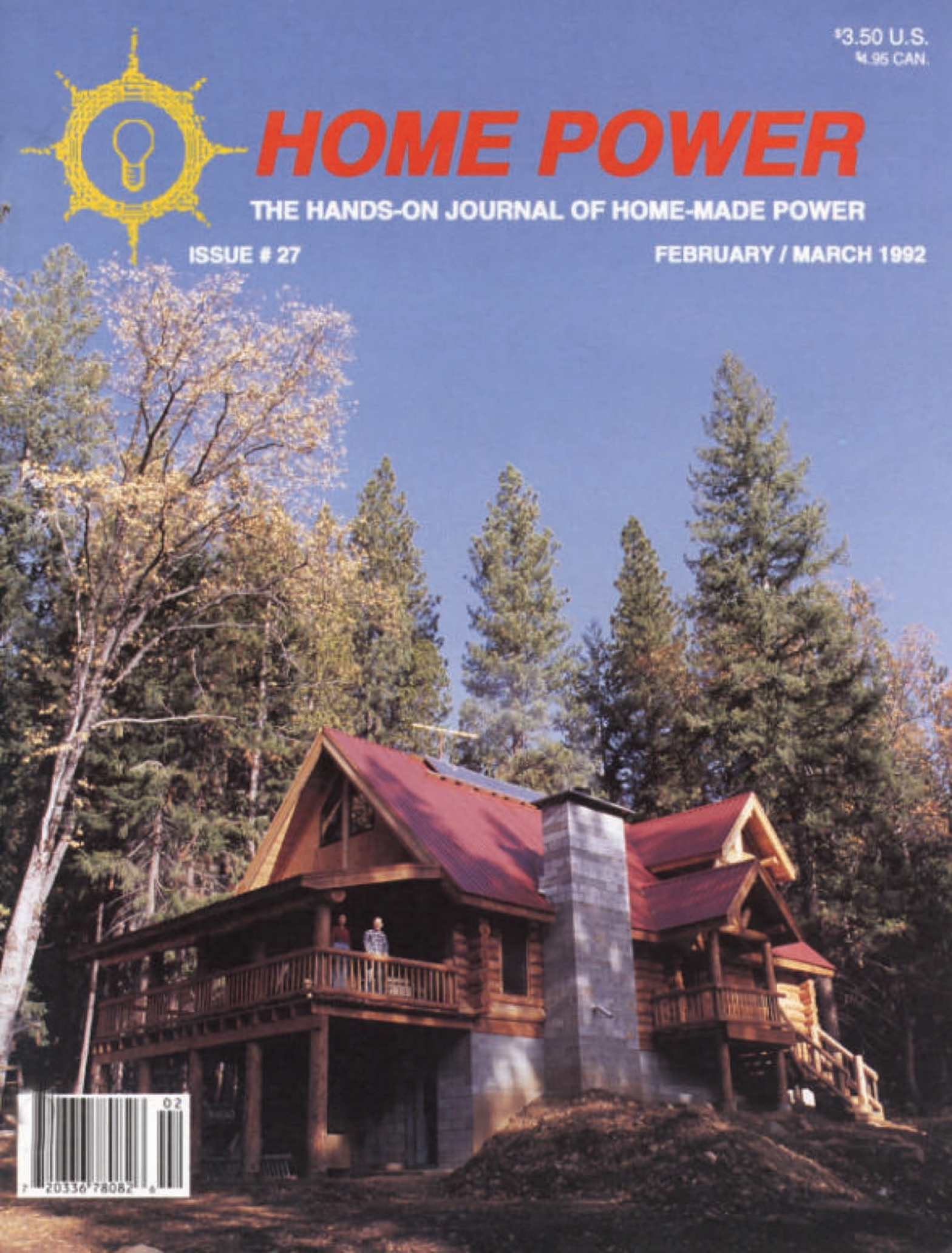
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ISSUE # 27
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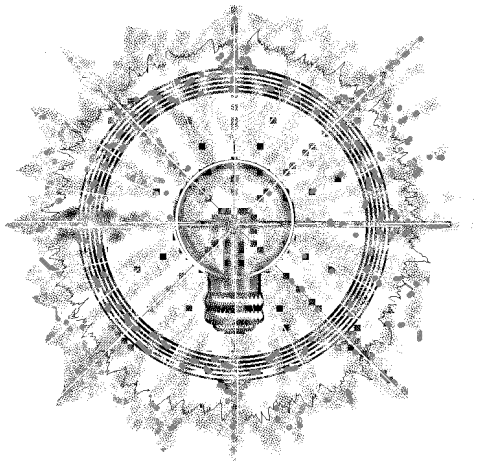

HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

Contents

Access

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

Think About It

"Safe upon the soild rock the ugly houses stand:
Come and see my shining palace built upon the sand!"

Edna St. Vincent Millay
1892 - 1950

Cover

Rook's Castle, a solar-powered, owner-built, log home with Mike and Waldi Rook on the porch. Story on page 6.

Photo by Richard Perez.

From us to YOU

Better safe than…

There is nothing like having something dear threatened to make one aware of the essentially risky nature of being alive. We work hard to make everything perfect; to make everything safe. Sometimes no matter what we do, things go wrong.

We have been living with our renewable energy system for over twenty years now. It is a good friend that has grown with us over these years. We were good enough friends that I invited it into our home. For years, our batteries have lived under my electronics workbench in our main room. Last December, one of our lead-acid cells exploded and disgorged acid all over the floor (gory details on page 69). While no one was hurt, I discovered that my friend had teeth!

It is much easier to be aware of safety after a good scare. Home power systems are growing in size and power. With their growth must come increased awareness of safety. To this end, you will find articles in this issue dealing with system safety. From overcurrent protection to battery containment, we must make safety our number one priority.

We have constructed a new battery room where the cells are safely contained away from our family. We are installing new wiring, circuit breakers, conduit, and fused disconnects. We've gotten a good scare and a good lesson. We are ready to give our system the respect it deserves.

Please join us at Home Power in a New Year's resolution. Let's make our renewable energy systems safer than ever. Build that battery shed and get the cells out of the house. Install those disconnects, circuit breakers, or fuses. Give the old system a rewire job, put the wiring in conduit and NEC approved metal enclosures. Become aware that the same system that runs the lights can also burn down the house. Better safe than…

Richard

People

Sam Coleman
David W. Doty
Michael S. Elliston
Christoper Frietas
Kris Holstrom
Kathleen Jarschke-Schultze
Kid's Corner Kids
Stan Krute
Don Kulha
Tom Lane
Therese Peffer
Karen Perez
Richard Perez
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Bob–O Schultze
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Electron
Connection
Full page

Above: Mike and Waldi Rook's owner-built, solar-powered log home. Photo by Richard Perez.

Rook's Castle

Bob-O Schultze – KG6MM

During winter in the Scott Valley of Northern California, the majestic mountains are the first things you notice. The valley is completely ringed with snow-dusted hills and peaks. In summer, this valley produces some of the best alfalfa grown anywhere on the West Coast, and the sweet smell of newly mown hay fills the air. But now, the brown fields and idle mowing machinery seem to be resting, as is the land, waiting for the rebirthing process of Spring.

