not a big concern. We have cooked at 9,000 ft. in 3 feet snow. It's the amount of sunshine that's critical.

• The time required will vary according to the type of oven you have and the time of day you cook. Most dishes take about the same time as a conventional oven once your oven reaches operating temperature. Prepare your dinner in the morning instead of the evening. You'll go home and eat while your friends go home and cook. All it takes is some practice.



A Slant-Faced Oven using steel backed mirrors to direct

• Need $ incentives? For each dollar spent on conventional cooking inside an air conditioned home, an additional three dollars will be spent cooling the house back down (according to a study done by Arizona Public Service Co.).

• Solar ovens are great for camping or at the beach. They use no flame and can be used in fire restricted areas.

The Tucson Solar Potluck & Exhibition

Nancy & I attended the 2nd Annual Solar Cookoff in Phoenix AZ in 1982. It was a great event, about 60 solar ovens in a cooking contest. The problem was that only judges got to taste all the great food. This is when my brain got in gear. Zap, we should organize an event with other solar applications included and have a BIG potluck dinner at day's end for everyone to share. Potluck attendees could sample solar cooked food and see other renewable energy applications as well.

We worked hard with several close friends and others interested, writing, calling, begging, etc. Well, about 30 people set up ovens and 300 to 400 people showed up during the whole day. 125 people ate dinner! It was a big success. We had music and stories for the kids. We had PVs, hot water, solar greenhouse displays & more. I have seen cooking devices made from the most unbelievable materials. One fellow this year used three M-75 ARCO PV panels hooked up to an inductive coil inside a small insulated box. He made cookies all day. Food samples are handed out all day, the favorite seems to be our solar cooked pizza.

Picture a beautiful panoramic view of the Santa Catalina Mtns, while you are nestled at a lower elevation amongst the mesquite trees. Solar ovens are everywhere, each emitting its own tantalizing smell. The sound of live music is in the air, powered by PV. People are having fun and exchanging ideas all around you. The Sun is alive and well at Catalina State Park! The Solar Potluck has grown with time & continues to thrive. Attendance has varied over the years, this year 350 to 400 people showed up. Most people come, observe and go on their way. But next year, a few of those same people will show up with some type of solar project of their own.

This event is organized by a loosely formed group; citizens for Solar Cookery. We are not real formal but we get the job done. Money is not the issue here, it's solar consciousness we want to spread. There is a $2 charge to enter the park itself, but it's worth it. The park has trails, camping and represents the vast Sonaran Desert well. Obviously this event requires some money to make it happen. We never received any financial help, except for donations to cover our beer supply and through the sale of "T" shirts. This keeps us free from greed motivated interests which have different objectives than ours. We welcome all advice and especially welcome any literature, for handouts at the Potluck, that we can get. Camping is available, and we invite everyone to attend.

As far as we know, this is the only ANNUAL solar event for the general public in the U.S. I hope I am wrong and strongly welcome news to the contrary. Unfortunately, the date for the 7th Annual Tucson Solar Potluck and Exhibition is not yet set. We cannot reserve the park area more than six months in advance. I promise the date will be in Home Power when we set it in December. The Potluck is usually in late April or early May.

If anyone would like info on solar cooking or on the Potluck please write or call, Ed Eaton, POB 55891, Tucson, AZ 85703

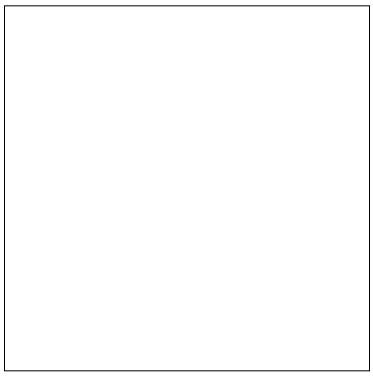
or 602-325-7860. Heck, just call to talk if you want to. This article was written by one person but the story has many, many names behind it....Nancy, Ron, Karen, Tony, Chunky, Bob, The Halacys, The Blankenships and more… Peace, Ed Eaton.

Good Sun Cooking Reading

"The Solar Cookery Book",by Beth and Dan HalacyPeace Press.

"Solar Cooking Naturally" by Doris Stutzman, HCR Box 305 J, Payson, AZ 85541.

"A Golden Thread, 2500 years of Solar Architecture & Technology" by Ken Butti and John Perlin, Cheshire Books.



A Regulator for All Sources & Seasons

Dale Glaser

At certain times of the year, many of us have more renewable energy power available than we actually need to keep our batteries charged. You may, for example, have enough solar power for winter use, but then have too much in the summer. Or you may use solar in the summer and add hydro power in the winter, but have more hydro power than you actually need since it's coming in 24 hours a day.

So power needs can vary throughout the year. What do you do when you have more power than needed to charge your batteries? I know some folks who monitor their batteries and shut off the incoming power when necessary, and others who just keep adding water to their batteries (and seem to go through batteries quickly!).

Many people now use voltage regulators to control their individual sources of power. But while automatic regulation is the best way to protect your battery investment, it may not always be economical, because if you have more than one energy source, you have to pay for multiple regulation

So, what would the ideal regulator in a renewable energy system be like? Here's my own wish list.

1. It would need to be easy to install and calibrate.
2. It would need to be adjustable for different seasonal temperatures, types and ages of batteries. And again you should be able to do this easily.
3. It would be nice to have "one regulator fits all", one regulator that would work with all the power sources in your energy system, including additional sources you might add in the future.
4. It would be rugged, and dependable.
5. (And why not?) It would be a regulator that not only protects your batteries from overcharge, but also gives that extra power back for other uses, like heating water, pumping water, running fans or lights, etc.
6. How about a regulator which was reasonably priced for what you got.
7. And finally, it would be fairly "idiot- proof." I'm not implying anything about myself, mind you, it's just that sometimes I'm not paying quite as much attention as other times. I'd hate to lose my investment in a voltage regulator during one swift lack of attention.

Well, lo and behold, there is a regulator around that meets these requirements! It's the EnerMaxer Universal Voltage Regulator made by the Enermax Corporation. This regulator taper charges your battery and very efficiently diverts the extra power to another load such as a water heater element, lights, etc. And the EnerMaxer will regulate up to 50 amps of current.

What's interesting is that the EnerMaxer is different than many regulators in that it doesn't connect BETWEEN a power source and your battery like most regulators, but connects right to the battery itself. Therefore it is "universal" in the sense that it can act as a single regulator for any number of power sources charging your battery. You don't need any other regulation on your renewable energy system besides the EnerMaxer.

It's Easy to Use

You simply connect the regulator (via a fuse) to the battery, and connect the output to the desired diversion load . Then you use one of two methods (described shortly) to adjust the regulator to the desired float voltage for your batteries.

What is the significance of the "float voltage" of a battery? For every lead acid battery there is an ideal float voltage which allows the maximum amount of power to be stored in the battery. This float voltage lightly gases the battery to prevent stratification of the acid and water, and prolongs the life of your battery by reducing the expansion and contraction of the plates which occurs during the charge cycle. A given battery's "ideal" float voltage will vary with temperature, battery age, antimony content, and electrolyte concentration of the battery when it was manufactured. The EnerMaxer takes all these variables into account when you calibrate the EnerMaxer regulator with the adjustment knob on the regulator's front.

Once you set the float voltage, the regulator will hold the battery to that voltage. If your power sources keep pumping power into the battery and try to drive the voltage higher than the adjusted float voltage, the regulator sends that extra power to the diversion load. On the other hand, as soon as you start using enough power to draw the battery voltage below the adjusted float voltage, the regulator stops diverting power.

This changeover from power going into the batteries to power being sent to a diversion load is instantaneous and very smooth, because the regulator is electronically sampling and diverting power at a rate of 400 cycles per second.

By holding precisely the right float voltage and gradually tapering off the charging amperage, your batteries are filled to their maximum charge capacity with minimum stress on the battery plates.
Why is there stress on battery plates? Whenever a lead acid battery is charged and discharged the battery plates expand and contract slightly as they undergo chemical change. Over time this expansion and contraction causes active material to flake off the plates and build up on the bottom of the battery cells. Holding a steady float voltage greatly reduces this problem and extends battery life.

The Calibration Process

The float voltage adjustment is made with a knob on the front

of the regulator. This knob has no "calibration" markings because the calibration adjustment you make will be unique to your battery, and its type, size, and age.

Calibration is easily done in one of two ways. Both these methods assume you have a fully charged battery and your power sources are continuing to supply power to the battery. And for both methods, you start by turning the adjustment knob fully clockwise (the maximum float voltage adjust point).

The first calibration method uses a voltmeter connected to the battery terminals. This method assumes you know what float voltage you want on your battery and is best used for new batteries where you can get the proper float voltage information from the battery dealer. You simply turn the adjustment knob on the regulator counterclockwise until the desired float voltage registers on the meter. Then mark the adjustment pointer position on the face plate. And you're calibrated!

The second method involves letting the battery charge until it is gassing - gassing occurs when a battery has absorbed almost all the charge it can. At that point, the extra power starts breaking down water into hydrogen and oxygen gases. Turn the adjustment knob slowly counter-clockwise until the battery is barely gassing, make your calibration mark, and you are calibrated!

There are a couple of situations where you might want to have more than one calibration adjustment mark on the regulator. One is to take account of seasonal temperature changes. This is because the internal resistance of a battery changes with temperature, and it takes a higher voltage to push power into the battery in the winter than in the summer. Therefore, some people have a "summer adjust point" (a lower float voltage setting) and a "winter adjust point" (a higher float voltage setting) to obtain maximum seasonal efficiency.

Another adjustment might be made in order to give your batteries an “equalizing charge” to correct uneven cell voltages. An equalizing charge is a gentle controlled over-charge, usually at a voltage higher than the float voltage, which allows low cells of the battery to charge up.

Once adjusted, the EnerMaxer will work automatically to optimize the charge going into your battery. The regulator will control any type or combination of battery charging source(s) - solar, hydro, wind, generator, etc. - within its 50 amp power handling capability, at either 12 or 24 volts.

Use the Extra Power to Heat Water

A very common use for the extra battery power you get from your EnerMaxer is to heat water. The water heater element in an electric water heater is easily replaced with a 12 Volt element (available from EnerMax or elsewhere). These elements come in different power ratings so you need to have some idea how much extra power you will be generating that will be used to heat water.

Some "Idiot Proofing" built-in

If you put a screwdriver across the output terminals of the EnerMax, it immediately shuts itself down, without damage. As soon as the short is removed, the regulator begins working again. Pretty nice.

The regulator will, however, fail if you reverse the polarity of the input leads during installation. However, a numbered connection sequence diagram is provided in the owner’s manual. You shouldn’t have a problem if you follow the diagram.

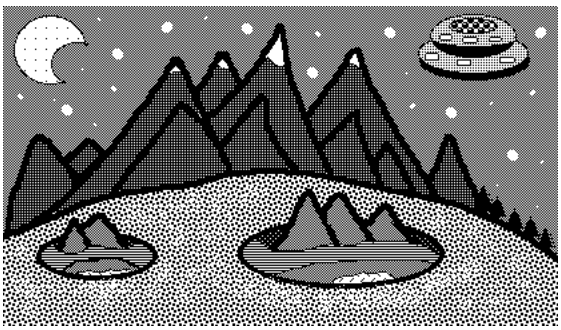
Cost

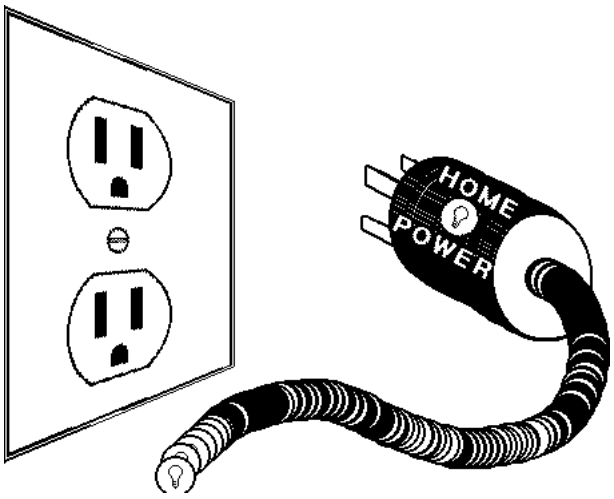
At $249 the EnerMaxer is certainly isn't the least expensive regulator on the market today. But it may be a bargain when you consider the longer battery life you'll get because of the smoothly tapered float charge. And because of its 50 Ampere capability and multiple charging source regulation, you will probably need only this one regulator for your entire system.

About the author:

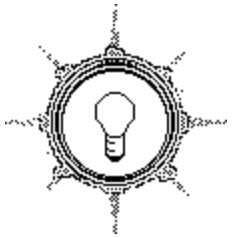
Dale Glaser is an renewable energy user and enthusiast who lives in the back country of Mendocino County in California. He was one of the original principles of the Burkhardt Turbines Residential Hydroelectric business, and has been tinkering with applying electronics to 12 Volt energy systems for years. He currently works as a reporter for an alternative paper in Mendocino County, and has written extensively in his paper on renewable energy, and alternative sanitation. He occasionally helps people install 12 Volt energy systems.

Enermax can be reached at POB 1436, Ukiah, CA 95482, or call 707-462-7604.





Home Power's Business



Display Advertising

Full Page	$1,200	67.5 sq. in.
Half Page	$672	33.8 sq. in.
Third Page	$480	22.5 sq. in.
Quarter Page	$377	16.9 sq. in.
Sixth Page	$267	11.3 sq. in.
Eighth Page	$214	8.5 sq. in.

Maximimum Vertical Ad size is 9 inches
Maximum Horizontal Ad size is 7.5 inches

We use Macintosh computers to publish Home Power. We can set up and lay out your display ad. Camera ready advertising is also accepted. For current, detailed reader demographics, call us.

