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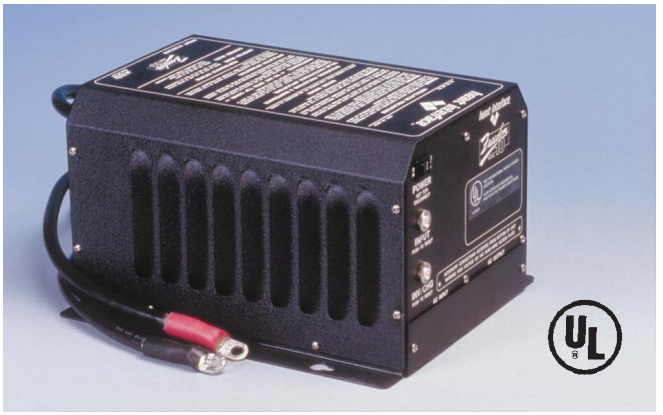

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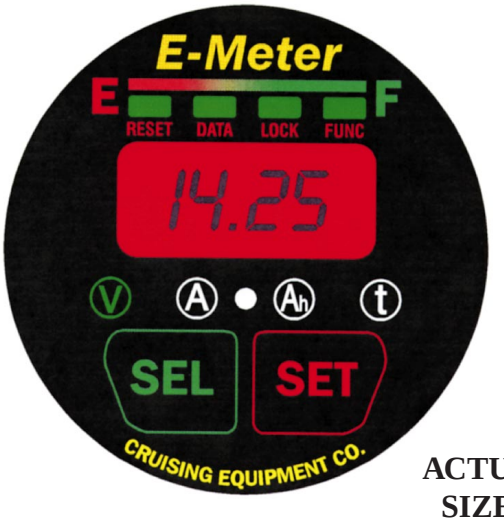

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Issue #51 February / March 1996

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GoPower

Fundamentals

Features

Cover: A potable water system is just part of a PV-powered health clinic in the rainforests of Guatemala.

Homebrew

Columns

Regulars

Access and Info

Access Data

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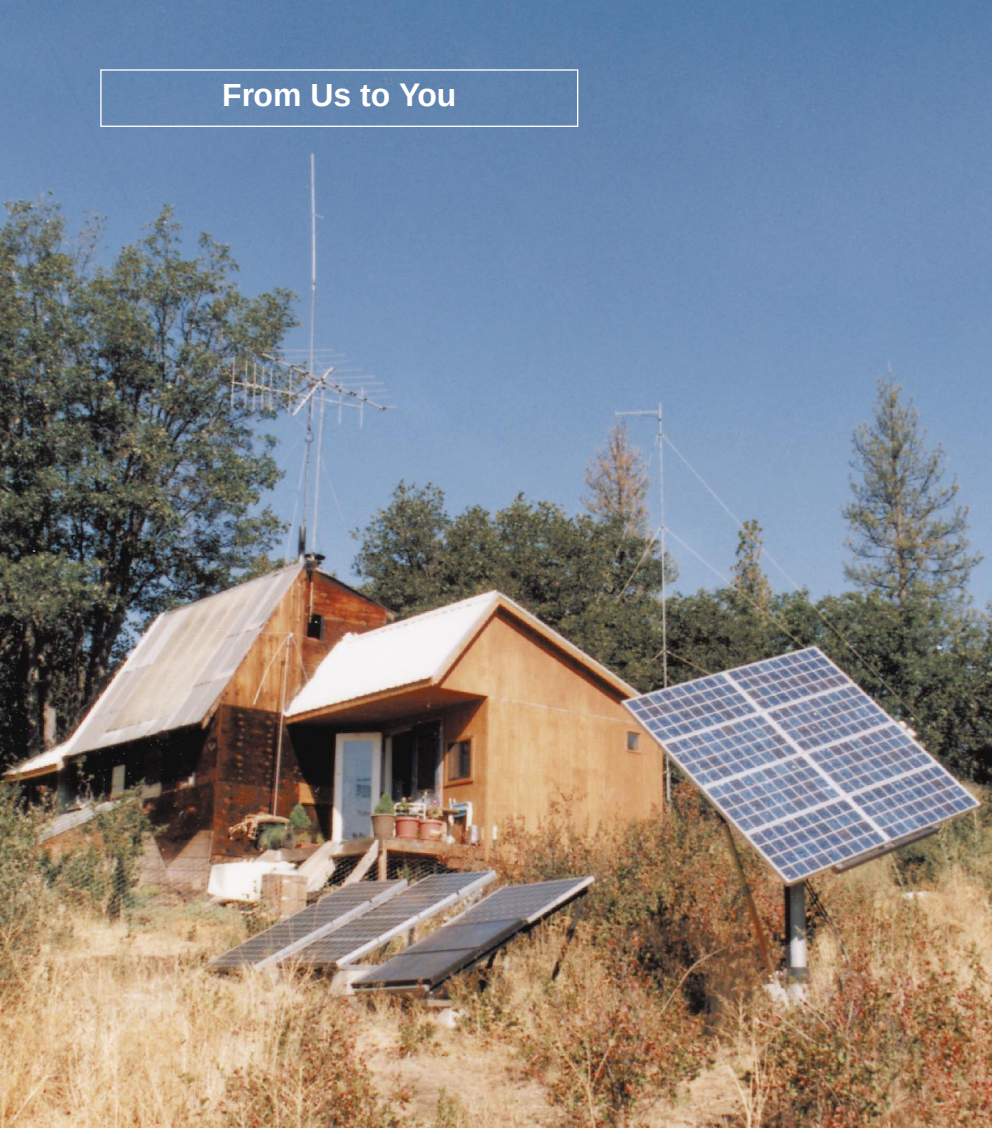

Funky Mountain Institute

or dispelling the myth of the "Home Power Towers"

Many of our readers expect us to be grander than we really are. There are no Home Power publishing offices in New York, London, Zurich, or Tokyo. We live and work at the Funky Mountain Institute shown in these photos. There are no "Home Power Towers." Only a small group of four people working full time and three others part-time. Our work is publishing the renewable energy information supplied to us by you, our readers. We aren't much different than our readers—we live and work powered by renewable energy, too. We, like our readers, believe in doing more with less. We can only hope that this is enough….

Richard Perez for the Home Power Crew

People

Bob Batson
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Carl Berger
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Drake Chamberlin
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Wes Edwards
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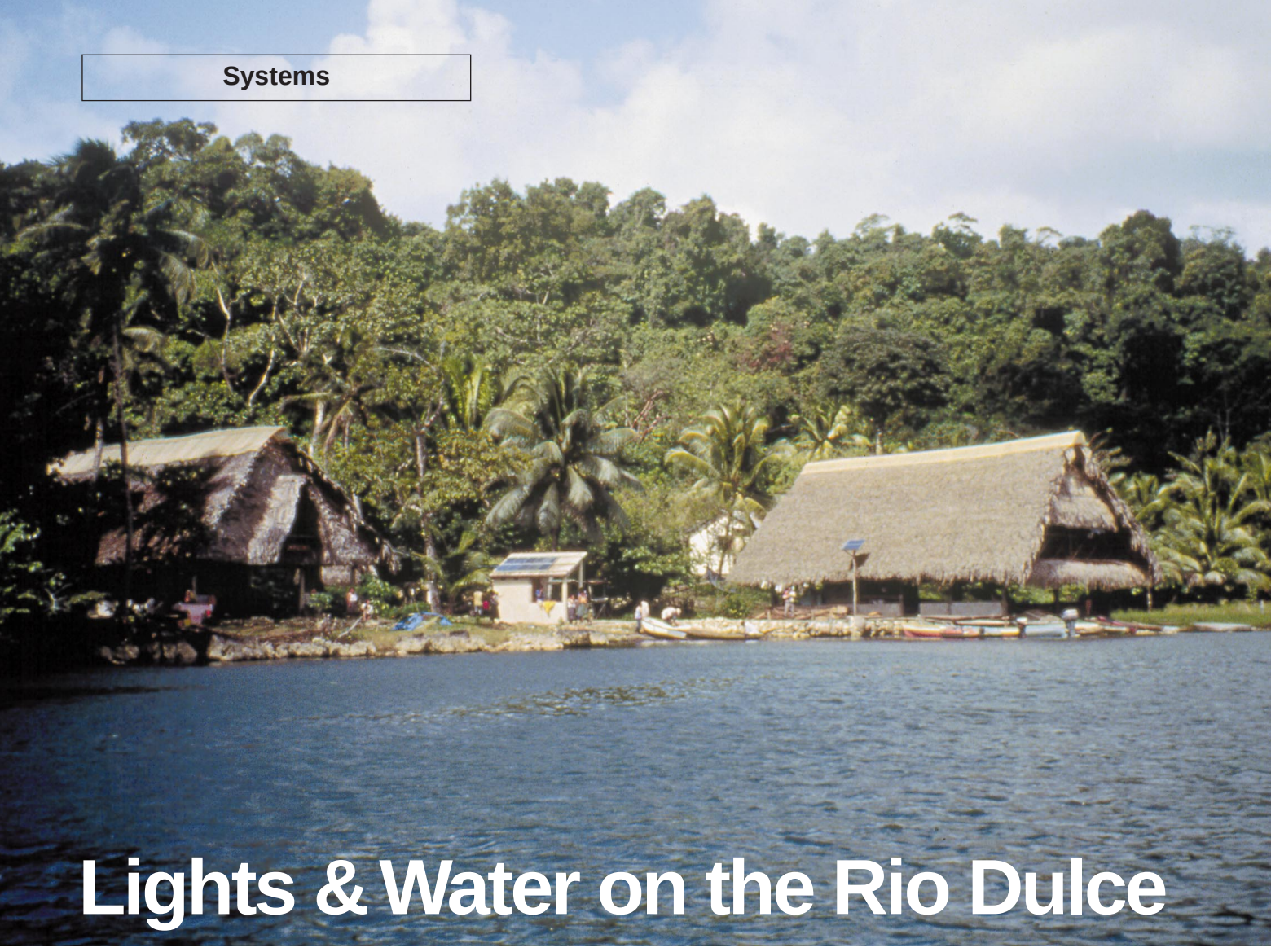

Lights & Water on the Rio Dulce

Eliot Zaiken

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In 1993, I traveled by land from Arizona to Costa Rica with the goals of finding volunteer work, as well as experiencing and enjoying the different Central American cultures. In Guatemala, I had the fortune of being introduced to Steve Dudenhoefer, an American who is the founder and director of AC' TENAMIT (Mayan for Pueblo Nuevo or "New Village"). Ac' Tenamit is a small grassroots development project whose mission is to increase self-sufficiency for Guatemala's Mayan Indians through programs of health care, education, and economic development in the rainforests of northeastern Guatemala. The project is located on a remote part of the Rio Dulce (Sweet River) in an area where electricity and potable water will never come to be, and malaria and other diseases are commonplace. Since that first meeting with Steve, I have made yearly trips to design and/or install several photovoltaic electrical systems and a potable water system using a solar powered Slowpump™. Having lights and water made a tremendous difference in the level of health care as well as the quality of life, and the project is an excellent model of a successful self-help project.

History & Background

In this area of the Rio Dulce, 60 minutes inland from Livingston by motor boat, there are over 6000 Kekchi (pronounced Kay-Chee) speaking Indians. They are direct descendants from the Maya living in over 40 communities scattered over hundreds of acres. They resettled there in the late 1970s and early 1980s after fleeing the political violence of Guatemala's central highlands which most likely would have taken their lives if not for their escape. They brought with them their culture, language, and way of life, without any system of health care, education, or economic support. They are very peaceful and friendly people, and openly share what little they have.

Ac' Tenamit is a completely private non-denominational organization with no support from the Guatemalan government. All support comes through private donations of money and materials primarily from the United States. The labor for construction is provided by volunteer work crews from the villages that the project serves. The villagers also play a vital role by electing community representatives in monthly meetings that discuss and formulate various aspects of Ac' Tenamit's general policies and growth. The project is based at Barra Lampara, a location on the river central to all the villages, although it could take up to 12 hours of walking and canoeing to reach the project for some villagers. At Barra Lampara there is a health clinic/field hospital, school, boathouse, offices, and sleeping space for the international volunteers and project staff. The international volunteers serve from one month to two years, depending on the project's needs and their availability. They are given room and board in exchange for work.

Above:
Students attending classes at the three-classroom school.

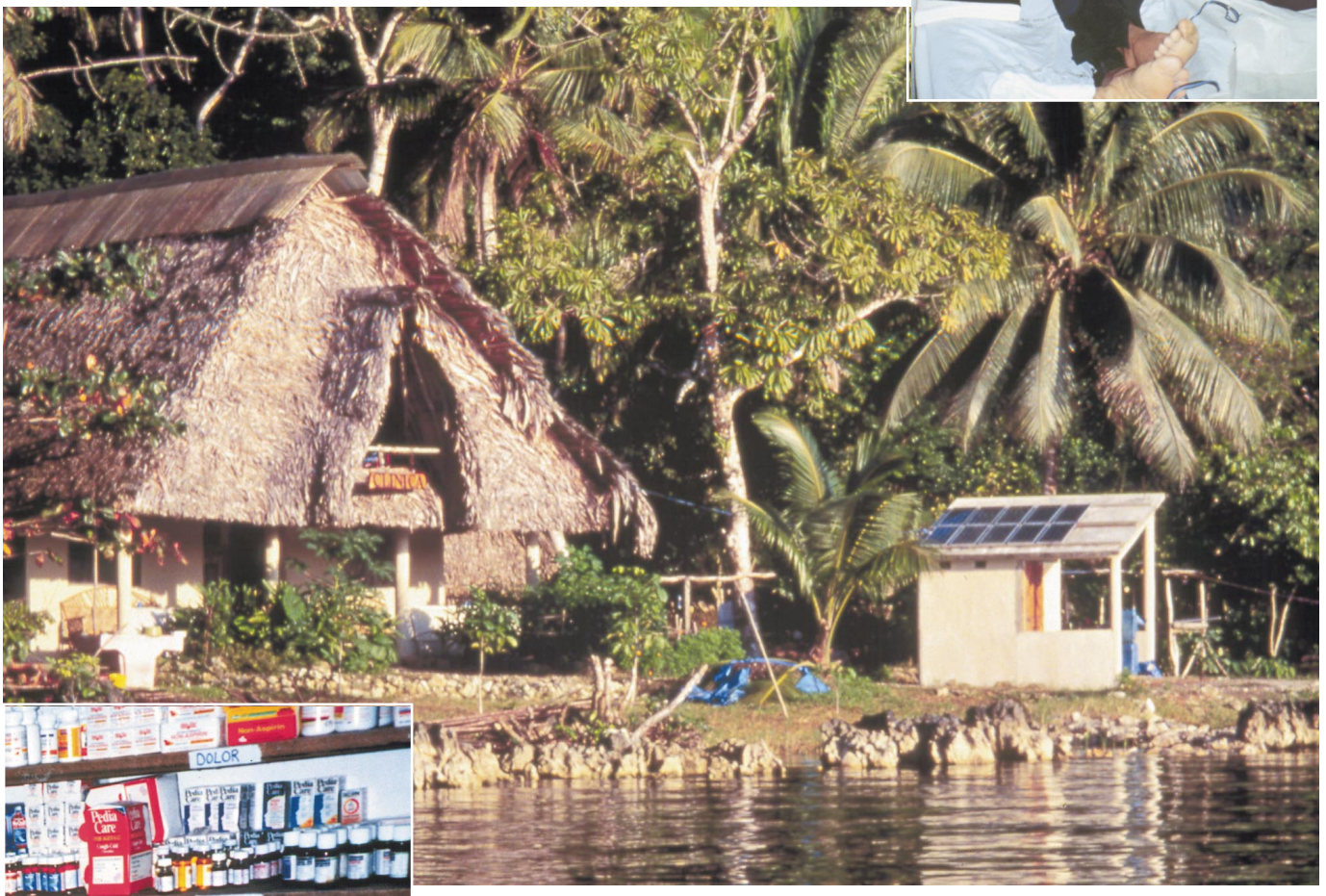
Below:
Villagers canoeing the Rio Dulce, the main means of transportation in the Barra Lampara area.

At this time, the main priority of the project is health care. The health clinic is open 24 hours a day and is staffed mostly by the international volunteers as there is not enough money to hire only Guatemalan health practitioners. In any given day, the clinic staff sees as many as 40 people. Both local medicinal plants and western remedies are

prescribed, although the majority of patients are treated with the latter. Medicine is primarily donated from hospitals and drug companies in the United States and shipped for free by various airlines. Most medicines have passed their expiration date and can no longer be used in the United States. Aside from staffing and maintaining the health clinic, much effort is put into an ongoing immunization program for children during periodic visits to the villages. In addition, health promoters from each village are trained at the health clinic to diagnose and treat most common ailments.

Right: A patient is sutured by nurse volunteers.

Below: The Barra Lampara Health Clinic on the banks of the Rio Dulce.



Left: Medicines are donated by U.S. hospitals and pharmaceutical companies, then flown to Guatemala for free by various airlines.

The school consists of three classrooms with about 90 students in grades 1 through 6. Students attend school from 7:00 AM until noon, and then go home to work with their families. They learn reading and writing in Spanish, geography, history, mathematics, and occasionally art and English. This school serves only the nearby villages but other schools have been built in the more remote villages. It is staffed and managed by Guatemalan teachers, although their salaries are paid by the project.

The third priority of the project is creating environmentally sensitive income generation opportunities. Several villages make paper from corn husks which are then used to make cards and notebooks that are sold in Guatemala and the United States. A Mayan woman on staff and living at the project packages and coordinates the distribution of the cards and notebooks. Other villages have had training in using manual sewing machines to produce clothing for personal use and sale.

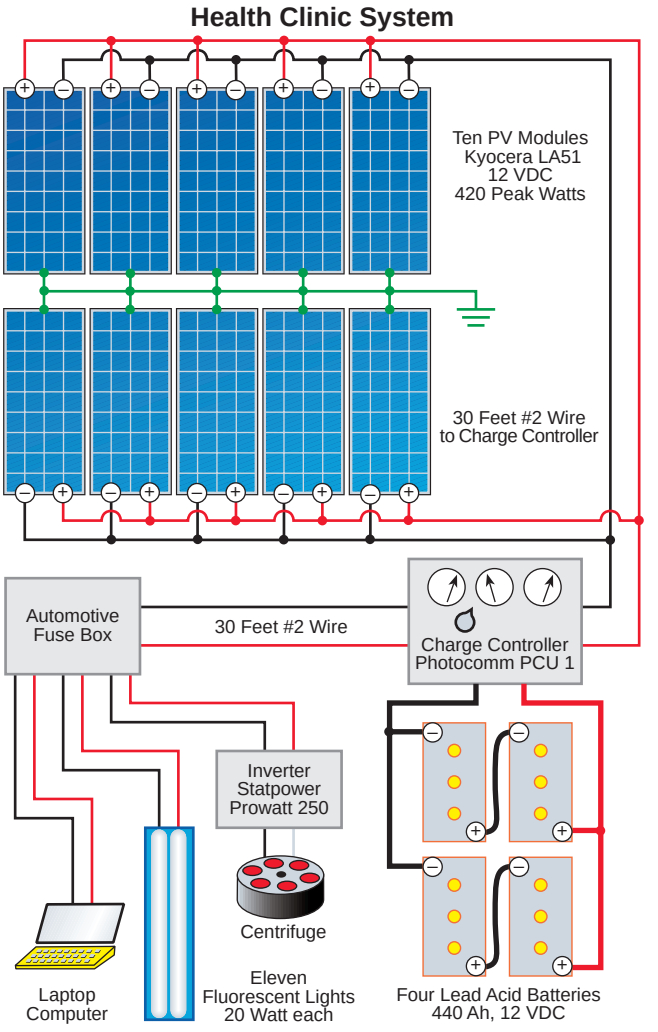
The Transportation Challenge

When I began installation of the project's first photovoltaic system in January of 1994, one of the greatest difficulties was obtaining and delivering equipment to the project. The nearest larger town is over an hour away by boat, and we could only buy some random electrical components and a limited selection of wires and cable at elevated costs. Most of the items needed to be bought in advance in Guatemala City, transported by bus six hours, and then by boat the rest of the way. Even in Guatemala City it usually requires visiting many different shops before finding the needed quantities. Photovoltaic equipment is very expensive in Guatemala, with a limited choice of suppliers. Fortunately, through the gracious support and assistance of Photocomm and Kyocera, photovoltaic modules and controllers were available to us at reduced cost in the United States. I brought them down with me on each of my trips. Getting through customs was an interesting ordeal, and at times took hours.

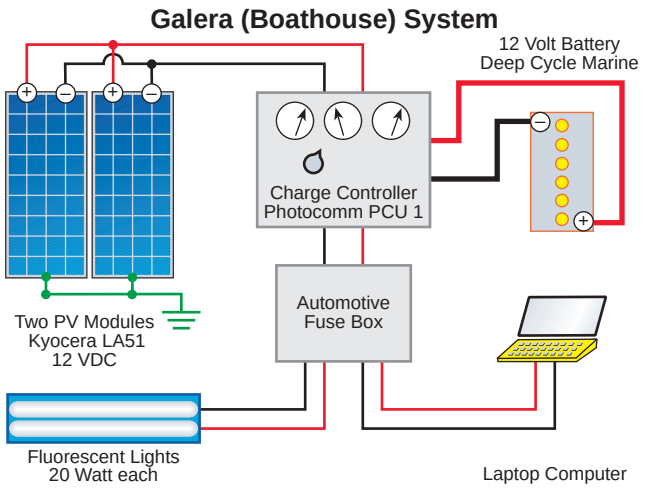
Power Requirements

The main use for the electrical system is lighting in the health clinic for medical and dental procedures. It had been very difficult to perform surgical procedures with flashlights and Coleman lanterns that burn you when you touch them. And can you imagine performing dental work with a headlamp and flashlights? We needed 11 lights for the eight health clinic rooms and the upstairs living spaces. 12 Volt, 20 Watt fluorescent lights were the most practical as they are reasonably priced and available in Guatemala City.

Above: Photocomm PCU1 controller and battery bank upstairs in health clinic.



A major premise in our work here is using locally available components whenever possible while keeping the technology simple. We chose 12 Volt systems over 24 Volts or 120 volts ac. Although it would be easier to use ac, it is difficult to monitor and control the usage of the large number of people living in and visiting the project. For the limited ac needs, we used a gasoline generator. An exception to this is our laboratory centrifuge powered by a PROwatt 250™ inverter donated by Statpower Technologies. It consumes about 1 Amp. Other 12 Volt power needs include Macintosh Powerbook computers, printers, and small hand-held automobile emergency lights that are used during medical procedures.



Health Clinic Solar Electric System

The health clinic's power source consists of 10 Kyocera LA 51 photovoltaic modules mounted on top of a cement roof 30 feet from the clinic. The modules were wired in parallel for 12 Volts and produce 420 Watts (27 Amps at 15.5 Volts) in full sun with an average of 2,100 Watt-hours per day, even in the rainy season. We were concerned about the output being a little low. After climbing up on the cement roof several times and feeling the heat, we attributed the lower performance to the elevated temperatures of the modules. A 30 Amp fused switch was also installed to protect the array.

Photovoltaic Regulation & Battery Storage

The photovoltaic array is regulated by a 12 Volt Photocomm Power Control Unit (PCU1) partially donated by Photocomm. This controller has most of the accessories we were looking for in one simple package including a 35 Amp load circuit breaker, analog meters, and most important, low voltage disconnect capability.

Fortunately, batteries were available in Guatemala City at a reasonable price. Our battery bank consists of four deep-cycle, 6 Volt lead-acid batteries which store 440 Ampere-hours at 12 VDC. This is 5.2 kiloWatt-hours, enough energy for about 140 hours of 20 Watt light usage before recharging. A wooden box holds the batteries and has a 4 inch hole to a 10 foot PVC tube for venting the hydrogen gases. As we are unable to afford Hydrocaps at this time, water needs to be added weekly. During my last trip in February after a year of continuous operation, I charged the batteries and measured the voltages. They are all performing well with full charges between 6.57 and 6.61 Volts.

Other Electrical Systems

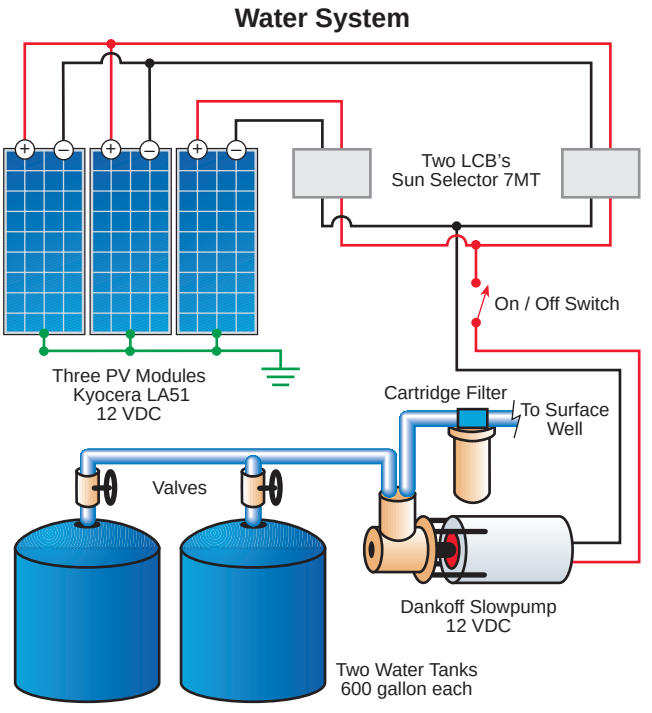
Fairly close to the health clinic is a galera (boathouse) with living quarters and offices above. Another small system was installed there using two Kyocera LA 51 photovoltaic modules, another Photocomm PCU1 12 Volt controller, and a donated, used 12 Volt deep cycle marine battery. This system powers several 20 Watt fluorescent lights, a Macintosh Powerbook, and a printer. We will expand this system when more panels and batteries are available.

Potable Water System

Potable water is probably the most important addition to the project. Prior to the installation of the system, drinking water was manually carried to the needed destinations from a questionable source that was a 20 minute boat ride away. As a result, potable water was used only where it was critically needed. Cooking and eating utensils were washed with river water and bleach. The river water is used by the locals for everything from bathing to defecating.

Finding information to design the system was very difficult. However, I was fortunate to have met Windy Dankoff at the 1993 Midwest Renewable Energy Fair in Wisconsin. He has been extremely helpful in aiding us design our system, and donated several components.

In a small valley behind the health clinic, we found a surface spring that provides a constant supply of water. We built a cement pump house topped with a traditional thatched roof and installed a pump box. Following Windy's recommendation, we used a Dankoff Solar Products 2507 12 Volt Slowpump™ for high flow with a lift of less than 140 feet. Although 24 Volts is



Above: Clinic sink. Faucets were also installed around the compound.

Above: Pump box containing Slowpump™, in-line filter, and Linear Current Booster™ supplies water from a spring. See the pump house on the cover.

more efficient, we chose 12 Volts so we could use an uneven number of photovoltaic panels. We are using three Kyocera LA51 photovoltaic modules to power the pump directly through two Sun Selector LCB™ 7MTs. On the inlet side of the pump we used a foot valve with strainer and a 5 micron in-line filter. The water is then pumped through 300 feet of 1 inch black polyethylene tubing to two 600 gallon fiberglass storage tanks on a ridge 60 feet above the pumphouse and health clinic. Gravity does the rest.

In full sun, the storage tanks receive 3.3 gallons per minute, filling in about six hours. Previously the system was running with two panels and one LCB™ at a performance of 2 gpm. However, when the cartridge filter was dirty, performance was reduced to about 1.5 gpm. This emphasizes the need to monitor and replace the filters as needed for peak performance. We are able to go about four weeks before the cartridge needs to be replaced. They are available in Guatemala City for about $5.

According to the Slowpump™ specification chart, the storage tanks should be receiving 3.9 gallons per minute plus or minus 10%. However, as with the health clinic array, we attribute an approximate 10% loss due to the elevated temperatures of the panels. Another factor is a slight chatter noise that is always present. From my conversations with Windy Dankoff, we attribute these to cavitation and released gases from the water supply. This could have been reduced if we had placed the in-line filter further away from the pump, and/or mounted the filter horizontally instead of vertically. We are looking into making these modifications where feasible. Taking the 10% loss into account from the elevated temperatures, our effective flow rate would be about 3.6 gpm which is within the performance specifications of the pump.

Above: Two 600 gallon water tanks sit 60 feet above the clinic and provide gravity pressure.

Health Clinic Solar Electric System

#	Description	Cost	%
*	Total of Subsidized Items	$1,700	39.6%
	Cables & Wiring	$400	9.3%
10	20 Watt Fluorescent Lights	$350	8.2%
4	6V Lead Acid Batteries	$340	7.9%
3	Emergency 12 V Auto Lights	$54	1.3%
	Switches, Electrical Boxes, etc	$40	0.9%
1	Automobile Fuse Box	$35	0.8%
1	30 Amp Fused Switch	$20	0.5%
10	Kyocera LA 51 PV Modules	*	
1	Photocomm PCU1 Controller	*	
1	Prowatt 250 Inverter	*	

Ac' Tenamit Potable Water System

#	Description	Cost	%
*	Total of Subsidized Items	$600	14.0%
	Valves, Connectors, & Fixtures Filter Assembly, Foot Valve	$350	8.2%
2	Sun Selector LCB7MT	$220	5.1%
2	600 Gal. Fiberglass Tanks	$80	1.9%
800	Ft. of 1" Polyethylene Tubing	$60	1.4%
	Wire, Connectors, Fuses, etc.	$40	0.9%
3	Kyocera LA51 PV Modules	*	
1	Dankoff 12V Slowpump	*	
1	Aquastar Water Heater	*	
	Total Cost	$4,289	

*These items were sold to Ac' Tenamit Nuevo at a reduced cost or donated.

We placed spigots in several centralized locations on the project grounds. More importantly, we built several sinks in the health clinic and now there is plumbed, potable water for washing wounds and cleaning equipment. We also installed an outdoor shower with an Aquastar on-demand hot-water heater donated by Controlled Energy Corporation.

Don't forget to turn off the lights and water on your way out...

The health clinic has had light for over a year now, and the batteries are maintaining their charges. Since the installation of the water system in February, there has been plenty of water even for showers. But as human nature will have it, both locals and westerners alike have learned to take the systems for granted. On numerous occasions I found lights on needlessly and water being used inefficiently. For now, the system is oversized enough for the the number of people who live and work there. As the project continues to grow more care will need to be taken to provide uninterrupted service for years to come. In the meantime, the project continues to provide valuable help and support for the local Kekchi population.

Ac' Tenamit/Pueblo Nuevo is a small non-denominational grassroots organization dedicated to increase the self sufficiency of Guatemala's Mayan Indians. It is primarily funded through donations from private individuals and civic organizations. 97% of these donations go directly to the project on the river. We are in need of money and materials, especially new and used photovoltaic equipment. For more information, or to inquire about volunteer opportunities, contact the Guatemala Tomorrow Fund, a tax-exempt organization dedicated to Ac' Tenamit.

Access

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10 Years of Utility Intertied Windpower

Carl Berger

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The date was October 17, 1985, and the entry in my notebook reads, “Credit meter installed by NYSEG, we’re on line.” This isn’t the beginning of the whole story but, for now, it’s a good start. The windmill is turning, a dream has been realized, and an adventure with wind power begun.

This adventure has given me quite an education in utility intertied windmills. By sharing some of my experiences, including the problems and surprises, maybe you can share in this education. To start, let’s take a look at the system.

The System

The windmill is a 4,000 Watt Whirlwind on a 120 foot guyed tower. My house is connected to the power lines like most other homes. When the grid electricity goes off for our neighbors, it is off for us as well. This system, like many other windmills connected to the electric utility’s grid, has no batteries. Something that is different from my neighbors is the two electric meters on the side of my house. The credit meter measures the amount of electricity we sell NYSEG, (New York State Electric and Gas), while the billing meter measures the amount of electricity we purchase from NYSEG. Electricity generated by the windmill is divided between the amount used by our home and the amount sold to NYSEG. We only sell electricity when the amount of electricity being generated by the windmill is greater than the amount of electricity the house is using at that particular time. This electrical control happens without any action on my part and isn’t noticeable when inside the house.

The windmill itself was made by Whirlwind Power Company of Duluth, Minnesota. Like many of the windmill manufacturers of the early 1980's, this company no longer exists. However, Elliot Bayly, the founder and former owner of Whirlwind is still in the windmill manufacturing business as World Power Technologies. This has been a real advantage when I needed parts or some advise. Elliot is just a phone call away and still has parts for my machine. In the past ten years I've needed Elliot's assistance three times, and each time the new parts or advise worked as needed.

When most people hear that the tower is 120 feet high, the first reaction is "why so high?" There is one good reason: a number of 80 foot tall Maple trees to the West of the tower. One rule of thumb says: "keep the windmill 40 feet above any obstruction within a 500 feet radius." Easy math shows a 120 foot tower would do the job.

Above: Carl Berger clips in with a safety harness before beginning the 120 foot climb to the top of his tower.

Installation

This entire windmill system was installed as a cooperative arrangement between myself and the windmill dealer. Although I feel reasonably competent at most construction and electrical projects, constructing a 120 foot tower and lifting a 300 lb. unit to the top was beyond my ability.

Building concrete foundations by blueprint, installing electrical wire per code, and similar preparations were not a problem for me. Because of this arrangement with the windmill dealer, I saved some money and got to know the system better. The major monetary savings I enjoyed during the 1985 installation was due to the Federal and New York State income tax energy credits available at that time. Because of these factors, the total cost of the system becomes a rather meaningless number for anyone to use as a guideline in 1995.

The Extras

When I called other windmill owners before purchasing mine, I was amazed that no one could tell me how much electricity their windmill generated. My technical way of thinking caused me to purchase some extra items that weren't really needed for the windmill. These included a previously owned kilowatt-hour meter from Arcman Corporation and a NRG Windhawk 8000 anemometer.

The kilowatt-hour meter measures the amount of electricity the windmill generates. This is a very different number than the amount of electricity I sell to NYSEG. If you remember from earlier in this article, the amount of electricity generated is divided between the amount used by my house and the amount sold to NYSEG. This meter provides the answer to, "how much electricity does your windmill generate?"

Above: The billing meter, credit meter, and lockable shutoff are located outside the house.

The Windhawk 8000 is an electronic recording anemometer. For me, it is a great curiosity satisfier. What is the current wind speed? What was the peak gust last month? What was average wind speed so far this month? How many hours was the wind speed over ten mph last month? With some careful record keeping and the push of a button the Windhawk provides the answer.

Both the kilowatt-hour meter and the Windhawk 8000 are great for understanding what is happening , or not happening with the windmill. When the anemometer shows the wind speed between ten and fifteen mph with no output from the windmill the search starts for "What isn't right?"

The Maintenance Question

The four kw Whirlwind does not fall in the category of a zero maintenance trouble free machine. It wasn't when the machine was new and it still needs maintenance about twice a year. Parts continue to wear, break, or are damaged by lightning. I'm quite sure the new machines are more reliable than mine, but somehow the idea of a windmill as a buy, install, and forget-for-ten-years machine seems rather unrealistic. With the idea that the windmill will need maintenance and repairs, the next question becomes: "Who will do the work?"