The Scott Valley

The Scott Valley is still very rooted in agriculture and natural ways. People wave to each other as they drive by. Perhaps that's why folks looking to relocate from the city or densely populated areas are drawn here like magnets. They are drawn to the clean air and the promise of days and weeks that go by just a little more slowly.

Residents zealously guard their lifestyle – as well they should. Land use policies for the valley floor are designed to keep farming as the primary use. Areas above the valley floor in the surrounding foothills, however, aren't as well suited for farming. The roads are a little bumpier, and services like the local power grid are harder to come by. Mike and Waldi Rook decided to build their dream home here, at 4000 feet elevation on a southern facing hillside above the Scott River.

Meet Mike and Waldi

Mike and Waldi Rook left Merced, California seeking a home in a less populated and more natural environment. They drove to Calgary Canada and as far as Wyoming and eventually settled in the Scott Valley. Their process of

moving to the country took five years from the time they made their decision to move. They knew from the very beginning that their new home would not be powered by a commercial utility because it is beyond paved roads and power lines.

The Rook's home is four miles and $24,000 from the nearest power grid. At least that is what Mike and Waldi were quoted three years ago when they bought the property. And Mike and Waldi would be required to have an all-electric home. This means electric baseboard heat, electric stove/oven, electric water heater, and other energy wasters that Mike and Waldi didn't want.

Planning the Castle

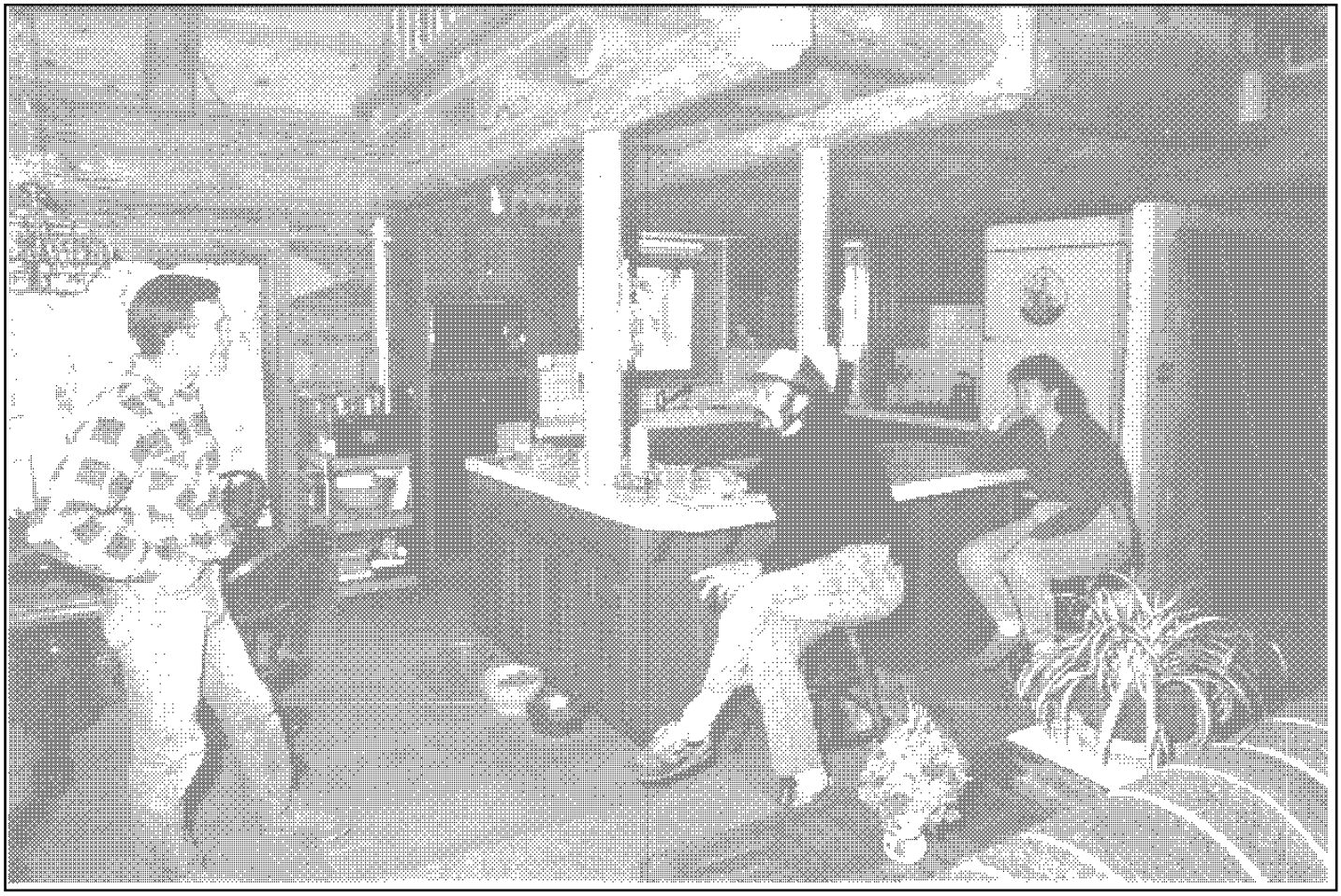
Building a log home is not for the faint-hearted. The basic shell is constructed like a stockade; the windows and doors are cut in afterwards. The builder must deal with logs weighing around a ton. Both Mike and Waldi are experienced home builders and have many hours of sweat equity to their credit.

There are a number of firms providing "kits" which make the job easier, but none of the available designs were quite what Mike and Waldi had in mind. The Rooks created a unique design of their own by borrowing parts from five different log home designs and incorporating features from their previous homes. Their log home has 1,900 square feet of floor area in the living space and an additional 1,200 square feet in the basement.

They decided to build their own home right from the beginning. Armed with an architect's rendering of their plans, an engineer's specifications for the foundation, and county approval, Mike and Waldi started their log home.

Building the Castle

A local contractor, Jack Little of Gazelle, California, milled and preassembled the walls at his facility months in advance. The logs used were Douglas Fir with a mean diameter of around 12 inches. They were harvested at Dunsmuir, California. The logs shrink naturally as they dry. Having them preassembled allows the contractor or



Above: Mike (left), Bob-O (center), and Waldi (right) in the kitchen of Rook's Castle. Photo by Richard Perez.

Above: a view of the living room from the second story balcony. Photo by Richard Perez.

owner to make adjustments off-site. When the foundation was ready, the shell was marked, disassembled, and moved to the homesite with log trucks.

Mike and Waldi had the foundation hole bulldozed and the slab poured by three large concrete trucks. Slabs are always tricky and the Rooks enlisted the aid of three helpers to help with the parade of concrete trucks. After the slab was poured, Mike and Waldi built the basement walls from concrete block, reinforced with steel and grouted full.