Long term display advertising is discounted, so buy ahead and save.

Home Power is published bi-monthly. Ad Deadline for the Dec/Jan 88/89 issue is 15 Nov 88.

Call **916-475-3179** for further details.

International Subscriptions

Due to the high cost of international mailing and packaging requirements, we must charge for copies of Home Power that are mailed anywhere that doesn't have a US ZIP CODE.

2 YEAR- 12 ISSUES
INTERNATIONAL RATES:

Mexico or Canada: Air- $24. Surface: $21.
Central America, Bahamas, Bermuda, Columbia and Venezuela: Air- $32. Surface: $ 23.
South America (except Columbia and Venezuela), Europe, North Africa: Air- $40. Surface- $23.
Asia, Australia, New Zealand,Pacific Ocean Islands, Africa (other than North Africa), Indian Ocean Islands, & the Middle East- Air $49. Surface $23.

All payments in US currency ONLY!

Surface shipping may take up to 2 months to get to you. All issues shipped in mailing envelopes to withstand the rigors of international mailing. If you have friends with a US Zip code who regularly send you packages, then we would be glad to ship them an extra free copy for forwarding to you. Bulk mailing to Canada or Mexico, write for info.

Home Power Mercantile

One insertion per customer per issue.
We typeset all ads. We do the best we can to make your ad look good. If you send too much copy, then you're bound to be disappointed. Flat Rate $80.
Advance payment only, we don't bill Mercantile Ads.
See other Mercantile suggestions on page 48.

Back Issues

All back issues are $2 each, while they last.
Shipped in an envelope via first class mail.

Issues 2,3,4,5, 6 & 7 are currently available. Sorry no more Issue #1s are available.

Home Power Magazine
POB 130, Hornbrook, CA 96044

MicroAds

These ads are designed for individuals rather than companies. So use your discretion. The rates are 5¢ per character, including spaces & punctuation.

Printing & Distribution Info for HP#7

Copies Printed = 10,000
Copies mailed under labels = 6,397
Copies shipped in bulk = 2,525
Call or write for bulk shipment info.

Home Power Magazine is FREE

Subscription Form

Free to those with US ZIP CODES ONLY. For international subscriptions see page 22.

If you want to receive Home Power Magazine, please completely fill out our free subscription form below, fold it up, tape it, put a 25¢ stamp on it & drop it in the mail. **You need only do this once**. Once you have responded to Home Power, we will send you each and every subsequent issue free. We encourage you to use this form to communicate with us. Please check the box(s) below that apply to your communication. This helps us deal with the mail. For those wishing **Back Issues of Home Power**, please see page 22.

☐ New Subscription ☐ Change of Address Include old Address ☐ New Info on your System ☐ Other

PLEASE PRINT

NAME _____

STREET _____

CITY _____ **STATE** _____ **ZIP** _____

The following information regarding your usage of alternative energy will help us produce a magazine that better serves your interests. This information will be held confidential. Completion of the rest of this form is not necessary to receive a free subscription, but we would greatly appreciate this information so we may better serve you.

FOR OUR PURPOSES WE DEFINE ALTERNATIVE ENERGY AS ANY ELECTRICAL POWER NOT PRODUCED BY OR PURCHASED FROM A COMMERCIAL ELECTRIC UTILITY.

I NOW use alternative energy (check one that best applies to your situation).

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

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

I want to use alternative energy in the FUTURE (check one that best applies).

☐ **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).

☐ **Photovoltaic power** ☐ **Water power**

☐ **Wind Power** ☐ **Other** _____

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
☐	☐	Battery Charger	☐	☐	Control systems
☐	☐	Instrumentation	☐	☐	PV Tracker

FOLD HERE

& TAPE

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

FOLD HERE

Return Address

_____

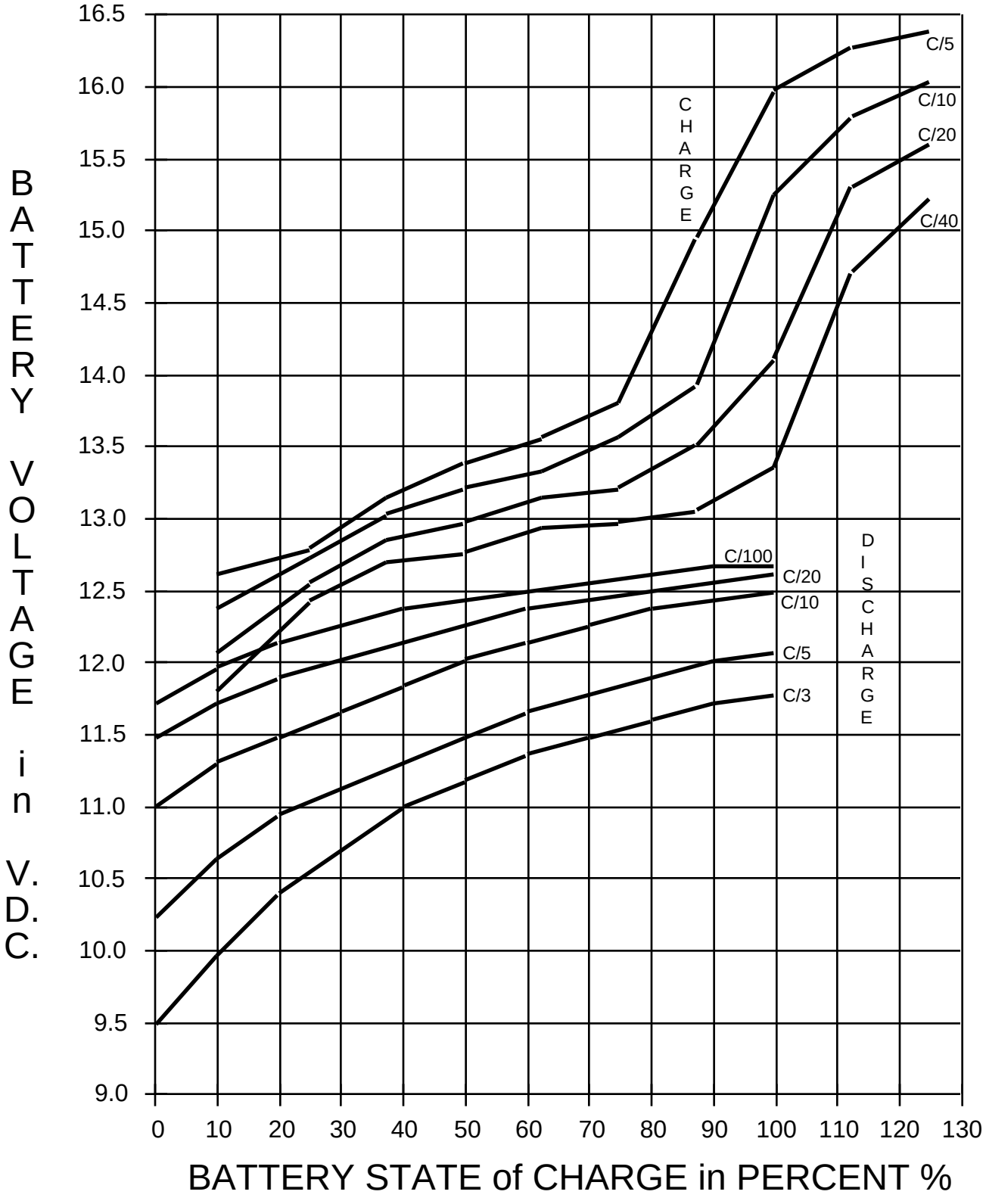
_____

_____

Place 25¢ Stamp Here

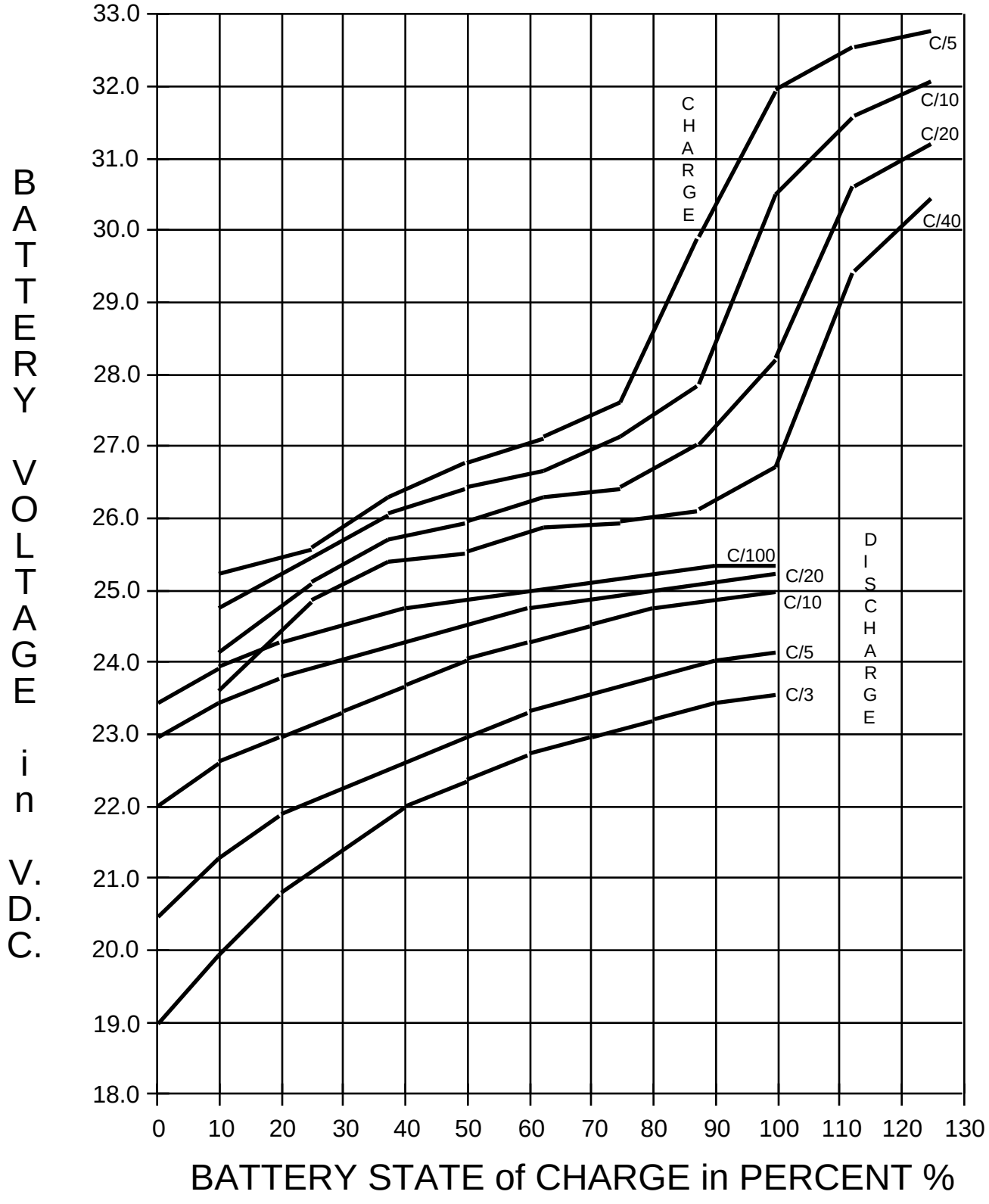
Home Power Magazine
Post Office Box 130
Hornbrook, CA 96044-0130

12 Volt Lead-Acid Battery Chart-78°F.



Home Power Magazine
POB 130, Hornbrook, CA 96044 USA • 916-475-3179

24 Volt Lead-Acid Battery Chart-78°F.



Home Power Magazine
POB 130, Hornbrook, CA 96044 USA • 916-475-3179

House Wiring, Standards & the Electrical Code

Windy Dankoff, with help from Mike Mooney

WARNING! "Cigarette lighter" type sockets are a de-facto standard for 12 Volts, only because there is not yet an official standard for DC home wiring. They are LIGHT DUTY, ALL of them, and are questionable even for the 15 Amps that SOME of them are rated for (the plugs only handle skimpy #18 lamp cord!). Use them at your "entertainment center" for your 12V stereo and TV that came with cig. lighter plugs (their current draw is very low). DO NOT USE THEM for DC lights and appliances in general! NEVER mount them within reach of children. A paper clip inserted into one of these sockets can turn red hot!

What To Use

It will probably be a long time before a true standard will emerge. Meanwhile, THERE IS A MUCH BETTER SYSTEM that many of us have been using for years. It is safe, child-resistant, easy to wire, locally available, and compatible with ordinary wiring hardware and cover plates! Go to your local electrical parts supplier and order "240 volt 15 amp horizontal-prong DUAL receptacles". They look like ordinary sockets except for the position of the prongs. Suppliers generally stock only single receptacles, but will get the duals if you order them. Plugs can be found in most hardware stores when you run out. Because these are 3-prong connectors, you can run 12 and 24 volts to the SAME receptacle.

Power Access for the AE Home

An important part of power distribution in any home is the method used to gain access to the system. The plugs and wall sockets to be used are critical.

• 120/240 vac: The standard of access for alternating current has long been established and should be used for the A.C. current developed by the inventor in the AE home. All established electrical codes should be strictly observed.