Within six months after the windmill was purchased, the dealer I worked with on the installation of my system was out of business. He did leave the name and telephone number of Darwin Brewer, who could be contacted for repairs. Although this was nice of the dealer, it was my intent from the start to do my own maintenance and repairs. Being in reasonably good health, mechanically inclined, and not too fearful of heights, doing my own repairs has proven to be a real advantage. Darwin is the nearest person I know of that could be contacted to do repairs, and he lives 100 miles away. When I ask for his help I realize it will be expensive. The mileage charge and two+ hours of drive time each way are not cheap. Fortunately, I've only needed his help twice in the past ten years. There is a person closer who repairs small (500 watt) machines on 40 foot tilt-up towers, but my unit is out of his field of expertise. As a result, I climb the tower and do most of my own repairs and maintenance. My wife Gail does a great job as ground crew.

There are at least four non-operating windmills within 50 miles of my house that were purchased about the same time as mine. When I contacted some of the owners about why they weren't running, the answer was, "It was too expensive to repair." My windmill would also be in the category of "too expensive to repair" if I didn't do it myself.

The Problems

During the past ten years my windmill has had three major breakdowns that caused significant loss of operating time. There has also been some time lost to minor breakdowns. However, loosing a day to a broken wire or three days to replace a synchronous inverter part are not significant problems.

The first major problem occurred when I noticed the main rotor bearing would loosen very quickly. Every month I'd adjust the bearings and within a few weeks they would be loose again. After this process continued for six+ months, I decided to look further into the problem. When I actually removed the bearings it could be easily seen that the shaft that held the bearings was significantly worn. Fortunately, I was working in a machine shop and had access to some excellent metal working equipment. With some chrome plate, cylindrical grinding and after-hours use of equipment, the windmill was running again. The total down time for this repair was six weeks.

The second major problem occurred with the synchronous inverter. A synchronous inverter is an electronic device that converts the continually changing frequency and voltage output of the windmill to 60 cycle 110 volt ac compatible with the grid. I did look inside this magic box but I quickly knew this was something that needed the touch of a professional. After some phone calls to make the arrangements, I removed the inverter and shipped it to the manufacturer, Acheval Electronics in Massachusetts. It was shipped back and after a total of five weeks down time, the windmill was running again.

The third major problem was the most difficult to trouble shoot and repair. The main shaft, that the windmill pivots around when it tracks the wind, loosened from its mounting. This shaft has three copper slip rings on the outside and three wires that are located in the center of the shaft and hang below. These three wires carry the electricity out of the windmill. When the shaft came loose, it rotated causing the wires to twist tighter and tighter until they shorted.

To replace the wires the entire windmill needed to be removed from the tower. With the unit weighing about 300 lbs. and the tower 120 feet tall, I called Darwin Brewer for help. Gail and I worked as ground crew and it didn't take long before the unit was on the ground.

After removing the damaged shaft, I saw there was no way I could repair the wires. A phone call was made to Elliot Bayly at World Power Technologies and the shaft was in the mail. It didn't take long, and the shaft was repaired, mailed back and the assembly could begin. The welded steel housing the shaft mounts into also needed repairs. By staying after work to do the machining for a few hours, the repairs were complete. To get the windmill back on the tower, Darwin was recalled and we were back on line after eight weeks.

In addition to the three major repairs, there were also a number of minor problems. Electrical wires came apart, screws needed to be tightened, shroud covers replaced… and the list of minor repairs continues. In total, the windmill has been broken 22 weeks in the past ten years. Expressed another way, the windmill has been available to run 498 weeks out of 520 weeks… over 95% of the time.

Windmill Surprises

It was no surprise that the windmill needed maintenance and repairs through the past ten years.

Above: Output Meter, synchronous inverter, safety brake switch, and Wind Hawk 8000 are located inside the house.

Average Wind Speed

Question to a windmill dealer: "How much electricity will be generated by this windmill at my site over a month's time?" The average wind speed at the site is often used as a factor in making this estimate. Below, three years are listed that show the difference between the average wind speed measured by the Buffalo National Weather Service and by the NRG Windhawk 8000 anemometer mounted at the 100 foot level of my windmill tower

Year	Buffalo	Carl	Difference
1990	11.5 mph	8.1 mph	3.4 mph
1991	11.1 mph	7.8 mph	3.3 mph
1992	10.2 mph	7.6 mph	2.6 mph

The two readings were taken approximately 15 miles apart and the readings are very different. Although the numbers are about three mph different, this difference is extreme when the subject is average wind speed. It is fairly common for the monthly output of a windmill to double when the average wind speed increases from eight mph to ten mph.

My experiences would have been different if my windmill was located near the weather station just 15 miles away. The relationship of windmill location to windmill output is very important.

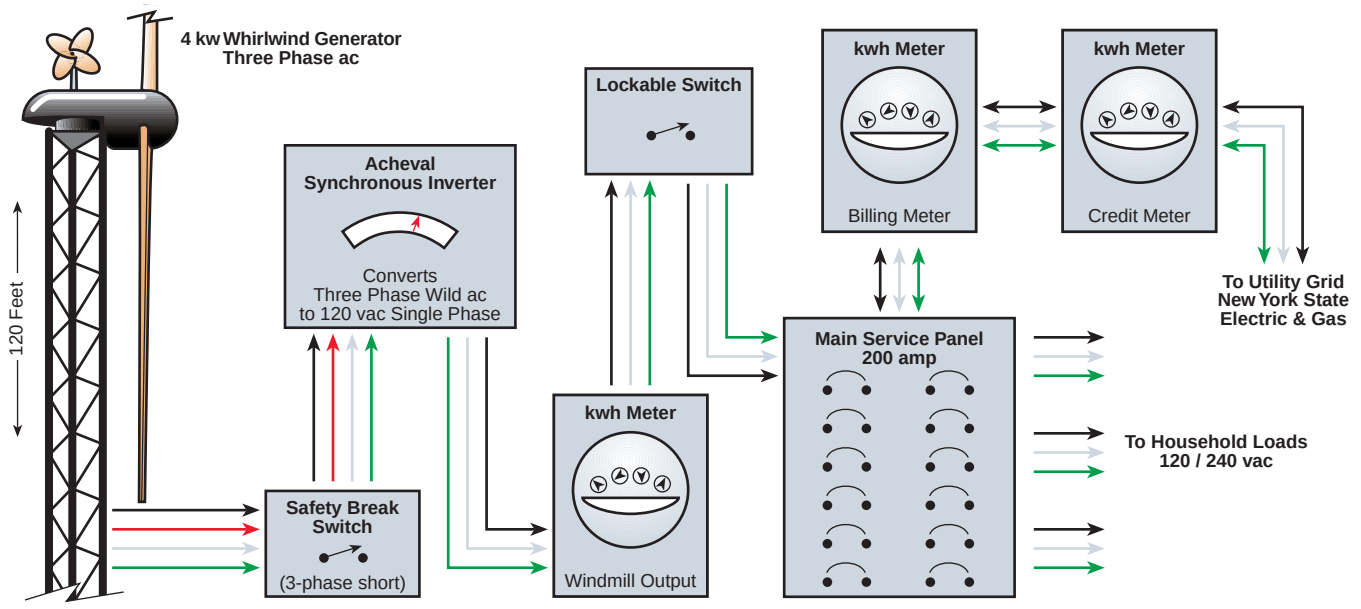
However, there were two observations that I didn't expect. First the average wind speed at my site, and second, the difference in windspeed (therefore windmill output) between winter and summer.

I honestly expected the wind at my home to be very similar to the wind speed at the Buffalo Weather Station. This was a bad assumption, (see Average Wind Speed sidebar). If my primary reason for installing the windmill was financial, this assumption would have been devastating. Even the dealer who sold and installed the windmill mentioned that my wind should be similar to the weather station's. No actual long term anemometer readings were taken, it was just a gut feel from looking at some maps and walking around my property.

The Buffalo area is well known for its winter snow storms. Although the winters aren't as bad as the reputation, we do get some stormy (good wind) winter weather. I expected the winter to be the high production months but I didn't expect the difference to be as great as it was. For example, it isn't unusual for the windmill to generate 200 kilowatt-hours during a good winter month. But when July or August arrives, the monthly output is about 50 kilowatt-hours (see Amount of Electricity: Generated, Used or Sold sidebar). In fact during August 1995, the windmill set a low output ten year record of 25 kwh during a month without any shut down time for repairs. Maybe someday I'll install some PV panels to help the low summer output.

Summary

When I look back over the past ten years... YES, I would do it again. But the windmill has not been a success from a purely financial reference. In fact, I



would have been better off putting my money in the bank from a "return on investment" point of view. But it wasn't installed as an investment. Rather, the windmill is something I wanted. It could be called a hobby, a sport, or maybe even a visible statement about my support of small scale nontraditional sources of electricity.

I've enjoyed having the windmill and enjoy the occasional person who knocks on the front door to ask all the windmill questions. The answer they often want to know… Yes, it really does generate electricity and Yes, it does lower my electric bill (see Amount of Electricity: Generated, Used or Sold sidebar for the details). The financial questions are important to most people who knock on the door.

Recommendations

My recommendations regarding a utility intertied windmill change a great deal depending on the person who is asking questions. For example: are monetary considerations the most important reason you are thinking of a windmill? If yes, then it is very important to measure the average windspeed at your site for at least one year. If there are reasons other than monetary that top the list, then I believe the average windspeed measurement becomes less important.

The maintenance issue is another one of my recommendations that changes with the person asking the question. For example: are you willing and able to repair the unit yourself? Are you afraid of heights? How close is your site to a person that could be hired to do repairs? The answer to these questions makes a big difference in my response to the question, "If I buy a windmill will the maintenance cost be high?" In my case, doing my own repairs has kept my windmill running. If I had to hire a person to repair and maintain my unit, I would have given up and simply said that my hobby was getting too expensive.

There are other recommendations I make to any one considering a windmill.

Do Your Homework Before Buying

Read everything you can find regarding utility intertied windmills. In particular, things by Mick Sagrillo and Paul Gipe. Talk to people who are actually doing what you are considering. They are a wealth of information.

Keep on the Good Side of the Town and the Utility

Work with your local zoning code officers and utility representatives. Do not attempt to get around or cheat on their rules.

Keep the Tower Tall

I've seen too many cases of short towers causing problems. Consider a tilt-up tower, they work well.

Amount of Electricity: Generated, Used or Sold

In a utility intertied system, part of the electricity generated is sold to the utility while part is used by the owner. Below are actual kilowatt-hour numbers from a typical winter month (November 1994) and a typical summer month (July 1994) from my system.

	November	July
Generated by windmill	**210 kwh**	**58 kwh**
Sold to NYSEG	**57 kwh**	**16 kwh**
Used by house	**153 kwh**	**42 kwh**

Notice that even in the month where generation is low, some electricity is sold to the utility. This happens when the windmill is generating more electricity than my house is using at a particular time. It does not mean that the windmill produced all the electrical needs for the house for the month.

Like the other residential customers with NYSEG, I pay about 13 cents per kilowatt-hour for the electricity I purchase. However, I have six cents per kilowatt-hour subtracted from my bill for the electricity I sell NYSEG. It is easy to see that the monetary value of the electricity the windmill generates is more in the electricity it prevents me from buying than in the amount of electricity sold.

It is interesting to guess how the above numbers would change if I used less electricity in my home… or how the monetary situation would change if New York State allowed net billing.

Buy Quality

Don't buy a broken windmill at a cheap price with the idea you can repair the unit. Few people have the time and talent this requires.

Consider Windmill Monitoring Devices

I've never regretted purchasing and installing the kilowatt-hour meter or the Windhawk 8000 anemometer. They work well at letting me know when there is trouble and provide the answer to, "How much electricity does your windmill generate?"

Support Your Local Windmill Dealer

If your local windmill dealer has experience with utility

intertied systems and sells the machine you want, consider buying from that dealer. He has been through the problems and negotiations before.

Access

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Arcman Corp., 807 Center St., Throop, PA 18512 • 717-489-6402

Darwin Brewer, 5115 Brewer Rd., Woodhull, NY 14898 • 607-458-5542

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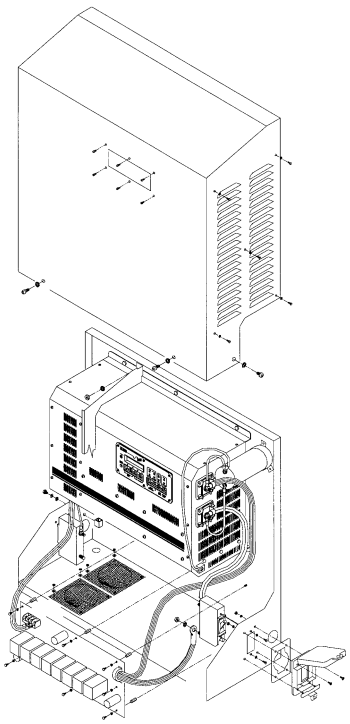

SW series inverter with optionaloutdoor enclosure and ground fault protection for roof mounted arrays.
Unit illustrated is our 5.5KW utility interactive SW5548PV model.
Size: 30" high x 30" wide x 11" deep

Model:	SW2512	SW4024	SW4048	SW5548	SW5548PV
Continuous Power	2500 watts	4000 watts	4000 watts	5500 watts	5500 watts
Surge Amps (AC)	50 amps	78 amps	78 amps	78 amps	Not applicable
Input Voltage Range	10 to 17 VDC	20 to 34 VDC	40 to 68 VDC	40 to 68 VDC	35 to 75 VDC
Peak Efficiency	90%	94%	95%	96%	96%
Idle - search mode	under 1 watt	under 1 watt	under 1 watt	under 1 watt	Not applicable
Idle - full voltage	12 watts	16 watts	16 watts	20 watts	20 watts
Charger Amps (DC)	150 amps	120 amps	60 amps	75 amps	Not applicable
Unit Weight	90 lbs (42kg)	105 lbs (48kg)	105 lbs (48kg)	136 lbs (63kg)	148 lbs (68kg)
Size - Inches	22.5" x15" x9"	22.5" x15" x9"	22.5" x15" x9"	22.5" x15" x9"	28.5" x15" x9"
- Centimeters	57 x 38 x 23	57 x 38 x 23	57 x 38 x 23	57 x 38 x 23	63 x 38 x 23
Export Version (230/50hz)	No	Yes SW3024E	Yes SW3048E	No	No

Features:

- Low distortion sine wave output with high efficiency conversion and bi-directional operation (inverting, charging or utility interactive operation)
- Two inverters can be operated in series for 120/240 VAC output (three wire) using the optional series interface cable
- Adjustable search mode circuit can reduce idle power to 1 watt
- Current compensated, adjustable low battery cutout voltage
- Adjustable low battery cut-in, high battery cut-out and cut-in
- Protection circuitry guards against over-current, short circuit, over temperature, low battery and high battery conditions

Options:

- Remote display and control panel for more convenient mounting
- Stacking interface cable allows units to be operated in series for 120/240 VAC output (three wire) - Provides twice the power for 240VAC loads such as well pumps or large machinery
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- PV array ground fault protection

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Features:

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- 3 stage regulation - Bulk, Absorption and Float.
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- Adjustable setpoints with testpoints
- Charge and load control modes (both)
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Options:

- Battery temp sensor

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David Rippner, Susan Root, Wes Edwards, and Michael Potts

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Sound check: a first nasty buzz from the speakers, so we hid and waited hopefully. Soon the soundman found the source of the buzz on the analog side, corrected it, and music from the CD player boomed out across the valley. "WOW! Great power: so clean and quiet," the soundman observed. True techies, we nodded knowingly, trying not to show any emotion.

Providing electricity for the remote stage at the Hog Farm's Labor Day Pignic is just part of our job. During most of the year, the Hog Farm at Black Oak Ranch is an intentional community for Merry Pranksters and other '60s activists, and the summertime venue for Camp Winnarainbow, a rural performing arts summer camp. But for a few days every September this gathering site near Laytonville in northern California hosts our favorite late-summer party. In its fourth year, the Pignic is now so successful you'll have to get your tickets from BASS or Ticketron!

Since Laytonville is just a short roll down Highway 101 from our homebase in Redway, Alternative Energy Engineering (AEE) and its volunteer crew have powered the event since its inception. It takes a day to load three trucks full of voodoo electricity, drive an hour, and then a few intense hours to unload and set up our power system. Afterwards, except for routine tweaking, we are rewarded with two days and nights of dancing, camping, playing and pignicking. We are old enough to appreciate this chance to rejoin a thriving subculture that came of age with us during the '60s. Thanks to clear skies, abundant sunlight, and state-of-the-heart solar power technology, we knew it would be easy to supply ac power for the event's sound and lighting.

Above: Davy, David, Wavy, and Joe

David's Plan

Following AEE founder David Katz's plan, our 24 Solec S53s and 24 British Petroleum BP75 photovoltaic modules fed a 14,000 Ampere-hour Chloride Industrial battery courtesy of Batteries Inc. and Joseph Marino. The battery powered a stack of four Trace 4024 sine wave inverters to produce 240 vac stepped down to 120 vac with a pair of eight kilowatt transformers. Safety first: an 8 foot ground rod driven into the soft earth, all equipment grounds coupled, neutral wires bonded at the transformer output. The 4/0 cables between batteries and inverters had 400 Ampere, class T fuses installed in-line. Because this was a very temporary system, our disconnect consisted of two Anderson 350 Ampere connectors. Not quite up to code, but at least we were not hard-wired to the batteries.

"Wonderful and Amazing"
—Ken Kesey, on solar power

Sound tests began just before twilight Friday. The quiescent power draw from the PA was about 2,500 watts. Cranked all the way up, the draw was 5 kW. What a stereo! The light man's power check was next, swinging 6 kilowatts around with his small board for fades, cascading, and other effects. He ran through all his functions and enthused, "This is

Left: And the crowd goes WILD to the sound of bands amplified by the power of the sun.

Above: The Alternative Energy Engineering crew setting up the PV system.

so cool!". Altogether our system would provide as much power in one hour as a normal American house consumes in a day.

Saturday

Saturday, the first day of the Pignic, dawned damp, foggy, and cold. By nine a.m. we had wiped the dust and dew off the banks of modules and the first band was setting up. Experience has shaken most of the bugs out of our portable system, and we have learned how to balance our loads to optimize system performance. While the stage is running, the techs need to check the meters occasionally, but we had plenty of time to walk around and renew old

"Wow, great power, so clean & quiet!"
—The Sound Guy

acquaintances. Wearing our "Power To The People" clenched-fist T-shirts, the AEE contingent is a noticeable presence. Performers and musicians come and go in the wooded campground behind the stage and the air is filled with the evocative aromas of an era: patchouli, coffee, and fragrant smoke. Comfortable camping arrangements, great food, and hot showers attract a satisfied crowd of volunteers, performers, and their families.

At 10 am an audience of all ages started pouring in, covering the field with blankets and picnic baskets. A horseshoe of vendors ringed the crowd. From the roof of Further, the red-painted bus that carried the Pranksters and some of the brightest lights of the psychedelic era on zany jaunts across the USA, master of ceremonies Wavy Gravy, San Francisco author, poet and philanthropic clown known for his work with terminally-ill children and SEVA foundation, announced the

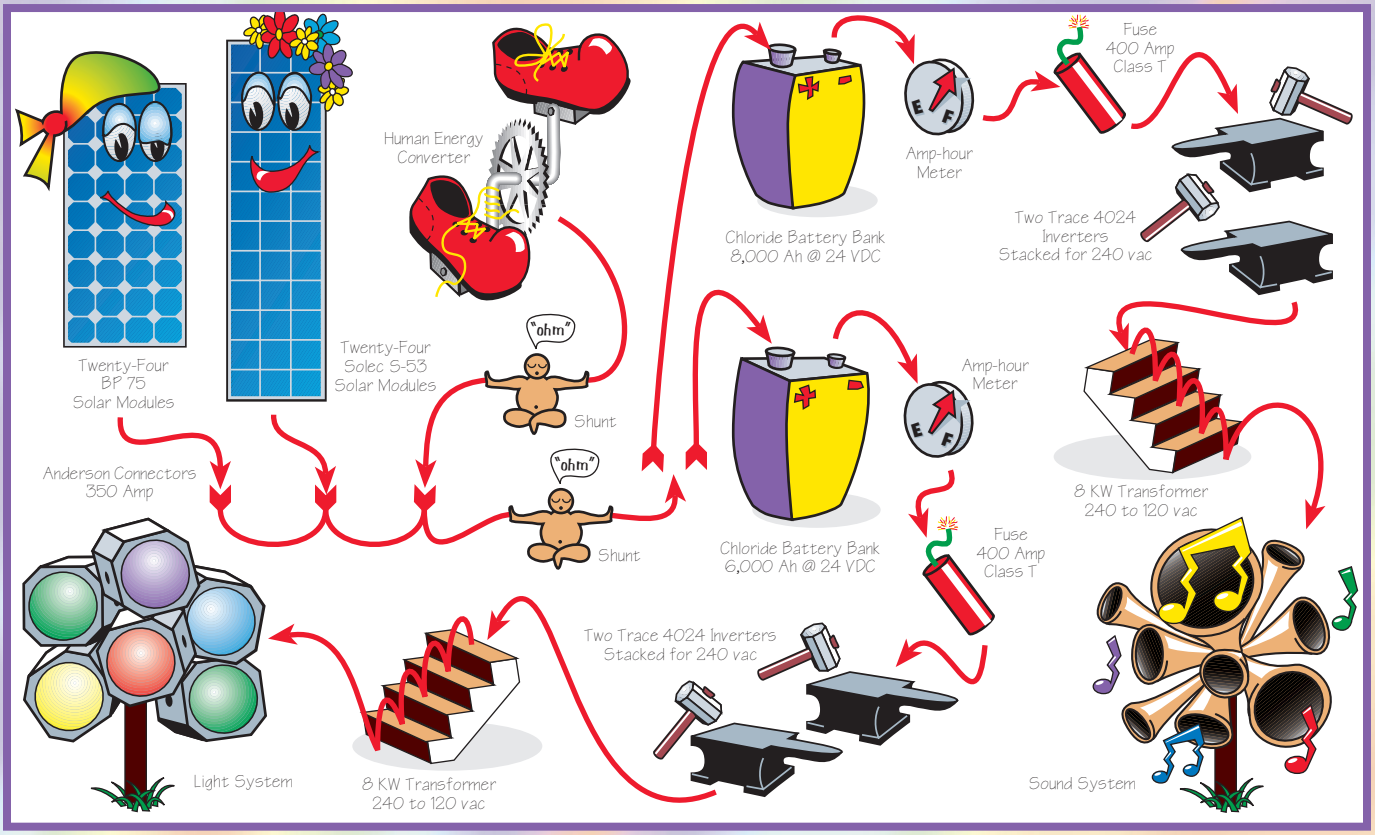
"Up the Sun!"
—Timothy Leary

day's special events: an unscheduled memorial tribute to Jerry Garcia, lead guitarist of the Grateful Dead, followed by the "Canonization" of psychedelic / educator / mystic Timothy Leary. For this climactic ceremony, Ken Kesey stuffed a small iron canon with black powder and "heaven balls" and fired above the heads of the reverent throng. Tim was then robed and given a tall wizard's hat and scepter, with which he blessed the crowd.

Powering the Music

When the first bands began playing we checked power consumption and estimated that we had enough storage for the entire 10 am to 11 pm, two-day show. Our battery and inverter truck was east of the stage beside the 80 Ampere, 2 kW array stretched out in three Zomeworks ground mounts and a large pole mount. Using a Fluke 87 connected to a 500 Ampere 50 mV shunt, chief installer Wes Edwards assured us that we did indeed have adequate storage. We started out

Above: Human Energy Converter (HEC) getting the crowd powered up about powering up.



with an 14,000 Ampere-hours in the battery bank and the solar array pumping out 80 Amperes. When the bands were playing the peak consumption was around 125 Amperes. We connected Ampere-hour meters to each pair of inverters. During the last set the sound man asked if everything was going OK, because the base guitar sound was distorted. The volt meter indicated 22.5 volts under load. The inverters handled the loads well, and not everyone noticed it, but during high peaks there was some clipping. This is the nature of the Trace inverter: peak RMS output power is a product of battery voltage.

> "With the electric companies, the people have the power but The Man has the switch. With solar power, the people have the power AND the switch!"
>
> —Wavy Gravy

Bart Orlando parked his human-powered generator (see photo) on the audience side of the fence, close enough to feed power into our setup, and gave those who wanted to peddle a chance to help power the show. This simple direct demonstration of renewably-produced power always draws a crowd. It's clear from the looks on the peddler's faces that they feel they are playing their part to deliver the music. The hotter the band, the more sweat flies.

Taj Mahal played a long set far into Saturday night. When he finally lost his rich, sonorous voice and the stage powered down after a day without a hitch, we turned off the four Trace 4024 inverters, covered them with tarps to keep out the heavy dew, and headed backstage across the black-lighted bridge for the circle of tall tepees, light shows, music and dancers. Late into the night a crowd circled an enchanted bonfire while pickup groups of spirited musicians, from bluegrass to a didgeridoo quintet, serenaded us.

At sunrise Sunday we were fortunate to observe Wavy Gravy's tribute to the rising sun. We came upon him and the lead singer from one of the bands greeting that revered source of all earthly energy, their pants around their ankles, bare behinds saluting the first rays. Asked if it helped, Wavy cheerily replied, "It can't hurt!"

A Ride on Furthur

Sunday afternoon, after the Prankster's bus, Further, led a parade around the site, we went looking for interviews with the Pignic's luminaries, Kesey, Leary and Wavy Gravy. Kesey asked where we wanted to talk. We suggested somewhere out of the sun, and he said "How about on the bus?" The Bus! Awed, we climbed aboard Further as he directed the tricky extraction of a full-size school bus from a chaotic thicket of dancing and cheering celebrants. In ten minutes we

"This is So Cool!"
—The Light Guy

witnessed enough zaniness and divine confusion to render your correspondents teary-eyed and tongue-tied. Using closed-circuit TV, headset and boom microphone, to the tune of "She Wore An Itsy-Bitsy-Teeny-Weenie-Yellow-Polka-Dot-Bikini", Kesey directed the delicate procedure. Laughing weirdos hung off the fenders and ran around on the top, adding to the confusion, as the bus threaded its way to a shady backstage area. Asked his view on the solar-powered event, Kesey deemed solar alternative "wonderful and amazing". Rendered giddy by the crazed scene, we ran out of questions, so we bade him and the Pranksters a fond farewell.

Timothy Leary's cheery assessment of solar power was, "Up the Sun!"

We couldn't keep up with the frenetic Wavy Gravy or get him away from the adoring crowd long enough to ask him serious questions, but he let us know he was pleased to have the sun powering the lights and sound. After the dust settled, he told us "With the electric companies, the people have the power but The Man has the switch. With solar power, the people have the power *and* the switch!"

Another fine Pignic came to a close Sunday evening. We raced the dusk dismantling the panels and racks. They and the Trace inverters sold quickly at reduced prices. We're keeping the BP modules that Wavy Gravy autographed.

"Remember the feeling as a child, when you awoke and the morning smiled, it's time for you to feel that way again…."—Taj Mahal

Access

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Quiet in the Country

Robert Warren

Above: 980 Watts of PV on the barn roof (right) feed the battery shed (left).

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You might say that Don Waggoner got tired of hearing his generator run. Very, very tired. Or, you might say, that this is a *Home Power* enthusiast (he has subscribed for about four years, and has a complete collection of HP issues) who decided to put together a first rate photovoltaic system. And when Don builds something, he really does it right.

Don has been collecting and rebuilding wind generators for many years. He completely rebuilt the '32 Wincharger, on a 15 foot tower just outside his newly refurbished battery room, a couple of times. Don got a fair share of use out of it before it froze up last year. He has lived for years on 32 Volt DC systems. He also sold a couple of rebuilt "antique" Jacobs Wind generators to his neighbors, too. In fact, there are at least five wind generators nearby. Unfortunately, because of the hellacious high winds prevalent in his little valley, most of them have been blown apart several times.

System Design

Don figured that this time around, he would rely on some good, quiet, non-mechanical photovoltaic panels for a main charging source. Don is a retired fireman who "works" at his hobbies of street rodding and finishing his house and barn/workshop. His wife, Jaye, is a realtor. They had figured on investing about $12,000 on the PV system. John and I did a load analysis and some cost comparisons between different types of inverters, batteries, and photovoltaic panels. Within a couple of visits, we put together the system which Don had been planning for some years. Their electrical needs are modest. They use a quiet, functional, 1937 Servel propane refrigerator, a propane clothes dryer, and have 15 watt compact fluorescent lamps throughout the house. They don't have any resistance heat loads such as a stove, water heater, or baseboard heaters.

Inverter

Don had a brand new Trace 2500 watt, 32 Volt inverter still in a box in his barn, which he planned to use in conjunction with one of his old 32 Volt windspinners. We convinced him that it would be to his advantage to get the new Trace SW4024 Sine Wave inverter. He would have 120 volts ac available at all times, with a standard 24 Volt battery bank. The other main reason to go with a larger inverter was to handle his submersible water pump and washing machine at the same time.

Above: The Ananda Powercenter 5 and the Trace SW4024 are mounted in a separate room from the batteries.

PV Modules

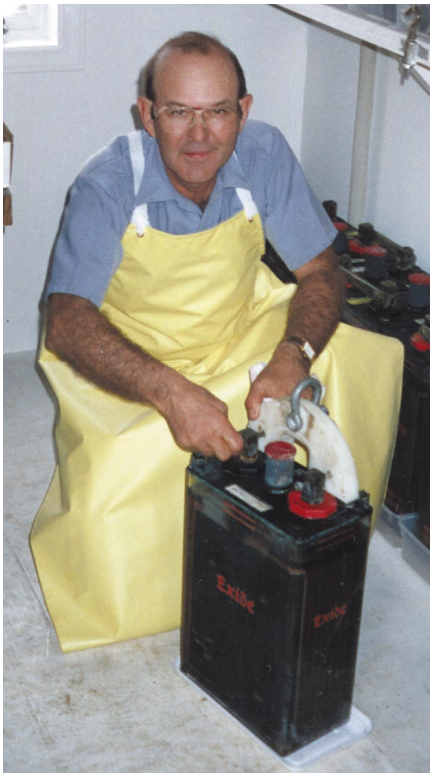
The 245 Watt, eight Volt photovoltaic modules from ASE Americas were developed over a 15 year period by Mobil Oil Co. The silicon cells are manufactured by a method light years ahead of other crystalline silicon technologies. There is virtually no waste in the silicon crystal growing process, as the wafers are grown as thin as required for the final product. They are sliced into square cells with a laser and machine-laminated into modules 4 by 6 feet, to make the world's largest modules. The cost of the 245 Watt modules is $5.85 per watt—a great price. Plus, you save installation time compared to the work of mounting and wiring, say, sixteen 60 Watt panels to get the same 980 Watts. Building or buying a rack to mount sixteen panels, as compared to four of these modules, would easily have cost three times more than the ASE roof mounting brackets.

Above: Robert Warren and Don Waggoner heft a 4 by 6 foot, 245 Watt panel into place.

PV Mounting

Mounting these 245 Watt modules has to be the easiest of any photovoltaic panels. Don made a safe and easy installation by building a solid temporary scaffold to work on. The foot area of the mounting brackets are already coated with a thick layer of bitumen to provide a positive water seal on any roof. For parallel surface mounting on a south-facing pitch roof, simply draw your chalk line for the first set of mounting brackets and screw them down. Then, using a 4 foot carpenter's level to space the next panel bracket (since the modules are 4 feet wide), the next bracket is mounted level and properly spaced at the same time. This also means that the brackets are properly spaced to lay directly over rafters on two foot centers. The brackets made for inside rows between panels have two support slots, one for the module on either side. The modules come with stainless steel mounting bolts and locknuts.

Once the mounting bolts are fixed to the side of the doublewalled, anodized aluminum framework (this is done with the modules still at ground level), the modules are literally "dropped" into place in the bracket slots, where they slide downwards and lock themselves into place. The four 245 Watt, eight Volt modules are wired into series for this 24 Volt system, so we had one wire per module to hook up to the next module. There are four junction boxes on the back of each module. Two of these are redundant because the module is internally bussed so you can pick up the negative lead from either junction box on one end and the positive lead from either box on the other end. It is easy to use short wiring runs in flexible plastic conduit between modules. While it does take two people to handle the



Left: Don Waggoner with one of the 480 Ampere-hour Exide cells.

Right: The 48 cells are kept warm by a solar thermal system on the ceiling.

module, you just lower one edge onto the support brackets and prop up the other edge closest to the first module with a short 2 by 4 inch block to get at the junction box. You only have to deal with attaching one ring terminal to the stainless steel 1/4 inch stud inside, replace the cover, and drop the module onto the brackets so the heavy-duty support pins slide home. The mounting brackets even come with a conduit nipple for routing the wiring through appropriate holes in the brackets. You couldn't ask for a cleaner finished look. ASE includes a substantial bypass diode, heat-sink mounted to the aluminum module's framework, to eliminate "hot spots" that may occur from shading.

Batteries

Don had been looking for batteries for a long time, and has acquired a knack for finding bargains. He managed to "score" some fairly young Exide telecomm batteries from a school closure. The batteries had powered a big uninterruptible power system for the computers and phones, so they had been well-maintained in a "float" condition. They are 480 Ampere-hour Exides with a life expectancy of 20 years. He built a 24 Volt bank with four sets in parallel (1,920 Ampere-hours). There were even enough cells left for three of his neighbors to get a couple of sets.

Don is a small guy, but very ingenious at moving these heavy cells. He had a hoist which he used to lift and place the 100 pound cells on the beefed-up shelves he built in his battery room. The picture shows one of the cells with a nifty plastic lifting bracket Don made for hooking them with the hoist. Note that Don is wearing full body protection: rubber gloves, apron, and glasses for working with batteries.

Don and Jaye's home

Don and Jaye's house is small (1,560 sq. ft.), but very comfortable. It sits on a cold and windy mountain high up in the Rockies (9,656 feet) about one hour from Denver. The public utility company wanted $50,000 to bring in power lines. He started building his house about six years ago getting his power for the last five years from a Honda 5 kw generator. It is an Earth berm house with log rafters, insulated to R-50, and it has a greenhouse/entry room for passive solar gain. No room for batteries there. His barn is filled with tools, heavy equipment, spare parts, and his prized street rod, so there is no room for nasty, corrosive batteries there, either.

The Power Shed

Don is an ex-fireman and had read Richard Perez's experience with a battery "melt-down". He decided that

the only legitimate place for batteries is in their own special building with two fire extinguishers handy, one inside and one outside. His solution was to refurbish a small storage shed with foam insulation he had scavenged. He even laid foam insulation under the floor to and make an airtight but ventilated battery room. There is a self-sealing door between the electronics room and the battery compartment. He decided to heat this room in the winter. The pipes and big radiator you see on the ceiling are part of a three-panel passive solar thermosyphon heating system to keep the batteries warm during the bitter cold Colorado winters.

Don ran his ac and DC electrical cables underground through conduit in the floor. He built four battery shelves reinforced with angle bracing, and an additional steel cable hanging support.