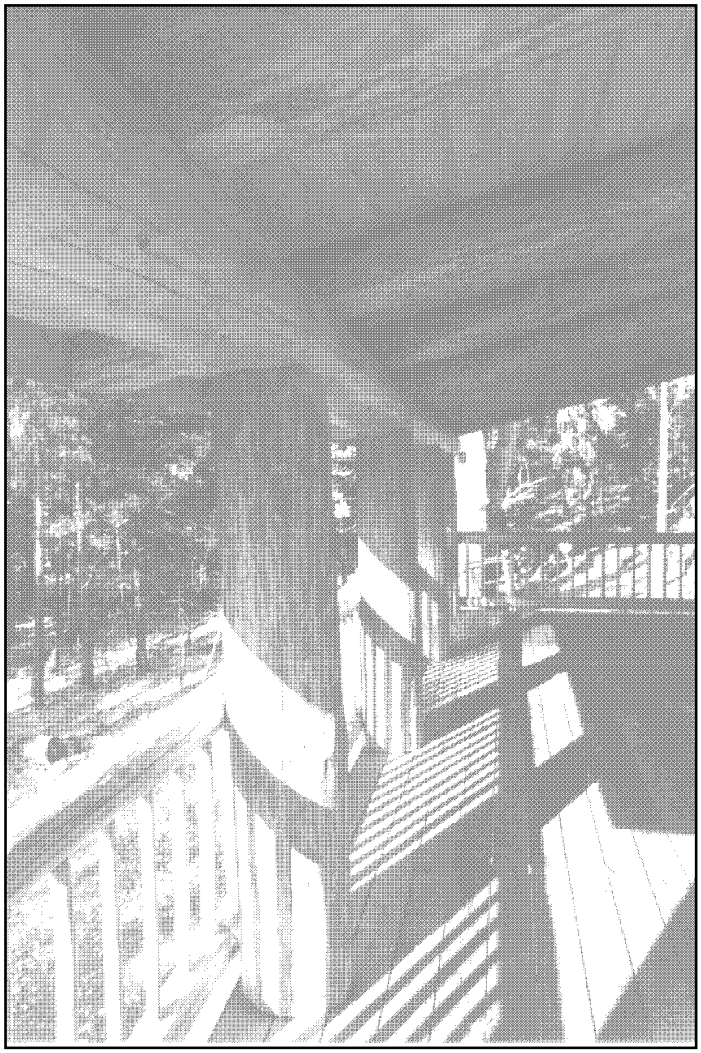
On the big day, a large crane was rented and the log exterior was reassembled on the foundation in a single day! That's even more amazing when you consider that the three logs holding up the roof weigh 2,200 pounds each. It took two log trucks and a flatbed to haul in all the logs.

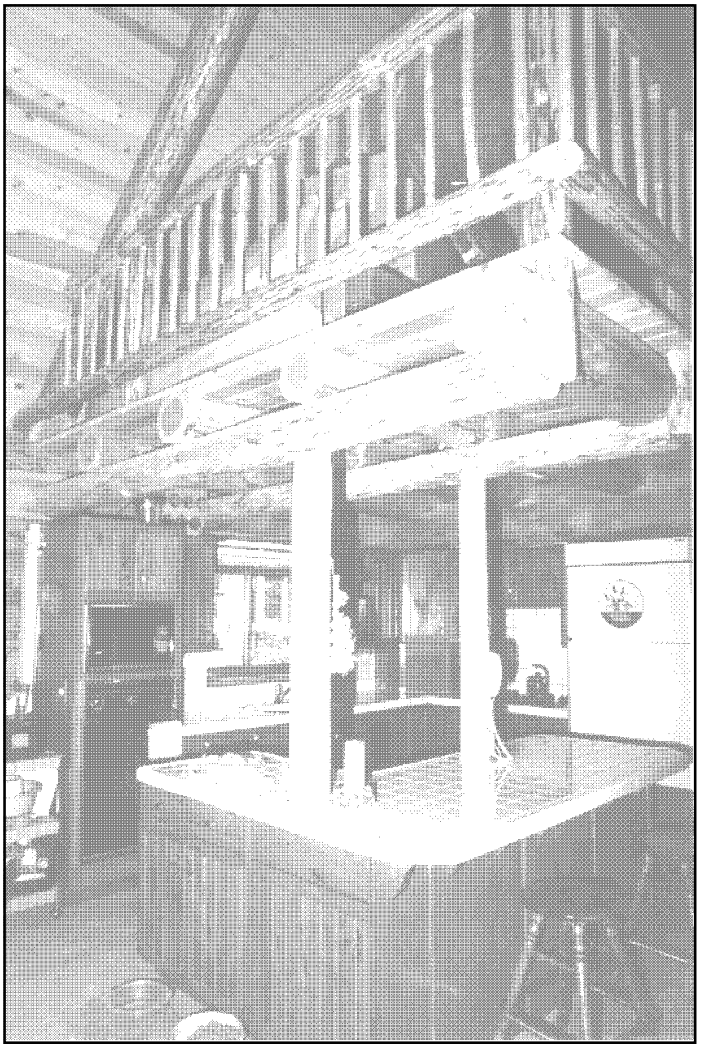
The log walls insulate the home. The R-Value of the log walls is 20, and the logs also act as thermal mass. They store the day's heat and then release this solar heat into the home at night. They work exactly the same as a Trombe wall. The roof is composed of 2 inch pine boards with an overlay of 5/8 inch plywood. Mike used two layers of heavy tar paper below the metal roof. The ceilings are also insulated with 2 inch thick foam for a total R-Value of 19. The floor between the basement and the home is insulated with fiberglass to R-19. All windows are double-paned. Mike and Waldi are snug and warm in their primarily wood-heated home.

Log Construction Challenges

With a log home, you have to precisely plan all of your electrical circuits and plumbing runs well in advance of construction. Each course of logs has to be drilled or notched, to accept the wire and pipe, as it goes up. This is no small thing and adds hours to construction.

Since Mike and Waldi's home is a custom design, the plans required approval by both an architect and an engineer. This takes time and costs money. Mike suggests seeking the aid of an architect who has done





Above Left: The porch on the west side of the house. Above Right: Mike and Waldi's kitchen with a Sun Frost refrigerator/ freezer to keep the food fresh. Note the second story balcony above the kitchen. Photos by Richard Perez.

many log homes. Designing and building with logs is different enough that those without experience will make serious mistakes on their first try.

Log homes settle. In fact, Rook's Castle has settled five inches during the last eight months. Mike hopes that it will finally stay put after a year. According to Mike Rook, a log home should sit fully assembled for a year before the holes for the doors and windows are cut. This allows everything to get acquainted, shrink, and settle. Mike uses large jacks on his interior beams to keep the roof true.