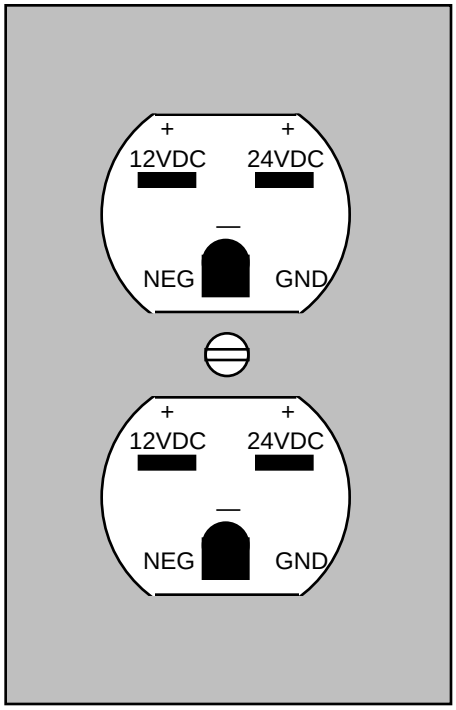
• 12/24 VDC: There is not yet a standard for low voltage D.C. power access, and it will probably be some time before one will emerge. Unfortunately, the automotive cigarette lighter type plug and socket are being used.

Sockets and plugs of this type have been adapted to conduit boxes for installation in motor homes and PV powered homes. THOSE NOW ON THE MARKET ARE FLIMSILY CONSTRUCTED, ELECTRICALLY UNSAFE, AND WE DON'T WANT ANY!

Described here, for your consideration, is an alternative method of access to the D.C. system which we have used for several years. It has proved to be both safe and child proof. As well as safety and convenience, we wanted a method which was durable, pleasing to the eye, and which would preclude any chance of cross-plugging an A.C. appliance into D.C., or vice versa. We also wanted the ability to access both 12 VDC and 24 VDC at each wall socket.

We have found the 250 volt/15 amp straight blade plug and receptacle shown below to be quite workable. The receptacles are manufactured by many in both single and duplex units, and are available in ivory, white and brown. We use the Leviton "Spec-Master" variety.

For the mating plug, we have found the 250 volt/15 amp Leviton "Spec-Master" to be a real jewel! It is very durable, looks good, provides excellent strain relief for the cord, and is very easy to assemble. Since we do use cigarette lighter plugs on occasion, we have made up a few "pigtail" pendants using



the Leviton plug and Safeco automotive adaptors (Radio Shack #RS270-1535A).

Power access is JUST ONE LINK in the chain of power distribution. In the near future we will cover THE POWER BUS, WIRE SIZE vs. LOAD and LENGTH, SPLICES and CONNECTION, CIRCUIT BREAKERS and FUSES, GROUND FAULT ANALYSIS, and SWITCHING.

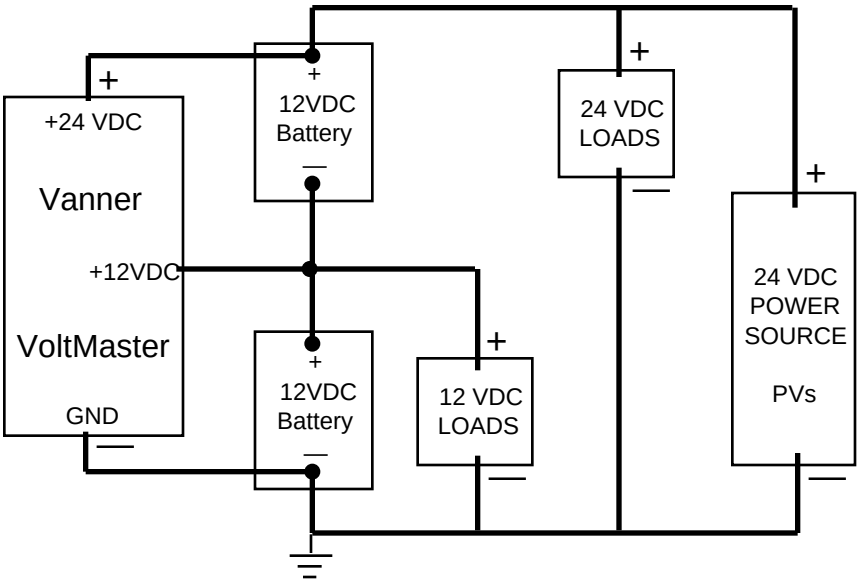
Now if you have a 12V TV to plug in, you wire it to the negative (ground) prong and the +12. If you have a 24V lamp to wire, connect it to negative (ground) and +24V. No one worries about plugging into the wrong socket and you only have two types of receptacles for your "triple voltage" system.

We use this system in our shop, office and house. It looks right at home alongside the ac receptacles powered by our inverter. Numerous PV installers have settled on this standard INDEPENDENTLY, after experience with inferior material.

WE URGE OUR CUSTOMERS, AND THE INDUSTRY IN GENERAL, TO CONTINUE USING THE HORIZONTAL-PRONG STANDARD FOR 12 AND 24 VOLT DC POWER.

This 12/24 Volt system shown causes 12 Volt appliances to draw from one half of the battery bank, thus discharging the battery unevenly. There are several solutions to this problem:
1) Use a bare minimum of 12 Volt power. Inequity will be of little significance and will be compensated for when batteries finish-charge and equalize.
2) Switch 12 Volt appliances periodically from one side of the battery bank to the other. Caution: if your battery negative is grounded (as recommended in HP#6) and a 12 V radio's negative frame/antenna is grounded (for example) switching to the ungrounded side will cause a short circuit! Use of this technique is best left to techies who KNOW what they are doing.
3) The BEST SOLUTION involves the "VOLT MASTER" BATTERY EQUALIZER, an electronic device that compensates for uneven discharge by balancing the voltage between two battery sets. It also allows you to use DIFFERENT SIZES & AGES of batteries to upgrade your system from 12 to 24 Volts-- this would cause problems without the Equalizer.

Volt Master is a proven device made for trucks, busses and electric vehicles that need to run 12 Volt radios, etc. from their 24 V. (or higher) systems. It is a DC/DC converter with current ranges of 10, 20 and 50 Amps DC. The Vanner Volt-Master costs between $235 & $359 depending on model. It is available from two Home Power advertisers, Alternative Energy Engineering and Flowlight Solar Power.



Wiring in General
Use conventional hardware and wiring methods. Standard wiring practices are easiest, economical, approvable, and ultimately safest for your DC as well as ac wiring. Consult a Low Voltage Wire Size Chart (or see Home Power #2, pages 33 to 35) so you don't cheat yourself with undersized wire. Use efficient lighting (fluorescent &/or quartz-halogen) to reduce wire size requirements as well as energy consumption. Stranded wire is NOT electrically different from solid wire, just more flexible. We usually use welding cable for heavy lines to inverters because it is not so stiff.

Circuit Breakers, Fuses & Switches
Surprise! Ordinary 120/240 vac household breakers are SAFE and FUNCTIONAL at DC low voltages. We recommend "SQUARE-D" brand, which has been tested by factory engineers and judged safe up to 60 VDC. They are safer and easier to wire than the plastic automotive/RV fuse boxes often supplied for DC systems.

Another lucky break: Ordinary 120 vac wall switches (NOT mercury) work fine for low voltage DC lights. For over 5 Amps., order "T-Rated" switches from your electrical supplier. They are rated for DC and ac use. They click rather loudly, evidence of the fast break action required for higher DC currents.

SAFETY!
If you are not adept at house wiring, study text books on the subject and/or hire an electrician! A battery-based, low voltage electrical system has enough force behind it to burn down you house, just like conventional 120 vac power. This can happen if your system is not properly designed and wired. That's why electrical inspection is required for homes in general. Inspection is not always enforced for independently powered homes, but a few solar-electric fires may eventually convince the authorities otherwise.

About Codes and Standards
Your electrical inspector's "Bible" is the "NATIONAL ELECTRICAL CODE". However, like the rest of us sinners, he/she is allowed to vary from the occasional rule. The Code is a set of RECOMMENDATIONS. The inspector's judgement is based on state regulations and HIS/HER DISCRETION, both of which may vary from the Code. For instance, the Code presently calls for "twist-lock" connectors for DC. In the opinion of PV home specialists and engineers we have talked to, this requirement is NOT necessary for safety at low voltages and inspectors tend to agree. The Code also says that plugs and receptacles must be of a design that is not already an exsiting standard for another type of service. We were allowed to waive this recommendation for our DC home and shop because we don't use 240 volts. There are other connectors for that purpose.

ELECTRICAL INSPECTORS are intelligent people who are curious about our work. Their interest, first & foremost, is your long-term safety. If they hesitate to allow the unusual, it is only from a lack of knowledge. Teach them. Show them your books, catalogs and articles like this! Open

their minds a little. Ask for THEIR advice. Your inspectors job is to HELP you!

Windy Dankoff is owner/manager of Flowlight Solar Power and Flowlight Solar Pumps, POB 548H, Santa Cruz, NM 87567, or call 505-753-9699. This article is from the new Flowlight "Catalog & Handbook of Hard-to-Get Supplies for the Independent Powered Home", available for $6.

Mike Mooney is owner of B & M Distributing... He is an Electrical Engineer with years of DC experience in aircraft systems - a first class "electricianando" whose home is 100% PV powered.

Build Your Own Electronic Ignition

Richard Perez

Most all single cylinder gasoline engines use a magneto to fire their sparkplug. The magneto works OK most of the time. But when the weather is cold or the points get old, the magneto ignition gets sluggish and the engine is hard to start. Here is a very simple & inexpensive electronic ignition system that can be homebuilt built for virtually any one lung gas engine used for making electricity.

So why use a magneto?
When a manufacturer makes a small gasoline engine, he doesn't know what particular application the engine will eventually serve. The engine could be used on a pump, a rototiller, a compressor, or maybe a generator. In many of these applications, there is no source of electricity available to the static engine for ignition purposes. These small engines have no battery. So these engines commonly make their own electricity to fire the sparkplug with a magneto.

The magneto ignition system is very simple and requires no battery to start the engine. Magneto ignition operates by using at least two fixed permanent magnets on the engines flywheel. These permanent magnets rotate past a fixed coil near the flywheel. The magnetic field passing through the coil generates the electricity necessary to start the engine. The timing of the spark is controlled by a set of breaker points wired in series with the low voltage side of the coil.

The entire setup is simple enough, but has one very great drawback. It requires that the engine be spun in order to generate the electricity needed for ignition. The operator of the engine provides this initial spin by pulling on the starting rope. Hopefully, only one pull will do the job. However, if the engine is worn (low compression), the weather is cold, or if the breaker points are pitted, then the engine will be difficult to impossible to start. The reason is that the magneto's output is directly proportional to the rotational speed of the engine. The faster the engine spins, the hotter the spark. Spinning the engine by hand doesn't turn the engine very fast, hence weak spark.

So why an electronic ignition?
Well, in our case, laziness and lack of time and money. Here's the story… During issue production for Home Power #2, in the dead of winter, our Honda engine refused to start. I pulled and pulled and nothing happened. The PVs weren't putting out much due to cloudy weather and the batteries were getting low. We had mucho computer work to do and no electricity to do it with. After some 5,600 hours of trouble-free operation, our engine/generator had let us down. I started trouble shooting the engine and found no spark on the plug. I disassembled the the rope starter and removed the flywheel. An examination of the inards revealed that the coil had an open circuit in the high voltage windings. Well, there is no fix for a broken coil; it must be replaced.

It's a long way to town. I knew that the local Honda dealer wanted an arm and a leg for a new coil that he certainly didn't have in stock (usually 2 weeks minimum order time). So I started looking around for an alternative to purchasing a new coil from Honda. I was fortunate in that this engine is driving our 12 VDC alternator. This means that there is 12 Volt energy available to the motor as the alternator is wired to our large storage batteries. Such is not the case with pumps, etc. So I decided to convert the Honda engine from magneto ignition to battery/coil ignition- just like an automobile.

The battery/coil ignition has several distinct advantages over magneto ignition. The intensity of the spark in a battery powered system is very hot regardless of the rotational speed of the engine. Battery powered ignition starts the engine easily when it is cold, and produces a more intense spark.

Building an Electronic Ignition
After a few trips to the junk box and a few hours of R&D, I came up with the following circuit that worked. The circuit's schematic appears on the next page.

This circuit uses the stock ignition breaker points to switch a PNP power transistor (Q1) which in turn switches the low voltage windings of a stock automotive ignition coil. I used a new set of points as my old ones were pitted and burned. By actual, measurement the ignition points in this circuit are only passing 5.6 mA. of current. I have included R2 in the circuit for points that are corroded or pitted and not making good contact. The use of R2 increases the current through the points to about 15 mA. for greater reliability on funky points.

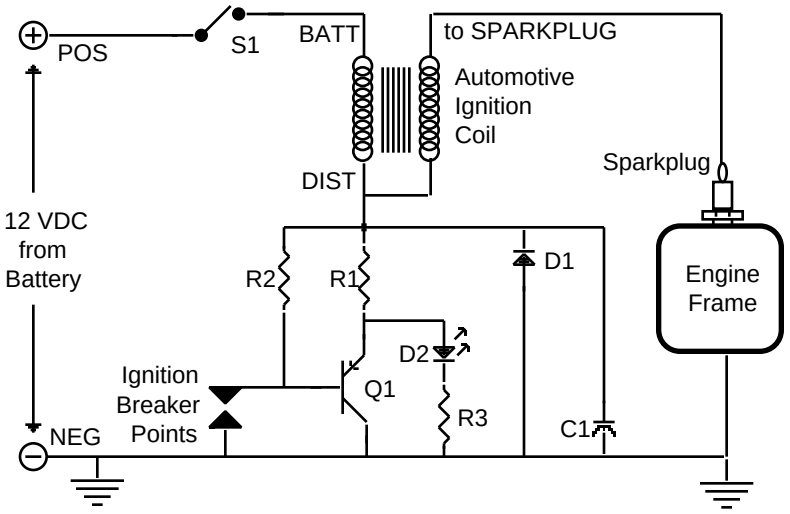
The PNP transistor I used is a 2N3789. I used this transistor because it had the required ratings and I had it in the junk box. Just about any PNP will work if it can handle at least 5 Amperes of current and has a Collector to Emitter voltage rating of at least 60 Volts. I have tried a MJE 2955 in the circuit and it works fine. The MJE 2955 is available from any Radio Shack store (RS part #276-2043) for $1.99. Those with the bucks might want to try one of the new power MOS transistors; they should work well.