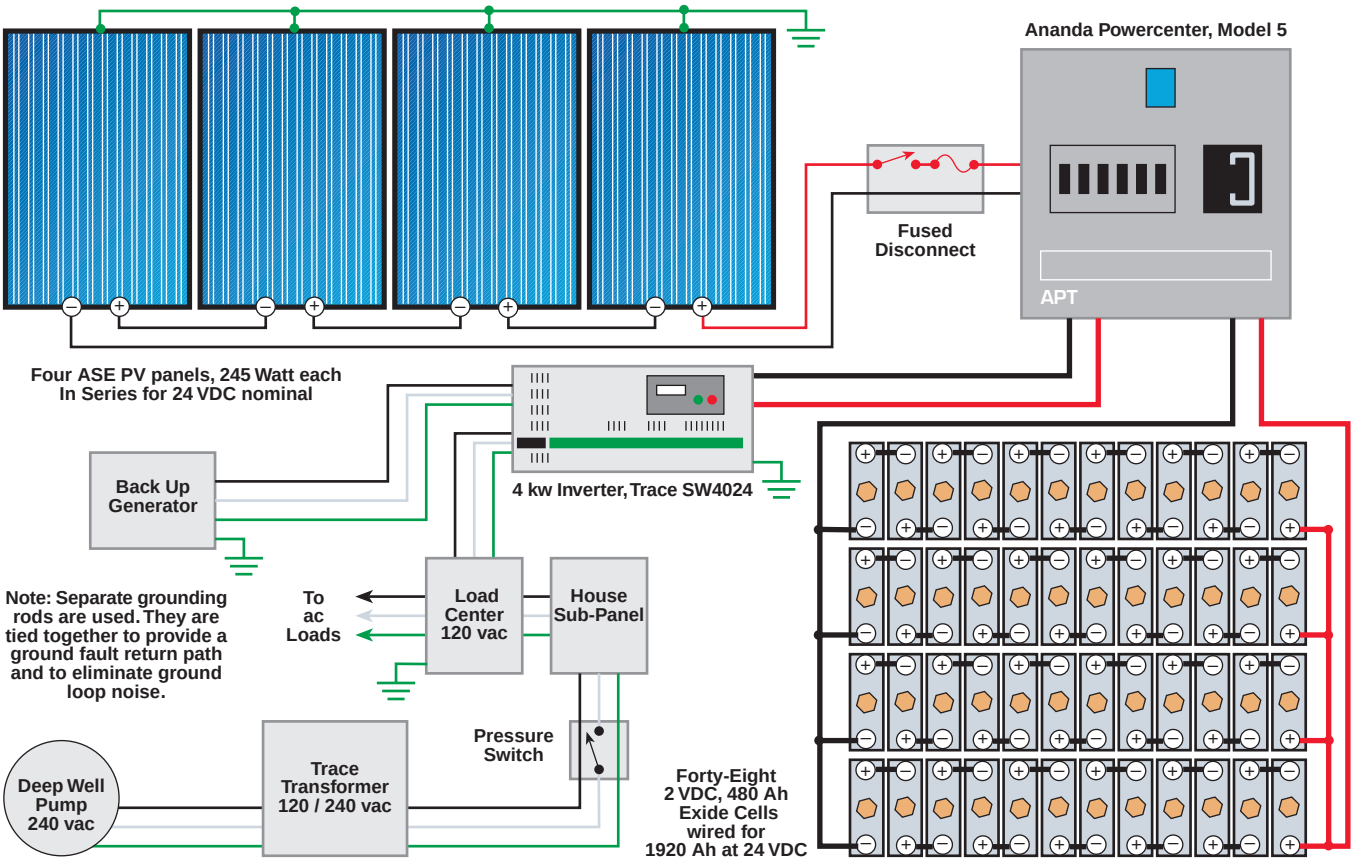
All copper piping for the heating system was re-cycled scrap copper from various cannibalized solar collectors. The solar collectors were also scavenged, as was the solar heat exchanger, about twice the size of a truck radiator. The day he was installing his bus bars on the batteries, it was an overcast March day. About 40 degrees outside, and the battery room was a comfortable 70. The temperature gauge near the ceiling showed a radiator temp of 130 degrees.

Jaye found some plastic trays that exactly fit under his Exide batteries at Wal-Mart for 99 cents each. You can see that Don isn't going to have any problems with battery acid leakage.

He put a strong automatic closer on the door between the batteries and the inverter/control room and weather-stripped the door with foam tape so it would be air-tight. He vented the batteries to the outside with two 2 inch vents, top and bottom, at the far end of the room.

My favorite "invention" of Don's, however, is his clever way of protecting the batteries from being shorted out by a tool that slips or falls. Don cut 1.5 inch wide slots in lengths of 2 inch PVC pipe and snapped them into place over the rows of battery terminals. No exposed terminals means no hazard. Remember, these are massive 480 Amp batteries capable of discharging enough juice in a split second to literally vaporize the end of a wrench in a blinding flash.

Above: Rob's shop with four 245 Watt ASE panels. The battery shed with solar thermal panels is in the foreground.



240 vac Well Pump

Don already had a Trace 120/240 volt transformer. I have hooked up many 240 volt submersible pumps using these transformers, so I did a quick amp probe check to read the current draw of his well pump. It requires 6.5 amps at 235 vac. His well pump was his only 240 volt load other than occasional tools he might run off his generator/welder. Once the batteries and inverter were installed, I wired the transformer to run the wellpump by energizing it directly from the pressure switch (wired for 120 v), rather than having it energized all the time and thus presenting a large phantom load to the inverter. We get a little bit more spark on the contact points on the pressure switch, but since we are only using one side of the switch, we have a spare pair of points to change out when they finally get toasted. We do recommend using a heavy-duty pressure switch, however. His pump draws a steady 6.5 amps at 234 volts, so now the pressure switch has to handle 13 amps at 117 volts with its fleeting 32.5 amp start-up draw. This certainly isn't a problem for the Trace SW4024, either. The transformer energizes instantly and starts the pump with no problem. The transformer sits quietly near the pressure tank, not requiring any current when it isn't in use.

System Interconnection

We ordered the Ananda Powercenter pre-wired for a remote Tri-metric™ Ampere-hour meter which we installed in the house for ease of monitoring. Don has a part-time excavation service. He used his backhoe to dig the wiring trenches between the battery shed, the barn, and then over to the house. The PV modules feed into a 100 Amp disconnect switch inside the barn, directly behind and below the PV array. 4/0 copper stranded cable was run inside conduit and buried 2 feet deep to the battery shed. In the same trench, another conduit brings the ac power back from the inverter into a main ac breaker panel in the barn which then feeds the ac sub-panel in the house. It was really great to work on an installation so well thought out and to have the hardest part (digging trenches, pulling wire through conduit, and lugging batteries around) already completed.

The placement of the battery/control room away from the house with the PV modules mounted on the barn meant that special attention had to be paid to properly grounding all three buildings. Don used #4 bare copper to bond the module frames to ground, with the ground rod driven directly under the panels so that the electrical grounding path is short and direct. He then

Don & Jaye's Energy Consumption

#	Appliance	W-hrs/ day	%
1	Deep Well Pump	1050	35.1%
1	Microwave	475	15.9%
1	Inverter Standby	384	12.8%
1	Washer	280	9.3%
1	Dryer (Gas)	171	5.7%
1	Misc. Power Tools	143	4.8%
1	Hair Dryer	120	4.0%
1	Color TV	71	2.4%
4	Bathroom Lights	60	2.0%
1	Kitchen Table Light	48	1.6%
1	Vacuum Cleaner	46	1.6%
2	Living Room Light	46	1.5%
1	Bedroom Light	45	1.5%
1	Over Sink Light	30	1.0%
1	Stereo/Boom Box	18	0.6%
1	VCR	4	0.1%
1	Porch Light	3	0.1%
	Total Consumption	2995	*W-hrs/day*

Don & Jaye's System Cost

#	Component	Cost	%
4	245 W ASE PV Modules	$5,756	43.0%
1	Trace SW 4024 Inverter	$2,950	22.0%
1	Ananda Power Center 5-404	$1,395	10.4%
	Salvaged Batteries	$1,200	9.0%
	Installation	$1,000	7.5%
1	PV Mounting Hardware	$315	2.4%
1	Tri-metric A-h Meter w/Shunt	$269	2.0%
1	60 Amp Controller & Contactor	$249	1.9%
2	Inverter Cables, #4/0, @ 10 ft.	$130	1.0%
1	Metering Wire & Mount	$78	0.6%
1	Lightning Arrestor Module	$49	0.4%
	System Cost	$13,391	

drove a second grounding rod near the inverter and Ananda Powercenter. Per NEC Code # 690-43, he used the same size grounding wire as used for the power cables from the batteries (4/0 copper). [Editor's note: this section of the NEC has recently changed, we are no longer required to use cable this large in grounding circuits.] Then, a 4/0 lug attached to the inverter cabinet bonds the 4/0 wire to the ground rod just outside the battery shed. He dug a trench between the two grounding rods so he could connect the two grounding rods together to eliminate "ground current loops".

Just a few days after the installation was complete, Don called me to ask what the "high battery fault signal" he was getting on his inverter meant. "It means your batteries weren't that empty when you bought them, and now they're full," I told him. It also meant slightly adjusting the voltage set points on the inverter.

Don has a generator/welder near the battery shed. If he is doing some welding, then the extra power is fed through the Trace SW4024 into the batteries. His battery storage is around 1920 Ampere-hours. Even if they were 50% discharged when he bought them, the generator would have to run for 19 hours with the inverter's charger putting out a constant 50 Amps to fill them up. However, the PV modules are capable of putting out 40 Amps any time the sun shines. Plus, they don't make any noise or require gasoline & oil. So, Don is happy not have to listen to that noisy generator. He has seven acres of privacy, surrounded by US Forest Service land, so it is quiet enough to see elk grazing in his yard from the living room window.

Done Yet? Not Likely…

The solar panels which heat the battery room will have to be covered up in the summer, so that the battery room doesn't get too hot. We are looking for an automatic temperature control valve to shut down the solar thermo-syphon heating loop when the temperature gets too high. And sometime this summer, Don may put up another wind generator. He plans to add another 20 feet or so to his 15 foot tower and tie in a new wind generator in the 1,000 watt range. You can see from the photos that he has many signs to label his control room, battery room, etc. We just wonder what signs he will put up when we get the wind generator installed.

Access

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System owner: Don Waggoner, PO Box 783, Idaho Springs, CO 80452

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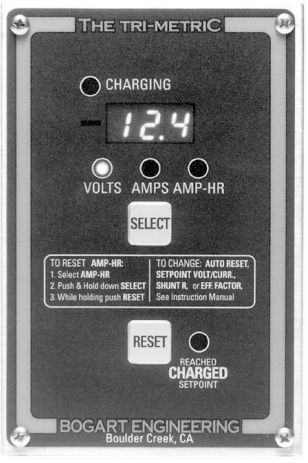

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PHOTOCOMM

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this is page 35

Public Service Solar

Drake Chamberlin

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In July of 1994, I was employed by Colorado's largest utility company, Public Service Company (PSC). The project was an 18 kw solar electric system.

My job was to wire the system. This included the power conditioning equipment, conduit systems and DC wiring from array to inverters. There were multiple ac and DC disconnects. There was also solar insolation monitoring equipment and a complex system of safety relays. The output was to feed into a 120/208 volt, three-phase electrical network.

The ac power developed by the system was to be monitored by a kilowatt-hour meter, connected to phone lines. The building's electric load, tied to this PV system, was to be monitored by another phone line. This phone line was connected to the 277/480 volt meter outside the building. Phone lines were also to connect with monitoring equipment near the array on the roof.

Above: Drake standing proud and thirsty in front of the PSC installation.

Below: PSC's Materials Distribution Center, home of the intertie system.

Above: The roof mounted ninety panel, 18 kW array.

The photovoltaic array was to be installed on the roof of a giant warehouse. The site was the company's Materials Distribution Center (MDC) building in Henderson, Colorado (just north of Denver). The power conditioning and control equipment were located in the shipping and receiving area below.

The system was required to pass the state inspection for National Electric Code compliance. This is an unusual requirement for utilities.

The Crew

The project was organized by Chris Thompson of PSC. Through her continued efforts over a period of 18 months, the solar installation was made possible. The period leading up to the installation was notable for its on-again off-again nature. Without Chris' sustained efforts, the system never would have gone on line.

Mark Boettcher, an electrical engineer with PSC also played an important role. A number of Public Service employees from the MDC facility were involved as well.

Personnel from Ascension Technology, the supplier of the system came out from the East Coast. They were also instrumental in assisting with the installation.

The solar array was to be mounted by a team of volunteers. They put in a tremendous amount of hard physical labor in the scorching sun. The work required finesse, as they were handling expensive (and heavy) solar modules.

Helping me were two assistants that worked one at a time. I have known both since they were small children.

Above: Gravel holds roof jacks to roof.

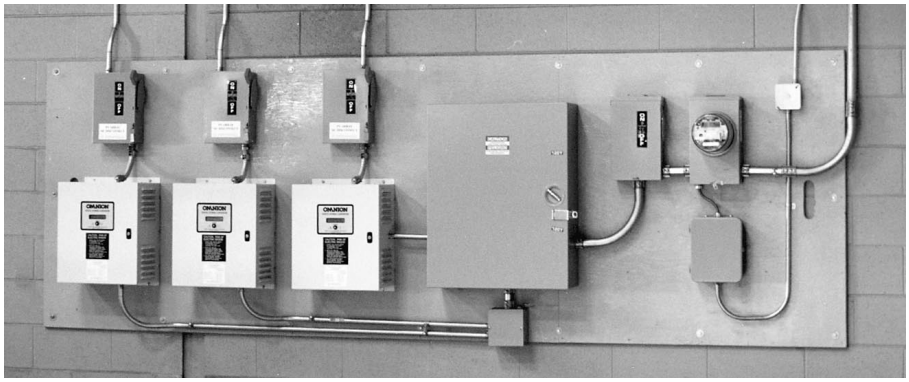
My thoroughly seasoned apprentice, Jeremy Dixon, was stranded with car trouble in a remote area. Since he was delayed, Jordan Jennings filled in until Jeremy could make it.

The System

The system was supplied by Ascension Technology, Inc. of Waltham, Massachusetts. The PV modules were produced by Mobile Solar, and the inverters by Omnion.

The solar array consists of three, 6 kW subarrays of 30 modules each. Each subarray feeds one of the three synchronous inverters.

The modules weigh about 107 pounds a piece. The measured open circuit voltage of the array is around 440 VDC (220 VDC bi-polar). The power from each module is rated at 285 Watts, with the ac contribution around 200 watts.



Above: The power conversion center.

An important element of this system is that it was required to be set up in compliance with the National Electric Code. Traditionally, these systems have had only to comply with utility regulations, which are not as stringent. This was a test to see if such a system could pass Code.

The Wiring

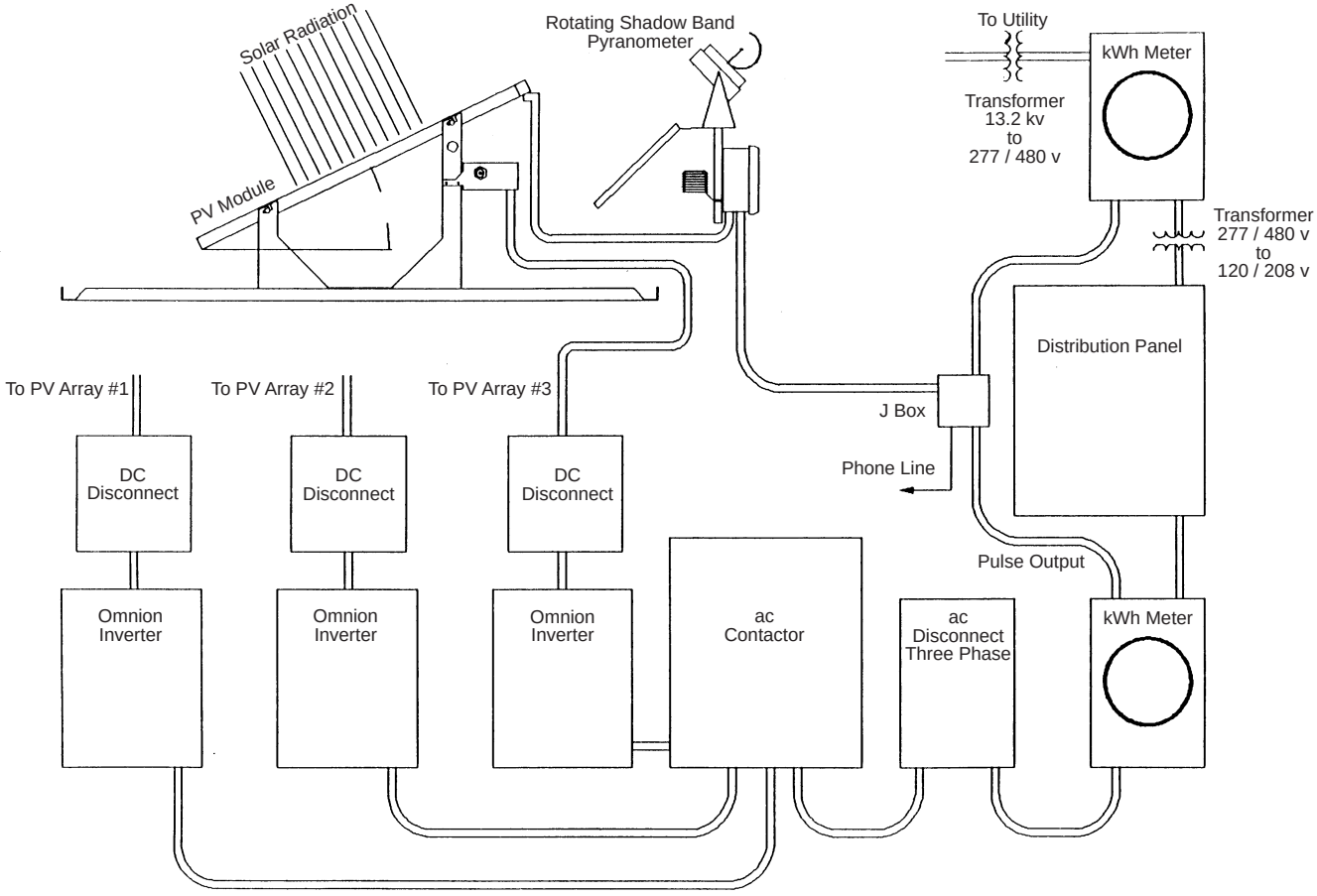
The wiring system that connects the array to the inverters and control equipment is extensive. As a demonstration system, everything had to be neat.

Three runs of conduit extend from the subarrays across the roof of the giant warehouse. The conduit penetrates the building 36 feet above the floor. They then angle down a wall to the support members of a 30 foot ceiling.

After more twists and turns, the runs finally make their way to the three inverters.

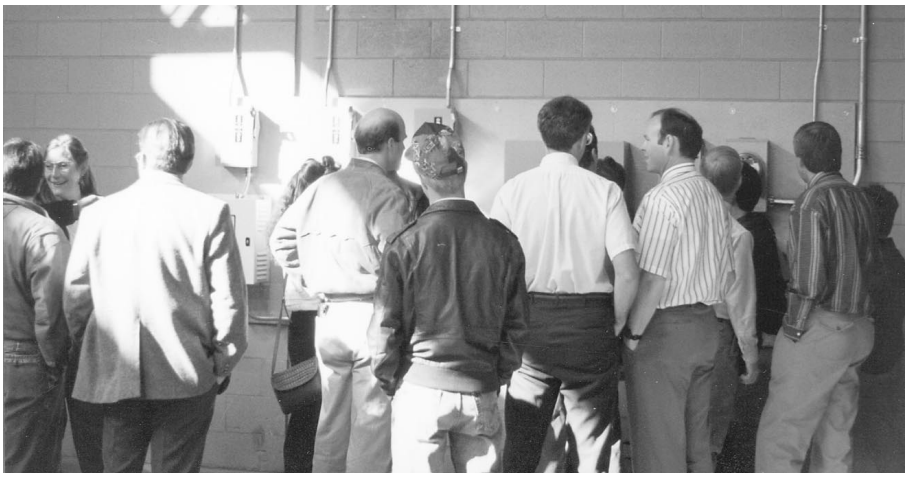
The runs consumed around a thousand of feet of 3/4 inch EMT conduit. Nearly a mile of #8 wire was used to make the DC connections. There was a separate run of 1/2 inch conduit for remote computer monitoring.

The wiring from the rooftop array supplies the three, single phase, 120 volt inverters. There is one inverter per phase of the three phase system. Each synchronous inverter automatically tunes to the impulse on the line it connects to.



No Holes in the Roof
One significant aspect of the system is the manner in which the array is mounted. The solar modules are mounted at a fixed summer angle. The low angle reduces wind loading. This is important since the system features mounting without roof penetration. The array is held in place by gravel ballast.

The team of volunteers shoveled gravel off of the designated area of the roof. A membrane was laid down on the area they cleared.



Above: PSC solar workshop.

The team then assembled the module support system. The legs, or "roof jacks," were connected to metal pans. The volunteers loaded the gravel they had earlier removed from the area on to the pans. The modules were then mounted on the roof jacks. The weight of the gravel holds the system to the roof.

Thirsty Work
Denver is a mile above sea level. A lot of Earth's protective atmosphere is left below. Much of the work was performed directly under the blazing July sun. A huge quantity of water and soft drink was consumed.

Participants had been warned that lightheadedness could be a sign of dehydration. The thin, dry air and the intense sun sufficed to desiccate workers on the roof. Chris kept morale high and strength up with pizza lunches and plenty of cold pop.

System Safety Features
The photovoltaic system "back feeds" into the grid, through the building's wiring and transformers. It is therefore essential that the system shut down if the line power should fail. This is to prevent hazards to electricians working on wiring and equipment. This safety feature is provided redundantly.

The Omnion inverters automatically shut down in the event of power failure. In addition, there is a set of relays that respond to the grid power. They disconnect the solar electric system in the event of any abnormal conditions to meet strict utility requirements which are in excess of the inverter's built-in protection.

Data
The system's performance is monitored in a number of ways. A modem on site connects through phone lines to a computer in Massachusetts. Ascension Technology's computer calls in each evening to get a report on the day's production. Ascension's computer also receives information from 46 other PV systems located throughout the country. Data is compared for various solar locations.

Solar conditions are evaluated through Ascension Technology's Rotating Shadowband Pyranometer. This instrument reads the intensity of sunlight. Once each minute, a shadow is cast over the sensor to measure diffuse light. The diffuse reading is subtracted from total illumination to evaluate the sun's intensity. This is a very simplified description of this highly sophisticated, multi-functional instrument's operation.

There is also a fixed Licor pyranometer on the array to register sunlight at the plane of the array.

Ascension's computer also compares data from the two kWh meters. One is the electric service meter by the building's transformer. The other is the one at the output of the solar electric system.

For More Information
For more information about the system, contact Mark Boettcher, whose address is given below.

Access
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Ascension Technology, Ed Kern, President, PO Box 314, Lincoln Center, MA 01773

ASC Americas Inc., (Formerly Mobile Solar Energy Corporation), 4 Suburban Park Drive, Billerica, MA 01821-3980 • 508-667-5900

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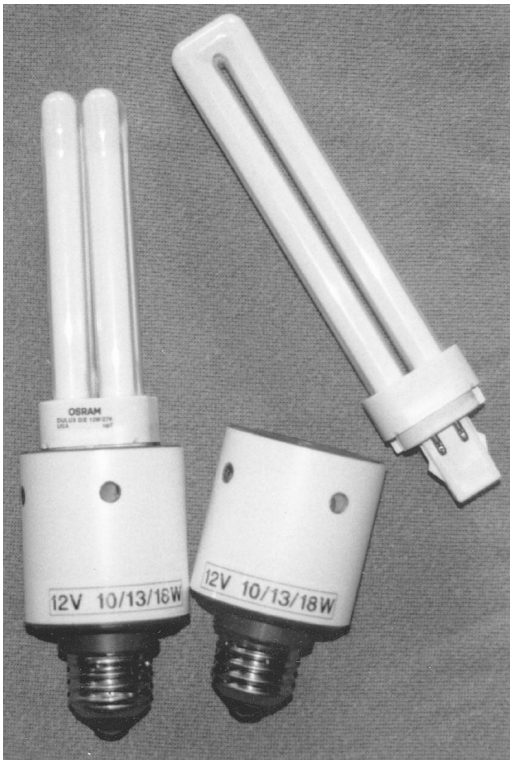

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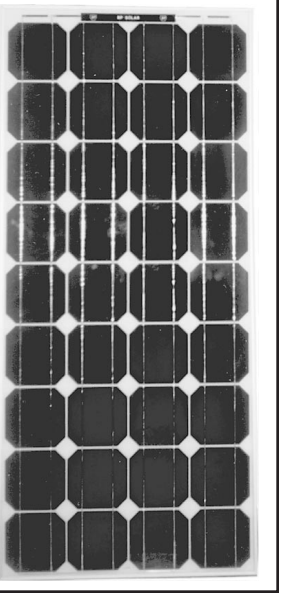

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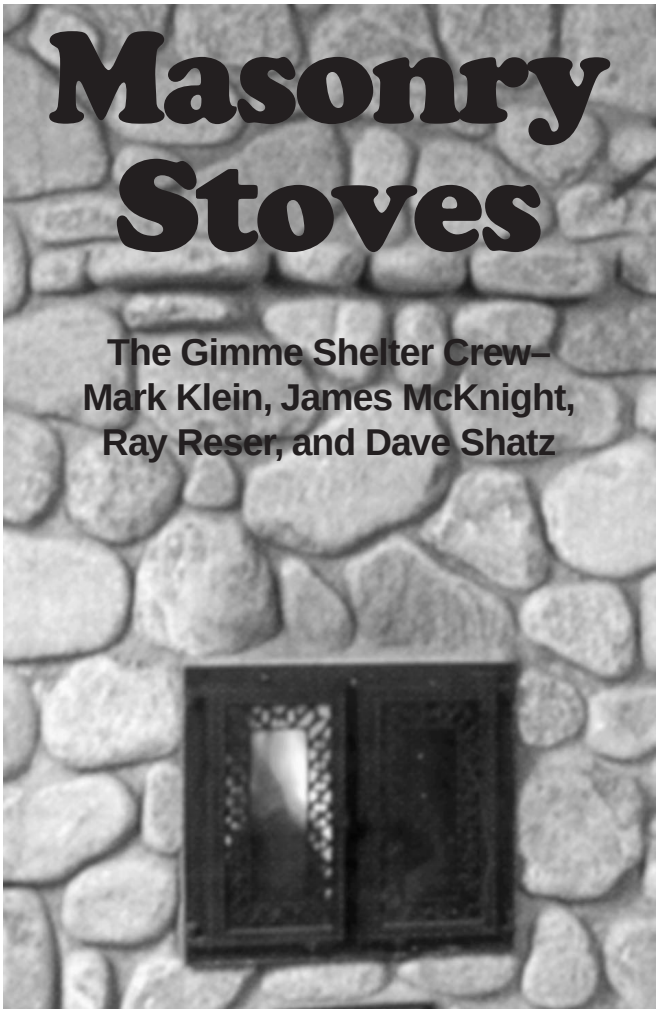

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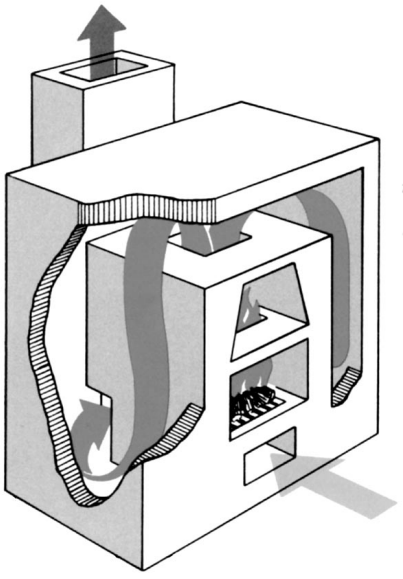
We like to build homes that are energy efficient, comfortable, and satisfying. Because we live in central Wisconsin, heating systems are a big issue as we work towards these goals. Conservation, passive and sometimes active solar heating, in that order, are important components in a renewable and sustainable heating system. In our climate, these solutions can only moderate home temperatures in the most severe weather. In addition, our solar ration is dismally small in the middle two months of our six month heating season—when it's dark and cold we've got to provide heat! In fact, warmth becomes an almost spiritual experience in the short days of the year.

Our favorite device to satisfy this need is a masonry stove. Why? Because these stoves, through their high mass technology, provide a stable, constant, user-friendly heat with relatively little active interaction by the homeowner. They also satisfy the desire for a central hearth as an emotional component of a home and are aesthetically pleasing. The icing on the cake is that through their high temperature combustion and low emissions, they are an efficient and environmentally friendly way to use a renewable resource for heat.

Masonry stoves are wood-burning, heat storing devices that use a refractory style combustion chamber to achieve extremely high temperature burns (1500-2000 degrees F). The super heated gases are routed through a long flue to capture most of the heat, then past a shut-off damper and up a chimney. In practice, these stoves are fired once or twice a day with 30 to 40 lbs. of dry, split firewood which burns vigorously for about 2 hours. When the coals are gone the damper is closed and the heat captured in the mass of the stove is released into the house over a period of 12-24 hrs.

A basic design concept is that the stove should be centrally located with an interior 8" round or 8" by 12" rectangular flue. Heat output ranges from 10,000 BTU/hr to 70,000 BTU/hr depending on size and style of the stove. It's worth noting that to sustain a 70,000 BTU/hr output for twenty-four hours, you would need to burn about 230 lbs. of seasoned firewood. This is serious heat production for extreme conditions and is equivalent to running a 100,000 BTU/hr fossil-fuel furnace full-tilt for the same period of time. In practice, stoves rated at 24,000 BTU/hr or better can carry a moderate to large, well built home.



Right: Contraflow style of masonry stove

AlbieCore

Main Wood Heat Co., Inc.
Albie & Cheryl Barden
RFD 1 Box 640
Norridgewok, ME 04957
207-696-5442

Components: cast refractory and firebrick (module weight 3200 lbs.), veneer locally provided

Footprint: 4' wide, 3' deep, 7' high, other sizes available

Emissions: NA

Options: direct fired bake ovens, see-through fireboxes, cookstoves, corner units, benches, hydronic loops

Workshops: yes

Cost: $3400+ FOB Maine

Note: footing, foundation, chimney, veneer are owner supplied

Biofire

Biofire, Inc.
3220 Melbourne
Salt Lake City, UT 84106
801-486-0226

Components: cast fired refractory core, ceramic tile, and stucco veneers

Footprint: 2'6" wide, 2'2" deep, 4'7" high (1600 lbs.) many other sizes available

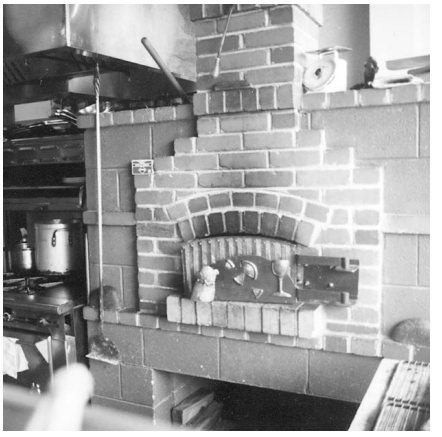
Emissions: 0.6 g/hr; 1.8 g/kg EPA tested

Options: cast refractory bake oven, corner unit, cookstove, benches

Workshops: yes, for installers

Cost: $7000+ (includes veneer)

Note: Installation by trained installers or dealers. Footing, foundation, chimney are owner supplied. Stoves are individually engineered for a specific installation



Direct Fired Bake Oven

Ovencrafters
Allen R. Scott
5600 Marshall Petaluma Rd.
Petaluma, CA 94952
415-663-9010

Components: firebrick, common brick, concrete block, concrete, vermiculite-locally procured

Footprint: variable

Emissions: NA

Workshops: yes

Cost: materials $300+, complete oven $5000+

Note: Allen provides plans, design services and construction and will happily participate in communal "oven raisings." These are direct fired ovens for baking purposes only

Heat output is directly related to surface area of the stove. Designs are modified by changing combustion chamber size and flue length to accommodate specific demands of the installation. The relationship between combustion chamber size, flue length, chimney size, and radiant surface area is fairly precise. Some manufacturers design each stove individually while most offer one or more designs which can be modified if desired. Stove manufacturers and builders are generally very helpful in providing assistance in sizing and placement of heaters.

Masonry stoves are probably the safest wood burning technology by virtue of a short burn time (no overnight fires) and lack of creosote because of high combustion temperatures. Low stove surface temperatures mean no accidental flesh burns from stove contact and no burnt dust to contribute to indoor air pollution. Carbon monoxide is a potential hazard from any combustion appliance and can be a problem if a shut-off damper in a masonry stove is prematurely closed. Combustion should be completed before shut down. Consider a CO detector as a home safety device.

There are four basic stove styles: Multiflue (Russian), Contraflow (Finnish), Grundofen (German), and Kakelugen (Swedish). A majority of the stoves being installed in North America are contraflow style, including AlbieCore, HeatKit, TempCast, and Tulikivi. Biofire and Envirotech stoves are Grundofen style and Moberg designs offer a Kakelugen style Swedish stove (Cronspisen). Biofire, Cronspisen and Tulikivi are imported, while the rest of the stoves are manufactured in North America. AlbieCore uses Finnish hardware and imports a selection of cast iron hardware from doors to cooktops.

Additional styles and uses of masonry stoves are cooking ranges, heating or stand-alone bake ovens,

Envirotech

Dietmeyer, Ward and Stroud
PO Box 323
Vashon Island, WA.
800-325-3629

Components: castable refractory fireplace module (3200 to 3600 lbs.), veneer locally provided

Footprint: 4'8", 5'8", or 6'8" wide, 2'8" deep, 6'6" high (min.)

Emissions: EPA rated .99 to 1.3 g/hr

Options: white cast refractory bake oven, see-through firebox

Workshops: yes

Cost: $3700-5700

Note: footing, foundation, chimney, veneer are owner supplied

HeatKit

Masonry Stove Builders
RR2
Shawville, Quebec, Canada
819-647-5092

Components: cast refractory, firebrick (2900 lbs.), veneer locally provided

Footprint: 4' to 4'4" wide, 2'10" deep, 6'8" high approximately

Emissions: Lopez Labs tested, 1 - 1.5 g/kg

Options: white cast refractory bake oven, see-through firebox, heated benches, hydronic loop

Workshops: yes

Cost: $4000-4850 delivered and assembled on site, within 300 miles of Ottawa

Note: footing, foundation, chimney, veneer are owner supplied

Lopez Quarries

Firecrest Fireplace Corp.
111 Barbara Lane
Everett, WA 98203
206-353-8963

Components: cast refractory and firebrick, ceramic flue (weight not available)

Footprint: 5' wide, 2'8" deep, 7' high

Emissions: 2.9 g/hr average

Options: bake oven, corner unit, cookstoves, and benches

Workshops: yes

Cost: $3700 FOB Everett, WA

Note: this is a fireplace heater with a large door. Retrofit kits available for existing fireplaces as well as masonry heaters. Footing, foundation, and chimney are owner supplied

high efficiency fireplaces, fireplace retrofits, sauna stoves, and hydronic loops. Cooking ranges provide classic solid fuel style rangetops that are fast and hot with a broad temperature range, bake ovens, and modest heat-capturing flue lengths. Masonry cooking ranges are arguably among the best of cooking devices. They provide a significant amount of heat when used in an extended burn mode. Cooking ranges are available from most builders and manufacturers.

Heating bake ovens are either direct fired ovens (black) in which the flue gases pass through the bake oven, or indirect fired (white) in which they circulate around the bake oven. Baking can be done in the white oven during combustion. In both cases, heating bake ovens perform well as space heating devices and are, in fact, space heater options offered by many manufacturers.

Stand-alone bake ovens are direct fired ovens which are intended for baking use only and provide no additional heat to the building. Sometimes these bake ovens stand alone with only a tin roof. They are fired once or twice a week and used for a sequence of bakes coinciding with the temperature curve within the oven. Direct fired bake ovens are classical baking devices with design roots that extend far into our past and are unsurpassed for hearth style breads. Allen Scott of Ovencrafters (see reference) is a bake oven builder with 15 years of research, baking, designing and building experience. Envirotech also provides a stand alone bake oven.