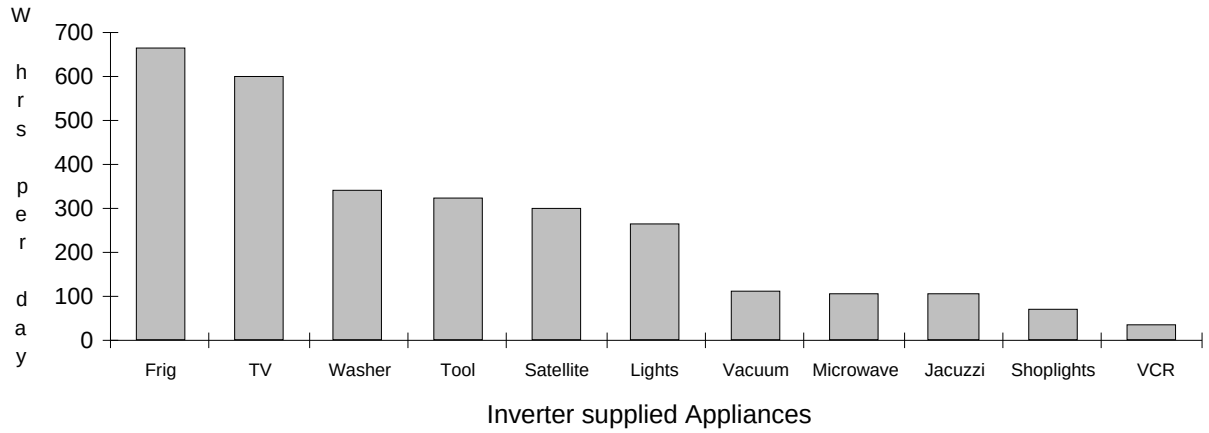
Sweat Equity

"There's no way we could have afforded it if we had hired a contractor," Waldi Rook. Mike and Waldi are self-sufficient people. They are handy and experienced. With the aid of some subcontractors, they built their own solar-powered log home. They built their own basement, put the roof on, did all the plumbing and electrics. In short, they worked very long and very hard for their beautiful home. For example, when they ran out of decking lumber and could only obtain unfinished boards, Waldi hand sanded every board before it went onto the deck.

The Electrical System

They had pretty much resigned themselves to life with a diesel generator when a neighbor handed Mike an old copy of Home Power. So much for the diesel! They read as many HPs and everything else they could find on the subject. They saw the technology develop and decided on solar electricity as their primary power source. The electrical appliances used by Mike and Waldi are detailed

The Major Energy Consumers in Mike and Waldi's System



Mike and Waldi Rook's Appliances

No.	Inverter Powered Appliance	Run Watts	Start Watts	Hours per day	Days per week	Watt-hrs. per day	%
1	Sun Frost Refrigerator	66	130	10	7	660.0	22.1%
1	27 inch Color Television	150	150	4	7	600.0	20.1%
1	Washing Machine	800	2400	1.5	2	342.9	11.5%
1	Power Tool	750	1500	1	3	321.4	10.8%
1	Satellite TV System	75	75	4	7	300.0	10.0%
3	Fluorescent Lights	22	22	4	7	264.0	8.8%
1	Vacuum Cleaner	800	2400	1	1	114.3	3.8%
1	Microwave Oven	600	1200	0.25	5	107.1	3.6%
1	Jacuzzi Pump	1500	3000	0.5	1	107.1	3.6%
2	Fluorescent Shoplights	80	80	1	3	68.6	2.3%
1	Video Cassette Recorder	45	45	2	3	38.6	1.3%
1	Incandescent Light	25	25	1	6	21.4	0.7%
1	Stereo	50	50	1	2	14.3	0.5%
1	Food Processor	400	800	0.1	2	11.4	0.4%
1	Blender	350	700	0.05	2	5.0	0.2%
1	Kitchen Mixer	300	300	0.1	1	4.3	0.1%
1	Soldering Iron	100	100	0.25	1	3.6	0.1%
1	Makita Charger	10	10	0.5	3	2.1	0.1%
	Average Daily Energy Consumption in Watt-hours per day					2986.1	

in the illustrations on page 10.

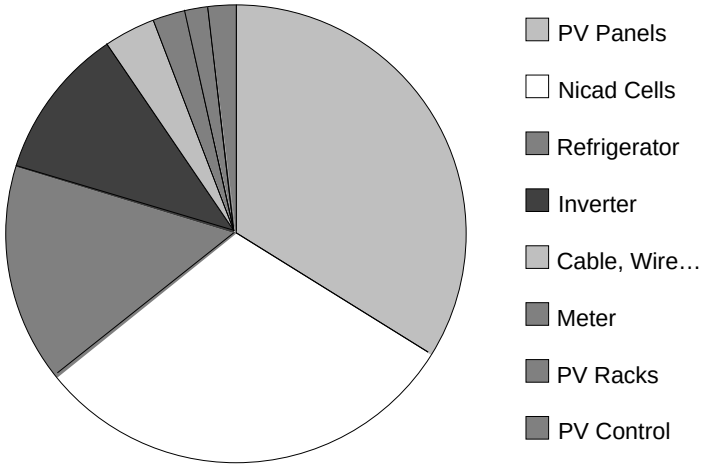
The Rooks opted for a 24 Volt DC system because they planned to invert all of their power to 110 vac. Not only are wire resistance losses reduced four times compared to 12 VDC system, but 24 Volt inverters are more efficient and deliver more power.

They also chose reconditioned nickel-cadmium (nicad) batteries from Utility Free in Basalt, Colorado, for power storage. The Rook's system uses sixty reconditioned Edison ED-160 nicad cells. Each ED-160 cell has a capacity of 160 Ampere-hours at a voltage of 1.2 VDC. The battery is configured as 480 Ampere-hours at 24 VDC (three series strings of twenty cells each). This battery contains enough energy to power Mike and Waldi's log home for four days. For maximum safety, Mike elected to construct a locked and insulated "power shed" on an external wall of the house. It gets cold at 4,000 feet during the winter. The nicads will maintain more capacity when cold than lead-acid batteries. Mike likes the nicad cell's ability to support repeated deep cycles without losing capacity or requiring equalization charges.

The main power source is sunshine. The Rook's system uses fourteen Kyocera K-51 photovoltaic modules mounted on their roof. Each module produces about fifty Watts when exposed to the sun. The Rook's PV array is configured at 24 VDC and produces around 21 Amperes in full sun. Their array produces an average of 3,000 Watt-hours of energy daily. Mike mounted the modules on his steep 45° roof. The mounts are not adjustable because the roof is not an easy or safe place to get to. The modules are wired to the battery with #4 gauge copper wire. The Rook's also use their 120 vac generator to supply power during sunless periods. Mike says they run the generator about five hours weekly during the winter, to pump their water, run the washer, and refill the batteries.