The only automotive ignition coil I had handy was an old 6 Volt Chevy coil. I used it and placed a ballast resistor in series between the coil and the emitter of the PNP transistor. It took 2.3Ωs of resistance to keep the current through the coil in check. I made the 2.3Ω resistor using some nichrome wire from an old 120 vac electric hot water heater. If you have a 12

VDC coil, then use the appropriate, factory made, ballast resistor. Many modern 12 VDC ignition coils have built-in ballast resistors and require no external resistor.

The backwave diode (D1) protects the transistor from the high negative voltages generated by the collapsing magnetic field in the coil. D2 is an LED which helps timing the ignition system. When the points are open the LED is lit, and when the points are closed the LED remains dark. I used an ignition capacitor in the circuit, eventhough removing it had no appreciable effect. The capacitor is used in conventional systems to protect the ignition points from arcing & burning. In this electronic ignition system, the main switching is done by a transistor. The ignition points handle very little current, & at low voltage, so arcing is not a problem here and the capacitor is probably redundant.

Well, bottom line is that the Honda was running about 3 hours after it failed. No trip to town, no waiting or paying for new parts. This electronic ignition has been functioning for over 1,500 hours without failure. It has had some beneficial side effects. The ignition is hotter and has slightly reduced our fuel consumption. The motor now starts first pull, even on a very whimpy slow pull, every time. The sparkplug is staying cleaner due to the hotter spark. Nuff said…



Q1- PNP- 2N3789 or MJE 2955 or any 5 A., Vce 60 VDC min.
DI- 2N1202 or any five Ampere diode with 50 Volts PIV
D2- any LED
C1- Ignition capacitor (optional, see text)
R1- Ignition ballast resistor- 1 to 3Ω, 25 Watts, see text
R2- 1kΩ, 1/4 Watt, see text
R3- 1kΩ, 1/4 Watt
S1- 5 Ampere switch

Radio Links Provide Phones Far From Telephone Lines

Jim Longnecker

Home Power readers have in common more than just the need to generate their electricity. Many are also miles away from the public telephone service, and are denied hardline communication with the outside world. Recent advances in electronics, and new laws freeing more of the radio spectrum for personal and business communication, are rapidly changing the way people can use radio equipment to provide rural telephone service. In the past, as an alternative to bringing in expensive overhead or buried wires, those areas without telephone service were forced to either use crowded mobile telephone channels, or crude "phone patches" on business radio systems.

How Radio Links Work

Radio links provide connection of the telephone line to conventional telephone equipment at a remote site. All links use a full-duplex radio (talk and listen at the same time- just like downtown!) at each end. Directional radio antennas link the remote site with the phone line. The radios used are low powered (under 25 Watts) UHF transceivers, usually licensed on the "split" frequencies between the UHF business channels. The remote site has a conventional telephone, and normally the user cannot detect a radio link in use. Also, computer modems can be used on most links.

Where to Install a Link

In order to get phone service to a remote site with a radio link, there are a few physical requirements. First, there must be a phone service available within a few miles of the site, in most cases less than 20 miles. Second, and equally important, there must be a "path" for the radio waves between the remote site & the telephone line. By a path, we mean nearly line-of-sight, although trees and even some terrain variations can be overcome. Jim Carlson of Carlson Electronics has installed links even in situations where a path did not seem to exist. Careful examination of topographical maps, prior to rejecting a site is important. The link end at the remote site can be installed as far as 1,000 feet from where the telephone is to be used, allowing even more flexibility in many cases. Each end of the link must be supplied with either 12 VDC or 117 vac power. A single PV module, 40 W output, together with a battery, will supply adequate power in most applications.

Money Matters

Initial cost of a radio link may seem high, compared to the cost of simply buying a telephone for your home or business, as most run about $3,500. When compared to the costs, and esthetic considerations of placing telephone poles for miles or burying miles of cable, the figure is much easier to justify.

Also the user owns the link and is billed by the phone co. as a regular land line telephone at normal downtown rates. Compare this with radiotelephone services using the phone company's equipment (like IMTS radiotelephone, see Home Power #4, pages 29 to 32), where air time charges are made of about $1.00 per minute. And this is in addition to all regular telephone charges like long distance charges. At a buck a minute, it doesn't take long to run up an enormous phone bill.

Maintenance of a link should be much less than wireline, especially over rough terrain. Low powered radio equipment is very reliable, and should last 10 years or more, with minimum maintenance. Jim Carlson says his customers rarely call for service, and then most calls do not involve equipment failure, but environmental damage like wind damaged antennas, etc.

Telephone Company Tariffs, The FCC & More

Your telephone company can be either cooperative or not, depending on their individual policies, when you ask for a telephone connection that they know is destined for transmission by a radio link. Jim Carlson spent many hours with the California Public Utilities Commission, and representatives of Continental Telephone, when first starting to install these links, and can usually answer, to the utilities satisfaction, any legal questions. These links also are licensed by the FCC, usually in the Business Radio Service. There are a few requirements for the licenses, and Carlson's firm can help potential link users with any questions.

A new radio service, the BETRS or Basic Exchange Radio Telephone Service has just been announced by the FCC. This service, announced in FCC Docket 86-495, makes 50 pairs of frequencies available to private users. Licensing for this service is in its infancy, however Jim Carlson is following through in researching this, and will report back to Home Power readers as the procedures are established.

Multiple Lines & Microwave Stuff

In cases where multiple lines (6 or more) are required to areas, such as remote subdivisions or industrial plants, Carlson installs short hop microwave systems. New equipment is available on the market that makes microwave cost effective at this level.

Sources

Jim Carlson, Jim Longnecker and Carlson Electronics can be contacted at 707-923-2911 or at 774 Redwood Drive, Garberville, CA 95440. Carlson Electronics sells equipment from TELEMOBILE, RITRON, & others. Microwave equipment from SR TELECOM of Canada and DIGITAL MICROWAVE of San Jose, CA is available for multiple line users.

Editor's Note: We are currently trying out the Telemobile UHF radiotelephone system. We'll let Home Power readers know

how it works to our remote office site in Home Power #8. Early indications are that it is a real winner. RP.

CQ HOME POWER HAMS

Windy Dankoff KE5HV
& Brian Green N6HWY

We are proposing a new schedule for hams:
Regional Home Power Nets
7.230 MHz on Sundays at 1330 Pacific, Central, & Eastern time.
3.900 MHz on Wednesday at 2000 Pacific and Eastern time.
14.290 MHz Sunday at 1900 UTC.
Novices
7.110 MHz on Wednesday and Saturdays at 0500 UTC.
Regional nets will keep the same times when we resume normal Standard time this fall.

On The Horizon

Solar Energy Research Institute (SERI)

SERI and ARCO Team for Breakthrough

Another one of SERI's partnership efforts is paying off. The biggest news in solar cell research this year, according to Jack Stone, Director of Solar Electric Research at SERI, is ARCO Solar's new low-cost 1 square foot solar panel. Fabricated of copper-indium-diselenide (CIS), the new panel converts 11.1 percent of the sun's energy into electricity, a 30 percent increase in prior performance levels.

The achievement is a result of a three-year, cost-shared subcontract. ARCO is spending $4.8 million on the effort; SERI is contributing $4.2 million.

ARCO's breakthrough has the potential of bringing the cost for solar electricity down to 13 cents per kilowatt hour (compared to the 30-35 cents it costs today). Estimates are that CIS panels like these could be made at under $100 per square meter (about $9.50 per square foot) in large-scale production. In addition to its high efficiency and low cost, CIS has very stable properties, maintaining its power output after thousands of hours of testing.

New Cell Structure Patent Granted

Researchers at SERI have been granted a patent for a new tandem photovoltaic device that has promise of being both inexpensive and highly efficient. It uses gallium indium phosphide for the top cell and gallium arsenide for the bottom cell.

This tandem combination should theoretically lead to devices that are 34% efficient under one sun. Currently, devices are about 14%-15% efficient. Because the two materials possess crystal structures of the same size, the top cell can be grown on the bottom cell without creating the atomic structure defects that degrade the top cell's efficiency. The two materials are also current-matched so the device will not be diminished by one cell's providing less current than the other. The isolated top and bottom cells both exhibit excellent device characteristics with internal quantum efficiencies (the ratio of generated electrical current to incident light intensity) in the range of 80% to 90%. Adding to the attractiveness of this device is the commercial availablity of gallium arsenide and the discovery of several new and useful properties of gallium indium phosphide.

Reprinted from SERI Science & Technology In Review. Contact SERI at 1617 Cole Boulevard, Golden, CO 80401-3393.

"Things that Work!"

Home Power tests Backwoods Solar Electric's Battery Charge Controller

Richard Perez

This battery charge controller operates in two modes. As series resistance to control incoming energy from any DC source. And as a shunt regulator which connects loads to the batteries in order to control system voltage. Steve Willey's battery controller operates either or both ways. The strong points of Backwoods Solar's controller are versatility and quality.

Shipping Container & Documentation

The unit arrived in fine shape via UPS. Documentation is very brief and could use more diagrams and pictures. After several readings and some head scratching, we got if figured out and installed using the documentation.

Physical Examination

The control box is 10.25 inches wide by 8.25 inches high by 4.25 inches deep. The unit contains two large analog meters. One is an expanded scale, 10 to 15 VDC battery voltmeter. The other is a DC ammeter that reads 25 Amperes full scale. Two switches which control the modes of the controller are located on the front panel. The front panel also contains 3 Light Emitting Diodes (LEDs) that indicate the control's status.

I opened the box and examined its inards. The switches, connectors, printed circuit board, and the box itself are of the highest quality. All power handling components within the controller are rated at 30 Amps. The voltage adjustments for the switching logic are marked and easily accessible. Large, low loss, wiring bars are provided to interface the control with the rest of the system. A large silicon diode is well heatsunk for blocking purposes in PV systems. The box itself is made of heavy gauge steel, with louvers on the top, and a first class paint job.

Installation & Test System

We installed the controller between 155 peak Watts of PV modules and a battery pack of 350 Ampere-hours at 12 VDC. The controller was easily wall mounted using a few screws. Knockouts for wiring are plentiful on the bottom of the controller. These knockouts accept standard wire clamps for a "code sanitary" installation. The unit comes supplied with a low loss battery cable assembly with attached fuse.

Control Operation

There are two switches that set the mode of the charge control. The first, labeled CHARGE control switch, selects how the incoming DC energy is processed by the controller. The CHARGE switch has three settings: 1) it passes the incoming DC energy in voltage controlled mode, 2) it passes the DC energy in voltage uncontrolled mode. and 3) it disconnects the DC power source from the batteries.

The second switch is labeled Auxiliary. The auxiliary selects how an auxiliary load is connected to the system's batteries. The Auxiliary switch selects between; 1) auxiliary load connected to battery when voltage is high, 2) auxiliary load connected directly to the battery, and 3) auxiliary load off.

The logic of the control sets two voltage switching points. One switch point is for HIGH voltage, the other is the LOW voltage switch point. The actual voltage of these switch points is user programmable via two potentiometers on the control board. When the system voltage reaches the high set point two things happen. One, a resistor is inserted in series with the incoming DC power, thus reducing system voltage. Two, the auxiliary load is connected to the battery, also reducing system voltage. When the system's voltage falls below the low voltage set point, then the process in reversed, i.e. the resistor is taken out of series with the power source, and the auxiliary load is disconnected from the battery. In our use, the voltage switch points remained stable once set.

The high and low voltage sensing logic, coupled with the two manual switches, offer six different combinations. These combinations fall into two categories, either series or shunt (parallel) control of the incoming DC energy. One may mix and match both these types of regulation to suit any particular system. This control will function in PV, wind, or microHydro systems with equal facility and effectiveness

We adjusted the voltage sense points to suit our system and let the control do its job. When the incoming energy from the PV array produced system voltages above 14.5 V., then the controller reduced the array's current from 11A. to 4A. We also tried using the Auxiliary load function. When the PVs drove the voltage over 14.5, then the auxiliary load was added automatically to the system by the controller.

We set the low voltage switch point at 13 Volts. When the system's voltage fell below 13 Volts, the resistance controlling the PVs incoming current switched out of series and the array resumed its normal production of 10+ Amperes. Also, when the system voltage fell below 13 Volts, then the auxiliary load was disconnected from the line. The auxiliary load can be virtually anything-- a fan, a pump, a water heater, or whatever.

With the charge switch set on manual, the series regulator is defeated & the incoming power is fed directly to the batteries. Even if this series regulator is defeated, the shunt regulator will still function. The user can chose between 4 distinct modes of regulation: 1) series & shunt, 2) no series & shunt, 3) series & no shunt, and the transparent mode of no series & no shunt. In addition to these four regulation modes, the switches also offer the OFF state to disconnect the power source and/or the auxiliary load from the batteries.

We tested the unit's meters for accuracy. The voltmeter was within 2% and the ammeter was within 5%, according to our Fluke 77 DMM. The unit was able to handle its full rated current without problems. No heat was detected where it shouldn't be during full current operation.

Cost

Retail price of this battery charge controller is $260. This is in keeping with the high quality of the hardware used and the basically "hand made" nature of the control's manufacture. Contact Steve Willey at Backwoods Solar Electric Systems, 8530-HP Rapid Lightning Creek Rd., Sandpoint, ID 83864, or call 208-263-4290 for more information.