High efficiency fireplaces use elements of masonry stove design to comply with the strict emission standards of states like Colorado while retaining the esthetics of traditional fireplaces. Moberg Designs or Lopez Quarries are good examples of this approach.

Fireplace retrofits recycle the components of existing conventional fireplaces (central location, foundation,

Moberg Heating Masonry Fireplace

FireSpaces, Inc.
921 S. W. Morrison Street, Suite 440,
Portland, Oregon 97205
503-227-0547

Components: cast refractory masonry blocks (2000 lbs.)

Footprint: 5' wide, 3'9"+ deep

Emissions: 3.4 g/h; 3.9 g/kg average

Options: corner, cookstove, gas units

Workshops: no

Cost: $5400 FOB Portland

Note: this is a fireplace heater with a large viewing door. Other masonry heaters available including Cronspisen, Tulikivi. Footing, foundation, chimney, veneer are owner supplied. Installation by dealers and manufacturer

Scandinavia Fireplace

T.N.T. Masonry Heaters
12380 Tinker's Creek Rd.
Cleveland, OH 44125
216-973-0588

Components: cast refractory, firebrick (1400-3000 lbs.), veneer locally provided

Footprint: 3'4" wide, 1'4" deep, 3'6" high to 4' wide, 3' deep, 7' high

Emissions: NA

Options: retro-fit fireplaces, see-through firebox, white and black ovens, benches—all stoves are custom built

Workshops: yes

Cost: $3900 assembled, add travel time and shipping from Cleveland

Note: footing, foundation, chimney, veneer are owner supplied

TempCast

TempCast
3332 Yonge St., PO Box 94059
Toronto, Ontario, Canada M4N 3R1
800-561-8594 • FAX 416-486-3624

Components: cast refractory (2600 lbs.), veneer locally provided

Footprint: 3' wide, 1'10" deep, 6'5" high

Emissions: 2.8 g/kg

Options: cast refractory black bake oven, see-through firebox, corner unit, gas-fired units, double stacked units

Workshops: limited, 10% units are installed by owners using manuals

Cost: $3050-4700 FOB Point Colborne, Ontario, Canada

Note: footing, foundation, chimney, veneer are owner supplied

and chimney) into a masonry stove with significantly improved efficiency and reduced emissions. This is a direction that Tim Custer of T.N.T. has focused on and is noteworthy considering the large amount of inefficient fireplaces in existing homes.

Sauna stoves can be used for space heat if placed within the envelope of the home. They are available from AlbieCore and Tulikivi.

Hydronic loops are included as options by many stove manufacturers, notably HeatKit, AlbieCore, and Envirotech. HeatKit uses a stainless steel loop in the combustion chamber to provide up to 5 kw water heat using a circulating pump or convection. AlbieCore uses a stainless steel heat exchanger above the secondary combustion chamber. Envirotech uses a 60' coil of copper tube under the insulated lid of the stove.

Access

Authors: Mark Klein, James McKnight, Ray Reser, and Dave Shatz, Gimme Shelter Construction, PO Box 176, Amherst, WI 54406 • 715-677-4289

Access to Mansonry Stove Information:

Nearly all the manufacturers listed below provide useful information packets free or for a nominal charge. It has been an education reading through their literature and an inspiration seeing the beautiful and functional stoves they build. The Masonry Heater Association of North America, 11490 Commerce Park Dr., Reston, VA 22091 • 703-620-3171, is a trade organization which will provide the names of members throughout North America who are stove builders, dealers, and manufacturers. Their newsletter is densely packed with information regarding research and development in stove design, emissions testing, and sustainability issues.

Woodburning Emissions

Heater Type	Particulate Emissions g per kg	Carbon Monoxide g per kg	Net Efficiency %	*Annual Particulate Emissions, kg	*Annual CO Emissions, kg
Open Fireplaces, All	17.3	126	NA	95,288	694,008
Masonry Heaters, All	2.8	75	58	15,422	413,100
Phase II Woodstoves	7.3	70	68	40,208	385,560
Phase II Pellet Stoves	2.1	20	68	11,567	110,160
Conventional Stoves	15.3	115	54	84,272	633,420

Source: Masonry Stove Builders, HP Staff
* Assumes Burning Three Cords of Dry Hickory (The Most Dense) per Heating Season

Tulikivi

Tulikivi U.S., Inc.
255 Ridge-McIntire Rd.
Charlottesville, Virginia 22903

Components: soapstone combustion chamber and veneer (2400-9000 lbs.)

Footprint: 2'7" wide, 1'6" deep, 4' high to 3'9" wide, 2'7" deep, 6'5" high, many styles and sizes available.

Emissions: 1.35 g/hr average

Options: bake oven, corner unit, cookstoves, benches, variety of soapstone veneers available

Workshops: installer training

Cost: $3000+ (includes veneer)

Note: installation by trained installers or dealers; footing, foundation, chimney are owner supplied

David Lyles' *The Book of Masonry Stoves* 1984, is a wonderful review of the origins and developments of masonry stove design. David's book is currently unavailable but may be available after June 1, 1996. Contact Heating Research Co., PO Box 300, Acworth, NH 03601.

Albie Barden has done an impressive amount of writing about masonry stoves and Finnish fireplaces, including his book with Heikki Hyytianen, *Finnish Fireplaces-Heart of the Home*, ISBN 951-682-168-5. Contact Maine Wood Heat Co. (see AlbieCore specs).

Fine Homebuilding Magazine has printed a number of useful and interesting articles about masonry heaters. Look at issues #7, 15, 21, 36, 42, 66, 70, 71, and 76. *Fine Homebuilding* can be found at your library or contact The Taunton Press, Inc., 63 S. Main St., PO Box 5506, Newton, CT, 06470-5506 • 800-283-7252.

This listing of manufacturers and builders is by no means complete and exclusive but is intended as an introduction to masonry stoves available in North America. Please use the Masonry Heater Association for access to the many talented custom builders throughout the country. Stay warm.

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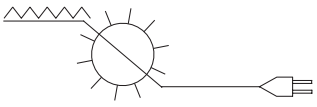

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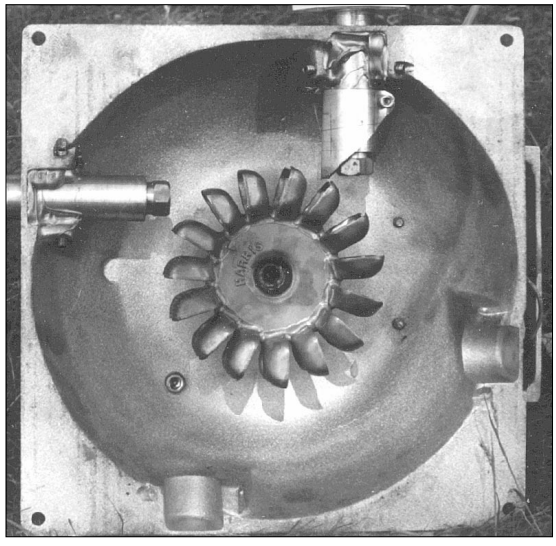
Bob-O Schultze, Hydroelectric Editor, Home Power Magazine



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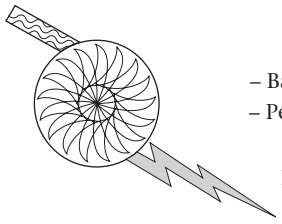

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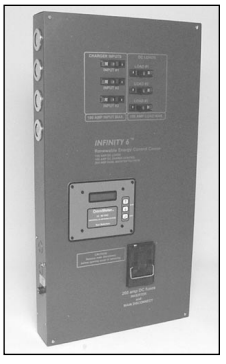

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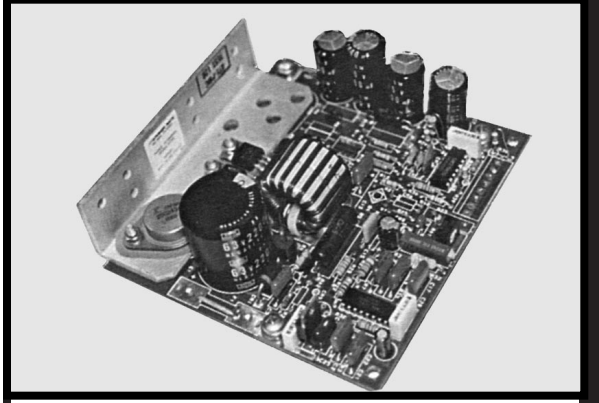

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GoPower

Above: Entrants from Michigan colleges line up at Michigan Ideal Speedway for the '95 GLEA race.

Back on Line

Michael Hackleman

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Students tell me that they have taken math courses because they were told to, but never understood what it could do for them until they needed it for Electrathon. Teachers have told me that students have come to them asking to be taught "how to" things that the teacher had previously given up on teaching as too difficult. They soaked it up! Administrators tell me that Electrathon is an answer to their prayers for a way to make technical subjects exciting to both students and faculty. How can we give up? Paul Zellar

These are the words of Paul Zellar of the Great Lakes Electrathon Association (GLEA. Great acronym!) . They represent some observations Paul has made in the course of a project to keep Electrathon events happening in Michigan. When Jordan College closed its doors last year, it looked like the Electrathon event for Michigan High Schools would die, too. Paul Zellar stepped in, contacted schools and potential sponsors, and eventually signed up 36 colleges for the 1995 year.

Mike Beebe (Ohio) and Jeff Dailey (Indiana) lent a hand, too. After the orientation meeting, the schools began building vehicles. (Are these kids and vehicles beautiful, or *what!* I got a good *long* laugh looking at Sparky.) Finally, nineteen schools arrived at the Michigan Ideal Speedway to compete, some with multiple entries—there were 24-EVs! Lakeshore High School from Stevensville did the tortoise-and-hair number on Lake Orion to take the 1995 trophy.

Paul is exhausted—it is 30-40 hours weekly. I hope to get a letter or some email that says that a team and sponsors are ready to help with GLEA—publicity & fundraising—for1996. Thank you for your efforts, Paul.

Below: "Sparky, the Wonder Cow" is moo'ed by crew and won the trophy for "Best Appearing."

Back on Line?

Space in the magazine imploded in HP50, so I sacrificed the GoPower editorial (or, more accurately, dodged having to write it). Did anyone notice? Anyway, HP readers have been sending me newspaper clippings of (and asking me to *do* something about) these weird ads that show all the bad things that EVs will do to us if the ZEV mandate (2% ZEVs beginning in 1998) isn't killed. Anti-EV campaigns from individuals or groups (with innocent-sounding names) are fronting for oil companies and automakers. Since most automakers are quietly gearing up to meet the mandate, it sounds like market share "positioning." What am I doing about it? Finishing up the EV book, of course. What can you do about it? Write a letter to the editor of your local paper to squawk. Quote something from *Home Power* (with Access) so that other readers know where they can get more information on EVs.

Speaking of Spaced

Have you ordered videos or books from me—and no word? Contact me at my new address. Sorry about this; I'll send materials or a refund. Working on the EV book has me zipping around in a Santa Cruz, Willits, and Agate Flat triangle—for weeks at a time. I just moved, too. I made the mistake of forwarding mail, so it's going in circles trying to catch up with me. Hasn't been a real "office" either. So, please try again.

Right: The carbon-fiber body of Breutgayot (Detroit) was designed, constructed, and tested in 75 school days.

Info on Smaller EVs

Howard O. Wright sent me a copy of a delightful publication, *Opportunities for Electric Vehicles* (35 pages), which he authored with help from Taira Yoshimura. It concentrates on issues related to small EVs (i.e., neighborhood EVs) and includes photos of small vehicles from around the world to support design ideas. Check it out.

Access

Michael Hackleman, PO Box 327, Willits, CA 95490. email: michael.hackleman@homepower.org

Great Lakes Electrathon Association (Attn: Paul Zellar), PO Box 224, Sparta, MI 49345.

Howard O. Wright, 425 32nd Ave, Eugene, OR 97405.

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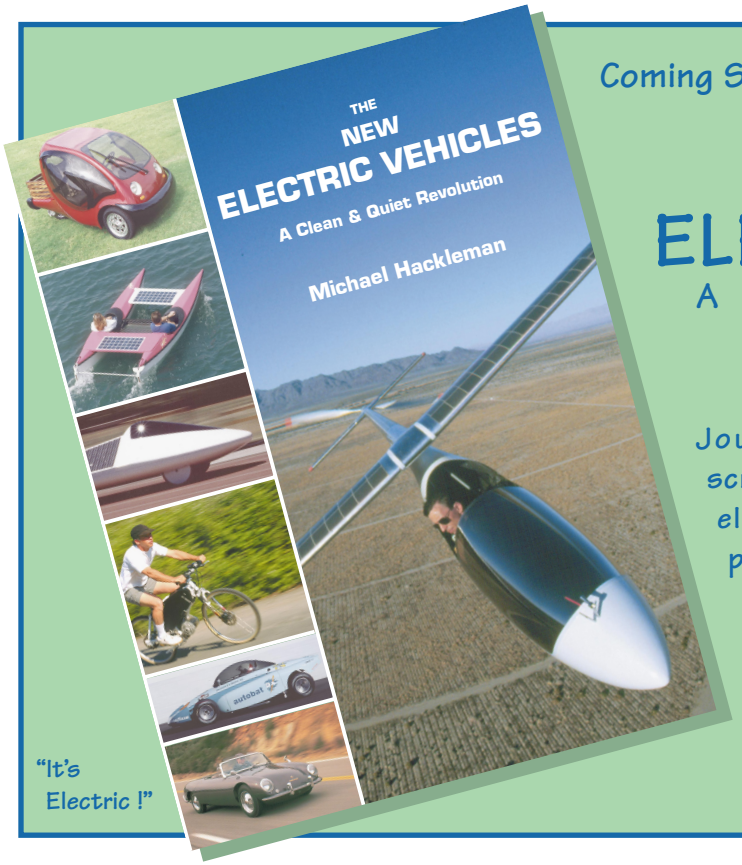

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Available March 1996

From the GoPower Files

Michael Hackleman

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The GoPower file folder was getting a little fat, with stuff ranging from a photo-and-caption to articles as big as a novelette. So, this is a little like potluck. Enjoy!

Above: You can rent an electric City Bee for use on San Francisco streets near rail stations.

Bees in the City?

Green Motor Works has teamed up with PIVCO AS, Norway, to lease 40 City Bee's to BART (Bay Area Rapid Transit) for 24 months of use in the San Francisco Bay Area Station Car Demonstration. The City Bee meets European (automotive) standards and has a top speed of 40-50 mph (a 45-35 mph range, respectively) in an urban driving cycle. The City Bee uses an aluminum space frame chassis and a thermoplastic body available in red, blue, or green. The City Bee has a 1750 pound curb weight and a GVWR of 2,200 pounds. Brakes are disc (front, with regenerative braking) and drum (rear). The initial delivery of City Bees' will use Solectria or Brusa AC induction motor/drivetrains. Later versions may use series motors from Advanced DC Motors.

Above: This electric Kewet from Green Motor Works is used by the Alahambra police department.

Pickup II

A consortium of interests—Sacramento Electric Transportation, Advanced Research Projects Agency (ARPA), Ciba Composites, Horlacher AG, McClellan Air Force Base, and Sacramento Municipal Utility District (SMUD)—have produced a prototype pickup truck, Pickup II, as part of the Freeway-Worthy Electric Vehicle Development Project.

Above: Pickup II is a modified electric Horlacher that would grace any business or corporate environment.

Pickup II has a low curb weight (under 2,000 pounds), a BVW (battery-to-vehicle-weight) ratio of 40%, a Brusa AC induction motor/controller (38HP peak, 20HP nominal, with regenerative braking), and a 168V lead-acid battery pack (Electrosource Horizons). The composite body/chassis makes the Pickup II fast (0-30 mph in five seconds, 80 mph top speed), long ranging (100 miles, city driving cycle), and efficient (1/2 cent per mile of electricity, or 120-175 Watt-hours per mile). The Badichequ charge/discharge management system means a full charge in 4-5 hours. Pickup I has been in service since May, 1994 (50,000 miles logged). Pickup II has an increased front crush zone to meet D.O.T (Department of Transportation) safety standards.

Above: Suntera's "shop" Pickette.

Suntera
Suntera is cranking out Pickette-class utility vehicles. One is shown here and another graces GoPower's cover this issue, with a Hawaiian skyline. More great pictures by Stevi Johnson-Paul from Suntera.

A Different Kind of PET
While universities and colleges build solar cars to race, Burt Newland has designed and built a solar car for everyday use. PET, or photovoltaic electric transport, was started in November of 1990, and finished August 1992. It was built at Sebring Auto Cycle, Inc.

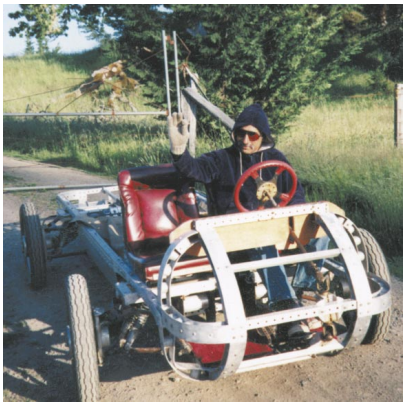
PET's frame (1.5 inch square aluminum tubing) is skinned with aluminum sheet (.015 inch). Three 12V lead-acid batteries store energy and are linked through two PPT (peak power trackers) from AERL (Australia Energy Research Labs) to 33 Solarex PV modules. The array generates 1,000 Watts in full sun.

Right: Grandpa (Capt. Burt Newland) gives Monica & Herby Bretch a solar ride. Panel is removed to show motor & wheel assembly.

Above: Imagine "No Exhaust Pipe Here!" on the rear of your car!

Left: PET is charging up batteries anytime it is parked or driving somewhere.

PET uses two 36 VDC 1.5HP motors to drive stock boat trailer wheels (4.80 x 12), and is geared for 35 mph top speed. The steered front wheel (3.5 x 4) came from a go-cart. Hydraulic disc brakes on the drive wheels are activated separately with foot pedals. The throttle is located on the steering yoke. Good job, Burt. Wow—a solar-powered street machine!



Above & Right: George Buono powers his homebuilt EV from PV panels that also power his home and shop.

A Solar-Powered Utility Vehicle

George Buono (his friends call him Solar George) handed me a copy of *Solar-Powered Utility Vehicle*, a 20-page booklet that details his solar-powered dwelling, shop, and other solar-produced works. Half of the book covers the design, construction, and operation of his Geo Solar vehicle. Hey, I've driven this machine on the street and seen video of it moving through snow. Skits along like a water spider. Adjustable suspension and clearance. Easy to handle.

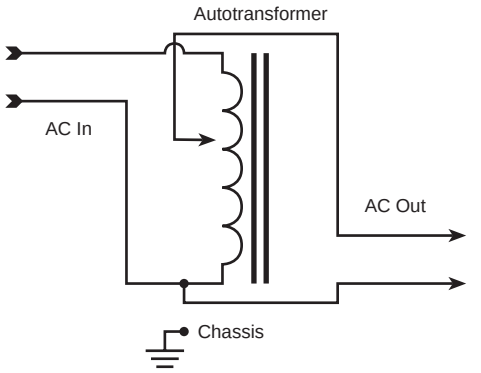
Feedback on Variac Chargers

I have some comments regarding Michael Hackleman's article, "An EV Battery Charger" (HP#47, pg 59-60). First, the schematic for the Variac autotransformer is wrong. An autotransformer is a single winding transformer, not a 2-winding type as shown. The danger is that the hot lead is electrically common, not the neutral as stated. A ground fault device is essential with this type of transformer, not just for the shy or those who have no savvy with electricity. Second, note that the ground wire should be shown connected to the frame of the transformer, not to the neutral lead as shown in the schematic. The only place a ground and neutral are allowed to be connected is inside the service panel.

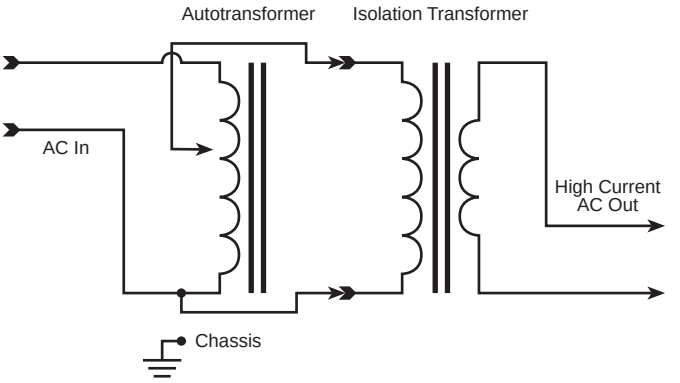
Home Power is an enjoyable, educational publication, but is important that you not show an uninformed person how to electrocute one's self. David H. Morrison, Grand Rapids, MI.

Thank you, David, for your feedback. *HP* readers interested in this charger—take note! David's letter had the Wizard, Richard, and I scanning electrical books to help us clarify the inner workings and unusual characteristics of the "autotransformer." Briefly, we found that it is considered to be an effective and efficient way to supply variable voltages where the transformation ratio is not too high. Its popularity is understandable. Since portions of the windings are used simultaneously as the primary and the secondary circuit, the autotransformer requires less copper *and* iron than a 2-coil (isolated) transformer where the rated power is similar. The savings in material means less weight, i.e., 60 pounds vs. 45 pounds, respectively. The autotransformer is wired like a single coil (primary and secondary windings are connected together), so the autotransformer is both inductive AND conductive. David's comment, "the hot lead is electrically common, not the neutral as stated" is technically correct. As well, the "grounded wire" in the circuit diagram *should* be connected to the autotransformer's chassis, *not* to the neutral. This will enable you to use a GFI (ground fault interrupt) breaker, as the original article mentioned. Please note the revised diagram.

Right: Circuit suggested by David Morrison. Ground the autotransformer's chassis.



Below: Circuit suggested by Michael Tandy. Autotransformer controls input of high-ampacity isolation transformer.



More Feedback on Autotransformers

Regarding your comments on the expense and potential electrical shock hazards of Variacs in HP#47, you may be pleased to learn that you can save money, increase the output, and add safety to your Variac-based chargers by connecting the output of the Variac into an appropriate stepdown transformer, i.e., a 15A Variac fed into a four-to-one stepdown transformer will yield a variable 60A output that effectively (electrically) isolates the output from the AC input lines. (This assumes, of course, that you can obtain your desired voltage after the stepdown.) I built just such a 60A charger for my auto repair shop and it has worked very well for years. I originally got the circuit suggestions and the parts from Mike Quinn Electronics, who is located adjacent to the Oakland Airport (in California). Hope this may help you. Michael Tandy, Berkeley, CA.

Michael Tandy's idea of using an autotransformer to "drive" a standard, isolated step-down transformer (of higher capacity) is an old trick that works well. The autotransformer's output is constrained by the amount of current the winding (wire) size can handle. Thus, the wattage an autotransformer will transfer *drops* proportionately as smaller output voltages are selected. There's a big difference between a (rated) 15a at 120v

and 15a at 12v (a tenfold difference in wattage!)! Piggybacking the autotransformer's output into a high-capacity, stepdown transformer (match ratings, please!) yields both isolation and increased recharge rates of current. The downside is the higher weight and cost of the additional transformer. My original article described an application where a *lightweight* charger was desired to be carried onboard an EV.

Incidentally, Variac is a *brand* name. A variety of manufacturers—Allied, MagneTek, Ohmite, Staco, Stancor, Superior, and Thordarson—also manufacture and sell autotransformers.

Access

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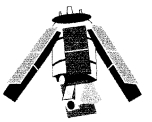

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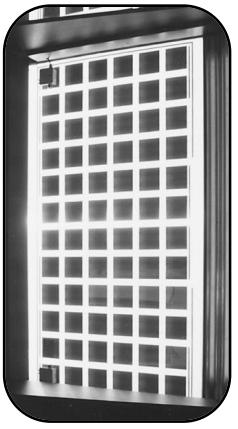

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Safety in EV Design, Operation, and Maintenance

Bob Batson

Below: Bob Batson's company, Electric Vehicles of America, Inc., produces cars, pickups, and heavy trucks.

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Although electric vehicles (EVs) have been in existence for more than 100 years, their recent and accelerated development has occurred faster than industry standards have been adopted. My experience is that an EV can be safely operated, maintained, and made crashworthy.

A good design results from careful consideration of the specific EV being built. Each component and modification to an existing vehicle must be considered relative to its impact on the conversion design and overall safety of the vehicle. Any EV project should make use of a qualified engineer for critical decisions.

These specific recommendations are intended to represent a conservative design for the protection of the driver, vehicle occupants, and the general public. This does not supersede or negate any existing codes, standards, or governmental regulations.

Criteria for Safety

First, let's identify the criteria for a safe design: single failure, redundancy, and separation.

• Single Failure. No single component should be critical to safe operation. Thus, safety should be maintained if any single component fails, even as a consequence of a crash or rollover. For example, if a fuse protects a circuit, what happens in an overcurrent situation if the fuse fails to "blow"?

• Redundancy. Single failure analysis suggests redundancy of safety components is needed. A second in-line fuse should ensure that at least one fuse blows. Contactors, activated by separate power sources, might also work to interrupt high-voltage power sources, as necessary.

• Separation between high voltage components is also critical for a safe design. Batteries, contactors, or other components with significant voltage differences should not be located near each other. For example, in a 120 Volt power system, the first and last battery should not be located beside each other.

Operational Recommendations

It is essential that an EV operate safely to protect the drivers, passengers, and pedestrians.

Electrical System

• All control and power circuits should be fused. The fuse should be located near the source of power (i.e., battery pack).

• The wire size should be adequate for the intended load. In addition, the wire should be automotive wire. Wire designated as "THHN", "TEW", or "oil and gas resistant" is not automotive wire. In fact, its insulation will crack and contribute to ground faults.

• Wiring should be protected against mechanical damage. Wires penetrating metal surfaces, such as the firewall, should use grommets or other barriers to protect against chafing of the wire. Wires in proximity to metal edges or other objects which can cause fraying should also be protected.

• The power system should not be grounded through the vehicle frame. Although this is acceptable on the 12 Volt system, it is unacceptable and unsafe for voltages greater than 24 Volts.

• Upon actuation by the key switch, a voltmeter or indicator light should indicate that the power system is connected ("on").

• Putting the key switch in the “off” or “stop” position should disable the power system.

• Opening any vehicle front door with the key switch in the “on” position should activate an audible alarm.

• A contactor is recommended as an electrical disconnect when the power system is turned “on” through a key switch.

• Circuit breakers are not designed or recommended for this service.

• Flexible wire is recommended in place of solid buss bars for the battery interconnects. Flexible wire doesn’t transmit vibration between batteries and provides greater protection from short circuit.

• All EVs require an auxiliary battery (12V), even if a DC-DC converter is in use. This ensures operation of the warning flashers, brake lights, headlights, etc. if the DC-DC converter fails.

• If the regenerative braking system is actuated upon throttle release, the brake lights on the vehicle should illuminate.

• The wiring system in the vehicle should be protected from the effects of high humidity, salt, and water spray.

• The accelerator potbox should not be placed in a crush zone of the vehicle. This is to prevent a collision causing full power to the motor.

• The power system should be automatically disconnected in the event of a crash. This can be accomplished by connecting an inertia switch to the contactor(s) control circuit.

• The controller, motor, and other large components should be located so they do not penetrate or significantly damage the passenger compartment in the event of a crash or rollover.

Battery System Considerations

• In a vehicle with flooded lead acid batteries, contactors and other components should not be located above or near batteries. Any arc might cause an explosion if hydrogen gas is present. The enclosure for these batteries should be vented to ensure that the buildup of gasses is prevented.

• A low SOC (state-of-charge) should activate a warning signal (alarm, light, or gauge).

• The battery enclosure should not permit electrolyte leakage into the passenger compartment during a crash or rollover.

• The battery compartment should prevent the batteries from exiting the vehicle or entering the passenger compartment in the event of a crash or rollover. Welding a restraint system is preferred if the vehicle has a frame. For a unit body vehicle, the requirements are more complex and may involve a combination of welding and bolting to carefully selected attachment points. The batteries should be restrained sufficiently to prevent their leaving the compartment during a crash or rollover event.

Vehicle Handling

• The vehicle’s center of gravity (cg) should be kept low. Batteries positioned high in the vehicle will adversely affect vehicle handling.

• There is considerable flex in a vehicle frame or unit body. It is essential to allow for differential movement between components.

• The Gross Vehicle Weight Rating (GVWR) as identified on the door jam placard should not be exceeded. If this rating is exceeded, one should evaluate the effect on brakes, wheel bearings, axle strength, and fatigue of the unit body. Decreasing the vehicle payload capacity (e.g. passenger, cargo, etc.) will be required in most EV conversions.

• The weight distribution of the EV should be considered and remain within the limits set by the manufacturer to ensure proper vehicle handling.

Maintenance Practices

The EV will require periodic maintenance. Therefore, the design should accommodate ease of maintenance as well as safety from the hazard of electric shock. The following practices are recommended:

• It should be possible to disconnect mechanically both electric poles of the battery pack from the motor and controller. These maintenance disconnects are in addition to the electrical disconnects used for operation.

• Components should be arranged to allow accessibility for testing and replacement. Segregating the batteries into three or four battery boxes will minimize exposure to high voltages when maintenance is performed on the batteries.

• The distance between first and last batteries in the pack and between contactors should be maximized to help prevent an accidental short circuit. Dielectric barriers can be used to assist in this separation.

• Barriers over batteries (and/or battery terminals) should be used to protect personnel and reduce the possibility of a short circuit condition. The direct contact with live parts of an electrical circuit whose voltage is greater than 50 VDC or 30 Vac should be prevented by housings, covers, or other types of protection.

• The battery box should be labeled to alert users of the potential dangers. The label should specify the chemical technology used by the battery.

• Harnesses carrying cables with voltages greater than 50 VDC or 30 Vac should be easily identifiable by color or a “warning” designation. Individual cables routed separately should also be easily identifiable as power cables.

Conclusion

Safety is essential in any vehicle. We accept the explosive risk associated with gasoline vehicles because manufacturers have designed the vehicle to minimize the possibility. EV manufacturers should mitigate the risks of electrical shock in an EV and inform its users of these hazards.

If you have questions, comments, or have experienced EV safety problems, please contact me.

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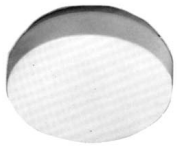

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An Electric Car: Making the Switch

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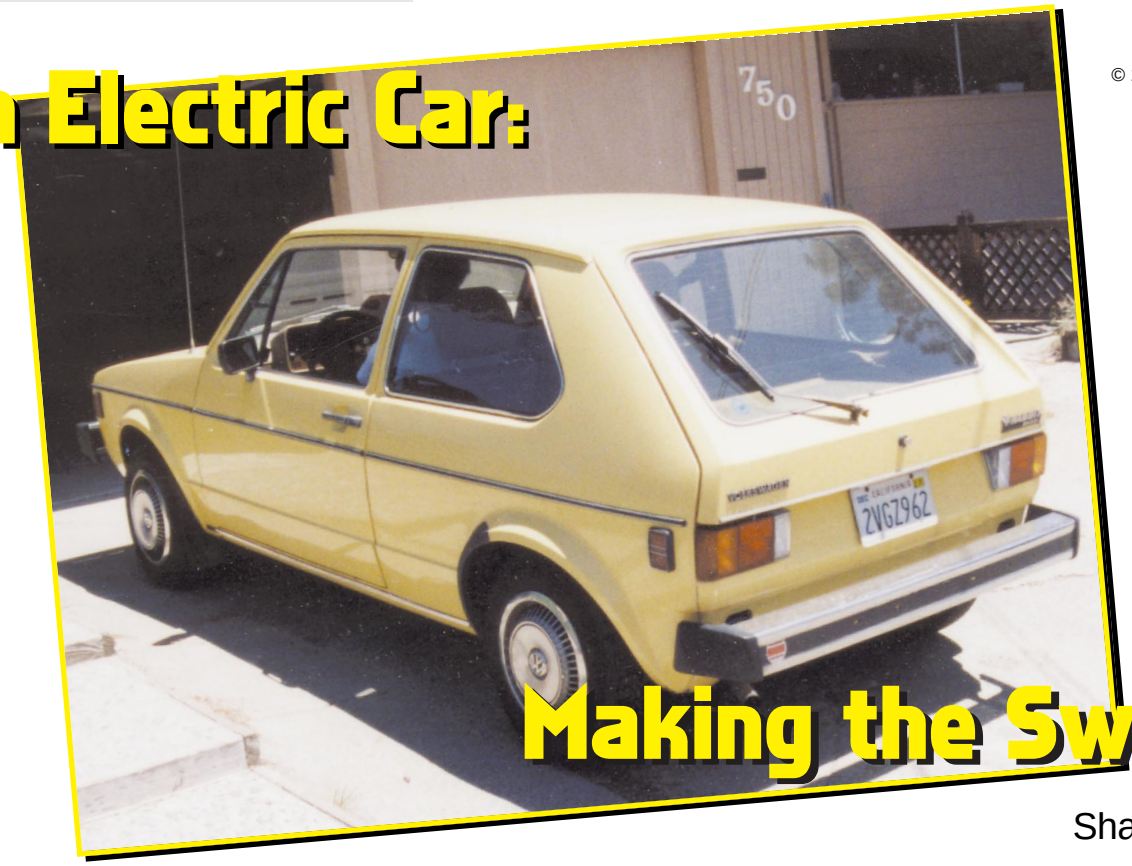

Shari Prange

Half the story on any electric car conversion happens before the first wrench touches the car. This is the story of all the decisions and preparations that led up to the conversion itself.

The EV Desire

Chuck Hursch lives in Larkspur, California, just north of San Francisco. Like many people, he found his interest in alternative fueled cars transformed into a personal goal by the Exxon Valdez oil spill. He felt a need to make a significant change in his lifestyle to reduce dependency on fossil fuels.

"At first, I was interested in compressed natural gas," he said. "When I looked into it further, however, I decided it really wasn't practical for me, because of the limited availability of refueling stations. Also, it still relied on fossil fuel. I wanted something better." He started to investigate EVs.

At the 1992 Solar Energy Expo & Rally (SEER) in Willits, California, he saw electric vehicles in the flesh for the first time. By then, he had already started to get used to the idea of electric cars, and was beginning to think maybe he could even own one.

Initially, range was a concern. As he learned more about EVs, however, he realized he could use an electric car for most of his daily driving, and rent a gas car for long trips. And, this is just how it worked out.

"The clincher was the renewable resource aspect of electricity," said Chuck. "That was the most interesting part of it for me. I realized that I needed to be more self-sufficient, and my long-term goal is to live off-grid. An electric car conversion is a step along the way to energy independence."

To Build Or Not To Build

Okay, the range issue was resolved, and Chuck wanted an EV. The next question was how to get an EV. Should he build it himself, or have it built for him? Since he lives in an apartment with a carport, he didn't have a space in which to do the conversion.

A friend, Preston McCoy, offered garage space and assistance with the project. Preston was president of the North Bay Chapter of the Electric Auto Association. Preston had some hands-on experience, having already built two conversions for himself, a Chevette and a Fiat.

Another option was to have the conversion done by Mike's Auto Care in San Mateo. Mike Slominski has built numerous conversion of various kinds of cars for customers, and has a reputation for quality work.

In the end, Chuck decided to take Preston up on his offer and do the conversion himself with Preston's help. "I looked at it as a learning experience, a chance to really know and understand my car," said Chuck. "Also, I've always wanted to do electronic kit projects and never got around to it."

Tools were not a problem. Chuck had a basic collection since he had done tune-ups and small repairs on a VW Bug for years, but he had never pulled an engine out before. "I had to buy a few things, but I didn't mind," said Chuck. "I didn't need to get much. Preston had a garage full of tools."