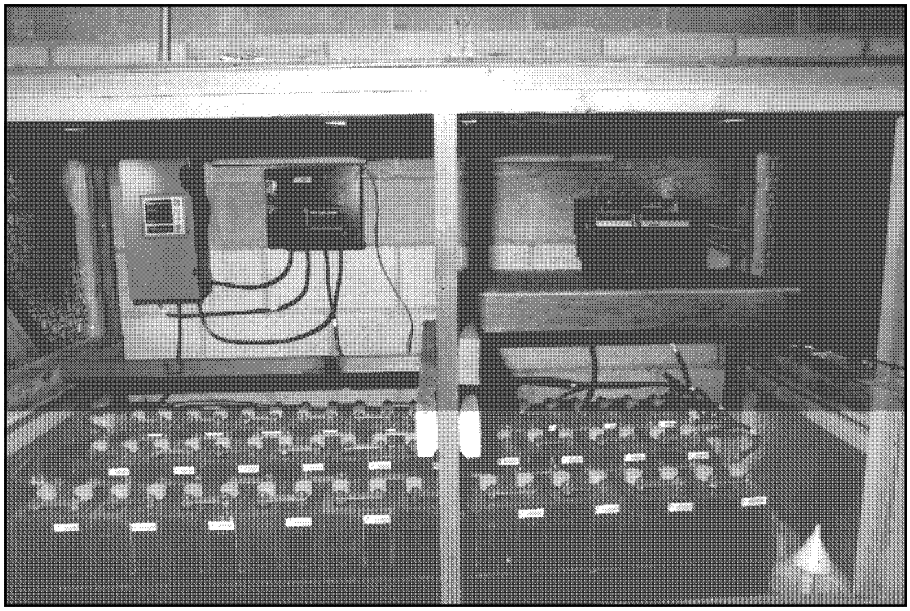
Mike and Waldi chose the Trace 2524 inverter due to its high wattage output and excellent track record for reliability. Since all of their power use is through their inverter, reliability is very important. A Heliotrope CC-60C PV charge controller rides herd on the PV array. An Ample Power Energy Monitor mounted in the kitchen allows the Rooks to keep track of the battery state of charge.

Where Mike and Waldi Rook's Bucks Went



Mike and Waldi Rook's System Cost

No.	Hardware Item Description	Cost each	Ship each	Item Total	% Cost
14	Kyocera K51 Photovoltaic Panels	$320.00	$0.00	$4,480.00	34.02%
60	Reconditioned ED-160 Nicad Cells	$64.00	$2.50	$3,990.00	30.30%
1	Sun Frost RF-16 (120 vac)	$2,050.00	$0.00	$2,050.00	15.57%
1	Trace 2524SB Inverter/Charger	$1,402.00	$9.00	$1,411.00	10.71%
1	Cable, Wire, Disconnect & misc.	$475.06	$0.00	$475.06	3.61%
1	Ample Power Meter- Nicad	$299.00	$0.00	$299.00	2.27%
4	PV Mounting Racks	$60.00	$0.00	$240.00	1.82%
1	Heliotrope CC-60C PV Controller	$225.00	$0.00	$225.00	1.71%
			Inital Hardware Cost	$13,170.06	



"We thought we were going to have to change our lifestyle, to be honest with you. You know, moving up here without power. But we haven't had to."

–Mike Rook.

Above: Mike Rook's insulated battery enclosure. Inside are 60 nicad cells, a Trace inverter, a Heliotrope CC-60C PV controller, and a fused disconnect for the array. Photo by Richard Perez.

Above: Mike (left), Waldi (center), and Bob-O (right) on the deck of Rook's Castle. Photo by Richard Perez.

The illustrations below give all the financial details of the Rook's system. Initial cost of the system was $13,170.06.

Living with Renewable Energy

"A lot of people still think that living with solar electricity means reading by car tail light bulbs and doing without," Mike told us. "Folks that come over are amazed at our totally 110 vac house, complete with the big microwave and the 27" color TV and satellite receiver. We've given up nothing by using the sun for our electricity, we've just learned to use it efficiently." Mike also described a phenomenon common to many photovoltaic power users. "Recently, we traveled south to spend the Thanksgiving holidays with family and friends. I found myself constantly turning off lights left burning in unoccupied rooms." Sound familiar?

We asked if the Rooks had any regrets with their system. Mike volunteered that if he had it to do over, he'd have purchased the Trace inverter and the batteries first and used them to substantially reduce the time spent feeding and listening to their noisy generator during construction!

"The times, they are a'changing..."

Beside being accomplished log home builders, Mike and Waldi both hold California Realtor licenses and own the Scott Valley Real Estate Brokerage. Their Renewable Energy lifestyle brings a new and necessary aspect to the real estate biz. I can almost see one of their ads now... "FOR SALE – 20 acres with spectacular views. Several choice home sites with excellent solar insolation for your renewable energy powered home." That kind of information is invaluable if you're looking for land. Most realtors wouldn't have the foggiest idea about RE possibilities. To Mike and Waldi Rook, living with sunshine is more than just a good idea, it's their dream home come true.

Access

Author: Bob-O Schultze, 19101 Camp Creek Road, Hornbrook, CA 96044 • 916-475-3401

Owners: Mike & Waldi Rook, Scott Valley Real Estate Brokerage, 11806 Main St., Ft. Jones, CA 96032 • 916-468-2252

System Design and Specification: Electron Connection, POB 203, Hornbrook, CA 96044 • 1-800-945-7587

How It All Began

Mick Sagrillo

Many of us wind freaks feel pretty smug about having what we think is the first wind generator in the neighborhood. I mean, we're energy pioneers after all, aren't we? What most don't realize is that wind power isn't a new idea.

History

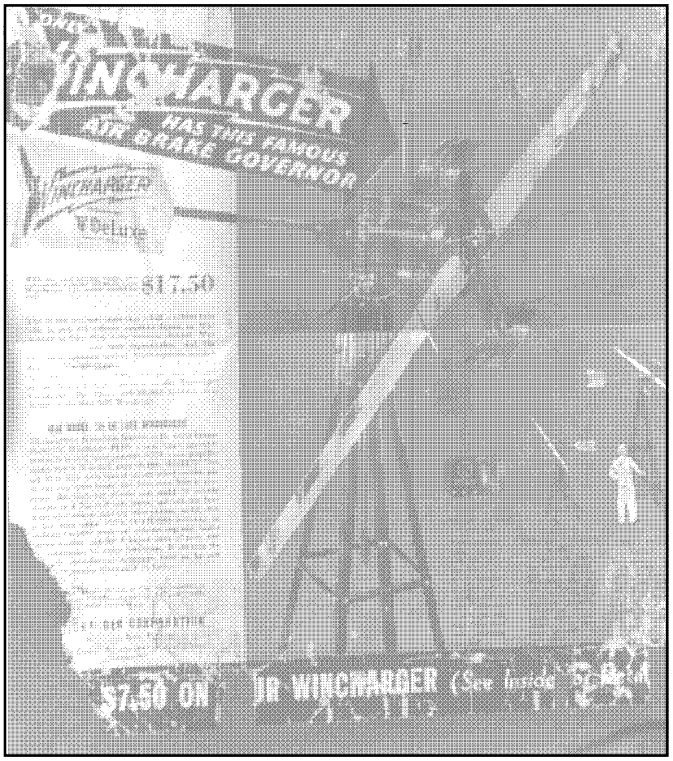
I don't mean using the wind to pump water or grind grain. I'm talking about wind-generated electricity! A half century ago, literally millions of American families across the Midwest, the Great Plains, and the West depended solely on the wind for their electricity.