Conclusions

We can recommend Backwoods Solar's Battery Charge Control as a "Thing that Works!". We liked its quality & especially its versatility. It can be used in PV, wind, and/or microHydro systems. This control's ability to become completely transparent & disappear from the system at the flick of a switch is great. Our only complaint is about the control's documentation. A control with this much versatility needs more documentation to enable the user to realize its wonderful potential.

Backwoods Solar's Battery Charge Control. Photo by Brian Green

Build your own Battery & Inverter Cables

Richard Perez

Distributing low voltage electricity around home power systems has always been a problem. Every element in every circuit, especially in wiring and connectors, is a potential source of voltage loss. And in 12 or 24 Volt systems we need all the voltage we can get. No where is low resistance wiring and connections more important than within the battery pack and the inverter wiring. These circuits may have to transfer over 500 Amperes of current. Even small amounts of resistance in these connections can lead to unacceptable voltage losses at high rates of current. Here's how you can make your own very low loss, long lived, battery and inverter cables.

Resistance- our biggest enemy

The amount of resistance that a piece of wire has is determined by three factors: 1) the wire's physical material, 2) the wire's cross sectional area [wire gauge or size], and 3) the wire's length. In low voltage systems, the only material to use for wiring is copper. Aluminum has about twice the resistance as copper for the same wire gauge, and is virtually impossible to solder. These factors dictate the use of copper wire exclusively in low voltage systems. The actual physical length of a piece of wire is determined by the job we need it to do. A wire must reach from point A to point B in order to do its job- conducting electricity from A to B. So this factor is a given, and we have no choice to make here. That leaves the cross sectional area or wire gauge up to us as our only choice.

The larger the amount of current we wish to transfer thorough a wire, the larger its gauge must be. For a through explanation of wire gauge and its relationship to resistance see Home Power #2, pages 33 through 35. In the series/parallel wiring that connects individual batteries into packs we must use large gauge cables to minimize resistance. The same is true of the cables that connect an inverter to the battery pack. The large amounts of current moving through these cables can result in excessive voltage loss if careful attention is not paid to the entire cable's resistance. This voltage loss translates into poor inverter performance and greatly lowers system efficiency.

Cables & their Connectors

The situation is further complicated by the connectors used on each end of a piece of cable. These connectors are a part of the entire circuit. A connector that has high resistance will cause the same voltage loss as undersized cables or wiring. A series circuit is like a chain-- it is limited by its weakest link. Each and every element within a cable must have low resistance if the entire cable is to have low resistance. Money spent on large diameter cables is wasted if they are not provided with low loss connectors on each end.

The method of attaching the connectors to the cable's ends is very important. Connectors that are merely mechanically crimped to the wire's ends are not acceptable. These mechanical connections oxidize over time. Copper oxide is a very poor conductor of electricity. Mechanical connections may have relatively low resistance when they are first made, but after several months their resistance increases as they oxidize. The decay of mechanical connectors is vastly accelerated when the connectors are attached to the poles of lead-acid batteries. Lead-acid batteries always collect a certain amount of sulphuric acid on their surfaces and on their wiring & connectors. This acid rapidly attacks mechanical connections and quickly results in unacceptable voltage losses.

So it is not enough for us to use large diameter, low resistance, cables on our batteries and inverters, we must also have low resistance, durable connectors. Soldering the connector to the cable is really the only way to keep the battery's acid electrolyte from attacking our connectors. A soldered connector is permanently sealed, there is no way the acid can destroy the connection between the cable and the connector. Most commercially available connectors are the crimp on type. Solder type commercial connectors are available, but are very difficult to solder with home tools. Cheer up, though, all is not lost. We can…

Make Our Own Connectors

These connectors are made from copper tubing sleeved over the copper cable. Use only clean, thick walled, soft copper tubing. Don't use hardened copper tubing, or oxidized, dirty tubing. The proper copper tubing is available at most any hardware store, and is sold by the foot. Use stranded copper cable with THHN or THW insulation.

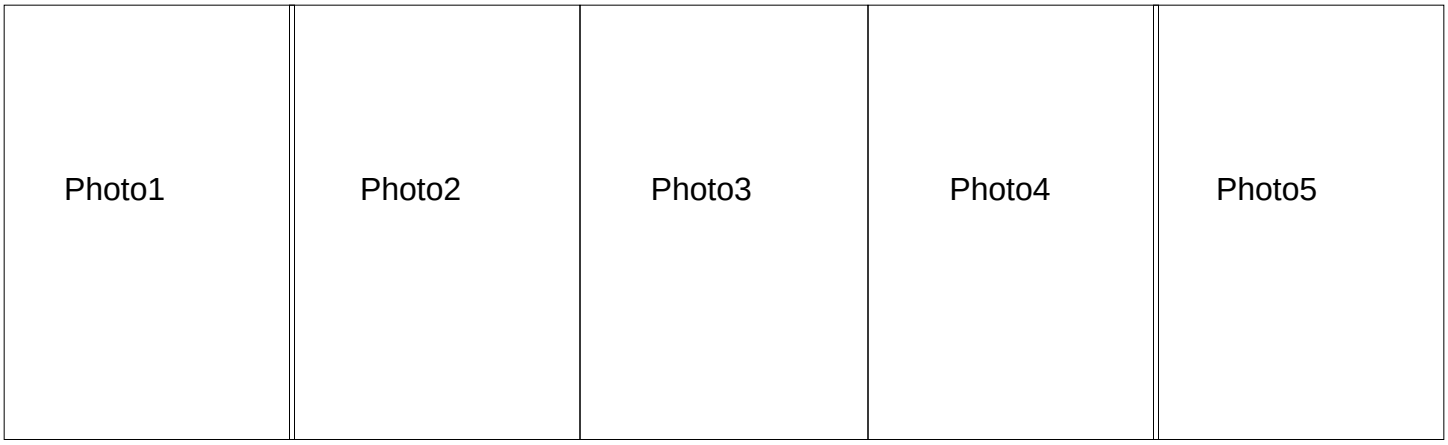
Use the appropriate gauge copper cable for your application. Consider "0" gauge copper cable as a minimum size for very short (under 6 feet) cables. For cable lengths over 6 feet use 00, 000, or 0000 copper cable depending on length. To figure out exactly what size cable to use in your application see Home Power #2, page 33. Measure the length of cable you require very carefully. These cables are very stiff and all bends require a large (3 inches or better) radius. What follows now are step by step instructions, complete with photos, for attaching soldered connectors to your cable's ends.

1. Strip 1.75 in. of the insulation from the ends of the cable.
2. Take the twist out of the individual wires that make up the cable. The wire strands that make up the cable should be fanned out until they are all parallel and not twisted around each other. This makes flattening the finished connector much easier. A set of pliers aids in this process.
3. Cut 2.5 inch lengths of the copper tubing. Use 5/8 inch diameter tubing for 0 gauge cable, 3/4 inch tubing for 00 & 000 cable, and 1 inch tubing for 0000 copper cable.
4. Lightly coat the stripped, untwisted ends of the cable and the interior of the copper tubing with solder flux. I use

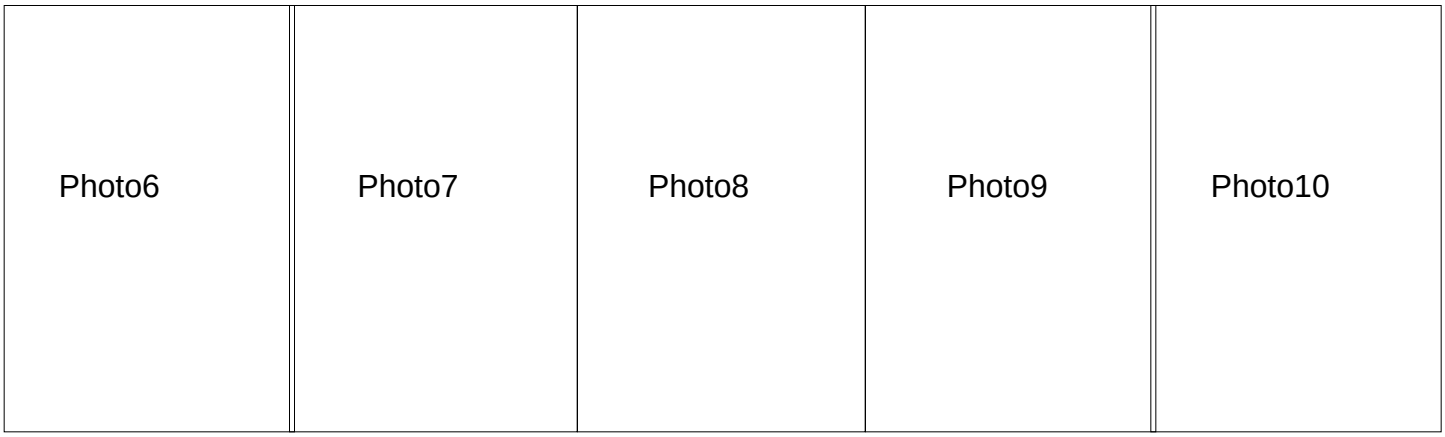
No-Corrode flux, but use whatever you wish as long it is noncorrosive and not acid based.
5. Slide the copper tubing over the stripped end of the cable. Leave about 0.25 in. of the cable outside of the copper tubing.
6. Flatten the tubing, with the wire inside, in a vise.
7. Pound the entire assembly on a flat surface with a hammer until the connector is flat and even. Note that the copper wire doesn't extend all the way into the tubing. There is about 3/4 of an inch of tubing that has no wire within it. Pound this area flat.
8. Put the portion of the tubing with no wire inside into the vise & roll it back upon itself. This makes a sealed end to the connector so that the solder will not run out during soldering.
9. Chuck cable into a vise with the cable up & the connector down. Heat outside of the copper tubing with a propane torch until the flux begins to boil from the open end of the tubing.
10. Melt solder into the open tubing end gradually, until the tubing is full. When the tubing is full, the solder will overflow the open end of the tubing. Use a good grade of solder, I like Kester 44, 60% tin and 40% lead.
11. Allow the connector to cool before removing from the vise.
12. Locate the hole to be drilled in the connector with a punch. Then drill the appropriately sized hole.
13. Trim off the end of the connector that doesn't contain any wire.
14. Polish & brighten the connector using a wire brush chucked into an electric drill.
15. The connector is now complete.

The result is a soldered connector that actually has less resistance than the cable itself. The strands of wire that make up the cable extend ALL the way through the connector. Compare this with commercial soldered connectors where the wire stops and then the connector begins. These homemade connectors not only have less resistance than the cable, but are actually mechanically stronger than the cable itself. And they are totally sealed, there is no way for the connection to corrode internally. If the connector becomes corroded on the outside, simply remove it from the battery and polish it with the wire brush again until it's bright and clean.

It's a lot of work to make these cables, but once you've done it, the job is done FOREVER. So dust of the propane torch and make something that really works and lasts.



Photos by Brian Green



Letters to Home Power

Letters printed unedited. We'll print your name & address if you say it's OK.
Compiled by Karen Perez

Dear Home Power:

I take exception to the letter from Mr. W.J. Kaszeta in the No. 6 issue of "Home Power". The implication that Solar Retrofit Consortium's is of some unknown quality that has not yet stood the test of time, is totally misleading! SRC only manufactures two Fluorescent LIGHT FIXTURES, a 20-watt and a 40-watt valance model. (the 40-watt uses a 32-watt tube). The reason being no other size bulbs are readily available in the Third World! We DO NOT MARKET OUR BALLASTS SEPARATELY!

The reason we ship the 40-watt fixture with an F 40 SSP30/WW/RS bulb (we know it is not the most efficient!), is because most of our customers prefer its color temperature. On the second page of our catalogue, there is a full range of designer colors offered, plainly stating the lumens of light when used with SRC's fixture. SRC's light fixture Ballast contains a serial number, and SRC guarantees a free replacement of that Ballast if the Ballast fails within 5 years of the date engraved on the Ballast case IF THE SERIAL NUMBER IS INTACT. No other manufacturer World Wide of 12 VDC Ballasts offers the same warranty!!

We have thousands of these Ballasts in use in Central and South America. Some of them are over 12 years old, and have not failed in normal household use. Several Central and South Americans have enacted legislation against U.S. dumping refrigerators and A/C., etc., with an EER rating of next to nothing on them and recently, the Dominican Republic has placed a 300% import duty on 40-watt fluorescent tubes while the 32-watt is duty-free.

As to having to pay $6.00 wholesale, my suggestion is "PRI should dump their Purchasing Agent!" because the new 32-watt fluorescent tubes are being sold at 1/3 that price in the Third World!

Sincerely Yours, Kirt Ludlow, Solar Retrofit Consortium, Inc., Box 34, 200 East 71st Street, New York City, NY 10021 U.S.A., (212) 517-3580

Editor's Note: We've been using the SRC 40-watt valance model for the last 8 months, we like the warm color; it's very bright and the fixture is efficient. See HP#4, "Things that Work!". And it really does… RP.

In light of the political winds concerning alternative tax credits, the new Oregon Alternative Energy Device Tax Credit is a refreshing change of wind direction. The '87 Oregon legislature adopted a unique AE tax credit that is based on the expected performance of the system rather than a percentage of the systems cost, as were previous tax credits. At the time of its implementation last January it was the only performance based AE device tax credit in the nation.

The AE device must be installed according to the local building codes, on the primary or secondary residence of the Oregon taxpayer who is applying fir the credit. The AE device must use solar, water, geothermal, wind or be a heat pump water heater and produce at least 10% of the total energy need. The credit is based on the expected first year's energy production or savings. For an AE device on a house connected to the utility grid the credit is $.60 per KWH saved/produced the first year of operation, up to a ceiling of $1500. (or the cost of the system which-ever is lower). Most of the AE applications will be on grid connected homes. Because of the nature of Home Power's readership I won't go into this aspect of the law any further.