Choosing The Model

The next issue to decide was which model of car to convert. Chuck's first experience driving an EV was Preston's Fiat. He loved the silky smooth feeling of the motor. He wanted a car that would run well, could carry a good load of groceries, and had decent acceleration.

He had been watching the classified ads for a while, considering a Honda Civic. In general, he liked Japanese cars better than European cars because of little details, like window cranks that don't fall off. He also looked at the conversion kits available and the kinds of cars they fit.

Handling was also a major concern. Chuck worried about the safety of an EV with the added weight of the batteries front and rear. How would the car respond on the freeway if he had to slam on the brakes or make a quick lane change?

Electric Auto Association member Scott Cornell cleared up those worries with a ride in his wife Anna's Rabbit. "Scott took me to an empty street, whipped that car around tight turns, and stopped so fast he nearly put me through the windshield," said Chuck. "Most important, the car had a good ride, like a 'regular car'. I was sold. I thought, 'I can live with this car. It will get me around in comfort.'"

Finding The Perfect Donor

Chuck had looked at half a dozen cars for sale while deciding on a model. Having narrowed the chassis choice down to a VW Rabbit, Chuck began to search for The Car. He found it in just a couple of weeks. He checked out three or four Rabbits before ending up with a diesel in running condition. Some were too old, had too many miles, or cost too much. The winner was clean, felt good on a test drive, shifted well, and didn't smoke excessively. It seemed like a good car, and he didn't want to spend a lot of time looking.

Another issue for Chuck was the viability of the donor car before the conversion. Chuck planned to drive it for a while as a diesel, to be sure he was happy with the car, that he could "live with it". If he found he didn't really like it, he could sell it as a running diesel and start the search again.

The car passed the prenuptial test, so Chuck started preparing for the conversion. First, he completely overhauled the mechanical parts of the car, including rebuilding the constant velocity joints on the axle shafts and installing new brakes. He wanted the chassis as mechanically sound as he could make it before investing the time and money of the conversion in it.

Financing The Project

Financing the project was not an important issue for Chuck. When he made the decision to get an EV, he set up a savings plan, and put money away monthly for over a year before he started the conversion. Chuck said, "Altogether, I put about $10,000-$11,000 into the project, including the donor car, mechanical work, conversion parts, batteries, and a Russco heater. It was just a matter of planning it into the budget."

He admits that $1,600 was probably on the high side for the donor car, but stresses that it was a good

Above: Preston McCoy (left) and Chuck Hursch (right) wear big grins as the conversion begins.

investment to get a sound chassis. “It’s worth it to pay a little more for a good donor,” said Chuck. “Don’t go for the cheapest car you see.”

Since the diesel engine was healthy (it got 50 mpg), Chuck was able to sell it for $400 to recoup some of the cost of the donor car.

Choosing a Kit

Chuck had been shopping for a kit during the same time he was deciding which model car to use. He definitely wanted to use new, quality parts rather than scrounging for used or surplus pieces because he was committed to ending up with a car he would be happy with.

The main part of the drive system was pretty well predetermined. The Advanced DC series-brushed motor and the Curtis/PMC MOSFET pulse width modulated chopper controller were the most widely used components. However, there were differences in the list of parts comprising the rest of the kit from dealer to dealer.

Chuck settled on the Voltsrabbit kit from Electro Automotive about the same time he decided on the Rabbit as the model of choice. “I didn’t have connections to do my own design, so it was worth the money to get the complete prefabricated custom kit. I wanted something simple enough that I had a chance of getting it done and having a functional car at the other end of the project. If I did the racks and other stuff myself, by the time I got done I would have spent just as much money.”

The kit was certified for California tax credits, which helped offset the cost. The certification meant the kit was exempt from sales tax, and qualified for a one-time $1,000 credit on Chuck’s state income tax.

Time To Wrench

All the decisions were made, and the preparations were done. It was time to pick up tools and get busy. Next issue we’ll look at how the conversion process went for Chuck.

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Author: Shari Prange, Electro–Automotive, PO Box 1113, Felton, CA 95018 • 408-429-1989.

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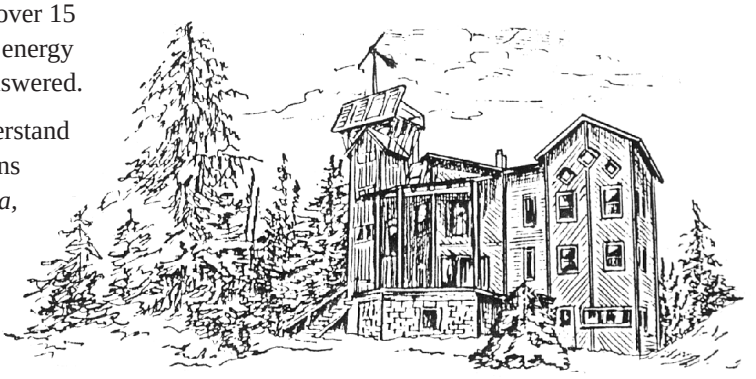

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Generators as a Backup Power Source

Richard Perez

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Generators driven by engines offer one big advantage—lots of power available on demand. This advantage has made the engine-generator or alternator the most popular backup power source for RE systems. This article focuses on choosing the right generator and then how to effectively and efficiently employ it as a backup power source.

Analyze the Situation

Every situation is different. Some folks employ generators as backup to their regular utility power. Other folks use the generator (or genny) to recharge their batteries when the sun or wind sources have not kept up with their energy consumption. The amount of power required varies from application to application. The climate and physical accessibility varies from system to system. All of these factors need to be analyzed before deciding on a specific genny. Make the wrong decision at this early stage of the process and you are doomed to unsatisfactory gennny performance.

Let's look at *Home Power* Central's system here on Agate Flat. We are eight miles for the nearest electric utility service. Our office and home are sourced by a 2,000 Watt photovoltaic array and a 1,000 Watt wind generator. Our battery, while large enough to have its own room, only stores enough power for about three days of cloudy, windless weather. And usually this is more than enough. For the last three years we have only used our little 12 Volt backup generator (see HP#42, page 28) for about five or ten hours each winter. When we expanded our office, the additional computer equipment consumed more power. Over time, our energy consumption has grown to over 10 kiloWatt-hours daily. This fall we experienced the worst cloudy weather we have seen in 25 years of living on Agate Flat. We had about two full sun days in two, windless months. We were in big trouble. *Home Power Magazine* has solid deadlines. We need power for computers to keep this magazine on schedule. I went shopping for a generator and here is what I found.

Backing Up the Grid

Consider the situation of a household wishing to back up their utility power during blackouts. The most common reason given is the freezer full of food. A blackout of four or five days will certainly ruin all the refrigerated food. In fact, most utility power outages in the USA are less than a few hours in duration. If the utility did fail for durations of five days, the cost of buying and running the generator would be paid for by five to seven long-term outages. This situation doesn't occur to many folks. In some grid-connected homes the heating system, even though fired by natural gas or oil, requires electricity to operate controls, pumps, and/or fans. Outages of as little as one day may make the home cold and uncomfortable. Power outages of several days may freeze the home's plumbing. If your home could be damaged or severely inconvenienced by a power outage of longer than three days, then the genny is your logical choice for backup power. RE sources with battery backup are not cost effective if all you wish is power during infrequent, short-duration, utility power outages. If you are grid connected, then you will probably run the generator less than 50 hours yearly. This means that buying an expensive generator is not cost-effective. Even the cheapest generator will run about 500 hours and this means ten years of use.

Backing Up PV and Wind Systems

Since renewable energy systems are designed with days of energy storage in their batteries, only prolonged cloudy or windless periods are a problem. The best way to deal with energy shortages in RE systems is conservation. If the system is low on energy, then put off energy intensive jobs like doing the wash. Inevitably, most RE systems will experience infrequent periods of extreme power shortage. It is just too expensive to size the RE system for the absolute worst case scenario. If these low power periods cannot be met with conservation, then the genny is the most cost-effective backup power source. Of the 3869 PV systems listed in our subscribers' database, 1941 or 50% use gennies for backup power. Of the 623 wind systems listed in our subscribers' database, 372 or 60% use a generator for backup.

The energy deficit in RE systems is deeper than the grid connected system. We not only want to run the household, but also need to recharge the depleted battery. This means more power is demanded from the generator. Recharging large batteries is a long procedure requiring more generator operating time. Backup gennies in RE systems will typically run between 100 and 200 hours yearly.

Please note that I am talking about backup power here. The genny is not suitable as a prime power source for

stand-alone systems. It is too expensive to operate at levels of over 200 hours per year. If you are operating a generator over 200 hours yearly, then you need to expand your PV and/or wind system. There are exceptions to this rule. Consider systems located in Alaska, for example. Here the generator is the only power source for much of the winter.

Types of Engine-Generators

It's easy to be confused by the large selection of generators available. Not only are they available in different sizes, but they also consume a variety of fuels and most importantly, they have widely varying price tags. Let's look at some of the choices we make when buying a generator.

Fuel Source

Gennies can consume either gasoline, diesel, natural gas, or propane. Most of the inexpensive models consume gasoline. Your choice of fuel should be made on the number of hours you plan to put on the generator yearly and on fuel availability. If you are backing up the grid during infrequent outages, then the gasoline generator is the most cost-effective. This scenario simply does not use the generator enough to make the higher price of diesel or propane models cost-effective. In undersized RE systems, increased generator usage makes it cost-effective to purchase the higher quality, more expensive generators.

The major advantage of gasoline or diesel as a fuel is its portability. Some sites are not supplied by natural gas or bulk propane service. For example, our site on Agate Flat is too remote for bulk propane delivery. Our only choices for generator fuel here are gasoline or diesel. The major disadvantages of gasoline as a fuel is storage and flammability. We use small, five gallon gas cans in good condition. We have four stored well away from the house and office in a cool, shady location. Don't store gasoline inside your home or garage, it's not safe. The gennies that consume diesel are usually of higher quality than the gasoline models. We chose a gasoline model so we could syphon fuel from our truck. This makes fuel transportation safer and more convenient. Diesel gennies can be hard to start during very cold weather, which is just about the only time we need to run the generator.

Propane or natural gas is a better choice for generator fuel if it is available. Generators fueled by propane or natural gas will last longer and burn cleaner than their liquid-fueled cousins. Natural gas and propane are more easily and safely stored than liquid fuels.

Size

There are really only two sizes of generator—adequate and too small. Don't buy one that is too small. Gennies are rated in the electric power output in kilowatts. This rating is always the maximum amount of power that you can extract from the generator. It is more efficient on fuel to run the generator at no more than 75% of maximum rated loading. Running the generator at its full load rating will not only be less efficient, but will radically shorten the engine's lifetime.

Gennies are rated for using resistive electrical loads. If you are running reactive loads like battery chargers and electric motors, then the poor power factor of these loads will actually increase the loading on the generator. Since reactive loads are mostly what we want to power, consider derating the generator by an additional 25%. This will compensate for the poor power factors of the reactive loads.

A rule of thumb on generator sizing is to figure out how much power you require then double it. This 2X factor makes sure that the generator can deliver the power you require without straining or browning out the loads with low voltage. We commonly see gennies in the range of 4,000 watts to 10,000 watts being used as backup for the grid or RE sources.

Engine Details

There are many different types of engines driving generators. The more inexpensive models use a single cylinder, air cooled engine. The higher quality units have multiple cylinders and are liquid cooled. It's worth giving the engine the hairy eyeball because it will likely be the first part of the generator to wear out.

If you are running the generator less than 50 hours yearly, then it is a waste of money to buy a multi-cylinder, liquid cooled model. If your generator operating time is in the range of 200 hours yearly, then it is cost effective to consider the more expensive, multi-cylinder, liquid cooled models.

Liquid cooling gives the generator a more stable operating temperature. Since most backup gennies in RE systems are operated during the winter, liquid cooling helps the engine keep a constant temperature while running on cold winter nights. Another advantage to liquid cooling is a substantial reduction in engine noise due to the sound-deadening water blanket surrounding the engine.

Consider the availability of remote engine starting. Some gennies can be started without leaving the house, others require that you actually go to the unit to start it. My personal preference is not to remote start the generator. Consider the following story.

My neighbors had a 7.5 kw propane-fired, two cylinder, air cooled Onan generator. It was demand-started by switching on any electrical appliance in their house.

One afternoon, John drained the generator's oil for an oil change. He went to the barn to feed the horse leaving the generator draining its oil into a pan. Pat, unaware that the genny was having its oil changed, switched on a light. The generator automatically started and fried its bearings in less than five minutes. The damages came to over $700 and the generator was out of service for a week while its owners hauled it to town for repair.

This is why I prefer to have a human visit the generator when it is started. Check the oil level and the coolant level. Listen for strange, unusual, and often expensive noises before the genny self-destructs. If you insist on remote-starting your generator, then it must be equipped with automatic controls which will shut it off if the oil level is low or if the engine temperature is too high.

The speed at which the engine runs is a factor in its longevity. Air cooled units operating at 1800 RPM will usually last much longer than those operating at 3600 RPM. This area of distinction has recently been blurred by modern engine designs employing advances engineered for motorcycle engines. For example, Honda makes gennies with engines running at 3600 RPM that will outlast most 1800 RPM models. These high tech gennies use overhead cam shafts and liquid cooling.

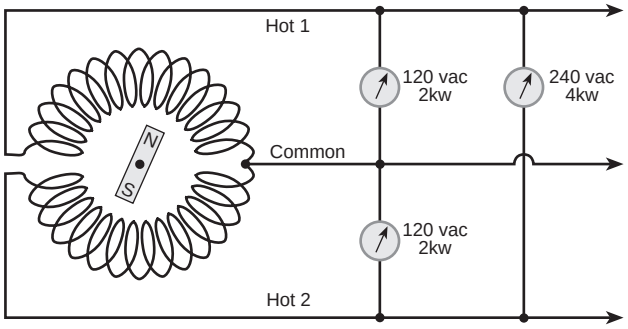
Consider the method of oiling used in the generator's engine. Most inexpensive models use splash lubrication. This means that a bit of metal is attached to the engine's crankshaft. This bit of metal splashes oil around in the interior of the engine thus providing lubrication. More expensive gennies use pressurized oil lubrication, just like an automobile engine. The engine's bearings float on a cushion of pressurized oil, giving the engine a longer lifetime before it requires rebuilding.

Inexpensive air cooled engines will run for around 500 hours before requiring an overhaul, and the genny will cost about $500. Multi-cylinder, liquid-cooled engines will run between 5,000 and 10,000 hours before requiring a major overhaul, and the genny will cost around $3000. Consider that the cost differential between these two types is about six to one, and their longevity differential is about ten to one. In the world of generators, you get what you pay for.

Alternator Details

The generator used in these units is actually an alternator. It is a 2 phase, 120/240 rms volt ac, 60 hz, alternator. While this may seem like technical trivia, the fine print on the alternator determines the performance you will get from the unit.

For example, consider a 4,000 watt alternator constructed to make 120/240 vac. This means that most alternators are actually producing two 120 vac sinusoidal wavefronts that are 180 degrees out of phase. When the output of one phase is positive maxima, the output of the other phase is at a negative maxima (remember, this is alternating current). What this technical detail boils down to is that on a single 120 vac phase only half of the generator's power is available. In order to get the generator's full rated output power, you must use it as 240 vac across the two phases. This nasty technical detail has bitten more first-time generator buyers than any other.



Two Phase AC Alternator

The "you get only half power on 120 vac" rule is another good reason for oversizing the generator. Consider that most of your loads are probably 120 vac. Consider that only half of the generator's rated output power is available on a single 120 vac phase. Buy a bigger generator.

Another technical factor to be considered is peak voltage output. While the alternator is rated at 120/240 vac what this really means is: the alternator makes two 180 degree out-of-phase sine waves that have an individual voltage, if they were rectified and filtered to direct current wavefronts of 117 volts rms (Root Mean Square). Actually the voltage of each 120 vac wavefront should vary from positive 164 volts to negative 164 volts. These positive and negative voltage maxima are known as peak voltage and abbreviated as vpp.

What really counts here is that almost all gennies exhibit low peak voltage. Ideally we would like to see ±164 vpp, but in fact most gennies only deliver ±155 vpp or less (in some cases, much less). What rescues this technical detail from the realm of trivia is that most of the stuff we want to power with the generator is run from the peak, not the rms voltage. Electric motors, transformer-based battery chargers, and many other appliances do most of their work by using the peaks of

GENERATOR CURRENT IN AC AMPERES AT 117 VAC

WIRE GAUGE	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110
25	14	14	12	12	10	8	6	6	6	6	6	6	4	4	4	2	2	2	2	0	0	0
30	14	14	12	12	10	8	6	6	6	6	6	6	4	4	4	2	2	2	2	0	0	0
35	14	14	12	12	10	8	6	6	6	6	6	6	4	4	4	2	2	2	2	0	0	0
40	14	14	12	12	10	8	6	6	6	6	6	6	4	4	4	2	2	2	2	0	0	0
45	14	14	12	12	10	8	6	6	6	6	6	6	4	4	4	2	2	2	2	0	0	0
50	14	14	12	12	10	8	6	6	6	6	6	6	4	4	4	2	2	2	2	0	0	0
60	14	14	12	12	10	8	6	6	6	6	6	6	4	4	4	2	2	2	2	0	0	0
70	14	14	12	12	10	8	6	6	6	6	6	6	4	4	4	2	2	2	2	0	0	0
80	14	14	12	11	10	8	6	6	6	6	6	6	4	4	4	2	2	2	2	0	0	0
90	14	14	12	11	10	8	6	6	6	6	6	6	4	4	4	2	2	2	2	0	0	0
100	14	13	11	10	9	8	6	6	6	6	6	5	4	4	4	2	2	2	2	0	0	0
125	14	12	10	9	8	7	6	6	6	5	5	4	4	4	4	2	2	2	2	0	0	0
150	14	11	10	8	7	7	6	5	5	4	4	4	3	3	3	2	2	2	2	0	0	0
175	14	11	9	8	7	6	5	5	4	4	3	3	3	2	2	2	2	1	1	0	0	0
200	13	10	8	7	6	5	5	4	4	3	3	2	2	2	1	1	1	1	0	0	0	0
225	13	10	8	7	6	5	4	4	3	3	2	2	2	1	1	1	0	0	0	0	0	-1
250	12	9	7	6	5	4	4	3	3	2	2	1	1	1	1	0	0	0	0	-1	-1	-1
275	12	9	7	6	5	4	3	3	2	2	1	1	1	0	0	0	0	-1	-1	-1	-1	-2
300	11	8	7	5	4	4	3	2	2	1	1	1	0	0	0	-1	-1	-1	-1	-1	-2	-2
325	11	8	6	5	4	3	3	2	2	1	1	0	0	0	-1	-1	-1	-1	-2	-2	-2	-2
350	11	8	6	5	4	3	2	2	1	1	0	0	0	-1	-1	-1	-1	-2	-2	-2	-2	-3
375	10	7	6	4	4	3	2	1	1	1	0	0	-1	-1	-1	-1	-2	-2	-2	-2	-3	-3
400	10	7	5	4	3	2	2	1	1	0	0	-1	-1	-1	-1	-2	-2	-2	-3	-3	-3	-3
425	10	7	5	4	3	2	2	1	0	0	0	-1	-1	-1	-2	-2	-2	-3	-3	-3	-3	-3
450	10	7	5	4	3	2	1	1	0	0	-1	-1	-1	-2	-2	-2	-3	-3	-3	-3	-3	
475	9	6	5	3	2	2	1	0	0	0	-1	-1	-2	-2	-2	-3	-3	-3	-3	-3		
500	9	6	4	3	2	1	1	0	0	-1	-1	-1	-2	-2	-2	-3	-3	-3	-3			
600	8	5	4	2	1	1	0	-1	-1	-1	-2	-2	-3	-3	-3							
700	8	5	3	2	1	0	-1	-1	-2	-2	-3	-3	-3									
800	7	4	2	1	0	-1	-1	-2	-2	-3	-3											

Generator Wire Table

Codes The body of the table contains the Wire Gauge Number (AWG) for the correct size COPPER wire
"0" Wire is designated by 0 "00" Wire is designated by -1 "000" Wire is designated by -2 "0000" Wire is designated by -3
Wiring is specified for a power efficiency of 98% and/or the correct ampacity

the alternating current wavefront. This means that battery chargers and motors will not perform up to spec when powered by a generator with low peak ac voltage.

Noise

Engines are noisy, there is no way around this. You can do three things to minimize the noise pollution: buy a genny with a good muffler and water cooling, locate the genny far from the house, and give the genny a sound-proofed building to live in.

The less expensive the genny, the noisier it will be. If noise is a problem for you, be sure to listen to the unit operate before buying it. There is no substitute for a good muffler and a water jacket for noise suppression. Space is a good silencer, but even 100 feet or more can be too close for a noisy, air cooled unit. If you put your genny in a sound-proofed shed, make sure to allow adequate ventilation.

Maintenance

Over the years you will lavish many hours of care on your generator. Most important is the interval between oil changes. Many inexpensive gennies have an oil change interval of 25 hours on their engine. Better quality units have an oil change interval of 100 hours. Consider the oil change interval when you decide which genny to buy.

Generator to Load Wiring

Once the generator is in place we must still move its electric power by wire to the loads. If most of the work we do with the generator depends on its peak voltage, then wire is one place we don't want to skimp. Oversizing the wiring feeding generator power to the loads is a very good idea. While the NEC specs a 5% voltage drop as acceptable for 120 vac system, I would suggest that 2% or less is better for gennies. At an energy cost of over 80¢/kwh, generator power is more expensive than PV power. Undersizing the current handling conductors is foolish economy and only

intensifies the generator's low peak voltage problem. The table shows the proper gauge copper wire for generator connection. Please note that the generator is listed by 120 vac output current. To find the output current of your generator divide its rated single phase wattage (usually half of the genny's total rated wattage) by 117 volts ac and you will get its single phase current. For example our 6000 watt Honda generator delivers about 3000 watts on each 117 volt phase, so single phase current is about 25 amperes. Since our round trip wire length is about 125 feet, we could have used 8 gauge copper wire to hook the generator up to our battery chargers. We actually used 6 gauge because we had it on hand and after all, there is no penalty for being more efficient.

Battery Chargers

If your are using RE sources, then the main load for your generator is your battery, or more properly your battery charger(s). You will be using some type of power supply which converts 120 vac (or 240 vac) into either 12 or 24 Volts DC for your battery. This battery charger is a critical link in the power chain between your generator and your battery. In most systems, the battery charger limits the amount of power delivered to the battery. This results in much longer generator operating time, reduced efficiency, and wasted money.

Battery chargers are rated in terms of output current into the battery. In all cases this rated current is delivered only into a discharged battery with low voltage. As the battery voltage rises during recharging, the current output of the battery charger decreases rapidly. Expect the charger to deliver about half of rated current into the battery when it is about half way recharged. As the battery reaches a full state of charge, charger current will decrease to about 20% of its full rated output.

60 Hz Transformers

Battery chargers which use a 60 Hz transformer do most of their work using the peak voltage of the incoming ac wavefront. Expect any 60 Hz transformer-based battery charger to run at 40% to 70% of its rated current when it is powered by a generator. This includes the battery charger built into many inverters. This classification of chargers also includes almost all units sold for operation from grid power, including the large 60 Ampere gas station chargers that roll around on wheels. Sorry, but the laws of Physics are at work here. It's the voltage peaks that do the work in this type of charger and they are anemic on all generators.

Switching Power Supplies

The answer to battery charging from a generator is to use a 120/240 vac switching power supply. These types of battery chargers virtually ignore the peak incoming voltage and do most of their work using the average (or rms) voltage. A brand very popular with *Home Power* readers is the Power Source made by Todd Engineering. At Home Power, we use three of these Todd 70 Ampere battery chargers to recharge our batteries from the generator.

I wish I could say that these inexpensive (about $260 each) Todd chargers were perfect, but they aren't. While the combined current output of our three Todd chargers is over 200 Amperes into a battery at less than 12 Volts, the output current radically decreases as the battery voltage rises. At 13.78 VDC these three Todd chargers only deliver about 124 Amperes to the battery. At 15 VDC or higher the output of the three chargers is down to a measly 40 Amperes. Worse yet, the three chargers we own show considerable variation from one to the next. One of the chargers almost meets its maker's specification, while the other two fall far short of delivering their rated power.

The bottom line is that we also need to derate the performance of battery chargers in addition to derating the output power of the generator. All this combined derating means purchasing equipment that has much higher ratings and higher costs. I think its evident why using the generator/battery charger is a poor choice for a primary power source.

Effective Use of Generator Power

If the generator is running, then it is most effective to load it to within 75% of it rated maximum power. Go ahead and recharge the battery, but also do the wash, pump water, and do any other power-intensive chores.

A distinct advantage can be had by balancing the power factors on each of the generator's phases. For example, we here at Home Power gain about a 15% current increase from our chargers if we plug our 120 vac deep well pump into the generator at the same time it is powering the battery chargers. The inductive load of the well pump balances the capacitive load of the chargers. The result is the generator sees a combined load that is closer to resistive and therefore delivers more usable power to all of the loads. Check this out for yourself on your generator. Power factor is a reality for generator (and inverter) users just the same as with mega public utilities.

Are we happy with our new generator? Well, I'd rather see the sun shine or the wind blow. But if our RE sources don't provide the power when needed, it's nice to know that we can keep on producing this magazine with the help of our new Honda ES 6500 generator. It delivers about 3000 watts per phase, is very quiet, and recharges our depleted batteries in about five hours of

operation. Karen, after years of jerking the starting cord on our homemade 12 Volt engine/alternator, loves the electric start. I like not having to put off work because the system is running low on energy.

All in all, I'd rather have sunshine. While our new backup generator is powerful and reliable, it still feels like a giant step backward every time I pour dead dinosaurs into it….

Access

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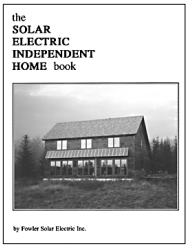

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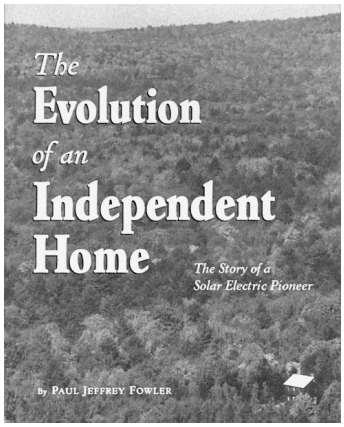
Good Books

The Evolution of an Independent Home

By Paul Jeffrey Fowler

Reviewed by Benjamin Root



Many of us who study RE technology and peruse new product information, are actually wanna-bes. Maybe we live in the city now, maybe we are already hooked up to cheap grid power. While many dabble in small RE projects to learn as much as we can; really, we dream of perfection. We imagine a place in the country, surrounded by the beauty of nature. Our neighbors will be like-minded and our friends, though their place won't be too close to ours. We will build smartly, always considering the land, its resources and demands, and our own aesthetics. We will finally have that all-providing renewable electricity system that we've been researching for so long. We will be independent, and proud of what we've created for ourselves.

In 1981, Paul Jeffrey Fowler made the leap. He bought land outside a small town in Massachusetts. The nine acre plot was 1.3 miles from grid power and had southern exposure. *The Evolution of an Independent Home* chronicals the process of building an energy efficient, passive solar home with a photovoltaic electric system. This is Jeffrey's story, describing the project from its inception through its current incarnation. Jeffrey explains his ideas and reasonings and the processes of the whole project. The search for an appropriate piece of land, through the building of the passive solar house is addressed in the first half of the book. The development of the PV system and his subsequent business as a PV installing dealer are described in the second half.

We know that every person's situation is different. From available money and the specifics of the site and climate, to our individual needs, the parameters of each project differs greatly. Renewable energy systems still perform best when custom designed for each user's situation. The value of this book is not as a "how to" manual. While the information is given in depth, the details are project specific. The true value of the book is as a model for approach. Jeffrey describes his hassles with finances, interactions with real estate agents and potential neighbors, and the ups and downs of the construction process. We can learn from his mistakes and hope to duplicate his successes in our own projects. There is potential to learn hard data, like the value of a vapor barrier under a concrete slab. But more important is what we can learn about the process of homesteading. This book gives insights into the range of decisions that must be made, and some suggestions for how to approach these decisions.

Jeffrey has been committed to photovoltaics as a source for electricity since its inception as a private home power option. The industry was young, standards had yet to be developed, and reliable inverters were merely a good idea. *The Evolution of an Independent Home* follows the development of photovoltaics as a viable energy source. Jeffrey's initial system differed greatly from his current one, and he describes the evolution in terms of advances in technology as well as his own needs. These chapters won't give us the information needed to install our own system. They will provide us with the questions that we must ask ourselves when planning a system and a lifestyle that works with it.

The Evolution of an Independent Home is about 250 pages with many photographs and illustrations. It is available through Fowler Enterprises for $21.95. The inspiration and knowledge we can gain through Jeffrey Fowler, and his willingness to jump into his dream with both feet, are as valuable as technical data. His dream came true, and ours can too. This book is motivational and useful to anyone beginning to plan a renewable energy or efficient home project. It will help you ask many good questions, and it will help you decide which answers ar best for you.

Access

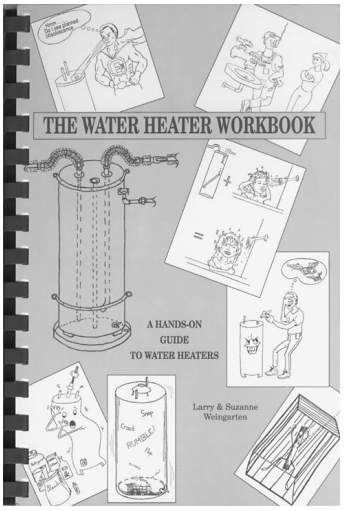
The Evolution of an Independent Home, The Story of a Solar Electric Pioneer, by Paul Jeffrey Fowler • ISBN 0-9645111-7-7

Published by Fowler Enterprises, 264 Bashan Hill Road, PO Box 253, Worthington, MA 01098.

The Water Heater Workbook

By Larry & Suzanne Weingarten

Reviewed by Michael Welch



Wow! This book has everything I'll ever need to know about domestic hot water heaters! It is a spiral-bound book of 154 pages, and is 5 inches wide by 8.5 inches tall.

The most important thing this book taught me was that when a water heater fails, don't automatically replace it! There are things that can be done that might make it work, saving you hundreds of dollars. The second most important thing I learned was that many hot water heater problems can be cured before they happen with a little preventive maintenance. Like making sure the sacrificial anode hasn't completely committed suicide (you'll have to read to find out what the anode is). Replacing it can extend the life of your water heater by a long time.

The book is very well organized with chapters on water heater anatomy, why tanks fail, maintenance, saving energy, what to look for in a water heater, installation, trouble-shooting, and commercial water heaters. The trouble-shooting chapter has 13 pages of symptom-cause-remedy charts, very well done. It has excellent appendices on sources for heaters, parts, and supplies, and has a very good bibliography and index.

The book starts with a quote from Thomas Peacock, "A book that furnishes no quotations is no book—it is a plaything." The Workbook has an interesting quote on every page covering a myriad of situations. It even has a chapter of more quotes aptly called "Desserts." One of my personal favorites is from Thomas Jefferson, "A little rebellion now and then is a good thing."

My recommendation: if you have a water heater or are about to buy one, then GET THIS BOOK! Even plumbers could learn from it.

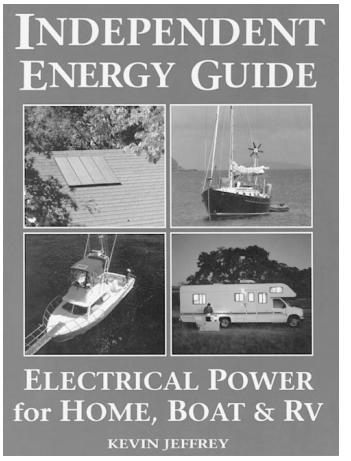
Access

The Water Heater Workbook is available by sending a $12 check or money order to Elemental Enterprises, PO Box 928, Monterey, CA 93942 • 408-394-7077 • ISBN 0-9630344-0-5

Independent Energy Guide

By Kevin Jeffrey

Reviewed by Sam Coleman



This book is a guide for choosing, installing, and using alternative energy equipment. It covers all the major alternative energy sources (PV, wind, and hydro), as well as various generator and alternator based energy sources. The usual balance of system components (batteries, inverters, instruments, etc.) are also included. There is a definite emphasis on marine usage and, to a lesser extent, on RV usage. The appendices contain product and source listings. There is also a chapter on basic electricity for beginners.

This 280 page, 7 by 9 inch paperback book is a comprehensive guide for anyone contemplating the move to alternative energy. Most of what you need to know to choose, install, and use your alternative energy system is included.

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Independent Energy Guide, $19.95, is distributed by Chelsea Green Publishing, PO Box 428, White River Junction, VT 05001 • 1-800-639-4099 • ISBN number 0-9644112-0-2

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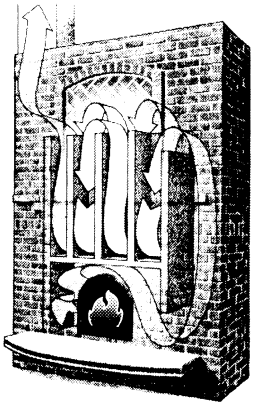

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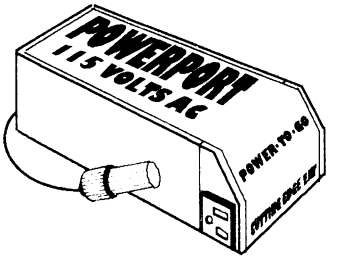

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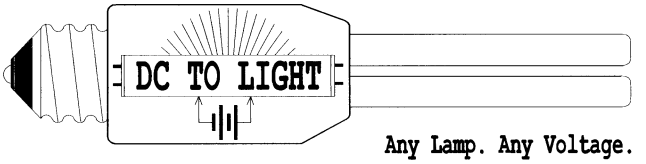

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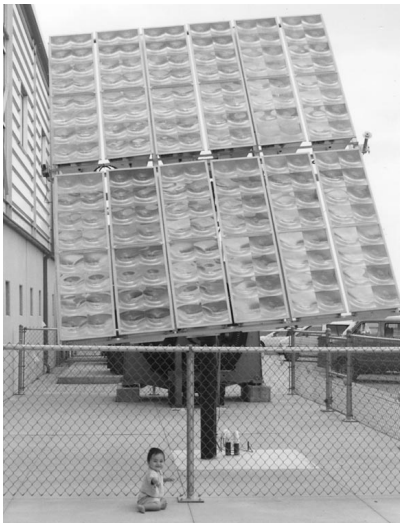

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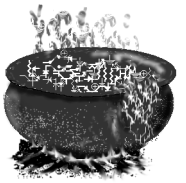
A Sneaky Timer for Trace Inverter Users



Homebrew

Andrew Bean

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In the beginning...I used a PowerStar inverter to run everything I could in my house. This included small mechanical timers for lights that gave my house the “lived in look”. This was fine as the PowerStar always put out 115 VAC. However, I recently changed over to Trace DR2424 units which use the famous Trace search mode. So I started looking for an electronic timer that would turn on the lights from its own battery power.

The Timer...

What I found was the Intermatic model DT1 electronic timer. It is rated for 15 Amperes resistive and inductive loads, and 1/3 HP motors. It is available in an older version which is programmable for one day and a new model which is programmable for a week. (The package has DT1 and DT1C markings) It costs about $25. I found mine at the local Meijers store. Since Intermatic is shipped all across the country you may find it in other stores and at a better price. The timer uses one AA size battery (supplied) for the clock/display memory functions.