The history of wind-generated electricity for the homeowner in the United States is a fascinating one. The idea for using wind power to generate electricity dates back to the 1860's in England. While many experimenters dabbled with wind-electric generators in the late 1800's and early 1900's, it was not until after the Great War that wind power really took off in this country. It began with, of all things, the airplane and the radio.

Wheels vs. Props

Early wind generators didn't look like they do today. They resembled the water pumping windmill that still dots the countryside and makes for picturesque calender photos. The waterpumper "wheel," the part that rotates in the wind, was the state of technology at the turn of the century. The arrival of the airplane with its sleek looking propeller changed the way people thought about converting the wind into rotating mechanical motion.

The airplane propeller and the wind generator blade spin by converting the air that passes over that blade (i.e., the air foil), into a force known as "lift." It is lift that causes the blade to move. (We're getting into a future article here.) Waterpumper wheels are very inefficient when matched to a generator, although they do a great job when attached to pumps. Because of this fact, wind generators incorporating the traditional looking wheel didn't produce a great deal of electricity.



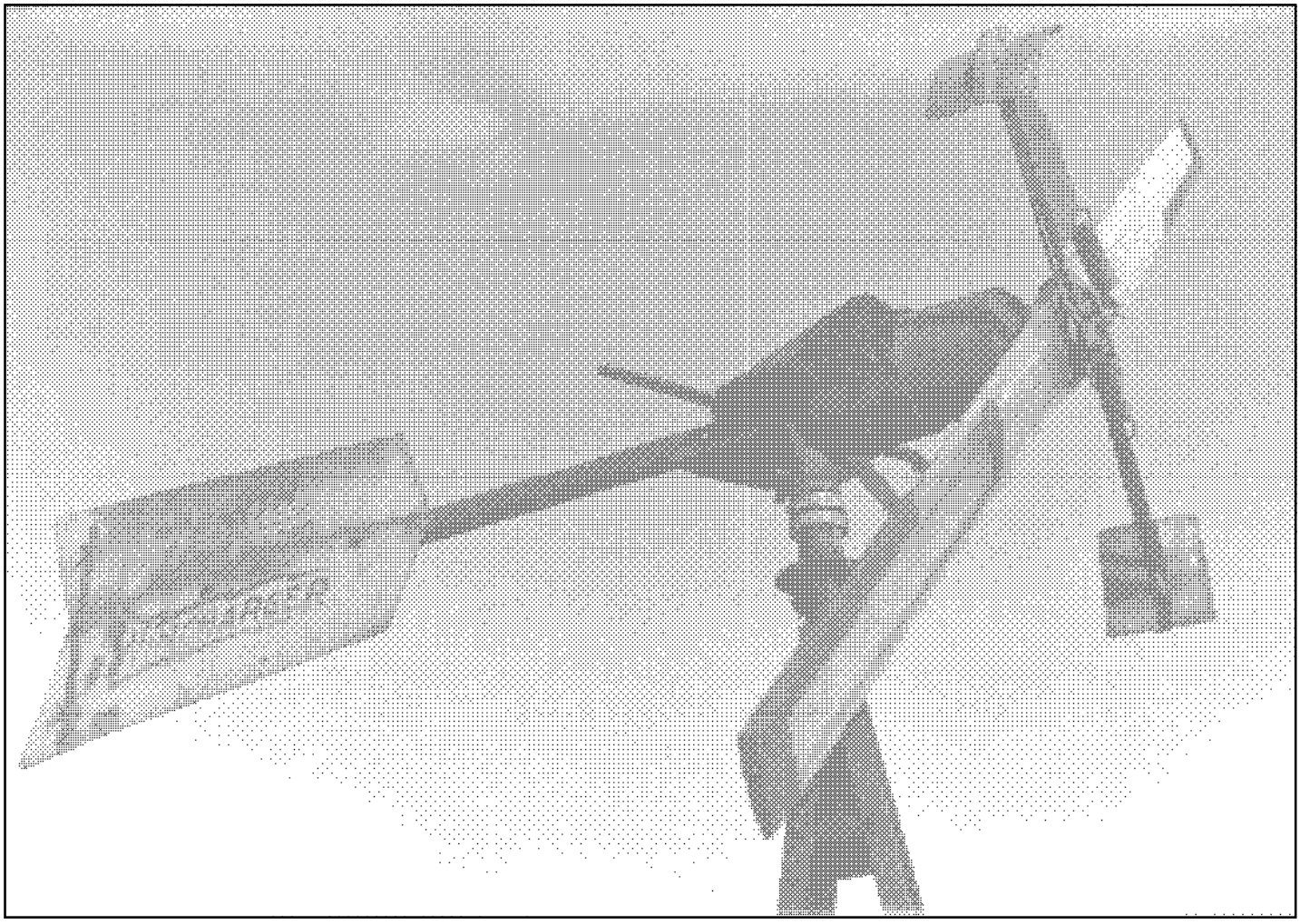
Above: A Wincharger brochure from the 1930's.
Photo by Mick Sagrillo

Still the decades of the 'teens and 20's saw manufacturers offering wind generators driven by wind wheels. In fact, they were hard to distinguish from their waterpumper cousins. At least one clever manufacturer, George Manikowske of the Aerodyne Company, offered a wind machine that could pump water and generate electricity at the same time!

The late 1920's hosted a flurry of activity by experimenters trying to adapt an airplane type of propeller to the wind generator. When making electricity, airfoils are far more efficient than waterpumper wheels because the power curve of a spinning airfoil closely resembles that of an electric generator. Technical articles began appearing in the scientific journals speculating on the efficiency advantages of airfoils over wheels. By 1931, the first patent was issued to Harve Stuart for what became known as the "Stuart (wind generator) Airfoil." Wind generators would never again be confused with waterpumpers.

The Radio

Farmers and ranchers of seventy years ago were



Above: An early 1930's vintage "radio charger." Photo by Mick Sagrillo

dependent upon the "wireless" as their most reliable source of daily news and market reports. Particularly isolated were those living across the Great Plains, where cities were few and far between. At that time, most rural newspapers were weeklies, at best. Ironically, the Great Plains is the largest windy area of the continental United States.