In homes that are not grid connected and are using the AE device as an electrical generation system the tax credit differs a little. These will be the systems that actually produce electricity (photovoltaic, hydro and wind). By their nature they will tend to be cost effective only in remote home sites. That is, homes that are not connected with the utility company. When the energy they will displace is the fossil fuels used in an engine generator, the efficiency of the generator is taken into account when figuring the tax credits.

The ceiling of the credit is still $1500 for the tax years of '88-'90 (dropping to $1000. in '91 and $500. in '92). The AE device must supply 50% of the home's electrical appliance needs (all of the non-thermal energy loads). This is in lieu of the 10% requirement that the grid connected home would use. The systems must be preapproved, the tax credit forms include some worksheets that the homeowner can use to figure their energy "budget". The forms also include a worksheet to estimate the first year's energy production.

Instead of the credit based solely on $.60 per KWH produced, the efficiency of the generator is taken into account, since the AE system is replacing fossil fuels. The Oregon Department of Energy (ODOE) figures the average generator converts about 27% of the fossil fuel's energy into electricity. Therefore an AE system displacing fossil fuels is 3.7 (1.00/.27 = 3.7) times more effective than a system connected to a utility. An AE electrical system tied to an engine generator back-up will get a tax credit of, $.60 x 3.7 = $2.20 per KWH produced the first year (dropping to $1.48 per KWH in '91 and $.74 per KWH in '92). For a PV system in Oregon this works out to $3-$4 per peak watt of PV array depending on location and site conditions.

Oregon D.O.E. will require that the homeowner or dealer fill out a tax credit form. Some of the information requested for a PV system is a sunchart, Spec sheet on the PV's, batteries, inverters, controllers etc, itemized cost of produces, sizing worksheets, system schematic and copies of the appropriate licenses and permits. The system must be preapproved before installation.

You will note that the credit is based on the energy produced. The ancillary items in a PV system do not count towards the credit. However, the system must be of compatible design. If you do not have a properly designed system you can not receive the tax credit. In other words you can't have a 1000 Peak Watt PV array on a 100 AH battery.

Hopefully the Oregon tax credit law can serve as a basis for other AE tax credit laws around the nation. Because the law is performance based it will tend to weed out the AE shysters who sell ineffective or overpriced systems. The homeowner will have an impartial accounting of the expected performance of the system before it is installed

If you have questions concerning the tax credit address them to Scott Lawrie c/o Oregon Department of Energy, 625 Marion St. NE, Salem, OR 97310. I can also attempt to answer any questions you might have.

Leo Morin, Free Energy Options, POB 430, Veneta, OR 97487

Dear Home Power:

Congratulations on Home Power and on what I know is a supreme effort to produce. Keep up the good work!

However, I would like to express some concern over your article "The Home Built BTU Boss" in issue No. 4. A better title

might be "Beware the BTU Boss"! As Mr. Bauer noted on his own heater, high stack temperatures are not uncommon on most gas fired appliances. And, of course, this represents an inefficiency on the part of the heating system. That's why conventional gas fired equipment rarely achieves a combustion efficiency higher than 80%.

However, there are several reasons for maintaining relatively high stack temperatures. These temperatures are necessary to maintain sufficient draft to move products of combustion out of the home and to maintain the flue gas temperatures above the condensing point. Natural gas condenses at 275°F and leaves behind a highly acidic residue that commonly eats away flue pipes, furnaces and most metals that it contacts. Cold outdoor temperatures further reduce temperatures and increase the possible damage.

Therefore, the "incredible 150°F" stack temperature achieved with the BTU Boss is well below the condensing point for natural gas and presents some serious concerns. What Mr. Bauer has created is a secondary heat exchanger which "works" to remove waste heat from the flue. The new high efficiency furnaces also use a secondary heat exchanger to remove the maximum energy from the unit. The clincher is that most of these use stainless steel components and special strategies to remove the acidic condensate and maintain draft.

In addition, by incorporating four 90°F elbows and an additional flue pipe, the natural draft of the heater can be severely impeded--in many cases flue gases will fail to properly exit the home allowing often dangerous products (potential carbon monoxide) to spill into the home.

The construction diagram is also highly deceptive in that it appears that the flue pipes are open into the room (a definite no). There also appears (from the diagram) to be no clear path for the gases to flow outside. While somewhat irrelevant given the earlier comments, if built according to the diagram an even more hazardous situation could result.

In any event, the bottom line is that the BTU Boss is a dangerous piece of retrofit equipment and should NOT be added to any heating system. The potential savings would be better spent on less glamorous items like caulk, weatherstripping and insulation.

Hopefully, this does not detract from the ingenious nature of Mr. Bauer--his energy saving spirit is commendable. I trust your future articles will reflect only state of the art equipment, ideas and techniques.

Best Wishes: Luke Elliott, Technical Director, The Energy Office, 128 S 5th St., Grand Junction, CO 81501-2602, (303) 241-2871

Editor's Note: Mr Elliot is right about his comments of the BTU Boss. What can I say, every so often one gets by us. Sorry. RP.

Dear Home Power Friends,

Thank you for putting out a very informative magazine. I somehow missed issues #4 & 5, enclosed is the money for those two issues.

We power our home with a Windcharger 200, 5 photovoltaics and a backup generator (Agtronic). We use a SunFrost refrigerator and heat our home with a 500 gallon wood fired boiler. We have used Flojet pumps for years to pump water to our home, which has worked very well.

Much of our equipment has been purchased from Backwoods Solar Electric. They have been great about answering questions and have been excellent in getting orders out promptly (and at good prices!).

I am in need of help from other readers. Our Dynamote B-12 inverter has stopped working. When an AC load is applied the breakers shut off. Sure would appreciate any advice as to the possible problem.

Also haven't noticed any articles on steam (not stream) power. We purchased a 5 hp steam turbine from Steam Power Products about 6 years ago and haven't yet tried it as an energy source to run an alternator. If anyone has had any experience with steam turbines I'd appreciate hearing from you. Any folks out there just getting started and having questions, write, we'd be glad to help if we can.

Jerry Grzeblelski, Box 5 Swanson Mill Rd, Tonasket, WA 98855

Thanks for the good work you are doing in Home Power. It is readable information on alternative energy whose time has come. I especially like your "Things that Work!" section, giving a "consumer report like" evaluation of alternative energy items offered on the market. I'd also like to see articles on the politics of alternatives' fight back from the Reagan administration's 80% cuts in R&D funds for alternatives in the last 8 years.

Thanks Again, Don Eichelberger, Albalone Alliance, San Francisco, CA

Hello Home Power,

Your magazine is great, my favorite part being your reader's exchange.

We love our PV system, it works wonders here in sunny Arizona. But even we get cloudy days and need back-up for our passive solar (batch) hot-water system. We've been searching for a source of quality Aqua-heaters, an efficient wood burning water heater. Does anyone out there know of a source? We'd love to get one in before winter sets in, so we need to get it soon. We sure appreciate any info or leads AND for your WONDERFUL magazine that brings home folks together!

In Peace, Terresa McConville, HC 63 Box 2652, Snowflake, AZ 85937

I am 10 years old and I would like to see some projects that I could do.

Thanks, Luke Vegnani, Bridgeville, CA

WOW! What a great idea. We've got the crew working on the idea.

I only had the chance to read one issue. I am a graduate of the Evergreen State College, and specialized in Alternative Energy. Your publication seems concise, well directed, and appropriately complied of well balanced materials. I personally like to get in depth with the Techy stuff. But it's better for most to keep it laymen oriented. I am signing up Evergreen as well.

Thanks, Jan Harris, Olympia, WA

We have not found the site we want yet so we don't know what we will have available. We would like information on all options available to help us be 100% independent of commerical power.

I really like the simple, clear way rather involved technical subjects were treated in the articles. I got the information I wanted without being burdened with engineering type technical jargon. Keep up the good work.

John Davis, Penn Valley, CA

An ad in the first issue of your magazine that I saw (#4) enabled me to buy my first solar panels at a decent price. You're doing a great service with your publication. Power to the People! Louis Montano, Winston, OR

Letters to Home Power

Two tidbits for the next issue: In HP #5, Frank Hansen asked in "Q & A" if anyone knew of a source of parts for Dunlite wind generators. We make replacement parts for most pre-REA and modern "homeowner-sized" wind systems, including the Dunlite. I am enclosing a copy of our Jacobs parts list and inventory of most of our used wind equipment for your files.

Item number two: In HP#3, John Shuttleworth makes a misstatement that has often been repeated, that is, that Marcellus Jacobs "invented the electricity producing wind powered generator". This is not true. The famous Jacobs Wind Electric wind generator was invented by Marcellus' older brother, Joseph. Joseph was first granted a patent on this wind generator in 1931, with subsequent patents on improvements to this wind generator being granted in 1933, 1936, and 1937, and culminating with a patent on the blade-actuated governor granted in 1949. While Marcellus was granted a patent on a very slight improvement (which is no longer used) to the blade-actuated governor in 1950, his first real patent relating to a wind plant was granted to himself and his son Paul in 1975, with several patents following from 1977 thru 1983 for his new wind generator system. All of the patents on the new Jacobs wind generator are shared by Marcellus with his son Paul.

The earliest patent that I have been able to dig up on an electricity producing wind powered generator was granted in 1918, and filed for in 1915. As Marcellus was born in 1903, he would have been 12 years old at most when this patent was applied for. Although I have not yet dug that far back, it appears as though there were patents granted for electricity producing wind powered generators before 1915.

While it is true that Marcellus holds many patents, most relate to areas not associated with wind power. Many of his patents were co-authored with his brother Joseph. These patents vary to such things as a burglar alarm, a tree felling jack, a portable power saw, emergency signals, an engine starter, adjustable lathe centers, planing floats for boats, a tidal flow system, and canal bank walls.

Although he is rarely mentioned, the real brains behind the Jacobs wind generator was Joseph Jacobs, the president of Jacobs Wind Electricity. Marcellus was general manger of the company. Joseph was killed in an automobile accident in the early sixties. Oddly enough, Marcellus died in 1985, also from internal injuries sustained in an automobile accident.

If anyone is interested, I can supply a list of Jacobs wind generator patent numbers. They could then request copies of these patents at their local library. They make for very interesting reading. All I request is a self addressed stamped envelope.

Mick Sagrillo, Lake Michigan Wind & Sun, E. 3971 Bluebird Rd, Forestville, WI 54213

Dear Folks at Home Power Magazine,

I've been going in so many different directions in my life that it took me all six issues of Home Power to be made aware of the existence of your magazine. It's great!

You know, somewhere in my boxes of back material I have the 14th and 15th issues of Alternative Sources of Energy, when it was still young and down-home and grass roots like HPM is now. Thanks for being around as a true people's publication, and I hope it takes a long while before you go "country yuppie" like Mother Earth News and "professional" like ASE. Home Power to, and for, the People.

Actually, I should talk about country yuppie; I'm sitting here writing this letter way out in the hills of Mendocino County on my Macintosh computer running off of a 300 watt Heart Inverter powered by solar panels!

I am friends and ex-work partner of John Takes of Burkhardt Turbines and Ross Burkhardt of Renewable Energy Controls, who provided the hydro system components Harry O. Rakfeldt wrote about in issue 6. It warms my heart to see people creating their own power sources using technology I was involved in helping create.

John and Russ and I and two other people were the original founders of Burkhardt Turbines hydroelectric business in Ukiah back in 1982. What eventually got me hooked up with these other people was an experiment I had done a year before with another friend.

After spending a year carting a battery up and down hill to my car, I determined to create my own power source. I sent away for a $10 used surplus DC motor and scammed up an old auto heater squirrel cage from the local wrecking yard. I attached a garden nozzle to the end of a hose off my 1800 feet of 1" water line (with 90# static pressure), and got an incredible 1 amp of power going into a car battery. Welcome Home Power! I said goodbye to kerosene lamps and strained reading eyes forever.

I later met Ross Burkhardt, who had started the Water Watts microhydro turbine business. As someone who is a master at being able to take an idea, and bring it into practical commercial reality, he had begun to gather a bunch of people together, I joined him, and we started Burkhardt Turbines to manufacture a slightly fancier version of the homegrown power source I had come up with. We used the 5" polyethelene pelton wheel from Paul Cunningham (Energy Systems & Design) in Canada, a car alternator, and a stainless steel salad bowl for a housing. The turbine evolved from there into the cast aluminum housing and silicon brass pelton wheel of the present day, when our business joined with Harris Hydroelectric.

But those were exciting days back in the early eighties as we bought electronic components from Radio Shack and explored the application of grassroots electronics to wind and water and solar power, making control and meter circuitry for our hydro plant. During that period I generated about six 3 inch thick binders of photocopied articles from every "popular" electronics publication and book I could find, copying any article that seemed in the least potentially applicable to alternative energy. I started pulling together my ideas with the fantasy of a book called "Working Notes for Electronics and Alternative Energy".

The book never happened, but I discovered that I had an ability to express complicated ideas in an understandable manner. What happened then for me was that I took some articles to our local alternative "back to the land" newspaper, and pretty soon I was writing a lot of how-to articles for them. And pretty soon I began to enjoy writing so much that I just moved on from the turbine business and joined the newspaper.

And here I am 6 years later having become a political reporter and activist on an alternative newspaper,who occasionally finds time to sit down and design some circuit to make my own or someone else's alternative energy system run a little better. My love and fascination of alternative energy continues, however, and I write articles whenever possible about what local folks are doing with their energy systems.

It was in talking with my friend Ross Burkhardt about writing an article on his Universal Voltage Regulator that I first saw your publication. I figure that probably a lot of the stuff I collected together for my "Working Notes" book would still be applicable for folks, and I'm going to dust it off and see what it may have to offer in the way of future articles for you...

Thanks for being around. Enclosed find check for $10. Could you send me the back issues so I can get caught up as well as future issues. I would like to review the magazine for my newspaper, as well as share some of my own ideas in future issues, starting probably with an article on Ross' great regulator. Be reading and writing you...