The Problem...

The timer won’t bring the inverter out of search mode as it comes out of the package. So I went inside the timer to see what really was happening. What I found was two circuit boards, one with some resistors, the relay, a capacitor, etc., and another smaller board which has the clock and programming functions. The area we are interested in is the relay board which I have traced out into the schematic shown here. (Note: I have modified three units so far and there were minor differences in the parts in each one. But the parts we will work with were the same in all three.)

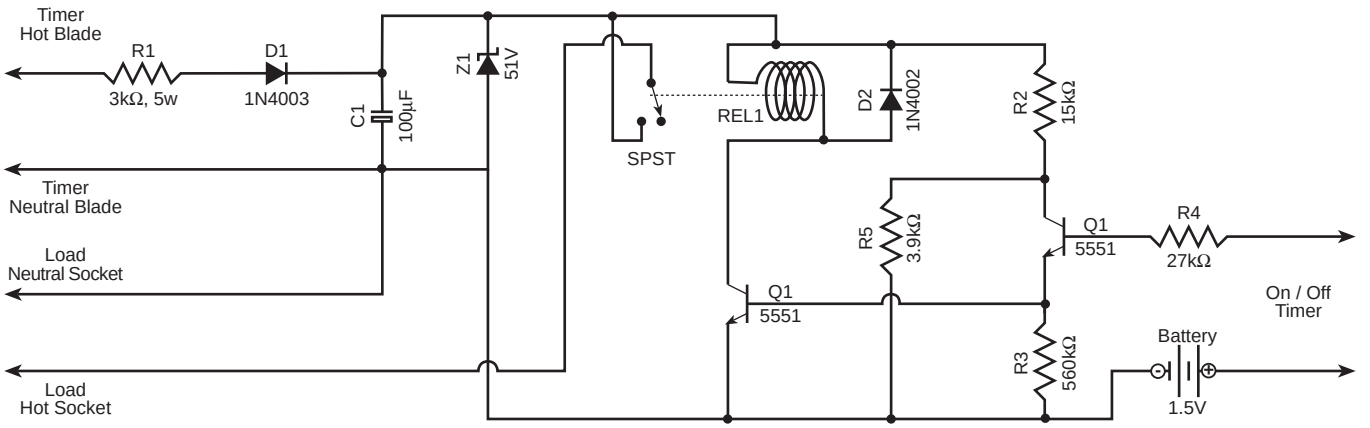
The Solution...

To make the timer work “correctly”, we will remove the two resistors R2 and R5 and attach the place they connected with Q2 (the collector) to the battery (+) terminal. Q1 will now get the right amount of voltage (when Q2 turns on) to activate the relay. In addition, removing the resistors takes all the load from the capacitor/zener pair. Now the inverter’s search mode pulses will gradually charge the capacitor to its normal operating voltage of about 51 VDC (regulated by the zener). This gives us enough energy from the capacitor to turn on the relay for about 1-2 seconds before the capacitor charge is gone and the relay again shuts off. Fortunately the 1-2 seconds is long enough for the inverter to respond to the load connected through the relay. When full inverter power is supplied to the load the capacitor/zener circuit again ramps up to 51 VDC to keep the relay turned on.

The Changeover...

The following steps are performed to change the timer. Please follow them carefully as you are working with the 115 vac section of the timer. Neatness is important here. Sloppy work will result in disaster!

1. Place timer on its front and remove the battery holder from the back of the unit.
2. Remove the two screws at the bottom back of the timer and the one screw from inside the area where the battery holder was installed.
3. Carefully pull up on the bottom back section of the case while making sure you get the top back section released from the two tabs holding the top edge in place.
4. Remove the 4 screws from the board holding the large blue box (the relay) and the one screw on the white plastic near the plug blades.
5. Gently lift out the relay board (it’s attached to the plug) making sure you don’t damage the two wire cable connecting it to the clock board.
6. Unsolder the two resistors R2 (brown, green, orange stripes) and R5 (orange, white, and red stripes). R2 is located on the left side by diode D1 and R5 is at the top edge to the left of the two wire cable.



7. Make sure you leave a clean hole from the left end of R5 so we can install a wire into the hole.
8. Cut a 2.5 inch length of 24 gauge (stranded is best) wire and strip 1/8 inch insulation from each end.
9. Put solder on one of the wire ends (tin the lead), and also tin a small area on the side of the (+) battery clip on the clock board. The (+) is on the right side and should have a small (+) by the clip.
10. Put the untinned end of the wire into the old R5 hole (the one farthest to the left - not the one by the two wire cable) and solder.
11. Put the board back into the case keeping the free end of our wire out so it isn't caught under anything.
12. Solder the tinned end of our wire to the tinned area on the battery clip.
13. Make sure all connections are secure, then reinstall: the circuit board screws, then the back cover (push the extra wire length towards the relay case), the back cover screws (make sure the top edge snaps into place), and finally the battery with battery holder.

The moment of truth...

Put the timer into a wall outlet with the inverter in search mode. Wait about 10-20 seconds for the capacitor to charge. Then press the on/off button and listen for the relay to click. After about 2 seconds you should hear the relay again click (off) due to the capacitor being discharged. You should now press the on/off switch again to "reset" the circuit so the capacitor will recharge. As long as you wait for the capacitor to recharge you will be able to turn the relay on. The next step is to plug in your light, coffee pot, or whatever and again enjoy timer functions with your Trace inverter.

The good and the bad...

First the bad. Due to the additional load of driving the relay the battery won't last quite as long as in the original timer design. However, I measured battery current draw of about 0.5 milliamperes when the relay was on and only 2 microamperes when off. I estimate you should still get about one year of life from an alkaline battery.

In addition, if your load won't bring the inverter out search mode when it is plugged in directly, don't expect this project to help! For example my Panasonic T15 light capsule won't come on with the timer as it doesn't bring the inverter out of search mode. So make sure your application brings the inverter to full power.

Now the good news. The timer also seems to work quite well with a NiCd cell. The timer display appears to "fade" at battery voltages around one volt which is the voltage at which NiCds are considered discharged. This is great as the information supplied with the timer says to replace the battery when the display dims.

Access

Author: Andrew Bean, 5867 W. Countryside Drive, New Palestine, IN 46163 • 317-861-5999

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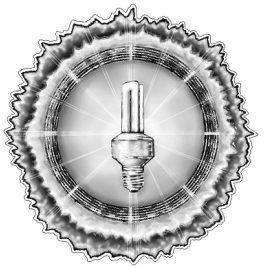

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National PV Production Statistics

Don Loweburg

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As we enter a new year, I thought it might be interesting to look at the national dimensions of the PV industry. The data is from the Department of Energy's (DOE) Energy Information Administration. In 1994, U.S.A.-manufactured PV modules increased 24% to 26 megawatts (MW) and they are expected to have increased another 20% or more in 1995. Over 50% of this total is exported. The domestically used PV, which includes 1.9 MW of imported modules, is about 10 MW. In terms of MW, crystalline silicon modules by far are the most dominant, prevailing with a 25 to 1 ratio over amorphous silicon.

The PV Usage Mix

Though 10 MW doesn't seem that great when compared to the rest of the world's usage, it is still the largest amount for any single country. If we examine where the domestically used PV actually goes by market sector, it breaks down in the following way: industrial—26%, residential—25%, commercial—20%, transportation—8%, utility—9%, government and other—10%.

Another way to look at the picture is from the perspective of application type. The largest application is remote power—35%, followed by communication—21%, consumer goods—12%, grid interactive—8%, transportation—8%, original equipment manufacturing—7%, and water pumping—5%.

A significant fact emerges from this data. If we combine the industrial, residential and commercial sectors we find that they constitute over 70% of the market by sector. Examining the market by application, we find that remote power and communication constitute over 50% of that market.

Who is serving these markets? The answer is private businesses. In contrast, the utility involvement amounts to 9% by sector and grid interactive (utility) constitutes 8% by application. It is clear that the utilities have played a minority role in the development of the PV industry to date. It is with these facts as background that IPP continues to challenge such poorly conceived programs such as the DOE subsidized TEAM UP (a program funding PV for a group of over 80 utilities nationally). The approach is completely backwards. TEAM UP provides incentives to the least deserving element of the market rather than rewarding those that have actually developed it to date. It is an outrage that the United States Government (read:taxpayers) is subsidizing monopoly corporations to enter markets that are already well served by small private enterprise.

Net Metering in California

During our last several columns, we have followed the progress of the net metering law in California. With the law due to go into effect January 1, 1996, the California PV collaborative crafted a model interconnect agreement to be submitted to all California utilities. The model agreement requires reasonable technical and safety standards and does not impose any additional charges to the net metering customer. The safety issues addressed include NEC compliance, the provision for a PV source over-current and a clearly marked disconnect on the main service panel, and the following minimum inverter safety features: The inverter must disconnect from the grid in the event of high or low voltage (± 10%), loss of grid power, and/or if the

grid frequency fluctuates (± 1 cycle). Finally, the inverter distortion (power quality) must meet standards set by IEEE 519. Though strict, these standards are presently met by a number of inverters on the market including the Trace SW products. The model agreement also details reasonable liability issues that might arise between the homeowner and the utility. The requirements for an insurance policy are unresolved but a $100,000 minimum homeowners liability policy is suggested. Two California utilities, Southern California Edison and San Diego Gas and Electric were very cooperative in this project. (The model agreement is available electronically by contacting me at i2p@aol.com.)

PG&E Fights the Growth of PV Intertie

In stark contrast to the other California utilities, PG&E filed an Advice Letter with the California Public Utilities Commission (CPUC) requesting permission to bill net metering customers a flat-rate meter charge of $14 monthly plus an additional $2.17 per kW of PV array. Additionally, they asked to require the homeowner to carry a commercial liability insurance policy of $1,000,000. These additional costs would make net metering unreasonably expensive for any homeowner in PG&E's service area. PG&E also testified against the net metering bill while it was in the legislature last Spring. It is very clear that PG&E is a foe of net metering. Wake up PG&E management! With uneconomic nuclear power plants, high rates, poor customer service, and employee layoffs, don't you need some good PR?

In response to PG&E's abusive tariff request, IPP members, the California Energy Commission, California PV Collaborative members, CALSEIA, and several potential net metering customers sent protest letters to the CPUC detailing the many reasons they should not approve PG&E's request

SCE's Offgrid PV Program Almost Ended…

In a surprise move last November, The Commission Advisory and Compliance Division (CACD) of the CPUC recommended an immediate end to Southern California Edison's offgrid PV program. As you know, IPP has opposed this program on a number of grounds. Primarily we see the entrance of a regulated monopoly into markets already being served as having anti-competitive implications detrimental to the continuing development of the independent PV business. This program is not needed by the industry or the customers, and we can support that position by noting the very low participation in the program. To date, only three contracts have been awarded and 7 kW installed in a year and half. CACD resolved to end the program for a different related reason. The program is over $200,000 in the red! For that reason CACD felt that the ratepayers were exposed to unnecessary risk and recommended to shut the program down. IPP supported CACD in this matter. However, the California Energy Commission and a number of PV industry representatives who still believe the PV industry needs utility involvement in off-grid PV went before the commissioners directly and lobbied to continue the program. In what I can only call a very "interesting" situation, the commissioners directed their own staff (CACD) to rewrite the resolution in support of Edison's program.

Trouble in Paradise

In Hawaii, a group of rural off-gridders are being forced to accept grid power and its accompanying over-development. For the full report see this Internet world wide web site: "http://hoohana.aloha.net/redroad/".

"The Red Road on the big island of Hawaii is the King's Highway. This historic, naturally pristine road has been traveled by Hawaiian royalty since ancient times." The report describes the installation of grid power by the utility Hawaii Electric Light Co. (HELCO) in an already well established solar powered region of the Red Road, the Puna District, on the Island of Hawaii.

This grid project is against the wishes of the majority of area residents. Furthermore, the project started before proper public review and before any permits were issued. It has been ruled in court that permits and an Environmental Impact Statement are required. Lines have even been extended to service bare land. The Public Utilities Commission reports that HELCO must have many more new subscribers to break even. The line extension profitability is clearly predicated on further development. This contravenes current laws, resolutions, and plans at federal, state, and county levels. It is recommended that development be curtailed there in volcanically active areas. There are also cost overruns and other externalities which must be included to fully account for the costs of this project.

Endangered species in this area are adversely affected by power poles and wiring. Representative Patsy T. Mink, in a letter to Michael Wilson, head of the Hawaii Department of Land and Natural Resources says, "I believe that the law requires an Environmental Impact Statement prior to approval of this construction. Given Kaua'i Electric (Citizen's Utilities) Company's request that all the people pay for their Iniki losses in increased utility rates, it is important that this hazard review be conducted as it will have future implications for the entire state."

It is area residents' position that the economic, ecological, health, and geological risks make alternate

power sources an effective solution for the generation of electricity in this environmentally sensitive and volcanically active area. “Citizens of the area ask that the HELCO power grid be removed and sustainable technology installed.”

Access

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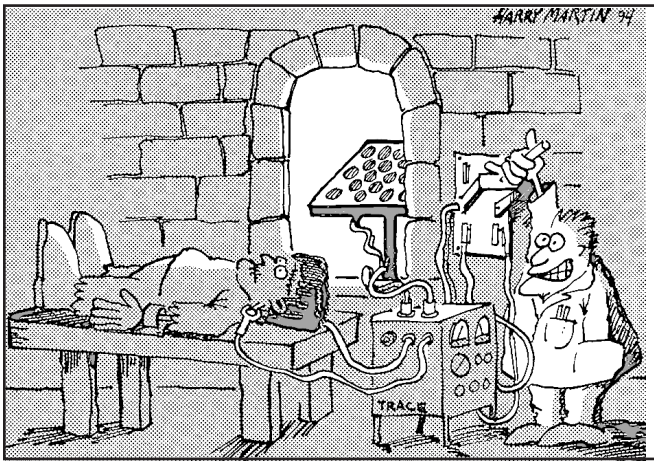

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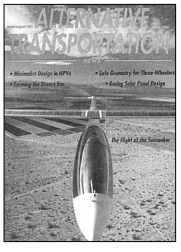

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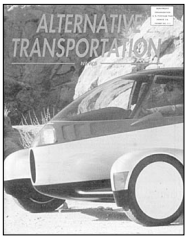

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The National Electrical Code® & PV Module Wiring Methods & Cables

John Wiles

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The National Electrical Code (NEC)®, updated and published every three years by the National Fire Protection Association (NFPA), is the most current and comprehensive electrical safety requirements document in the world. The 1996 NEC has just been published and work is already underway on the 1999 edition. Hundreds of volunteers work on a three-year cycle to review and update the NEC with the latest technology and methods of connecting electrical power systems. Representatives from the photovoltaic (PV) industry, academic institutions, the inspector community, Underwriters Laboratories, Inc. (UL), and the electric utility industry meet regularly to modify and update Article 690 of the NEC that deals with PV systems. Although Article 690 covers only nine pages in the NEC, about 90% of the remaining 1000 pages of the code also deal with aspects of PV installations. The NEC has been legislated into law by over 40 states and by most major cities in the United States. Paperback copies of the NEC are available for $25-35 at most electrical equipment distributors. The NEC and the hard bound NEC Handbook are available from NFPA (see access).

The NEC requires that all equipment be examined for safety. While the local electrical inspector (authority having jurisdiction, or AHJ) will inspect the field-installed wiring, the AHJ relies on the listing or labeling mark of an acceptable testing laboratory like UL or ETL to provide an indication that all equipment, conductors, and devices have been examined for safety. The listing mark ensures that the equipment has been tested to meet a number of appropriate safety standards relating to shock and fire hazards. Many inspectors will only inspect or approve systems that have been assembled with listed components. Insurance and Mortgage companies often require electrical inspections.

The inspector will be looking for the good workmanship required by the NEC. Installations that resemble other electrical power installations will be more readily accepted than those that use unconventional installation practices and equipment that does not resemble normal electrical supply equipment.

All listed equipment comes with labels and/or instructions that define the requirements (developed in conjunction with the requirements of the NEC) for installation and use of that equipment. Violations of these instructions or requirements may result in unsafe systems and equipment damage. The inspector, in many cases, will verify that these instructions have been followed. Almost all of the material that is printed on labels attached to electrical equipment has been placed there to meet a safety requirement. Much of the material found in equipment instruction and installation pamphlets and manuals is also mandated by safety requirements.

Safety vs. Performance

NEC requirements for PV installations and the requirements found on labels and in instructions for listed equipment, when followed, will generally result in a safe installation. While listing equipment to UL Standards and installing that equipment to NEC requirements does not guarantee high levels of performance, higher performance frequently is achieved. The required manner of sizing components, discussed below and in subsequent Code Corners, and the quality of listed equipment will generally result in PV systems that have higher levels of performance than systems that do not meet NEC requirements. Of course, it is possible to install a code-compliant system using listed equipment that has not been designed or adjusted properly.

PV Modules

PV modules are the major part of any PV system. While they are a relatively expensive portion of the system, they are durable, long-lasting, and nearly maintenance free. When exposed to sunlight, they will produce power for over twenty years. Since they must be mounted in exposed locations, the wiring that connects them to the rest of the system should be as robust as the modules themselves in order to achieve a safe, reliable, and durable installation. The NEC provides guidance in the installation of this wiring, and both the wiring methods and types of cables are covered in this Code Corner.

Safety — First, Last, and Always

PV modules are electrical power producing devices. Although the typical module produces only 40-80 Watts of power at a nominal 12 Volts, it still can pose a shock and fire hazard, especially in a system configuration, where the modules are connected in series and parallel for higher voltages and currents. It is not uncommon to see residential systems with PV arrays that can deliver

40-60 Amps at 24 Volts with charge controllers that are designed to handle over 100 Amps. In the larger commercial installations, PV source circuit voltages can be 600 Volts and higher.

It is strongly recommended that PV modules be covered with an opaque material during installation so that the terminals are not energized. Working at night and in other very low-light conditions can also lower the shock and fire hazards but at the expense of creating other hazards. Insulated tools and insulating gloves should be used if module wiring is accomplished on illuminated PV modules with live electrical contacts.

PV Module and Array Wiring Methods

The NEC outlines numerous wiring methods that are acceptable for connecting electrical equipment in the field. It does not cover the internal wiring of equipment since that wiring is viewed as part of the equipment listing process. Wiring methods include the following: 1) Use of multiple conductor cables with outer jackets (Types NM, TC, and UF), 2) Use of single conductor cables (RHW, RHH, THHW, etc.) in conduits (metallic and non-metallic), 3) Use of several other cable types under various circumstances that are delineated in the code. While PV modules may be connected using any of these "conventional" wiring methods, they may also be connected using single-conductor, exposed cables from module junction box to module junction box.

In all installations, the conductors must be properly attached to the PV modules with good electrical and mechanical connections. Following the manufacturer's instructions and using supplied materials will facilitate these connections. In many commercial installations, local codes (which supplement the NEC) require that conduit be used for all wiring. This means that modules designed for conduit fittings must be used. Some consideration might also be given to using either conduit or a multiple-conductor sheathed cable for any installation where the public has access to the wiring on the back of the modules. The conduit or sheathed cable provides an additional degree of protection from physical damage for the enclosed conductors over and above the protection afforded exposed, single-conductor cables.

Cable Types

While the NEC allows single-conductor USE, SE, and UF cable types to be used for module wiring, the best choice usually narrows down to a type USE-2 cable. It is a direct burial cable that is also sunlight resistant and has insulation with a 90°C (Celsius) temperature rating when wet. Standard USE-2 cable cannot be used inside a building (even in conduit) because it does not have the required flame retardant in the insulation. However, USE-2 is frequently additionally marked as type RHW-2 which indicates that it is also suitable for use inside buildings when routed through conduit.

SE cables are not commonly found in the single conductor configuration — they are usually available in cables with two exposed conductors and a bare cable for grounding. UF cable is suitable when manufactured as a multiple-conductor cable with jacket, but single-conductor UF cables are not commonly available and may have long-term durability problems in PV systems.

Since PV module wiring is normally confined to exterior locations, any exposed, single-conductor PV module wiring (such as USE-2) must be connected before or as it enters a building to one of the normal, "conventional" wiring methods. This must be done because exposed, single-conductor cables are not allowed inside buildings. USE-2/RHW-2 cable can be used for exposed, single-conductor module wiring and can then be installed in conduit for interior building runs. A roof-mounted, weather-proof junction box could also be used to provide a transition point between two different wiring methods.

A cable with an insulation rated for wet locations should be selected when using conduit in exposed (outdoor) PV installations. RHW, XHHW, RHW-2, and XHHW-2 are the best choices. Although THHW has a wet-rated insulation, there may be long-term durability issues associated with this cable when used in PV systems. Cables with a -2 marking indicate that the insulation has a 90°C temperature rating when wet. These types of cables are needed when connecting PV modules, because they operate at high temperatures as described below.

Cable Sizing — Ampacity

Ampacity is a term defined in the NEC that denotes the current-carrying capacity of a given conductor under a specific set of conditions. The ampacity of a conductor depends on the size of the conductor, the material of the conductor (copper or aluminum), the type of insulation (USE, XHHW-2, THHN, etc.), the type of insulation on the conductor, the mounting location (free-air/exposed or in conduit), and the ambient temperature. Tables 310-16 and 310-17 in the NEC provide details on the ampacity of various types of cables.

When a cable is installed according to the requirements of the NEC, it is designed to operate at least 20 years and still be safe. If the ampacity rating or operating temperature is exceeded for this cable, it may become unsafe in fewer years.

PV Module Rating and Operation

PV modules are rated under an illumination of 1000 watts per square meter with a cell temperature of 25°C (77°F) in a laboratory. However, when modules are exposed to actual outdoor operating conditions, the illumination may be 1150 W/m2 or higher on normal days, and the operating temperature may range from the lowest expected ambient temperature (-40°C or below with a strong winds) to 20-40°C above the highest expected ambient temperature (45°C ambient plus 30°C equals 75°C). The electrical output of the module (voltage and current) varies as these illumination levels and operating temperatures change. The output may be significantly different from the rated outputs marked on the back of the module.

PV System Design

The starting point for the balance of systems (BOS—cables, overcurrent devices, and disconnects) design is the rated module open-circuit voltage and short-circuit current printed on the back of the module. In order to meet NEC and UL requirements, the rated open-circuit voltage (Voc) must be multiplied by 1.25 to account for cold weather operation. This new voltage, called the maximum circuit voltage, will be used to determine the voltage rating of the module interconnection cable, array wiring, and other components. The rated short-circuit current (Isc) is multiplied by 1.56 to account for expected sunlight levels and NEC required 80% operating limits on cables and overcurrent devices. This circuit current is used to determine the ampacity of the cables and the rating of overcurrent devices and disconnect devices.

Temperature Deratings For Cables

Cables must be sized so that they can carry the circuit currents without exceeding the safety margins established by the NEC. The cable sizes are determined by the needed cable ampacity at the operating temperature of the cable.

Tables 310-16 (conduit installations) and 310-17 (free-air installations) provide ampacity figures for cables operating at 30°C (86°F). These tables also provide ampacity derating factors for cable operation at other temperatures. There is a possibility that PV modules on hot days with little wind may have junction box temperatures greater than 75°C. Temperatures in this range indicate that only cables with an insulation temperature rating of 90°C or higher should be used; cables with 75°C insulation have ampacities of zero when operated at temperatures above 70°C and are therefore not usable. When using 90°C conductors, even the 30°C ampacity values must be derated for the 75°C module operating temperatures. If modules are always operated in areas where the maximum ambient temperature is well below 45°C (113°F), then the module may operate below 75°C, and smaller ampacity derating factors may be appropriate. If the maximum ambient temperatures are above 45°C, then the module may operate at temperatures higher than 75°C and larger ampacity derating factors must be used. For equal current requirements, higher operating temperatures generally require larger conductor sizes.

Example: A number 10 AWG (American Wire Gage) USE-2/RHW-2 cable has an ampacity in free air of 55 amps at 30°C. When operated at 75°C, a factor of 0.41 is used to adjust the ampacity to 22.55 amps (55 x 0.41). If this cable is installed in conduit, the ampacity starts at 40 amps and is derated to 16.4 amps at 75°C. The Code Corner columns in *Home Power Magazine* issues 45-48 provide examples of these calculations.

The temperature derated ampacity of the cable selected for module interconnections must be greater than the circuit current (1.56 x rated Isc). The voltage rating of the cable must be greater than the maximum circuit voltage (1.25 x Voc). With single modules in the 40-85 watt power range, selecting and sizing an appropriate cable is a relatively easy task. When modules are connected in series and parallel for greater outputs, the cable sizes and ratings need to be determined for each circuit that can have differing currents and voltages. Examples can be found in the back issues of *Home Power Magazine* mentioned above. The NEC applies other restrictions on the maximum ampacity of cables, particularly number 10 AWG and smaller, and should be referred to for the necessary details.

Module interconnection cables and other array wiring that is not connected directly to the module junction boxes may operate at temperatures that are closer to ambient temperatures. In these cases, an appropriate ampacity derating factor should be used in selecting the proper cable.

Every conductor in an electrical power system, including PV systems, must be protected for overcurrents produced by overloads, short circuits, and unexpected failure-related currents. Even though the overcurrent device rating is chosen after the cable size is selected, the type of overcurrent device may influence the cable type and ampacity calculations. The next Code Corner will deal with overcurrent devices and with the calculations for rating them and how they affect cable ampacity.

Access

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An NEC Article 690 Task Group, chartered by NFPA, is working on the 1999 NEC with a Technical Review Committee from the Solar Energy Industries Association. Those wishing to actively participate should contact Ward Bower at Sandia National Laboratories • 505-844-5206

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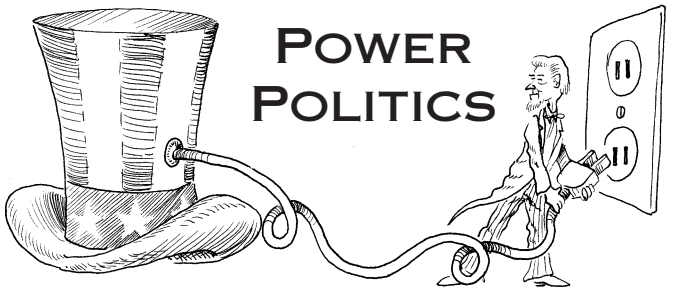

Finding Your Power and Seizing the Moment

Michael Welch

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Nature just handed me a great opportunity on a silver platter. I'd bet similar opportunities get handed to each of you from time to time. We should all do what we can to promote home-made power. It's both good for the environment and good for our pocketbooks. Oh yeah, it's fun, too.

People have been asking me if my power is still out. This week brought Humboldt County, California, the strongest winds in almost 20 years. My questioners obviously didn't know me very well. Closer friends know I have been living off-the-grid for several years.

But, I always look forward to answering questions like that, and it reminded me of a way I could make a difference in the world. These questions seem to come after natural disasters like high winds, flooding, earthquakes, and the occasional misdirected car kissing a phone pole.

I don't know what it is, but it makes me feel so satisfied to say, "You mean the electricity went out? Gosh, I never know when that happens because I make all my own electricity with solar panels."

In this storm, 28,000 local households were without power. Three days later, it was down to 19,000 and five days later there were still 7,000 households without electricity. PG&E admitted it would take them another 2 weeks before everyone's power was restored. All this in our relatively unpopulated county of 110,000 people. (PG&E's cost-cutting layoffs contributed greatly to the backlog of repairs needed, but that's another column.)

Taking Advantage of a Situation

As an experienced organizer and a seasoned opportunist, I knew what to do. I sent out press releases and letters to the editors extolling the virtues of having clean, safe, and, most of all, decentralized renewable energy to rely on. My computer has a fax modem, and look out! I know how to use it.

Sixty minutes and twenty dial-outs later every media source in my area knew what I wanted them to hear. I sat back and waited for those phone interviews with radio and print media and for the tv crews to show up to record my on-camera sound bites.

I've always been a little nervous in talking to the media, but when I realized that most of the media just wants to help get the story out and that I'm really talking to only one person (the reporter), it became a lot easier. It isn't at all like you see on 60 Minutes; the reporter is not out to get you. They just want an interesting story.

How to do a Press Release

Press releases are easy to write, as long as you keep them simple. If a reporter needs more information, they can always call you to get it. Keep the text to the point without being overly dry. Say all you can in as few words as you can, and as long as the information is complete and interesting, there is a good chance they will report it in their media just exactly as your release presented it to them.

Often times a reporter won't have time to call you for an interview, so it is helpful to them if you provide quotes within the text of your press release. Things like:

Solar advocate Pat Shmoe said, "What we are witnessing is yet another reason to become energy self-sufficient.", and:

According to Shmoe, "Trees were down everywhere. Sparks were flying where branches were laying across the power lines…. What a light show!", and:

Shmoe continued, "My next door neighbor has been without electricity and well water for five days since the power pole up the road got knocked out. Last night I invited her family into the warmth and light of my solar electric home and was able to send her back with a five gallon jug of drinking water."

That's the kind of thing the press eats up. You can bet your phone will be ringing for follow-up, and that some reporters may even contact you months later when they are ready to do a feature story on "Solar isn't just for hippies anymore." As a matter of fact, last fall we got a great front page feature on home-scale solar in the LA Times from a minor contact made with one of their stringers.

Things to Include in your Press Releases
Across the top of the first page, it should boldly state what it is: *PRESS RELEASE AND PUBLIC SERVICE ANNOUNCEMENT*. Next, it should state a date for release: *FOR IMMEDIATE RELEASE*, and: *FOR FURTHER INFORMATION CONTACT: Michael Welch, (707)822-7884*.

Then, choose a title that a newspaper reporter might be able use as a headline for their story, like *Local Solar Advocate's Electricity Never Goes Out*.

Next, write the release. Keep it short, sweet, and simple. Give the important facts early, and fill in the details as you go on. Try to keep it under two to three pages to encourage printing it just as you wrote it rather than hacking your writing, and don't forget the quotes. Unless it is important to the point of the press release or letter, keep the inflammatory rhetoric out. Be kind and gentle when trying to inform the public. Save the tirades for when trying to eradicate an evil harm.

If you have time, follow up a press release with phone calls the day after receipt. If a reporter hasn't yet read it or shuffled it aside into a huge stack of other items requiring attention, a phone call is usually all it takes to put it in the front of their mind again. The earlier in the day you can call, the better off your story will be. Papers often have early deadlines, and stories and interviews planned for evening TV news are often determined by mid-morning.

Letters to the Editor
If folks are anything like me, some of their favorite things to read in the paper (and Home Power Magazine) are letters. You can often reach a few more receptive people in this way than other ways. There's no trick to writing that letter to the editor, because they'll print almost anything. But more folks will pay more attention to it if it is also "short, sweet, and simple." Don't add quotes that a press release can benefit from, and humor or wit can make the difference between an interesting, informative letter and a dull, nobody's-gonna-pay-attention letter. Sign the letter and include contact information so that the paper will feel comfortable that it is coming from a real person.

With both press releases and letters to the editor, you should be choosey about when and how often you use the methods. Sending too many press releases will guarantee that they end up in the circular file. A steady stream of letters to the editor can work if they are very clever, as readers may come to look forward to them. But, if they are highly opinionated or not exciting, and they keep coming and coming, both readers and editors will begin skipping over them as soon as they recognize the sender's name or writing style.

Fax Me, Baby
Fax machines and modems are wonderful tools, unless you're some kind of Luddite. After composing my press release, I told the software to Print to Fax. That immediately awoke my faxware and a menu popped up asking me where to send it. I chose everyone listed in my fax phone book titled "Local Media."

Then I went to lunch and ran into my friend Kelly, and asked her, "Do you know what I'm doing right now?"

"Ummm, eating a vegie supreme burrito with extra jalapeños from Rico's?" she asked, suspecting it was a trick question.

"No, you silly duck. I'm sending out a press release as we talk!"

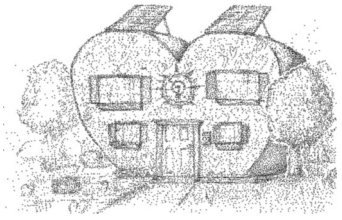
When I got back from lunch, the computer screen told me that all twenty faxes had been successfully sent. Modern faxes and fax modems can memorize a series of phone numbers and related information, ready to access at the press of a key. Months before, I had voice called all the local media to get their fax numbers. I have 400 fax numbers on my computer. (Which reminds me, I better back up my hard disk tonight.)

I had generated no paper or envelopes, and if the receivers used fax modems, they didn't either. My fax software even comes with an Optical Character Reader that does a pretty good job of translating an incoming fax into a word processor file. Faxing also gives some assurance that the press releases were less likely to get buried with the tons of mail that media outlets normally receive. Still another advantage is that the faxes arrived moments after sending them instead of days, as is common with the US Postal Service.

You, too, Can Be an Activist
Mad about anything? Need to let your Congress person or garbage company know what you think? Does that busy intersection need a stop sign to make it safe? Want to help make a change? As you can see, anyone can do it, and the more of us that are actively working to promote and educate about home-made power, the sooner it will become the norm in our society. It took me an hour to write my fax, and my guess is that it helped 2,000 people to learn just a little bit more about energy self-sufficiency. What a success! Please try it yourself. Oh, by the way, it was fun, too.

Access
Author: Michael Welch, c/o Redwood Alliance, PO Box 293, Arcata, CA 95518 • 707-822-7884 • 707-822-8640 BBS • Internet: michael.welch@homepower.org

Home & Heart



Kathleen Jarschke-Schultze

With the change of seasons comes changes in our power sources. We have wind and sun from spring to fall. In the winter our main source of power is the small hydro unit in our creek. Home improvements made in the summer are paying off now. From January 1, 1995, to January 1, 1996, we have only had to use our backup genset about nine hours.

Daily Hydro

Our hydro unit intake, or head, starts in a 6" pipe, goes down to a 5" pipe, then to a 4" pipe along an approximately 900' run in the creek. The unit itself is using two nozzles now, a 7/8" and a 3/4". This supplies us with 230 Watts, 24 hours a day (5.52 kWhr per day).

One thing about hydro power is that it gets you out and walking. We need to check the head intake screen almost everyday. This is where a good sturdy rake is a tool of beauty. In the autumn months you can make several trips a day to clean the head depending on your leaf fall. The high brown water during and after a heavy rain can bring a lot of small branches and rocks along your water course. Maintenance of your intake is very important to your power production.

Wind & Sun

During the winter months our PV panels produce some power. In fact if it is a cold, clear sunny day the PVs are at their best. Daily winter sun does not last too long in our canyon so this is not a major power producer here.

The wind which is a daily occurrence from spring to fall just stops during the winter. We get a little from traveling storm fronts but it is mostly gusts and not the sustained wind we need to generate much power.

Stormy Weather

This year Oregon and Northern California saw the worst storm in decades. We saw gusts of 65 mph here at the house. The Whisper 1000 wind machine went into a defensive mode and "helicoptered," tipping the blades up so they slow way down to protect the unit from damage. We did get full batteries out of the storm.

Millions of people were without power on the West Coast due to that storm. Once again we watched the news of the blackouts on TV. No one in our neighborhood lost power. Our creek was so high it was a couple days before we could get to the intake screen to clean it.

Winter Drying

My parents moved to a new home that included a washer and dryer set. I already have a cool washer, the Staber horizontal axis model (see HP#47) that I still love. So they gave me their old gas dryer. My dad also sent me the gas orifice that is needed to change it from natural gas to propane gas.

The model is a Kenmore Heavy Duty Plus. I have no idea how old it is. We made a place for it in the basement close to the washer. It is great! I can actually wash and dry clothes at home in the winter. We took measurements with Bob-O's Fluke and found that the dryer uses 365 W/hrs per 50 minute load. It has a start up peak draw of 37 Amps DC. This is something to consider when sizing your inverter. I do the laundry on weekends when Bob-O and I are not on our computers all day long.