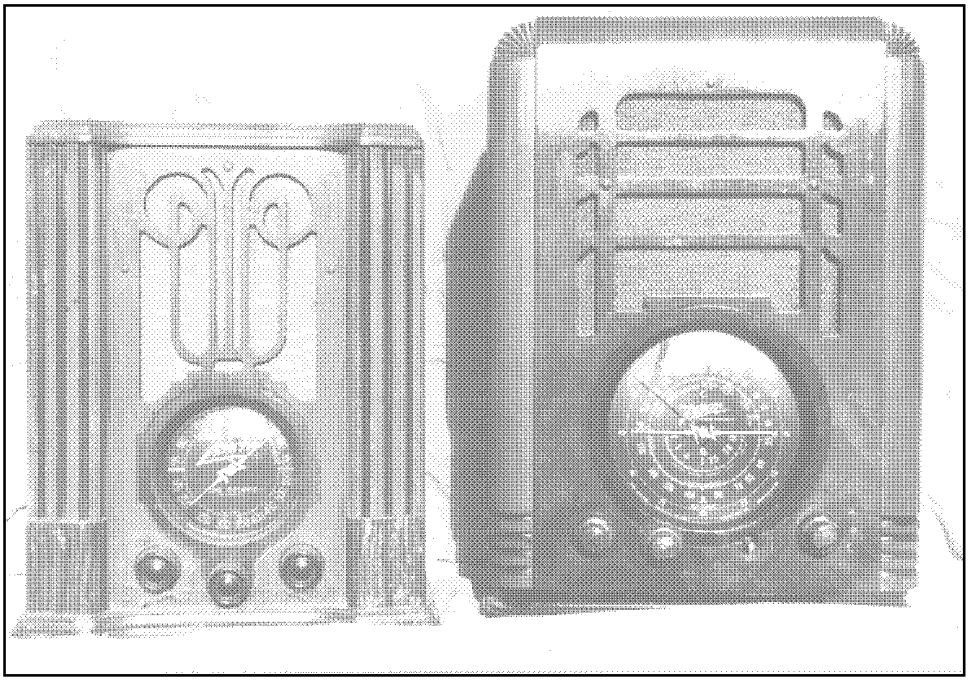
The "people's" radio of the time was the crystal set. It was small and expensive. However, crystal sets were not very powerful. Generally, only one person could listen at a time. The early twenties saw two major advances in radio: the development of inexpensive vacuum radio tubes and the birth of the radio industry as a method of mass communication. The widespread commercialization of vacuum-tube radios was one of the few good things to come out of World War I.

Dissatisfied with the poor performance and low volume of crystal radio sets, many people turned to the battery powered vacuum-tube radios. Depending on battery size, a vacuum-tube radio could be operated from a few hours to a week before the battery would need recharging. When the battery was drained it was time for a trip to town to have it recharged by a gasoline powered generator. This service was offered by another fledgling industry, the automobile repair shop/general store. Because of the high demand for this service and time required for recharging, it was necessary to leave the battery in town for a few days. During this time, the farm family had no battery to operate their radio. All of this occurred during the time of the Great Depression, and not everyone was well-off enough to afford the luxury of a second battery.

An Industry is Born...

Enter the six-volt wind generator! These small units

provided the necessary electricity to keep the radio battery continuously charged, often with some power to spare. It was a small step from the wind-powered radio to wind-powered lights. Electric lights first illuminated the chicken coop, then the barn, the kitchen, the parlor and finally, the workshop. Battery-powered lights were seen as being far safer and convenient to use than the kerosene lamps that they replaced.



Above: The Zenith Farm Radio (left) and the Zenith Deluxe Farm Radio (right).
Photo by Mick Sagrillo

The development of "radio chargers" proved to be wildly successful. One irresistible bargain was offered through the collaborative effort of the Windcharger Corporation and the Zenith Radio Corporation. Any farmer who purchased a Zenith Farm Radio received a coupon good for $19.50 off the purchase price of a $27.50 utility model Windcharger. The utility model Windcharger could be had for only $10! Better yet, the $44.50 deluxe model Windcharger could be had for a mere $15. Either offer represented a 66% discount during the hard times of the Depression Era. Needless to say, six-volt Windchargers and Zenith Farm Radios became very hot items across the Great Plains. By 1938, Windcharger had sold an estimated 750,000 of their wind generators world wide.

Wind-powered lights and radio programs proved to be so successful that farm families were soon demanding more. The little, six-volt "Radio Chargers" were replaced by larger 32-volt generating plants. Wind generator companies sprung up all over the United States. The list of manufacturers included Windcharger, Jacobs, Parris Dunn, Airlite, Hebco, Allied, Wind Power, Aerodyne, Nelson, Aircharger, Ruralite, Kelco, Air Way, and Wind Wing. Many of these companies merged over the decades.

And Grows...

Some companies offered all the conveniences of the city with a complete line of 32 volt DC appliances. Virtually all the electrical appliances we have at hand today were available to the 1930's and 1940's farm household. In the kitchen were mixers, toasters, hot plates, coffee pots, electric irons and refrigerators. Over in the parlor was the vacuum cleaner, fan, sewing machine, and, of course, the radio. Bedrooms held electric blankets, heating pads, and hot water bottles. Those families fortunate enough to have indoor plumbing could indulge themselves with electric shavers, curling irons, and space heaters. In the summer kitchen were cream separators, butter churns, and the ever popular washing machine. Electric milkers and sheep shears were used in the barn. Electric drills, grinders, and saws could be found in the workshop. All of these appliances ran on 32-volt DC electricity!

Wind electric systems, appliances and tools were made available to the rural populace by such mail order firms as Sears and Roebuck, Montgomery Wards, and the Delco (Light Plant) Company. These wind systems and appliances were so sought after that they were occasionally given away as a grand prize on "Queen For A Day."

Success didn't come from just the farm family. The Jacobs Wind Company found a niche with the gas pipeline companies of Oklahoma and Texas. Jacobs sold a wind generator called the "cathodic plant," which sent a continuous trickle of current through the gas pipelines. This current reversed the natural polarity of metal in contact with soil, thereby eliminating the electrolysis and corrosion of the buried pipelines. This unusual use of wind power helped the Jacobs Wind Electric Company sell $75 million worth of wind generators by the time it

ceased operation in 1957.

The End is Near

The Roosevelt Administration, responding to the growing need for electricity in "the West," and looking for ways to pull the country out of the Depression, worked hard for the passage of the Rural Electrification Act of 1936. The heart of the Act was the Rural Electrification Administration (REA) which would oversee low interest loans to rural electric cooperatives. One primary goal of the REA was to bring cheap utility power to every populated corner of the United States by subsidizing the stringing of power lines along virtually every country road. The REA would also "create jobs" (sound familiar – some things never change!!!) by employing thousands of workers to carry out the scheme. The REA was successful beyond anyone's belief. However, the passage of the REA signaled the death knell for a rapidly developing wind industry. The wind industry survived for another two decades, but eventually succumbed to the convenience of utility power by the mid-1950's.

As is still true today, most utilities and electric cooperatives viewed wind electric generators as a competitive threat. Because of this attitude, utilities and co-ops refused to provide utility power to farms that were serviced by working wind generators. The quick fix was to use a high-powered rifle to put the wind generator out of commission. Many were pushed off their towers and sold to scrap dealers, or disassembled and left to die an ungraceful death at the hands of the elements.

Some of these machines were carefully removed from their towers and stored in sheds and barns. These were the wind generators that were highly sought after during the second "discovery" of wind power in the early '70s. To those who caught the "fever," these were the machines that catapulted some tinkerers and entrepreneurs to the fame and fortune they strive for in today's wind industry.