Dale Glaser, Ukiah, CA

That's a deal we just couldn't refuse. We are publishing an article by Dale in this issue. Thanks Dale!

I thought you might be interested in the efficiency analysis calculations I made on the SolarJack deep well system described in Home Power 6. Objective: to find out just how good this system is at using solar electricity to lift water.

First, it is necessary to determine just how far the water is actually lifted. It's given that the static water level is 120 feet down, and the main water flow of the well is 9 gallons per minute, approximately 480 feet down. If we assume that during pumping the water level drop (from 120 feet to 480 feet) is proportional to the pumping rate (from zero to 9 gallons per minute) then, knowing the pumping rate, we can calculate the water level. (That is a risky assumption to make but it's the best we can do with the data given, and it should give a reasonably close answer.)

The pump's 1 and 7/8 inch piston makes about 30 seven inch strokes per minute; this works out to about 2.5 gallons per minute. We are also told that the system output is 1170 gallons per day. If the pump runs 7.8 hours pumping an average 2.5 gallons per minute it will indeed pump 1170 gallons.

This also tells us that the 1170 figure is for days when the sun shines all day. It's not a year-round average. At 2.5 gallons per minute, the "risky assumption" above gives a water depth of 220 feet: (480-120) x 2.5 / 9 + 120 = 220. Since the water has to be pumped an additional 75 vertical feet to the storage tanks, the total lift works out to 220 + 75 = 295 feet.

Now for the easy part: 1170 gallons x 8.33 pounds per gallon (at 60°F) x 295 feet = 2.88 million foot-pounds of energy: the system's daily net output.

For the input: 8 Kyocera modules x 48 watts per module x 7 hours equivalent full sun per (cloudless) day = 2688 watt-hours per day. And 2688 watt-hours x 2655.3 foot-pounds per watt-hour = 7.14 million foot-pounds of energy: the daily input from the modules.

Finally, efficiency equals output divided by input: 2.88 / 7.14 = 40%.

Now that may not look too good, but there are many sources of loss in a system like this, including the LCB, the motor itself, and the pulleys, belts, gearcase, levers, pivots, valves and seals. And the friction of the moving water against hundreds of feet of pipe walls. I wonder how how that 40% efficiency compares to a conventional system with a submersible multi-stage pump?

Dave Gusdorf, Gusdorf Electronic Repair, 649 Camino De La Luz, Santa Fe, NM 87501.

Editor's Note: Engine/Generators are generally less than 40% efficient, by themselves. If you consider wiring losses, losses in the pump's motor, and other losses in an ac powered submersible pump system, then the PV powered pumping system in HP6 is several times more efficient. RP.

Dear Friends at HOME POWER,

I've been reading HOME POWER closely and find the material very useful and accurate. You've got so many good ideas and facts that are just not available in any other publication.

We have been using solar panels on our recreational vehicle for 10 years - 6 years trailer and 4 years motorhome. It was one of the best investments we ever made. We continue to explore uses for battery power. One of the most practical was getting an inverter that changes 12 VDC to quiet 120 vac. We love our HEART INTERFACE 1200 watt inverter that allows using the microwave oven and all the convenience appliances we haul around. For the 3 or 4 months we travel in the RV, it has been a pleasure "roughing it" with this independent power system. Our recent book RVer's GUIDE TO SOLAR CHARGING and INVERTERS, published by AATEC, is our contribution in sharing our experiences for those seeking electrical independence in their RV. We enjoy talking and writing about this great technology. We realize that publishing HOME POWER free of charge to readers is a similar objective. We wish you well and keep up the good work.

Sincerely, Noel & Barbara Kirkby, POB 1562, Cave Creek, AZ 85331, 602-488-3708.

Hello Folks,

It is with great pleasure that I express thanks to you all for the much needed and valuable Home Power. It is my desire to attract someone interested in installing a show & sell work shop here in Reliance, TN. I am interested in the presentation & sales of AE equipment. Over 90 acres of setup and display area is available on a very low percentage basis. A large clear flowing creek is available for hydro presentations.

There is coming a time when public power will not be able to meet the demands of a growing population, unless more power is derived from natural sources. This is why it is urgent for inventors, engineers,and research scientists to come together in unity for workshops to speed up what is needed by all humanity.

I have the time and compassion to work with anyone for a much needed service. Please write for more information.

Emmitt S Adams, Box 17A, Reliance, TN 37369

The purpose of this note is two fold, first the ham radio network originally proposed by HOME POWER is alive and well. The usual frequency of the gathering is rapidly becoming 7236 KHz on Sunday afternoons 1630 hours Pacific time either standard or daylight. Some of the consistent check ins are: N6CDD Roger-Oakhurst CA, WB6EER Mike-San Simeon CA, N6FW Frank-Sunnyvale CA, W6HDO Cliff-Morro Bay CA, N6HWY Brian-Hornbrook CA, KG6IW Bill-Escondido CA, K7JK Jonny- Cave Junction OR, NK6P Jim-Monrovia CA. Many other individuals are listening and more check in on an intermittent basis. There are no prerequisites but it certainly is looked upon with favor if the station indicates power is derived by natural means!

The second item of note is the listing of a source of DC motors and batteries. The motors can be used as generators and batteries are new and dry, suitable for filling. Best of all these are 220 amp hour NiCd units with the Potassium Hydroxide powder included. Contact: Anker Electronics, 4168 Popular St., Suite B, San Diego, CA 92105-0120, 619-584-0725.

Apparently the DC motors are used on quality tape drives for computers. Both 12 and 28 volt models are available. The 12 Volt unit appears to be that used on Mary Duffield's boat the Aqua Alegre. Mike Mideke, WB6EER and I will report on the 28 volt unit when the San Simeon location gathers enough water for a test on Mike's wheel!

On a related subject, is there someone that can help with an optimum wind machine blade design? Is it possible to

design backwards? Suppose we have a curve of an existing generator in which torque is plotted on the X axis and amperage output is plotted on the Y axis. Can an optimum blade design be obtained?

Sincerely, Cliff Buttschardt, ESTERO SYSTEMS, 950 Pacific St., Morro Bay, CA 93442, 805-772-2132.

Q&A

We try our best to directly answer all your questions. Please remember that we are limited by our own experiences. If we don't have the direct personal experience to answer your question, we won't. We'll print the question anyway and hope that a Home Power Reader will have the experience to answer it. So this column is not only for questions to Home Power, but also for answers and comments from its readers. We try to answer as many questions as we can. Fact of the matter is that for every one we print, there are about 10 we don't. It's a matter of space. Hopefully, we will be larger soon and can deliver all the fine material that forlks have sent in. Thanks for your patience-- Rich

---

Dear Home Power Crew,

I am writing you in regards to the letter you published in Home Power #4 from Lisa Reynolds of Pearson, WI. She was looking for a 12 VDC color TV with a screen larger then 12 inches. I recently came across a 14 inch TV (12 VDC) with remote control in the Sears catalog. The TV is made by Magnavox and costs approx. $300. The catalog number is 57 B 40751C. Perhaps you could pass this information on to her and your readers.

My wife and I enjoyed our visit with you last month and appreciated your hospitality. I was hoping to see you at the Country Fair in Oregon, but our paths didn't cross in the crowd. It took me two and a half hours to get from Eugene to the fair grounds so I arrived late.

I am currently working in my "Micro-Cogeneration Unit". This consists of a 6 H.P. liquid cooled diesel engine coupled to an induction generator. I will be collecting the waste heat from the exhaust and cooling system and storing it in a 120 gallon water tank. I am curious about what kind of efficiency I can get from this rig. I will send you a full report if I come up with any good information. Also I will be attending the PV seminar offered by Colorado Mountain College in August. I am really looking forward to this.

If you are ever in the neighborhood, please stop by for a visit.

Sincerely, David Doty, Gig Harbor,WA

Thanks Dave, we enjoyed your visit, too. We're looking forward to hearing from you.

I have a Jacobs 2 kilowatt wind generator and plan to use it with a soon to be purchased 8 panel array with tracker. I intend to use the present 115 volt house wiring and, therefore, will run a Trace inverter off a battery bank. My question is this: should I use a rather odd-ball, more expensive 32 volt battery bank, since the Jake's windings were made for this voltage, or a less expensive and more practical 24 volt battery system? I have talked to a few people about this and have gotten quite a range of opinions on the matter. I have been told that a "24 volt Jake" will start producing power and peak out at lower wind speeds, but put out less overall wattage compared to 32 volts applied to its field windings. Considering the specific and consistent wind speeds we have in our hills, 14 to 16 mph for 6 to 8 hours daily, and my desire to get as many watts as possible out of the Jake, what would Home Power suggest? Use the enclosed $10.00 for that illusive and long sought after "free lunch". P.S. If there are any Jake owners out there with info. on this matter, give me a call, or write.

Jake Biondo, 19355 El Cerro Way, Watsonville, CA 95076, 408-726-1830

I wish I could give you specific info of the Jacobs voltage converstion, but I've no direct experience in these units. Basic physics does bear out the conclusions you have made so far. It's a matter of current through the windings of the generator. How about it Jacobs nerds?

Hi Folks,

First, let me congratulate you on your fine magazine. Keep it up!

I have built the Pulsar battery charger (HP#5, pp27) and am really pleased with it. There are a couple of questions: Every once in a while, the NiCad batteries being charged get HOT. This happened twice so far, with different batteries, one set being virgin AAAs. I disconnected them as soon as I noticed the heat. They do not seem damaged. What is going on? Is there a fire hazard?

I was charging six AA cells the other day, starting at 50mA. I had to trim the voltage at first. Soon I noticed the Ammeter needle creeping down. I kept adjusting up- first the voltage, then pulse width. Within two hours (sunset) the PULSAR was pulsing full bore but couldn't push more than 30 mA. What's going on? Are there self-regulating NiCads? Or can I only do four at a time?

Our household has been solar (9 ARCO 2000 PVs) for 7 years now. In winter, there's a Harris unit 1500 feet down the wire, with transformers at both ends if the line. This only works on runoff. To fill the gap, there is a 75 AMP automotive alternator driven by a vintage 1932 B&S 'ZZP' engine. For small AC loads (computer, video) I use a HEART 300W inverter. Power tools and the old Maytag run off of the 1800W DYNAMOTE. All is 12V since I feel switching between 24 and 12 is alot of hassle. I am learning about electronics rigging up 12V power supplies for the computer & monitor. It's nice to have NO HUM AT ALL.

We started out with a 500W Sencenbaugh wind generator but were leaping before looking: It is for sale. Bad site.

Again, you are doing a fine job of desktop/ mousetail publishing. Thank you. Fritz Oppliger, Redway, CA

Sounds like you may have a bad nicad. It is normal for nicads to heat up slightly as they are charged. If you can't touch the battery for five seconds without pain, then its too hot and something is radically wrong. If a nicad has failed in the open circit direction, then it presents a very high resistance, and the Pulsar cannot pump enough current through the cell (and all cells in direct series with the bad cell). On some small capacity batteries, the nicad pulsar may require adjustment of the voltage control to keep current within range for the pack. The duty cycle of the pulsar only reaches about 5% where say 2% may be necessary to regulate the current to the desired level. In this case, use the voltage control to lower the amplitiude of the pulse (its voltage) to the point where the current flowing into the battery is what you wish.

Dear Home Power,

I have enjoyed your magazine since its first issue, and have gained alot of useful information that I hope to put to use in the future. I would like to ask you or your readers if any of them have experimented with the possibility of using a work vehicle to produce supplemental power for the home, by placing a second battery system on the vehicle, and letting the alternator charge it whenever you need to drive the vehicle?

Q&A

Perhaps your computer could produce some useful charts of electricity production by using the amps of different size alternators, and the time run per week to determine how much power could be produced by each vehicle? Also, what would be the most efficient way to deliver this power to the home?

Thanks for any help you can provide, and keep up the good work.

Daniel T. Meirs, POB 2500, Lincoln, NE 68502

Yes, this mode of power production is happening. Many of us started out with an umbilical cord to our vehicle's battery. The car's alternator will fill an auxillary battery while the vehicle is running and the energy can be used later in the house. One problem with this setup is that the car must be continually reconnected to the vehicle. I've a friend that got the polarity reversed on this hook-up twice. Both times cost him a very new 12 VDC color TV set. Be sure to use a POLARIZED quick disconnect between the vehicle and the house. When it comes to high amperage alternator it's hard to beat the Chrysler 100 amp models. Unless you use very little electricity, I think you're going to spend a lot of time driving.

I have a one room cabin in rural South Georgia and am looking for an alternative energy source for air conditioning. Windmill power is not possible, and I prefer not to use a noisy generator. I am specifically looking for a propane air conditioner or information about it. I have a solar collector and 12 volt battery system that I believe can handle the electricity required to run the fan. I understand there once was a company called Arkla that manufactured these, but that the company was sold and the production ceased. Does anyone out have information on and access to a propane air conditioner?

Thank You! Judy McVey, 1693 Mchendan Ave NE. Atlanta, GA 30307

How about it, Readers, anyone know of a propane fired air conditioner? We've several systems in the neighborhood that use PV supplied energy to run evaporative coolers. They work well in areas with low humidity.

I have a highhead, low volume turbine, with a wheel made for a 1" jet. The drought in our region has run the ground water so far down that my turbine is from inefficient to worthless depending on the season. I'm in particular need of info on small pelton wheels that are efficient with a 1/4" jet and info on efficient 24 volt alternators. I have a good 1800 rpm, 120V alternator that may be fine, if I can come up with an efficient 6" pelton wheel. Other wise by-pass the charger and produce 24V direct to the batteries with a 4" wheel. Any Ideas?