I am wondering now if a more efficient motor could be put into the dryer like the washing machine motor conversion in HP #25. This would be a great improvement. More research is needed.

Hearth & Home

The double paned windows, roof top turbine fans, new doors and attic insulation we installed this summer are paying off now. The windows and insulation made such an improvement that there is at least a twenty degree difference between the outside temperature and the inside temperature when we wake up in the morning. That is when the house is the coldest with the fire having been banked for the night.

There were three doors that were installed in the summer makeover. After the wet weather had moved in we found that minor adjustments were necessary on all three doors to keep them latching properly. We took the opportunity to add door caulking to the frames.

Since the firewood box is in the mudroom we have an airlock to the outside cold. I highly recommend a mudroom for anybody who lives off the pavement. It is a great place to leave muddy boots and all the hats and gloves. We use one wall to store the skis, poles and goggles. Fishing poles and walking sticks all have a home here, with a couple of canoe oars thrown in. The mudroom, being on the North side of the house, is always cold so it is also a good place to store winter fruit, like pears or apples.

DSS Dementia

Well, we bit. We got a DSS satellite dish. The clarity of signal and picture is really superb. The guys watch a lot

of sports while I am drawn to the Home & Garden channel and the classic movies. Mystery Science Theater 3000 is a favorite now. It's funny though, even with all those channels to watch, sometimes there is nothing on. Since we got our dish two more have shown up in the neighborhood.

Arborsculpture

Bob and Golda Maynard of Energy Outfitters sent me several books for Christmas. One is the most fascinating book I have read in a long time. It is "How to Grow a Chair , The Art of Tree Topiary" by Richard Reames and Barbara Delbol. It is a perfect-bound paperback of 106 pages with black and white photographs, and pen and ink illustrations. The cost of the book is $16.95 plus $1 postage and handling.

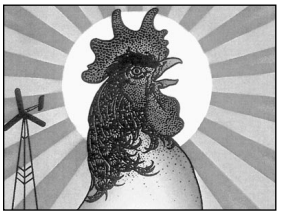
In this book Richard Reames gives a written and pictorial history of arborsculpture in general, and pioneer Axel Erlandson in particular. The really great thing is that after showing the possibilities of living tree sculpture, and this Erlandson guy was pushing the envelope, Richard tells you just how to do it yourself. Think of it, a set of table and chairs for your garden that are living trees.

Axel Erlandson, proprietor of the now defunct Tree Circus, did not tell anyone his secrets of arbor sculpture. If anyone asked he would say just that he 'talked' to them. Richard has done research both in the historic pictures of Axel's work and at his own nursery in Williams, Oregon to hone his skills. He even traveled to the old Tree Circus site where some amazing trees still grow unattended. It is indeed generous of him to share his knowledge with everyone.

Access

Kathleen Jarschke-Schultze is dreaming of arborsculpture at her home in northern-most California: c/o Home Power Magazine, PO Box 520, Ashland, OR 97520 • 916-475-0830 • Internet Email: kathleen.jarschke-schultze@homepower.org or kjs@snowcrest.net

Arborsmith Studios, 1607 Cave Camp Rd., Williams, OR 97544 • 541-846-7188 • arborstu@magick.net



The Midwest Renewable Energy Association Spring Workshop Schedule

MREA is a grass-roots, non-profit educational organization whose mission is to promote renewable energy and energy efficiency through education and demonstration.

Membership and participation in the MREA are open and welcome to all interested individuals and organizations.

February 24–25: Energy Efficient Construction Techniques
Instructor: Mark Klein of Gimme Shelter Construction
Location: Amherst, WI Cost: $200
In this workshop you will learn about residential siting and how to incorporate passive and active solar design, daylighting, hydronic heating, energy efficient and environmentally friendly building materials, and super insulation construction methods into your design plans.

March 30–31: Batteries and Inverters
Instructor: Bob-O Schultze of Electron Connection and staff member of Home Power
Location: Tomahawk, WI Cost: $250
Through demonstrations you will learn about batteries and inverters including performance, characteristics, installation, and safety considerations. There will be am emphasis on the Trace 4000 watt sinewave inverter. Basic knowledge of electricity recommended. Includes housing and food for the weekend.

April 13–14: Photovoltaic Systems
Instructor: Jim Kerbel of Photovoltaic Systems
Location: Amherst, WI Cost: $200
This course includes siting, design, and sizing, charge controllers, batteries, inverters, wiring, and installation methods of PV systems.

April 27–28: Solar Domestic Hot Water
Instructor: Chuck Gates of Altech Energy
Location: Forestville, WI Cost: $225
Through hands-on demonstrations and an actual installation of a two panel system you will learn different types and components, siting, sizing, transfer fluids, and controllers for solar hot water systems.

May 4–5: Grid-Intertie Wind Systems
Instructor: Mick Sagrillo of Lake Michigan Wind & Sun
Location: Milwaukee, WI Cost $225
This workshop covers siting, system sizing, installation, zoning, and utility issues, for utility intertie wind systems in the 3 KW to 20 KW range. There will be several site visits of working systems and equipment will be on hand for demonstrations.

May 11-12: A Place to Call Home: A Soulful Look at Alternative Building Techniques
Instructor: Mark Morgan; Builder / Philosopher
Location: Beaver Creek Nature Preserve, Fall Creek, WI Cost $250
Explore the mental and emotional processes involved in the design and construction of an alternative/renewable energy home. Workshop will include classroom discussion and hands-on work with various construction techniques including straw-bale, rammed earth tire, cord wood, earth-bermed, and passive solar designs. Fee covers housing and food for the weekend.

call or write **The Midwest Renewable Energy Association • PO Box 249, Amherst, WI 54406**
phone (715) 824-5166 • fax (715) 824-5399

HAPPENINGS

AFRICA
Needed: PV Volunteers for Africa. Solar Energy International (SEI) is organizing volunteers trained in the design and installation of small stand-alone photovoltaic systems. This pilot program, a component of SEI's INVEST Program, provides selected volunteers with an opportunity to work with small African businesses and community groups. Participants will work under the direct supervision of Energy Alternatives Africa (EAA). The EAA is a leading African organization promoting PV rural electrification.

To support this charitable program, volunteers must make a one year commitment and be responsible for paying 50% of their travel and in-country expenses. The total amount a volunteer needs to provide for the entire in-country year is approximately $5,000. The other 50% will need to be raised by SEI and EAA.

Potential volunteers are required to successfully complete SEI's PV Training program (or equivalent) as a prerequisite. The full four weeks of intensive technical training will cost each participant an additional $1700 for workshop tuition. Volunteers have two opportunities to complete the required training this year: May 28-June 21 or August 5-August 30.

To find out more about EAA please see *Home Power Magazine* issue #41. For background information about SEI please see *Home Power Magazine* issues @21, 31, 32, 49 & 50.

Solar Energy International, PO Box 715, Carbondale, CO 81623, 970-963-8855, Fax 970-963-8866 • e-mail: sei@solarenergy.org; World Wide Web: http://solstice.crest.org/renewables/sei/index.html

CANADA
A Sustainable Future: How Do We Get There From Here? A conference retreat sponsored by the Solar Energy Society of Canada Inc., June 9-June 12, 1996. This three day retreat will focus on topics that are key to the success of a sustainable energy future: policy options, technical developments, commercialization, and required action. For more information contact Solar Energy Society of Canada Inc., 250-2415 Holly Lane, Ottawa, ON K1V 7P2, Canada, 613-523-0974, Fax 613-736-8938, e-mail: solar@worldlink.ca

The "Alberta Sustainable House" is now open for public viewing every Saturday 1:00-4:00 PM free of charge. The first of its kind in Canada, the project emphasizes cold-climate state-of-the-art features/products based on the founding principles of occupant health, environmental foresight, resource conservation, AE, recycling, low embodied energy, self-sufficiency, and appropriate technology. Already in place: R17 windows, multi-purpose masonry heater, solar hot water, greywater heat exchangers, LED and electroluminescent lighting, solar cookers, and others. Under development: hydrogen fuel cells, Stirling co-generator, Tesla bladeless steam turbine, and others. Contact: Jorg Ostrowski, Autonomous & Sustainable Housing Inc/Alternative & Conservation Energies Inc, 9211 Scurfield Dr NW, Calgary Alberta T3L 1V9, Canada; 403-239-1882, Fax: 403-547-2671

The Institute for Bioregional Studies was founded to demonstrate and teach recent ecologically-oriented, scientific, social and technological achievements that move us toward ecological, healthy, interdependent and self-reliant communities. For more info: IBS, 449 University Ave, Charlottetown, Prince Edward Island C1A 8K3, Canada; 902-892-9578.

INDIA
2nd International Renewable Energy South Asia "96 Conference and Exhibition, February 12–14, 1996, New Delhi, India. For a registration form contact, Alternative Development Asia Limited, 5F 3 Wood Road, Wanchai, Hong Kong, Fax +852-2574-1997, Tel +852-2574-9133

SWEDEN
1996 European Union Wind Energy Conference and Exhibition, May 20–24, Goteberg, Sweden. Contact phone 49-89-7201-232, Fax 49-89-7201-291

NATIONAL
Energy info on the Internet can now be accessed via the Energy Efficiency and Renewable Energy Network (EREN), a multimedia WWW server developed by the DOE. Check it out at http://www.eren.doe.gov or contact: Energy Efficiency and Renewable Energy Clearinghouse, PO Box 3048, Merrifield, VA 22116; 800-363-3732; e-mail: ENERGYINFO@delphi.com

American Hydrogen Association Bulletin Board System: Solar Hydrogen BBS, 415-494-3116, 1200–14,400 baud V.32bis. V.42bis 8N1; also, Prosperity without Pollution: AHA Tempe BBS 602-894-8403.

Energy Efficiency and Renewable Energy Clearinghouse (EREC) is offering a free booklet, *Heating The Home* (FS236) for homeowners who would like information on cutting their energy bills. EREC is also offering free copies of the brand new DOE/EPA *Fuel Economy Guide—Model Year 1996.* The guide contains fuel economy estimates for 1996 model year cars, light duty trucks, vans, and special purpose 4WD vehicles. For free copies contact EREC: Phone: 800-DOE-EREC (363-3732); mail: EREC, PO Box 3048, Merrifield, VA 22116; e-mail: energyinfo@delphi.com; TDD: 800-273-2957; BBS: 800-273-2955.

The Learning to Water Wise and Energy Efficient is a program designed for children, grades 4 thru 8 to teach tomorrow's energy consumers wise habits that they can use for many years to come. Not only do teachers and students receive the instructional materials to learn the concepts and principles of conservation, but they also receive the hardware they need to apply what they have learned. The program is sponsored by local utilities or companies that want to make an environmental difference in their community. For information on helping implement the program in your community contact: Sarah Quarante, Energy Technologies Laboratories. 2351 Tenaya Dr, Modesto, CA 95354, 800-344-3234, fax 209-529-3554.

The U.S. Department of Energy's Office of Building Technologies (OBT) through NREL (National Renewable Energy Laboratory) is offering bulletins describing current research in heating, ventilating and air-conditioning (HVAC) that is being conducted by OBT and its labs.The free bulletins are *Thermally Activated Heat Pumps*, which discusses efficient gas-fired heat pump technology that heats and cools buildings without producing CFCs. Also, *HBCU Program at Tennessee Sate University* discusses research in alternative refrigerants. Limited quantities of these bulletins are available by contacting NRELs Document Distribution Service at 303-275-4363, fax 303-275-4053 or evanss@tcplink.nrel.gov (e-mail)

Sun Day, April 21, 1996, is an ongoing nationwide, grassroots, organizing and educational campaign to promote improved energy efficiency, renewable energy (solar, wind, biomass, solar hydrogen, geothermal and hydroelectric) technologies, electric vehicles, and sustainable agriculture as solutions to global climate change, energy imports, acid rain, radioactive waste, and other energy-related environmental problems. The campaign was formally launched on Earth Day 1992, with activities sponsored throughout the United States. Once again, many participating organizations will be sponsoring fairs, conferences, educational programs, political actions, and other events. If you are interested in participating contact Ken Bossong, Sun Day: A Campaign for a Sustainable Energy Future, 315 Circle Ave

#2, Takoma Park, MD 20912-4836, 301-270-2258, Fax 301-891-2866.

ARIZONA

The State of Arizona is now offering a tax credit for installation of all types of solar energy systems. A solar technician certified by the Arizona Department of Commerce must be on each job site. For info contact ARI SEIA; 602-258-3422.

Follow the Sun with SEI. Learn the latest in Passive Solar Building Design and Photovoltaic Technology. SEI is offering a series of workshops in sunny Tucson, AZ. Topics include Solar Water Pumping—Feb. 5–8; Solar Cooking—Feb. 9–11; Solar Home Design—Feb 12–24 (with special weekend workshops on hot water systems and cool towers); PV Design & Installation—Mar. 4–15;and concluding with Advanced PV—Mar. 18–29. Workshops designed for owner-builders, solar career seekers, industry technicians, ranchers, farmers, and those working in less developed nations. Pumping, solar cooking, and PV workshops have hands-on components. Tours will be included. Can be taken individually or as part of program. For prices, and brochure contact: SEI, PO Box 715, Carbondale, CO 81623 or call 970-963-8855, Fax 970-963-8866. Arizona residents may call 520-327-8558. SEI is a non-profit (501(c)3) educational organization, whose goal is to encourage the practical use of renewable energy through education & technical assistance.

Tucson Solar Potluck & Exhibition—May 4, 1996, Tucson, AZ Contact: Citizens for Solar, PO Box 40372, Tucson, AZ 85717, 602-748-7233

ARKANSAS

Sun Life is now conducting “Third Saturday Seminars” on inexpensive building techniques. Their focus is to teach home building from materials that can last a thousand years and cost less than conventional wood-framing. These are hands-on, all-day workshops. Contact Loren at PO Box 453, Hot Springs, AR 71902.

CALIFORNIA

OFFLINE INDEPENDENT ENERGY SYSTEMS WORKSHOP: Designing Your Home PV Power System For Beginners—Sunday March 24, 1996. The class will begin with a tour and discussion of our own PV system, which includes water pumping and telecommunications. We will then develop the following topics: basic systems types, determining power needs, the PV array, the battery, and inverters. We will discuss how it’s all put together such as any special wiring needs, code requirements and safety, instrumentation, and controls. We will also look at how to LIVE with PV in relation to appliances, computers, and entertainment equipment, attitude, and awareness. The workshop will be held at the Offline home/office about an hour from Fresno, California in the Central Sierra. Cost is $35 per person or $45 for two together. For further information, reservations and directions, please call, write, or e-mail Don and Cynthia Loweburg, Offline Independent Energy Systems, PO Box 231, North Fork, CA 93643, 209-877-7080. internet ofln@aol.com

The California Energy Commission’s HomePage address is: http://www.energy.ca.gov/energy/. A wealth of information on the Energy Commission, news releases, notices about hearings and workshops, an energy events calender, information on energy education for students, parents, and teachers, and hypertext links to more than 400 web sites that deal with all aspects of energy. For more information about the Commission’s Internet site please contact Bob Aldrich, e-mail: boba@energy.ca.gov or call 916-654-4989.

The San Francisco Institute of Architecture announces the nation’s first professional certificate and Master Degree programs in Ecological Design. Enrollments are now open for the Spring 1996, semester which starts February 26. Courses include: principles of ecological deign & architecture, ecological architecture design studio, solar energy—passive & active, alternative construction methods and materials, permaculture—landscaping & waste treatment, recycling & low-cost construction, alternative lighting & thermal systems, retrofitting, healthy & toxic habitats, urban ecology. For literature contact: San Francisco Institute of Architecture Information Office, Box 749, Orinda, CA 94563, 510-299-0181, e-mail: sfia@aol.com

COLORADO

Solar Energy International (SEI) is offering “hands-on” workshops on the practical use of solar, wind, and water power. The 1996 Renewable Energy Education Program (REEP) features one and two week sessions: Solar Home Design—May 6–17; Environmental Building Technology (straw bale, adobe, rammed earth, & natural building) weekends—May & September; PV Design & Installation—May 28–June 7 & August 5–16; Advanced PV—June 10–21 & August 19–30; Solar Cooking—July 1–3; Microhydro Systems—July 8–19; and Wind Power—July 22-August 2. Experienced instructors and industry representatives teach how to build homes and RE systems. Learn in classroom, laboratory and through field work. The workshop series is for owner-builders, industry technicians, business owners, career seekers and international development workers. The small, intensive and fun workshops may be taken individually or as a comprehensive program. The cost is $450 per week. SEI is a non-profit educational organization dedicated to furthering the practical use of RE technology. Contact: SEI, PO Box 715, Carbondale, CO 81623 or call 970-963-8855, Fax 970-963-8866, e-mail—sei@solarenergy.org

Visit the new National Wind Technology Center operated by the National Renewable Energy Laboratory, just outside of Golden. Facilities assist wind turbine designers and manufacturers with development and fine-tuning and include computer modeling and test pads. Call in advance, 303-384-6900, Fax 303-384-6901.

Windpower ‘96, June 23–27, Denver, CO Contact: Linda Redmond, AWEA, 122 C St NW, Fourth Floor, Washington, DC 20001, phone 202-383-2500, fax 202-383-2505.

The US Department of Energy and its National Renewable Energy Laboratory will host the World Renewable Energy Congress IV in Denver from June 15–21, 1996. Conference topics will include photovoltaics, solar thermal, wind energy, biomass, energy efficiency, economics and institutional issues, global and regional economic development, and environmental issues. The latest in energy efficiency and renewable energy equipment will be on display. More than 200 speakers have been invited and 500 abstracts for technical papers been received. Abstracts are still being accepted. For more information contact Bob Noun, 303-275-3062; Professor Ali Sayigh 1734-611634(UK), or Steve Hauser, chairman of the technical committee 303-384-7416

IOWA

The Iowa Renewable Energy Association is sponsoring the second annual Earth Day Tour on Sunday afternoon April 28, 1996. Systems with thermal solar space heating and swimming pools, photovoltaics and wind, and energy efficient and non-toxic housing will have open houses at many locations throughout Iowa. If you have a system you would like to display please get in touch with us. For details contact Prairie Technologies Ph 319-338-0836, Fax 319-351-2338, or PO Box 2132, Iowa City, IA 52244.

MASSACHUSETTS

The Northeast Sustainable Energy Association (NESEA) of Greenfield, MA, will present the FIRST INTERNATIONAL SOLAR ELECTRIC BUILDINGS CONFERENCE, the 12th annual QUALITY BUILDING CONFERENCE and RENEW ‘96 at the Copley Plaza Hotel in Boston, MA, March 4-6, 1996.

The combined event, called BUILDING ENERGY, will include: FIRST INTERNATIONAL SOLAR ELECTRIC BUILDINGS CONFERENCE featuring the world premier of the results of the International Energy Agency’s 15-nation program in solar optimization and building integrated photovoltaics (BIPV). In BIPV,

photovoltaics displace conventional roof and wall systems, lowering cost, improving performance, and generating energy for the building and the region's power grid. Experts from around the world will discuss over 5,000 built examples, national uniform interconnection standards for PV buildings, a BIPV shopping market in Switzerland, and many other advances. 12th Annual QUALITY BUILDING CONFERENCE, the distant, early warning system for professionals in resource and energy efficient, residential & light commercial construction. Critical topics, many not yet recognized broadly, and not-yet-famous experts get heard first at the QBC.

RENEW '96, presents near term opportunities in the development and production of grid scale renewable energy in the northeastern United States in a climate of deregulation and fierce competition. Northeast Sustainable Energy Association, 50 Miles Street, Greenfield, MA 01301, phone 413-774-6051, fax 413-774-6053

NEW YORK
The New York State Electric Auto Association (NYSEAA) is dedicated to sharing current electric vehicle technology. Monthly meetings, for date and location call Joan at 716-889-9516

May 10–17, 1996, the 8th Annual American Tour de Sol Road rally championship for electric and solar cars from New York to Washington, DC. For more information: NESEA, 50 Miles St, Greenfield, MA 01301, 413-774-6051, fax 413-774-6053.

NORTH CAROLINA
SOLAR '96, National Solar Energy Conference, featuring the 25th ASES Annual Conference and the 21st National Passive Solar Conference, April 13–18, 1996, Asheville, NC. For more information contact, American Solar Energy Association, 2400 Central Ave Ste G-1, Boulder, CO 80301

Solar Energy International (SEI) is offering a special one week workshop on PV Design & Installation and a three day Microhydro Systems workshop. Both will be held in Asheville coinciding with Solar '96, the National Solar Energy Conference. The PV workshop will be held the week before Solar '96, April 8–12, and costs $450. The MIcrohydro workshop the week after, April 19–21 and costs $300.Contact: SEI, PO Box 715, Carbondale, CO 81623 or call 970-963-8855, Fax 970-963-8866, e-mail—sei@solarenergy.org

OHIO
The Great Lakes Electric Auto Association's mission is to contribute to the freeing of the US automobile market from dependency on petroleum through advancements in electric and hybrid/electric technology. For more information: Larry Dussault, GLEAA, 568 Braxton Pl E, Westerville, OH 43081-3019, 800-GLEAA-44, 614-899-6263, Fax 614-899-1717. Internet: DUSSAULT@delphi.com

Solar and wind classes taught at rural solar and wind powered home with utility back-up. Maximum of 12 students. Must advance register. $40 fee per person, $45 per couple and lunch is provided. Please advise of dietary restrictions. Class #1 will be full of technical info, system design, system sizing, and NEC compliance, etc. Students will see equipment in use. Students may also choose class #2 and set-up a system (hands-on training), equipment selection, installation of modules, mounts, controller, inverter, and battery bank.

Dates: Feb. 24, Mar. 23, Apr. 20, May 18, Jun. 15, Jul. 13, Aug. 10, Sept. 7, Oct. 5, Nov. 2, Dec. 7. All classes held from 10:00 am - 2:00 pm on Saturday. Call 419-368-4252 or write Solar Creations, 2189 SR 511 S, Perrysville, OH 44864-9537.

OREGON
University of Oregon, School of Architecture, Eco-Design Arts Conference, April 11–14, 1996, provides an opportunity for environmental designers, artists, planners, and the community at large to explore solutions that are ecologically sound, aesthetically fulfilling, and indicative of our interdependence. Three days of panels, lectures, workshops related to the creation of regenerative communities, and a professional peer "juried track" spread over four days. A call for papers will be announced soon. For more info, call or write HOPES at 503-346-0719, e-mail; hopes@gladstone.uoregon.edu

Aprovecho Research Center has three internship openings for Fall term. Interns study organic gardening, sustainable forestry and appropriate technology. Help bring in the season's crop, do some horse logging, finish testing a new solar thermal pump, desalinator, solar dehydrator, and solar refrigerator. Cost is $500 per month, includes room and board, classes 8:30 to 5:30 daily. Contact Aprovecho at 80574 Hazelton Rd., Cottage Grove, OR 97424, 503-942-8198.

TENNESSEE
Bioenergy '96, The Seventh National Bioenergy Conference, September 15–19, 1996 in Nashville, TN. (Geared toward industry and cities) Call for papers, abstract deadline March 1, 1996. For more info contact the host, Southeastern Regional Biomass Energy Program, Tennessee Valley Authority, CEB 3A, PO Box 1010, Muscle Shoals, AL 35662-1010

WASHINGTON DC
May 10–17, 1996, the 8th Annual American Tour de Sol Road rally championship for electric and solar cars from New York to Washington, DC. For more information: NESEA, 50 Miles St, Greenfield, MA 01301, 413-774-6051, fax 413-774-6053.

Sixth Annual Tour of Solar Homes on May 19th. Tour is co-sponsored by the Virginia Solar Council and the Montgomery County Sierra Club. Tour homes include PV, passive heating, solar hot water and super-insulation. House are located in MD, VA and D.C. Tickets $15 (couple) and $10 (single) are tax deductible. Order by mail or tickets are available at some local stores. Volunteers are needed. • Virginia Solar Council, 6712 S. Kings Hwy, Alexandria, VA 22306 • 703-768-3108 • berger@ssims.nci.nih.gov

WISCONSIN
The Midwest Renewable Energy Association Spring Workshop Schedule.

February 24–25: Energy Efficient Construction Techniques, Instructor: Mark Klein of Gimme Shelter Construction, Location: Amherst, WI, Cost: $200—In this workshop you will learn about residential siting and how to incorporate passive and active solar design, daylighting, hydronic heating, energy efficient and environmentally friendly building materials, and super-insulation construction methods into your design plans. March 30–31: Batteries and Inverters, Instructor: Bob-O Schultze of Electron Connection and staff member of *Home Power*, Location: Tomahawk, WI, Cost: $200—Through demonstrations you will learn about batteries and inverters including performance, characteristics, installation, and safety considerations. There will be an emphasis on the Trace 4000 watt sinewave inverter. Basic knowledge of electricity recommended. April 13–14: Photovoltaic Systems, Instructor: JIm Kerbel of Photovoltaic Systems, Location: Amherst, WI, Cost: $200—This course includes siting, design and sizing, charge controllers, batteries, inverters, wiring, and installation methods of PV systems. April 27–28: Solar Domestic Hot Water, Instructor: Chuck Gates of Altech Energy, Location: Forestville, WI, Cost: $225—Through hands-on demonstrations and an actual installation of a two panel system you will learn different types and components, siting, sizing, transfer fluids, and controllers for solar hot water systems. May 4–5: Grid-Intertie Wind Systems, Instructor: Mick Sagrillo of Lake Michigan Wind & Sun, Location: Milwaukee, WI, Cost $225—This workshop covers siting, system sizing, installation, zoning, and utility issues for utility intertie wind systems in the 3 KW to 20 KW range. There will be several site visits of working systems and equipment will be on hand for demonstrations. May 11 - A Place to Call Home: A Soulful Look at Alternative Building Techniques, Instructor: Mark Morgan, Location:Beaver Creek Nature Preserve, Fall Creek, WI, Cost $250—Explore the mental and emotional processes involved in the design and construction of an alternative/renewable eneergy home.

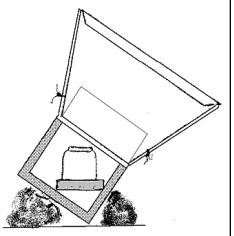
Includes classroom discussion and hands-on work with various construction techniques including straw-bale, rammed earth tire, cord wood, earth-bermed, and passive solar designs. Fee covers housing and food. MREA is a grass-roots, non-profit educational organization whose mission is to promote renewable energy and energy efficiency through education and demonstration. Membership and participation in the MREA are open and welcome to all interested individuals and organizations. Significant others may attend with you for 1/2 price. For more information call or write MREA, PO Box 249, Amherst, WI 54406; phone 715-824-5166, fax 715-824-5399

The Seventh Annual Midwest Renewable Energy Fair will be held June 21 - 23,1996, at the Portage County Fairgrounds in Amherst, Wisconsin. Contact Midwest Renewable Energy Association, PO Box 249, Amherst, WI 54406, 715-824-5166.

Get out of the kitchen and into the sun!

Heaven's Flame

a Guidebook to Solar Cookers by Joseph Radabaugh



Joseph Radabaugh's book of 96 pages with 11 photographs and 50 illustrations, provides plans to build an inexpensive, efficient solar oven from foil, glass, and cardboard boxes. Full color cover and durable binding. For under $15 (including the cost of the book) you can be cooking with the sun. Cook delicious food, save money on cooking fuels, and have more time to do the things you want to do.

Available for $10 postpaid inside USA (Mexico - Canada add $1, elsewhere outside USA add $2 S & H).
Please allow four weeks for delivery
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Need some back issues of Home Power?

If you don't know what you're missing, check out the index in HP#48. Issue 48 contains an index of articles in issues #1–#47.

You can buy them individually:
$3.25 each for #11, #13, #14, and #16 through #20
$4.75 each for #21 through #45 (except for #36)
$5.75 each for #46 through #51

Or

Deal #1: buy all 37 available issues for $116
Deal #2: buy 6 or more issues (of #21 through #50) for $4.00 each (sent bound printed matter).

for U.S. ZIP codes only, see page 81 for international back issues.

(Sorry, we're out of issues 1 through 10, #12 , #15 and #36). We are planning to compile them into a book. Until then, borrow from a friend. If you have a computer (or a friend with one) download the article you're missing by calling the Home Power bulletin board at 707-822-8640. Or check with your local library; through interlibrary loan, you can get these back issues. Jackson County Library in Oregon has all issues as does the Alfred Mann Library at Cornell Univ.)

Home Power, PO Box 520, Ashland, OR 97520 • 800-707-6585 • 916-475-0830 VISA / MC

the Wizard speaks…

ELF Protection

I've been asked about shielding against extremely low frequency (ELF) radiation. The ELF spectrum covers electromagnetic radiation from one to one hundred cycles per second. Last month I heard the following possible solution on the radio.

Take an audio white noise generator. Connect its output to a power amplifier. Connect the amplifier's output to a wire antenna enclosing the space to be protected. This sounds simple enough. Just make sure the inputs and outputs are matched for frequency and impedance.

I have NOT tried this myself. I have no idea if it really works. It may randomize the spectrum enough to decrease the ELF effects. It does, however, increase the amount of electromagnetic field energy in the affected area and may make the situation worse. It is, at least, a place to start for interested researchers.

Sundancin' in the Smokies
Solar '96
National Solar Energy Conference
Presented by American Solar Energy Society
Hosted by the North Carolina Solar Energy Association
April 13–18 1996
Grove Park Inn Resort, Ashville NC
Enhance Client Market • Stay Ahead of Competition
New Technology Demos • Professional Accreditation (LUs)
Innovative Day-Lighting Design • Software Design Aids
NEC Compliance • Active Solar Water & Space Heating
Design High Performance Solar Buildings
Special Coinciding Events
Solar Energy International
Hands-On How-To Workshops:
PV, April 8–12
Hydro, April 19-21
For more information contact:
North Carolina Solar Energy Association
850 West Morgan Street • Raleigh, NC 27603
919-832-7601

Needed: *PV Volunteers for Africa.*

Solar Energy International (SEI) is organizing volunteers trained in the design and installation of small stand-alone photovoltaic systems. This pilot program, a component of SEI's INVEST Program, provides selected volunteers with an opportunity to work with small African businesses and community groups. Participants will work under the direct supervision of Energy Alternatives Africa (EAA). The EAA is a leading African organization promoting PV rural electrification.

To support this charitable program, volunteers must make a one year commitment and be responsible for paying their travel and in-country expenses. The total amount a volunteer needs to provide for the entire in-country year is approximately $5,000. Additional funds will need to be raised by SEI and EAA to cover administrative costs.

Potential volunteers are required to successfully complete SEI's PV Training program (or equivalent) as a prerequisite. The full four weeks of intensive technical training will cost each participant an additional $1700 for workshop tuition. Volunteers have two opportunities to complete the required training this year:May 28-June 21 or August 5-August 30.

To find out more about EAA please see *Home Power Magazine* issue #41.

For background information about SEI please see *Home Power Magazine* issues @21, 31, 32, 49 & 50.

Solar Energy International
PO Box 715, Carbondale, CO 81623
970-963-8855, Fax 970-963-8866 • e-mail: sei@solarenergy.org
Homepage: http://soltice.crest.org/renewables/sei/index.html

Writing for *Home Power* Magazine

Home Power is a user's technical journal. We specialize in hands-on, practical information about small scale, renewable energy systems. We try to present technical material in an easy to understand and easy to use format. Here are some guidelines for getting your RE experiences printed in *Home Power*.

Informational Content
Please include all the details! Be specific! We are less interested in general information, than in specific information. Write from your direct experience — *Home Power* is hands-on! We like our articles to be detailed enough so that a reader can actually apply the information. Please include full access data for the makers of equipment mentioned in your article. *Home Power* readers are doers. They want access data for the devices and products you mention in your article.

Article Style and Length
Home Power articles can be between 350 and 5,000 words. Length depends what you have to say. Say it in as few words as possible. We prefer simple declarative sentences that are short (less than fifteen words) and to the point. We like the generous use of Sub-Headings to organize the information. We highly recommend writing from within an outline. Check out articles printed in Home Power. After you've studied a few, you will get the feeling of our style. Please send a double spaced, typewritten copy if possible. If not, please print.

Editing
We reserve the right to edit all articles for accuracy, length, and basic English. We will try to do the minimum editing possible. You can help by keeping your sentences short and simple. We get over three times more articles submitted than we can print. The most useful, specific, and organized get printed first.

Photographs
We can work from any photographic print, slide, or negative.

Line Art
We can work from your camera-ready art. We can also scan your art into our computers, or redraw it via computer. We usually redraw art from the author's rough sketches.

Got a Computer?
We would like your article's text on 3.5 inch computer floppy diskette if possible. This not only saves time, but also reduces typos. We use Macintosh computers. Please format all word processor files in "TEXT" format. We can also read text files on 3.5 inch IBM disks (720 KB, 800 KB, or 1.4 MB). Please format the IBM word processor files as ASCII TEXT.

You can send your article via modem to either the HPBBS at 707-822-8640 or via Internet. HPBBS address is: richard perez • Internet address is: richard.perez@homepower.org

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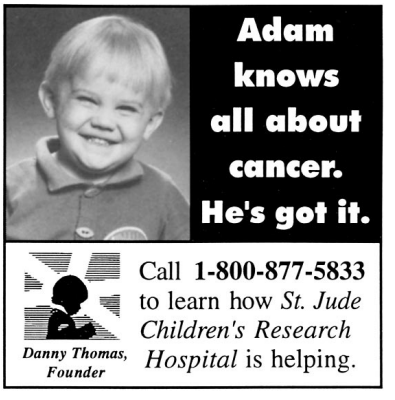
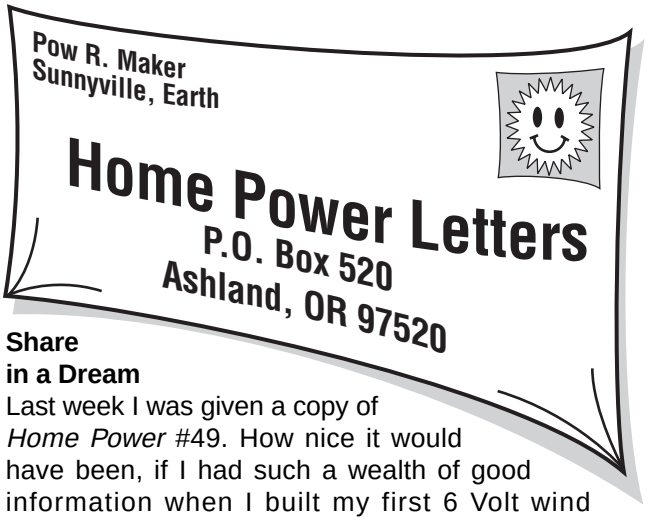
Internet Email via: richard.perez@homepower.org





Share in a Dream

Last week I was given a copy of *Home Power* #49. How nice it would have been, if I had such a wealth of good information when I built my first 6 Volt wind charger in 1934.

In 1935, a larger, more efficient one replaced the old one. We also built two small dams on streams using water wheels to charge batteries for cars and radios.

All this was done without much money, a lot of imagination, and hard work! This was done while I was home on the farm.

For over 50 years, I was a finish carpenter and a construction supervisor. I have been a member of the Carpenters Union for nearly 50 years.

During the 1970's, we built a Dutch windmill large enough to provide 12 Volt power for some lights, radio, and television, plus 36 Volts to charge the battery bank in an experimental electric car which we had as a "demonstration" for awhile.

We also constructed an "earth sheltered" house, which was easier to heat in the winter and much cooler in the summer!

In 1985 I retired, and moved to Beaver Island in Northern Lake Michigan. We bought a 10 acre plot of land, which is on the South end of the island. It is one of the best locations on the whole of Lake Michigan for using wind, waves, and sun, for being "self sufficient" for all of our needs as far as power and heat are concerned! It is an ideal location for developing "geothermal" for heat and refrigeration!

We have 750 feet of "frontage" on Lake Michigan with over a 200 degree panoramic view of the lake with wind and waves coming from the east-south-and west. We are protected by timber from the northwest, north and northeast.

I now have a problem! While I'm in good health, I'm slowly falling behind, both work wise and financially. We've put in a lot of time, effort, and money to build the house and shop, but I do not want to leave the island.

In six months, I will be 80 years old. During the last 60 years, I have acquired a lot of knowledge about alternative energy—enough to know how little I really know!

I now need help! Instead of selling out completely, would it be possible, that several others (5 or 6) with like interests would like to share this location with me?

We are looking for a select few who could contribute some money, ideas, experience, and work, to provide a unique environment in which we could enjoy the peace and seclusion of the island. We would be on the leading edge of those who are trying to make us much less dependent on electric utilities, oil supplies, etc....

I would be willing to deed the property to whatever this group would decide its final organization would be and would stay as long as I live. If interested, write to Elwood Van Antwerp, 17367 6th St, Arcadia, Michigan 49613, 616-889-6177. After April 15, 1996: Elwood Van Antwerp, PO Box 251, Beaver Island, Michigan 49782, 616-448-2227.

How about it readers, anyone want to take Elwood up on this offer? What an excellent opportunity for a non-profit organization to demonstrate the good life to the rest of the world! The Crew.

Ghana, West Africa

I just received my June/July 1995 issue and regretfully realized it was my last one. I moved overseas and did not receive the last few issues prior to June/July (no fault of yours). I have enjoyed *Home Power* immensely and feel the staff is doing a great job. One way or another I want to continue receiving *Home Power*.

I feel compelled to comment on one point you made in the June/July issue. On page 100 you suggested ethylene glycol is relatively safe. I guess relative is a vague term, and therefore somewhat accurate, but I still disagree. Ethylene glycol is one of the more dangerous poisons commonly found around the home. Seven cc's (approximately 0.25 of an ounce) is considered toxic to a 70 kg man if ingested, and the same amount can very effectively kill a a small child.

On to more fun topics. My wife and I moved to a rural village of 40 people in Ghana, West Africa about one year ago. We are volunteering our services as a pediatric nurse and a family physician. We built and operate a small health post, and are pursing various rural development projects. We started with nothing, but after months of a tough fight, we are finally getting settled in. Our house and clinic are powered by photovoltaic panels. Unfortunately, people from a "warring" village stole all the batteries for our main system and the batteries for small hut systems. We are

presently using three marine deep cycle batteries and only three of our seven panels. We hope to receive replacement batteries from the U.S. within a month. Our downgraded system is a joy compared to the 12 Watt portable system we used for the first nine months.

I built a solar box oven and am waiting for the rainy season to end before demonstrating it to the villagers. I am not sure how well it will be accepted given that most of their cooking is frying, not baking. So far they have remained hesitant to try new things. Do you know of any simple plans for building a parabolic cooker? That might be better accepted.

When replacement batteries arrive, I want to install one or two small "hut" light systems on a trial basis. At least from my perspective, I think having light a night is desirable. So far, the only interest shown was a man from a neighboring village who wants to run a television set so he can watch soccer matches. Apparently my priorities are not the same as others. Another question I have that you or other HP staff may be able to answer is information about solar food dryers? I ordered a book on the topic almost a year ago from Intermediate Technology Publications, but have not received it. I understand the topic has been addressed in previous issues of *Home Power*. Maybe you can direct me to references I can obtain.

Enclosed is a check for another year's subscription to *Home Power*. It is too valuable a resource to do without. Please send the magazine to my US address. Postal delivery is a problem for me in Ghana.

Douglas Stockman MD, N2ZYE, 9G5DS, Adidome, Volta Region, Ghana, West Africa

Hi Douglas, Wow, what a glaring error! Propylene glycol is the anti-freeze commonly used in various household systems. Warning, ethylene glycol should NOT be used in any situation where ingestion is even a remote possibility. Even automotive anti-freezes are being switched to propylene glycol. The poisoning of wildlife and children is a serious problem with ethylene glycol in the form of dumped automotive radiator coolant (yet another reason to use an EV.) Michael W.

Be on the lookout for issues 29, 30 31, 37 & 43. Issues 29 & 30 have information on solar drying, and issues 31 & 37 have instructions for simple parabolic cookers. Karen

RE Politician

My name is Jim Bell and I'm running for Mayor of the City of San Diego (California). If I'm elected one of my primary focuses will be to develop our region's renewable energy resources. If aggressively pursued, developing renewable resources in our region would amount to $1 to $2 billion of investment in renewable energy technologies.

But for this to happen, I have to be elected, and to get elected I need support. If you'd like to help, please contact me.

Jim Bell, Jim Bell for Mayor Committee, 2923 E. Spruce St., San Diego, CA 92104, 619-281-1447

Thanks for letting us know, Jim. The crew wishes we lived in your neck of the woods so we could vote for you. Hey, readers, let's give this good guy our support!

An Uphill Battle

We just recently got a chance to see your February/March 1995 issue of *Home Power* and enjoyed Allart Ligtenberg's article "Solar Cooking in Nepal" and in spite of the long delay, thought we would write. The Wisdom Light Group, the only manufacturer of photovoltaic modules and related hardware in Nepal, can fully appreciate the uphill battle (no pun intended) that Allart faced in spreading his technology "because of poverty, cultural and geographical barriers, different languages, and ethnic groups."

The difficulties that Wisdom Light faces are compounded because of the increased complexity of its technology, the isolation of the people from the concept of "electricity" and the disbelief that electricity can be converted directly from sunlight. We are also faced with the problem that many in the position to buy or fund photovoltaics have come to believe PV systems are unreliable and thus not suited to the remoteness of Nepal. This belief is prompted by persons who have used PV systems that not properly set-up. In spite of negative response in high places we have been able to provide smoke-free lighting to a number of homes.

We enjoy your publication. Keep up the good work.

P.S. We are continually in need of a directory of manufacturers of DC powered equipment that lists company names, contact persons, and other information such as size, shipping weight, power consumption, input voltage, and price. Is such a document published? It certainly would be a helpful tool for companies in remote parts of the world like ours who are trying to promote the use of solar electricity.

Heshey Phunjok, Managing Director, Wisdom Light Group (P) Ltd®, PO Box 6921, Dunbar Marg, Kathmandu, Nepal, 977-1-230973, Fax 977-1-228696

Hi, Heshey. Two publications come to mind, but I think it will be difficult to come up with some of the details you are looking for in any similar publications. The World Directory of Renewable Energy Suppliers and Services, 1995 (ISBN# 1-873936-40-0) is an excellent

Above: The aftermath of Hurricane Luis at Frank Delisle's place in Antigua. Note some of the batteries still standing. The modules are somewhere under the mess fallen onto the beach. They survived intact.

reference for companies and organizations you could work with. It is published by James & James Science Publishers, Waterside House, 47 Kentish Town Road, London NW1 8NZ, UK. Another very helpful directory is Paul Wilkins' PV Network News, as well as his binder, Off the Shelf. He can be reached at 2303 Cedros Circle, Santa Fe, New Mexico, 87505, USA.

Not So Fragile

I read something in a recent *Home Power* about the ability of solar panels to stand up to abuse. I can give you some information which may be of interest.

Hurricane Luis completely destroyed my home by the sea on the island of Barbuda. I lost almost everything: Bergey 1500 wind plant, diesel generator, two sets of batteries. But not the solar panels! I had twenty panels mounted on the roof. The whole building lost its foundations and toppled onto the beach and sea—but I was able to salvage all 20 panels, intact!

These panels, 20 of them, were subjected to winds of 207 miles per hour (as measured by a US Air Force Hercules C130 which flew through the eye of the hurricane and out thru the wall right over the island of Barbuda on which I live).

Tell me what greater punishment one could think of for these "fragile" power generators?

P.S. I was (fortunately) not on the island at the time of the hurricane.

Frank Delisle, Carib Aviation, Antigua, West Indies

We are sorry to hear of the destruction of your home, Frank. While the fact that your PV modules survived is great, it is small consolation for what you lost.

Not Surviving

In October's Q & A you asked for "tales about what kind of weather your PVs have survived." I have a tale of their not surviving: in 1994 in Virginia we had the Mother of All Ice Storms, in which rain froze on trees to a thickness of three inches. This broke limbs and toppled trees, and one of these hit and smashed a solar panel. Surprisingly, it still produces electricity at 12 Volts—but the amperage is too low to register on my cheap amp meter.

Greg Arens, Springfield, OH

While PV modules are pretty tough, they are not indestructible. The most common hazards are falling obstacles (like trees and buildings), baseballs, and idiots with firearms. Richard

Brake Help

In your December/January issue, Rich Meyer asked for help in repairing a rear wheel brake cylinder on a

Commuta-car EV. Nu-Kar Electric Vehicles, 710 Highway 57, Collierville, TN 38017, has rear wheel brake cylinder repair kits for this vehicle. Their phone number is 1-800-598-6904.

Eric Lund, Marco Island, Florida

Thanks, Eric, for proving that, collectively, our readers know everything!

More Brake Help

In reference to Your letter [Rich Meyer] asking for help locating a rear wheel brake cylinder which was run in *Home Power* #50, December '95/January '96, my first advise may be something which you have already tried. Most automotive brake systems are made by Bendix or Lockheed, thus parts are available in a vast assortment of standard configurations right from your local parts dealer and his catalogues. Generally, if you know the cylinder bore and stroke you can go into the proper section of a catalog and locate a specific cylinder by picture. Using this method I was recently able to locate rear wheel cylinders for a 1968 International Harvester 10 yard dump truck. These are quite rare, both because of age and because trucks of this size usually have air brakes rather than hydraulic.

There is the possibility that your brake cylinder is not any form of standard automotive. It may be manufactured by a supplier of small machinery parts such as garden tractors. These are harder to duplicate but Thomas Register in any well equipped library will list manufacturers of brakes for many purposes and you might be able to match it that way.

Then, in the order of ascending difficulty, there is the solution of using standard brake replacement parts to rebuild the inside of your cylinder or replace it with one of similar, but not exact configuration. It is possible to either line the inside of your cylinder or have it plated with chrome or copper to bring the bore out to standard. To do this you must bore it our oversize on a lathe, then either press in a cylindrical sleeve or find a hardchrome shop to plate it back up to less than standard size. The sleeve or the chrome is then machined back out to standard size. This assumes that the rest of the cylinder, including the bleeder screw, is OK. If not, then a similar sized cylinder might be found with a different mounting or a different mounting hole pattern. The back plate could be welded up and redrilled to match the new cylinder or the cylinder mounting could be turned on a lathe to fit the back plate.

The back plates are particularly holy. They tend to be fairly standard in configuration. It is possible to replace the whole center of one by machining out the old center and welding in a new one; by finding a replacement of the same diameter in a junk yard and using the whole brake assembly; or by changing the entire brake and drum to one of a more common availability.This is done routinely in hot rodding. Any good automotive machinist should be able to help you get from where you are to where you want to be.

Clifford W. Mossberg, Kasilof, Alaska

Cool

I'm a recent reader who's planning an alternate energy house next year here in Northern California. Each HP issue gives me something new to consider or maybe to confirm or deny a previous bit of research on solar application, hydro, etc.

However, one area I've not seen covered is alternate means of cooling, specifically thermosyphoning (or what I've heard called the "chimney effect").

Outside air is drawn into a buried pipe/culvert and uses the colder ground temperature to cool the air. The pipe, with the inlet end being down slope from the house, leads to the foundation and is vented in to a duct. The house has exhaust vents hig up convection creates a natural outflow.

Has *Home Power* covered this in the past or do any readers have experience with this kind of system? I'm looking for anything that will help me calculate pipe sizes and lengths, cooling capacity in cubic feet per minute, any pitfalls, and the like. I've used heating and cooling equations from engineering handbooks, but being an amateur (another word for ignorant), I'm not sure how accurate my results are. (A 12 inch culvert could lower temperature about 10° over in 100 feet?)

We hope to pair this kind of cooling system with a solar/infloor heating system. Our site in Lake County is very rural, with dry summers, good sun insolation and temperature highs in the mid-to-high 90°s and cool nights. We have a natural slope of around 15% that we can use for the height differential. Any light you or readers can shed on this will be of great help.

Tom Cammarata, Calistoga, California, cammarata@aol.com

Hi Tom, In issue #40 (April/May 1994) there is an article on about a home in Australia that uses thermal convection for cooling. In issue #41 there's an article about cool towers. Maybe some HP readers might have other suggestions?

DSS TV

I always enjoy your magazine but especially liked the article on DSS by John Wiles in issue #49. Your readers may like to know that DAMARK, a company in Minneapolis (800-827-6767), offers this equipment at

significant discount from list price. To get details of the programming packages DAMARK offers for DSS (from DirecTV and USSB) you can call 800-688-4579 (love those 800 numbers). They also offer a 30 day satisfaction guarantee. I hope this information might save your readers some hard-earned bucks.

I'd also like to strongly recommend a couple of books by Robert O. Becker, MD, who has done extensive research on the electrical nature of life. One is "The Body Electric" and the second is "Cross Currents: the Perils of Electropollution, the Promise of Electromedicine", which deals extensively with the deleterious effects that 60 Hz electric fields likely have on the human body. Makes me want more than ever to join those of you living off-grid in God's beautiful pines.

To Phillip Carroll (Q&A, HP#49) and others who are concerned about security: you might want to check out Heath/Zenith's X-10 security devices (also sold by Radio Shack as their Plug n'Power line of devices). I bought an extensive set from DAMARK in Nov "93 for $300, item B-4331-356207. While it's meant for 110 vac usage, all of the motion detectors, door sensors, and remote controls operate off of 9 Volt batteries. The control center (which receives signals transmitted from the sensors, tells you when and which sensors' batteries are low and includes a load alarm) has a 9 Volt back-up which will power the alarm. Why not step down your 12V to 9V and run it off that full time? They even have a module that will dial four different phone numbers and give a message that you record, But I don't know if it has a battery back-up. Worth investigating, I think.

Best of luck and life to all of you who live easy on the earth.

Patrick E. Gannon, 6400 Fruitridge Rd, Sacramento, California 95820

Hi Patrick, and thanks for the wealth of information.

An Old Dometic Fridge

I've been a subscriber for several years and always enjoy the news. This is the first time I've had a question I hope you can help with.

I'm getting ready, in a low rent way, to move off-the-grid. My finances are, alas, in the $100 at a time range. I've been donated an old Dometic fridge. It is gas/electric. I don't expect much, but this isn't working at all. When plugged into the electric it gurgles and burps. The heating element gets quite hot, but no discernible cooling takes place.

My question is: where can I get a shop manual or some form of info on diagnosis? I realize that the useful life of this fridge may be over, but I would like to be able to assess any fridge I might buy. At the least I would like to find out if such can be worked on by me.

I'm not totally unqualified as I have spent a few years working on auto air conditioning. I quit with the new regs. I ordered books on absorption refrigeration from my local library, but they describe things like how to cool the nuclear core at Chernobyl. Interesting, but not helpful.

I checked your index, but didn't see anything hands-on for this sort of refrigeration.

I will appreciate your input.

Susan Pettijohn, Meadview, Arizona

Hey, Susan. The problem may be due to transporting the gas fridge. We've seen this occur when the fridge is turned on its side for loading into a truck, or bounced around in a truck. The first thing to try is turning the fridge upside down and letting it sit for 24 hours. Then turn it back upright and wait another 24 hours. This has worked with many gas fridges. If not, you might try contacting Jeff 's Gas Appliances, 549 Central St., Willits, CA 95490, 707-459-5223. He's an HP advertiser and I've always found him to be very helpful. Michael W.

Sympathetic

We use cardboard boxes for shipping product out of the company for which I work. I have witnessed the price of corrugated increase at least four times in 1995. Corrugated is a paper product and the basic material from which many boxes are made, including ours. Because of my firsthand experience with rising tree-pulp product prices (say that fast ten times) I can sympathize with your need to raise the price per issue of *Home Power Magazine*. Whereas many readers possibly cannot.

I am a newcomer to the renewable energy market and quite frankly am not aware of another publication so devoted to all aspects of it and which includes readers' experiences as regularly featured articles. "Learning from each other", I think you wrote recently. I'm on a budget just now and you've been very helpful with my pursuit of joining the RE community, even within my limited means. Articles on smaller systems and ones noting ingenious applications have been especially useful. I find *Homebrew*, *Code Corner* and *Things That Work!* valuable. I read each issue from cover to cover and it's all interesting and enjoyable most of the time.

I knew nothing of RE before, but I'm learning, due to HP Magazine. Thanks for all you do, I salute the *Home Power* Crew.

Jim Wirth, Carlsbad, California

Thanks for the flowers, Jim. And double thanks for understanding about paper costs. We will keep the articles on smaller, less expensive, systems coming! Richard

Just Say No
Your article "Just Say No" in #48 was really good with picture.

We had so much stray voltage—current coming back onto our place from the power company neutral on the open, multi-grounded system, we just had to "Say No", to their electricity, and how nice it is to have our own. We have solar panels and batteries and have all the lights and TV we will ever need for as long as we live. Thanks for all the help, *Home Power*.

Have any other readers had trouble with stray voltage?

Dwight Gallatin, McCook, Nebraska

Warning
Received the back issues I ordered, they have been devoured like all the rest. Issue #49 was late getting to the only newsstand I have found which carries it (Border's at Pentagon City, Arlington, Virginia). After eight trips to look for my "fix", I decided I must subscribe. Your magazine should come with a Surgeon General's warning—It's addictive! My neighbor is now over here regularly attempting to bum my copies and RE catalogs. Not only is it addictive, it's contagious.

Timothy Thorpe, Arlington, Virginia

Hi, Timothy, another "patient" catches the RE "bug."

Better Educated
You've heard it all. HP is just a great resource. I tell my customers about it because an RE educated customer makes for a happy dealer. I'd much rather compete with West Coast prices than replace owner-abused or "gee, I didn't know it would look like that" incorrectly ordered products. Keep up the good work! I'll be sad if I ever read that you've sold out to Rodale, etc.

Highbush Solar, RR 1 Box 1572, Dixmont, Maine

Where Are They?
I enjoy your magazine. I just recently purchased a used set of hot water collectors made by Solar Resources International. Are they still in business? Do you have a current address and phone number? They were at 1735 E Indian School Rd, Phoenix, Arizona. I need some repair parts.

Allen Bruggink, West Bend, Wisconsin

Hello, Allen. We checked our databases and came up blank for an address or phone number for SRI. How about it, readers?

Battery Recycling
First and foremost, thank you for providing the best magazine anywhere. It is the only publication I can read from cover to cover without getting bored. I have always believed in alternative energy sources (especially RE) since I was very young.

Recently, in issues #48 & #49, you touched on lead-acid batteries and lead recycling. You presented the lead recycling business in a very positive light, and I am sure most new facilities operate in a similar fashion. However, it is my suspicion that most existing lead recycling facilities do not operate in a safe and healthy manner. Included is an article taken from the Indianapolis Star, Friday October 20, 1995. This article shows how some facilities do not follow rules, and there must be many, many others like it around the globe. I encourage other readers to collect information about such lead recycling plants, and stand up and speak out.

We as *Home Power* members must take it upon ourselves to police and govern the industries associated with our lifestyle. If we do not, we flirt with the certainty of disaster. It only takes a few irresponsible companies to give the whole idea a bad image in the eyes of the public. We are already up against enough, we do not need to fuel our opponents from within. This is not difficult to do. It is as easy as writing letters, making phone calls, or personal visits to companies, newspapers, television, citizen groups, and congressional people. It does not take a huge segment of the population to bring about change. For example, the crime bill that affects me and 4.4 million other men and women incarcerated in prisons, jails, on probation, or parole, or some form of supervision was authored by a special interest police organization of less than eleven thousand members.

If we do not take action now to ensure the safety of the industries which produce the products, materials, and services we depend on for our way of life, they will become our downfall. By complacent tacitness we fight the hand to hand battle for the CEO's who sit in the boardrooms of oil companies, nuclear power companies, and coal-powered electric companies everywhere.

In closing I would like to thank you once again for the best magazine around. Keep up the good work, and especially articles on the basics for numbskulls like me.

Tobias Konnersman #923069, PO Box 601, Pendleton, IN 46064

Well said, Tobias. We must continue keeping battery and other RE related businesses on the right track.

You Can't Beat That!
We are new subscribers to *Home Power*. Our dream seems to be not uncommon—work hard, save money, buy property out in the boonies of the Pacific Northwest, build a comfy cabin of our own design and our own hard work and creativity, and live a relatively simple life free of the stresses and strains of city life. It will be some time before it is realized, however, and we are studying and learning the skills in the meantime that will be necessary to fulfill our dream. A friend turned us on to *Home Power* and it has been a valuable resource in only a few issues. In the first issue we received we were fortunate enough to see advertised a one day workshop that was offered by Offline Independent Energy Systems, based in the tiny town of North Fork, California, in the central Sierras, near Yosemite (at the center of California!). We phoned immediately, signed up, and attended the workshop on October 21. The workshop proved to be an experience that was everything we had hoped for. Don and Cynthia Loweburg were friendly hosts and excellent teachers, who crammed more useful information in an eight hour day than you would think possible for the 20 some individuals that attended. Our previous experience with the concept of solar energy systems was limited, but because of Don and Cynthia, the material presented was relatively easy to understand and not overwhelming. The attendees were all different sorts of people with varying levels of knowledge, but everyone seemed to enjoy themselves and get a lot out of the day. The atmosphere was relaxed and friendly, and focused on sharing experiences and information. The workshop was held at their home/office which is, as you might assume, off-the-grid, and a couple of miles from the nearest paved road, power line, and phone line. The cost was low and the benefits high. You can't beat that! As we were driving away we knew we needed to share our positive experience with other *Home Power* readers, and encourage them to watch for announcements of future workshops and consider attending one (they offer several a year). In the meantime, we will look forward to the future issues of *Home Power*. Thanks for a great magazine!

Marianne Williams and Stephen Buckner, San Leandro, California

Thanks for the info, Marianne and Stephen. The Loweburgs are wonderful and capable RE people.

Building Energy
Something totally unexpected and wonderful has happened here at the Northeast Sustainable Energy Association (NESEA), so I have to tell our kindred spirits at *Home Power*. The good news? Without publicity, an international group has created more than 5000 photovoltaic (PV) powered buildings, including many in which the PV systems are integrated into the building skin. Building integrated PV displaces conventional roof or wall systems at significant cost savings over add on systems. They have also established national uniform interconnection standards, created a PV integration "shopping market" in Switzerland, and made many other advances. The better news? NESEA has been asked to organize the 1st International Solar Electric Buildings Conference as a world premier to showcase these advances.

How come very few people in the RE field know about this huge project? Steven Strong of Solar Design Associates, the USA representative to the group said simply, "We have been pushing further ahead instead of promoting [our advances]." Now the wraps have come off. NESEA will host a March 4–6, 1996 conference in Boston, Massachusetts called Building Energy featuring three conferences, the 1st International Solar Electric Buildings Conference, RENEW '96, and the 1996 Quality Building Conference.

RENEW '96 will focus on near term prospects for the widespread acceptance of both distributed and grid scale renewable energy in the northeastern United States. The Quality Building Conference has been described as "the distant, early warning system for leading edge, environmentally aware practitioners from the building sector."

There, I got it out. I hope my excitement and enthusiasm has touched you all and some of my fellow readers will contact us for information and attend Building Energy. Thanks for the great work you do! It makes all of us here at NESEA feel better in those times when we feel as if we are swimming against the tide.

Cheers, Paul Lipke, Building Energy Conference Info., Northeast Sustainable Energy Association, 50 Miles Street, Greenfield, MA 01301, 413-774-6051, fax 413-774-6053

Q&A

Small Batteries
Several questions about small batteries (D, C, AA and AAA).

1. How do the new Renewal alkaline cells differ from regular alkaline other than having longer (and narrower?) nipple tips?

2. Other than the special battery contact electrodes, how do these new Renewal battery chargers differ from other chargers?

3. If I could bypass the nipple-tip specific electrodes, what would be the effect of the Renewal charger on NiCds?

4. Can standard alkaline and regular cells be recharged? When I was young, several people claimed this to be true, but when I used a wall plug-in NiCd charger and forgot about it until several days later, I discovered a leaking battery and a black non-removable stain on the hard wood floor (it was emphatically suggested that I give up further such experiments). Last night I put a regular cell (non-alkaline) in a NiCd charger and monitored it carefully; it did seem to renew the voltage level. What should I expect in use?

5. It's recommended to fully discharge NiCds before recharging to avoid memory effect. Can they be over discharged?

6. How can NiCds be stored for long durations: charged, fully discharged, frozen, etc.?

Thanks to all of you folks there for the fine on-going work. And thanks to you [Richard], I appreciated the lead-acid battery workshop at Arcata's Renewable Energy Fair last spring!

Hugh Tinling, Salyer, California

Hello Hugh, here are some answers to your cell questions. For a complete article about the performance of the Renewal and other rechargeable cells, see HP#41, page 89.

1. Technically, the Renewal cells are alkaline cells just like NiCds, nickel metal hydride (NiMH) cells, and disposable alkaline cells. The Renewable is actually a souped-up version of the regular disposable alkaline cells. The Renewal is designed to take about ten full discharges and about 25 partial discharges before being discarded. NiCds and NiMH will last between 500 and 1000 deep cycles before wearing out. The major advantage of the Renewal cells is a slightly higher initial discharge voltage than NiCds and about two times the Ampere-hour capacity of the Nicads. The different nipple tips keeps the Renewal cells from being recharged in NiCd or NiMH chargers.

2 & 3. The Renewal charger is designed to recharge only Renewal cells. While you can bypass the special contacts, the charger will deliver poor performance into NiCd or NiMH cells. The voltage cutoff and charge current are too low for NiCd and NiMH cells.

4. Both disposable alkaline and regular flashlight cells (zinc-carbon) can be somewhat recharged. But as you found out, they cannot be over charged without damage. These cells are not designed to be recharged. Their cell cases are not up to coping with the internal pressures generated by recharging. If you insist on recharging disposable cells, then do it at very low charge rates (less than C/50) and do it before the cells are totally discharged. Be sure to terminate the recharge before the cell reaches 2 Volts so that the cell is not overcharged.

5. The memory effect occurs only in small NiCd cells (sintered plate types). While a single cell cannot be damaged by over discharge, a battery (series collection of cells) can be damaged. If there is a series circuit of cells (a battery), then it is probable that at least one cell in the series string will be reverse polarized by totally discharging the battery. Our experience is that if a NiCd cell is reverse polarized, then it permanently loses some of its capacity. The proper treatment for NiCd batteries (such as the sealed units that power cordless drills) is to run the tool until the battery shows signs of failing. Don't do something like put a rubber band around the trigger of your drill and let it run until the motor stops. This is guaranteed to reverse polarize at least one cell in the battery. Simply use the device until it grows weak or dim, then recharge the battery. This type of cycling will eliminate memory effect and also prevent reverse polarization of the cells in the battery.

6. The best way to store NiCd cells is discharged and at room temperature. Since the NiCd cells will discharge itself in about three months, there is no point to recharging the cell for long term storage. Richard Perez

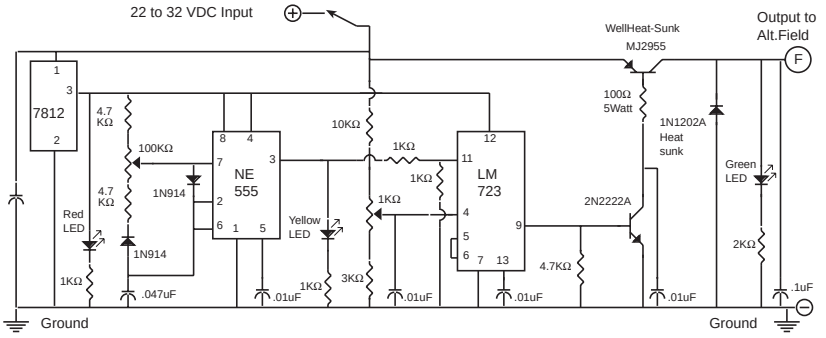
Electronic Field Controller
In HP issue #42, page 31 you listed a schematic for an electronic field controller, version 8.3.

I built a controller and it performs great. I do not have a clue as to how it works except, as we all know, "electricity is magic."

I'm in the process of up-grading my RE system and plan on changing my battery bank from 12 V to 24 V. Is there any way to modify the controller to work with the 24 V battery bank? Any help would be greatly appreciated. Thank you for a great ,magazine, I love the format with continuous, uninterrupted articles.

Len Lemanek, Newberry, Michigan

Hi Len, it's good to hear that you have the homebrew controller up and running. You can make several simple modifications and your 12 Volt electronic field controller will work on your 24 VDC system. Here's the skiz. See HP#22, page 74 for a complete article. Richard Perez



Field Controller

I am building your electronic field controller, version 8.3. Do you have any notes or advise on setting it up and determining the pot settings?

Ken Brostrom, Mercer Island, Washington

There are two settings on this device, Ken. Set the amperage control for whatever current you desire (usually about C/20 into the battery) or until your engine bogs down under load. Set the voltage control so that it regulates at about 15 VDC in 12 Volt systems and about 30 VDC in 24 Volt systems. Both controls should be adjusted with the engine/generator running and recharging the battery. Richard Perez

Water or Electrolyte

Home Power keeps getting better, and more than ever I check out the advertising to find what I need. My large battery bank is showing signs of age. Should I add electrolyte instead of water when I refill? I enjoy reading all of Michael Hackleman's articles. He's great.

Walker Johnson, Santa Barbara, California

Hello Walker. You should keep on adding water. The only time to add acid to the cells is if the cells have spilled and electrolyte has been lost. Try giving your cells a series of equalizing charges. If this doesn't restore their lost capacity, then try an electronic pulse unit (like the DuraPulse). If that doesn't work, then try EDTA (see HP#20 and 21, and HP#47) treatment. If that doesn't work, then replace the battery. Richard Perez

Helio-Gram

February / March 1996

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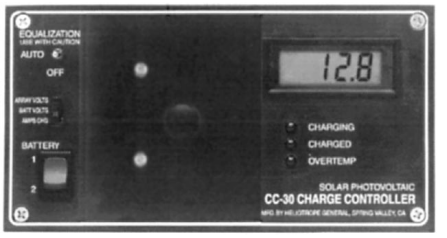

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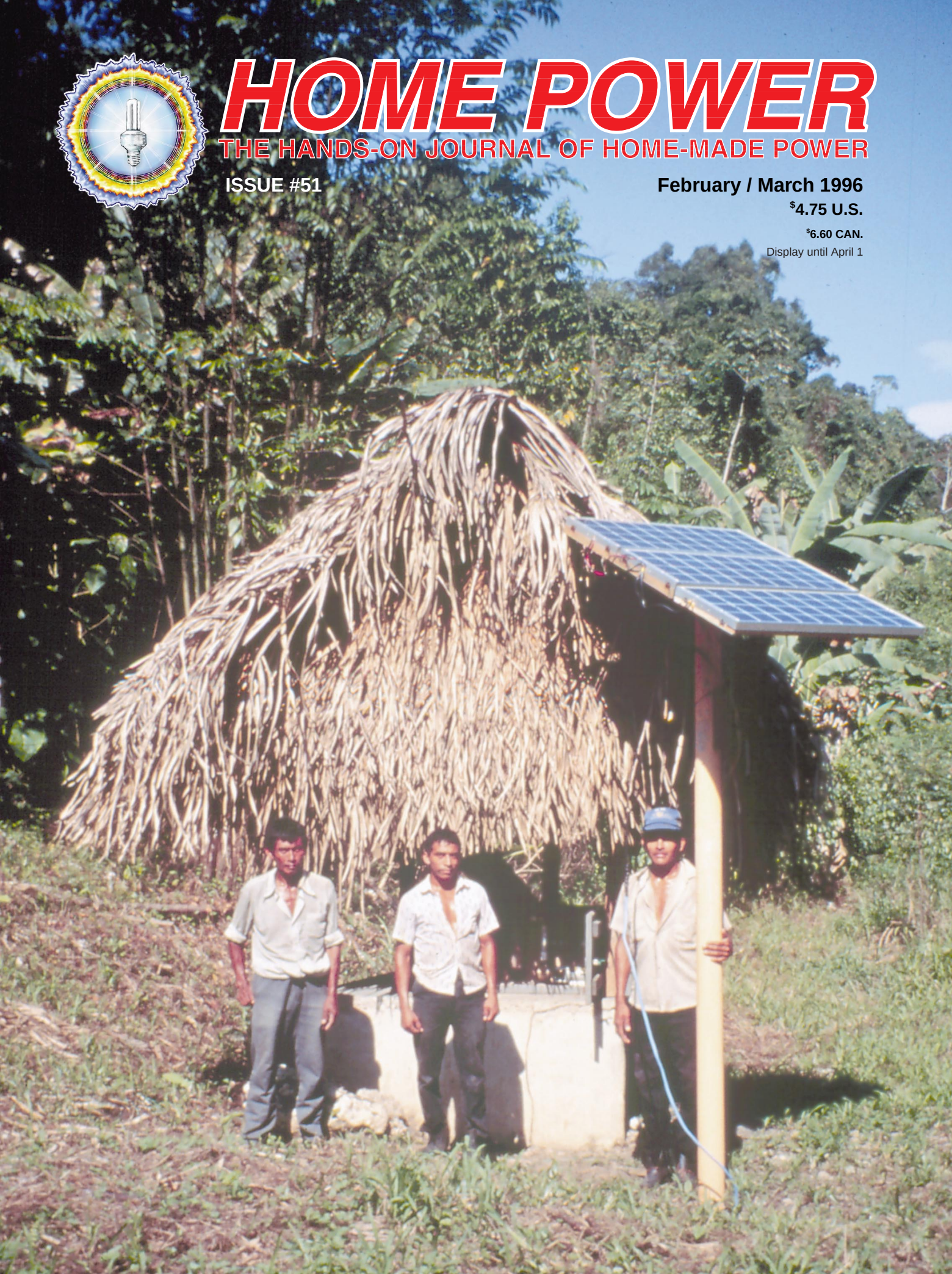

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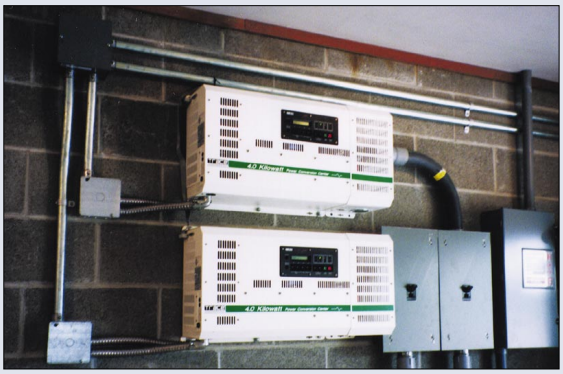

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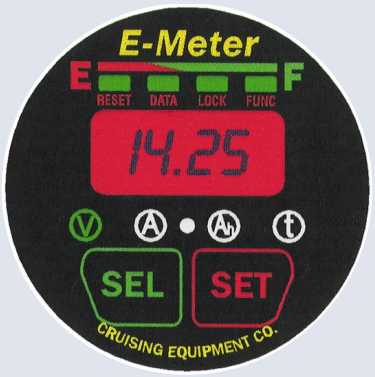

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