Bill Ruggles, Bakersville, NC

Contact both Don Harris of Harris Hydro and Paul Cunningham of Energy Systems and Design. Both are advertisers in this issue and are experts in turning a trickle into Watts.

What about kerosene refrigerators?

Does anyone sell retrofit carburetor kits to change gas powered generators to propane? As a licensed auto mechanic, I know of kits and how to put them on car/truck engines, but have not yet seen any for small engines.

Your magazine is really good! Read them cover to cover when I get it.

More Power to You! David St. John, Mad River, CA

Well, David, to a physicist it's just plain ass-backwards to burn something to make something else cold. Electric compressor type refrigerators will work in low voltage RE systems. In fact the finest and most efficient refrigerator made are strictly for low voltage operation. Check out Sun Frost refrigerators and freezers. They have a Mercantile Ad in this issue.

Books for YOUR Shelf

Home Power receives many RE books for review. The following are on our Buy List.

THE NEW SOLAR ELECTRIC HOME

by Joel Davidson, (ISBN #0-937948-09-8) published by Aatec, POB 7119, Ann Arbor, MI 48107. 408 pages of essential info for home power producers.

LIVING ON 12 VOLTS WITH AMPLE POWER

by David Smead & Ruth Ishihara (ISBN # 0-945415-02-8) published by Rides, 2442 NW Market St. #43, Seattle, WA 98107. Very good technical sections on all phases of home power, 344 pages.

RVers GUIDE TO SOLAR BATTERY CHARGING

by Noel & Barbara Kirkby (ISBN #0-937948-08-X) published by Aatec, POB 7119, Ann Arbor, MI 48107. Complete coverage for the mobile home power producer, 164 pages.

HOW TO INSTALL A SOLAR WATER HEATER

by James E. Cook (ISBN #0-9619932-0-0) published by Save On Solar, 6905 White Rabbit Rd., Battle Creek, MI 49017. Details on closed loop anti-freeze systems, 89 pages.

the Wizard Speaks…

The Free Lunch

What is a free lunch? In physical space/time, the free lunch is defined as a system which creates more energy than it consumes. Despite the protestations of modern science, this goal is attainable. In fact, there are at least two ways to do it. One way is through an inorganic transformation system, using self-regenerative feed back loops. For example, data acquiring, artificial intelligence, computer programs. Another way involves reprogramming the bio-sphere through understanding DNA. Just like our lives and bodies…

A third path, however, does exist. This involves the evolution of the body to a point where it can transform any form of physical energy into any other form. This path traverses all realms of experience. It means evolving the essential self to total control of its individual environment. Thus, the free lunch enters the realm of absolute individual freedom; it relates to the power of the self to experience only that which it wills. This also extends to controlling the environments of others if they so wish. Here one must be VERY careful that one does NOT overstep the boundaries of CONSENT.

Vote Libertarian!

Freedom, Power, & Peace to All.

Saw An Oak Turn Red Today

Daniel K. Statnekov

Saw an Oak turn red today
Falls comin' sure as balin' hay
The summer heat has lessoned some
As has the sound of insect's hum

Corn's been down now 'bout six weeks
Fodder's chopped, the silo creaks
And pumpkins layin' on the vine
A promisin' pie, you know the kind

Fields of stubble all in rows
Luring deer along with does
Their looking for an ear or two
Left out for them and in plain view

This Autumn time that's nigh upon
Minds me of those years'r gone
And chestnuts roastin' on the fire
Rainstorms that turned the roads to mire

Preserves that mom put up in jars
Before we drove to town in cars
The oaken bucket, water well
Cows coming home with tinklin' bells

The steam smell heat of barn and stall
Another memory of Autumn's Fall
A country scene I'll nare forget
No matter what the age I get

Seems the critters all about
Knew seasons changin' without doubt
Storin' food in holes and dens
Cept'n those we kept in pens

And longer shadows shade the lawn
Days are shorter, colder dawn
The streams more lively, seems to know
Soon winter freeze'll make it slow

We used to watch the signs to see
How cold a winter it would be
Caterpillers creepin' crost the road
Their stripe a tellin' nature's code

And furry coats on stock, like sheep
Another sign that meant a heap
When Autumn's chill a message sent
Into their brains just what it meant

Us human bein's piled up wood
Getting ready best we could
Drinkin' cider, sour mash
And puttin' by a little cash

'Pears no different than the rest
What we do to make a nest
When Autumn's blush of color warns
Us winter's comin' with its storms.

Home Power MicroAds

Rates: 5¢ per CHARACTER, include spaces & punctuation. $10 minimum per insertion. Please send check with your ad. Your cancelled check is your receipt.

INSTANT DOMES AND GREENHOUSES: 20 minutes set up! 8 to 18 feet diameter. Proven performance and reliability. Many models. Send $1.00 for catalogue. SHELTER SYSTEMS, POBox 67-HP, Aptos, CA. 95001 (408) 662-2821

SOLAR WATER HEATER. Closed loop, PV option. You install and save. Illustrated instructions, 96 page manual, $10.95. Save On Solar, Inc., Dept. HP, 6905 White Rabbit Road, Battle Creek, MI 49017.

JACOBS WIND ELECTRIC replacement parts, new blades, and blade-actuated governors. We make replacement parts, and have new blades, for most all wind generators, pre-REA to present models. Many used parts, too. Lots of used equipment available: wind generators, towers, both synchronous and stand alone inverters, batteries, Aermotor waterpumpers, and some PV's. Best prices on Trace inverters and Sovonics PV modules. Information: $1; specify interests. Lake Michigan Wind & Sun, 3971 E Bluebird Rd., Forestville, WI 54213 Phone: 414-837-2267. THIS MONTH'S SPECIAL: Rebuilt 4kw DWS wind generator with blade-actuated govenor: $2500 + shipping.

ALTERNATIVE ENERGY EQUIPMENT CATALOG. Everything for stand alone power generation, PV's, Hydro-Electric, Wind Generators, Inverters, Water Pumps, Regulators, Refrigeration, Tools, Books, and much more. 92 pages with design guides. $3. US, $6. foreign: WESCO, Box 936-HP, REDWAY, CA 95560

JACOBS, BERGEY, WHIRLWIND, and WINCO Wind Generators, Kyocera Solar Systems, Trace Inverters, Towers, Batteries, Portable Generators, 12 Volt Converters, Pumps, and Light Fixtures. *We Build Custom-Built Wind and Solar Powered Homes. Built-Rite Construction, R.R. #3 Box 48, Ligonier, IN 46767.

THE ALTERNATIVE LAND ACQUISITION HANDBOOK provides you with 6 Ways to get land FREE or ALMOST FREE! Land Reclamation•Alaskan Homesteading•The Indian Homestead•Mining Claims•Tax Delinquent Land-Lost and•Forgotten Land! Send $20 to Ridgehaven POB 862 Glen Ellen, CA 95442

COMPLETE SOLAR ELECTRIC POWER SYSTEMS. We offer the EchoLite photovoltaic power package: designed to provide modular components for easy installation, secure mounting and quick access. Perfect for remote sites, homes, RV's & marine applications. Free Brochure. Sunwater: 219 Van Ness Ave. Santa Cruz CA 95060 408/423-2429

ENERGY SPECIALISTS Best Published Prices Anywhere. We carry a full line of ARCO Photovoltaic products, inverters, energy efficient appliances, Yamaha generators as well as hydro-electric equipment. SPECIAL: Solavolt, 9 watt panels, fully warranted, $80.00 plus tax & shipping. For your energy needs whether it be starting a system or expanding your existing power, contact us at area code (916) 392-7526 or write to P.O. Box 188710, Sacramento, California 95818. Catalogues are available for $5.00 each postage paid.

9" BRONZE PELTON WHEEL RUNNER. About 1-8 Kw output. Sacrifice $350.00. Eagle Shield Radiant Barrier, for info 509-738-2346

THE EAGLES NEST. Incredible view of Columbia River, 2 miles north of Kettle Falls, WA. NEW 3000+ sq. ft. custom, All Woods Home & large shop. Unique setting. 1 of 2 homes in 5 miles of riverfront. Garden, drilled well, power, phone, Rainwater system 2400 gal., many decks, thermo windows. Indescribable beauty and value. Future investment Bonanza. 509-738-2346 $96,000 owner contract.

32 V JACOBS WIND GENERATOR - 2400 Watt, new since rebuilt, solid state controller $1,500. Jay Greene, HALIBUT COVE, AK 99603 (907) 296-2241

EAGLE SHIELD™ Reduces cooling cost. Reduces heating cost. Easy to install (self or company). Guaranteed Satisfaction. Phone: 916-436-2761 Write: 13505 Old Hwy. 99-So., Grenada, CA 96038

SOLAR-MEXICO'S CABO OFFICE SCHEDULED TO OPEN OCTOBER 10TH If we can be of any assistance south of de border, please contact us at: SOLAR-MEXICO, 20152 Cypress Ave. Unit B, Santa Ana, CA 92707 (714) 724-1155

ELECTRIC MOTOR, GENERATOR, AND TRANSFORMER WINDER-TROUBLESHOOTER offers free consultation. I'm also looking for a good job in an A.E. related field. Can redesign. Best to call 8-10 P.M. 713-723-4830 Pete Rainey

JACOBS TWIN MOTOR, 1500W. 32V. rebuilt generators, with control panel and stub tower, $500.00. John Beck, HC06, Box 9, Mandan, N. D. (701) 663-7399

DYNAMOTE INVERTER. 12 Volts D.C. Input Output 120 Volt AC 60 cycles 1800 Watts surge 2.5 Amps with cables $250.00 Cash. J. Burkholder, 10455 McClelland Road, Calhan, Colorado 80808 719-683-3022

CARETAKER WANTED for remote property in northern California. Free rent and small monthly stipend in exchange for work. References required. Inquire c/o Kahn, 78 Schooner Court, Richmond, CA 94804.

FOR SALE 2 Kohler 110 VDC generating plants 1500 W at 1000 RPM Model D SN's 24644 and 24645, 32V auto start. Look like unit on page 8 HP#4. They are in Ontario and not available until next spring. Probably only one operating unit can be made from the two. Write for details. Best offer. W.W. Kelly 307 Alliance St., Havre De Grace, MD 21078

120 WATT SPECIAL Complete ARCO Solar Electric System, 120 watts with mount and regulator. System pre-wired. Full warranty included, $799.00. Contact: ENERGY SPECIALISTS, P. O. Box 188710, Sacramento, California 95818.

THE MOTHER EARTH NEWS, Vols: 1, 2, 5, 6, 8, 10, 24-29, 33-82; Best offer, one or all. Used Homesteading and How-To books, 1/2 to 2/3 off list price: Send $1 for current list. Also RCA 9" Color AC/DC TV, like new, $175. Goodier, Rt. 5, Box 137, Huntsville, AR 72740

FREE CATALOG OF 12-VOLT PRODUCTS! Plug into cig. lighter or clip directly to battery. Lantern, Vacuum, Hair Dryer, Chainsaw, Bug Zapper, Drill, Fan, VCR, Fry Pan, Microwave, Refrigerator, Toaster & many more! P.O. Box 664-HP, Holland, PA 18966. 1-215-355-0525

FREE MEGAWATTS! All-year creek has hydropower system! Quality built modern chalet is nestled on 20 forested acres in the foothills of the Cascades. Sequestered by national forest. Just $89,950 - Dan Dodge C-21 Points NW 1-800-521-6721.

40 W. 12 V. HELIOPOWER PV Panels $228.80. Equal savings on higher or lower watt models. 10 year warranty. All at cost + 10% plus shipping. Ron Becker, Box 396, Ruidoso, NM 88345

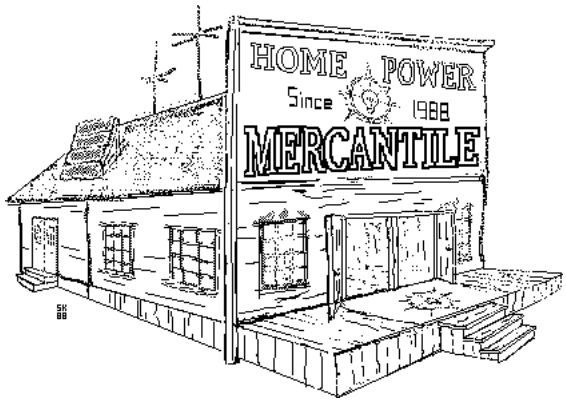
A. Y. McDONALD "SOLAR JET II" PUMP 1500DJ with jet ejector bolted on. For 4" diam or larger well. Incl control. Used 3 months. $950.00. Jean Smith, Star Route 55-0, Oroville, WA 98844 (509) 485 3900

ONAN 6.5 KW GENERATOR, (6.5 NH-3CR/8389), Battery, Solenoid, Strainer, Regulator, Muffler, Flex, Natural Gas or convert to Propane, never fired up, Brand New $3700 or BO, Sun, Wind & Fire, 7637 SW 33, Portland, OR 97219, 503-245-2661

DISTRIBUTORS WANTED - MULTI PURE DRINKING WATER SYSTEMS. Full or part time employment. Highly motivated individuals who would like an opportunity to make high commissions & bonuses marketing the finest product in its field. Call or write; HOME PURE WATER, Box 3457, Ashland, OR 97520, CALL CA 1-800-822-4447, ext.197, or USA 1-800-334-5543, ext 197, residence 503-482-1647.

Humor Power

Index to Advertisers



Mercantile Points To Ponder

- One insertion per customer per issue.
- $80 per insertion, paid with your ad copy.
- We typeset all ads, no exceptions.
- Sorry, no graphics, no exceptions.
- We will do our best to make your ad look good in the available space.
- If you send us too much copy, you may not like the result.
- Examine other ads for guidance.
- We don't bill Mercantiles, your cancelled check is your receipt.
- Call **916-475-3179** for more information.