Access

Mick Sagrillo seeks fame and fortune at Lake Michigan Wind & Sun, 3971 E. Bluebird RD., Forestville, WI 54213 • 414-837-2267

Above: Hastings Mesa. Photo by Kris Holstrom

Power Struggle

Kris Holstrom

Telluride, Colorado – where stars and ski bums have come to mingle with regular folks enjoying one of the most beautiful mountain environments around. Many of the working class settled on nearby mesas. Hastings Mesa, sixteen miles from town, is home to an abundance of elk, deer, hawks, and eagles, in addition to a group of people who are committed to living off the electric power grid.

The Beginning

Rumors began to circulate last fall regarding the imminent installation of power lines on Hastings Mesa. Consistent information was difficult to obtain from the local power company so current and future residents of the mesa formed the Alternative Energy Alliance to deal with the company's line extension plans. Our desire is to keep commercial power off the mesa and allow Hastings Mesa to be a showcase of alternative energy options. We are the only mesa left in this region that can make the claim to being a solar community. We would dearly love to keep this status.

We are opposed to the power line extension for environmental and economic reasons. The relative inaccessibility of the mesa has attracted environmentally aware, "pioneer" type people. We fear that having commercial electric power available may bring in a different type of resident: one who may not care about the local and global degradation caused by coal-fired power plants, one who may not accept his responsibility to live in harmony with the earth.

The Mesa
Hastings Mesa can remain a unique alternative energy community where the beauty of the landscape is preserved while residents enjoy a comfortable lifestyle. Already in place on the mesa are fully equipped homes powered by non-polluting photovoltaic and wind generating systems. If commercial power is available property values and subsequently property taxes will rise. As a result of this we fear current landowners may be forced into a financial bind where they cannot afford to keep or build on their chosen homesites. This would aggravate the already evident division between wealthy second-homeowners and the working class trying to live near their place of employment.

While the current political climate in this county favors maintaining 35 acre lots, this could change. The ability to hook to the grid could increase pressure to subdivide the mesa into smaller and smaller parcels.

The Plan
Rather than wait until the power company presented us with a *fait accompli*, we began a media campaign and sent out a letter and questionaire to all landowners on our mesa. Out of 285 questionaires sent, we received 118 responses. Of these only 10 wanted commercial power. Many people indicated that they would be very upset to see power lines or commercial power available on the mesa.

The media campaign began to get others interested in our situation and alerted the power company that they had substantial opposition. The power company sent out their own questionaire and stated that 166 lots desired power with only 65 negative responses. Developers who owned large parcels were responsible for many of these "lot" requests.

The Meeting
The power company met with us and other area residents to explain their policies and procedures. A company spokesman described each step in the planning process. After a needs survey is accomplished, alternatives, including keeping an area off the grid, are developed. Engineering and environmental evaluations of each of the alternative routes are made. Area landowners and pertinent agencies, such as the Division of Wildlife, Bureau of Land Management, and Forest Service are contacted. A first draft of a Basic Environmental Report (BER) is completed as required by the Rural Electrification Association (REA – who lends the local power company money). The BER, the spokesman noted, is required even if no money is to be borrowed for the project.

The next step in the process is to hold a public information meeting. The alternatives must comply with county land use codes and a final BER completed prior to presenting the project to the power company board and REA for approval. Once approval is obtained, and engineering costs and easements are collected then surveying and staking can occur. Prior to construction of a line, pre-construction contacts are made with affected landowners and construction easements are obtained. Then the project is built, followed by mitigation of any construction impact, according to the spokesman.

After outlining their procedures, the spokesman "set the record straight" regarding their plans for the mesa. He told us they had "no plans" for a line extension, but must react to several requests for power they had received. He denied that the power line extension could go through simply to meet demand of a large developer on another mesa. The power company has shown a degree of sympathy for our position and has referred some people to a solar power company for further information. Due to misinformation received early on, trust in the power company is fragile, at best.

The Present
At this point in time they are contacting those who indicated a desire for grid power and are proceeding with investigating various routes in two areas on the mesa.

The difficulty of our situation is that if just one individual is able to obtain the necessary easements and pay the costs, the power line will go in. Our approach to solving this problem is through education.

We are contacting people who have requested power to advise them of the costs and benefits of alternative power options. The economic argument is strongly in our favor. The power company has estimated costs of the underground lines at $50,000 to $100,000 per mile. These costs must be borne by those requesting power. While future people who hook-up would share in the cost, many mesa landowners are committed to discouraging the consumers who will be paying the bill.

Options
The Alternative Energy Alliance is also putting together a packet of information and examples of alternative energy options to be given to local realtors. We want to encourage them to sell to solar savvy clients and environmentally concerned individuals. Our hope is to attract neighbors to live on the mesa who are willing to take responsibility for the impact of their energy needs.

Good News
Our fight to keep the power lines off Hastings Mesa has brought us together as neighbors. We have a common purpose, but do not know if we will ultimately be successful in maintaining our fledgling solar community. We would greatly appreciate hearing from anyone out there who may have helpful or encouraging information or ideas.

Access
Author: Kris Holstrom, POB 896, Telluride, CO 81435 303-728-3401

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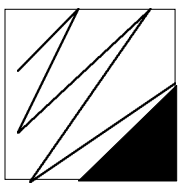

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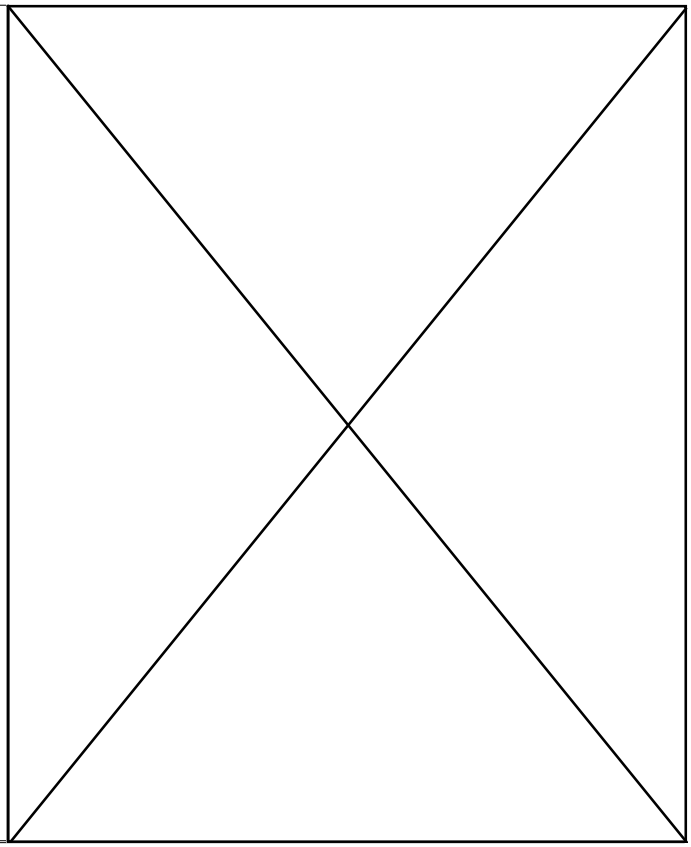

Wiring Non-Identical PV Panels

Michael S. Elliston and Tom Stockebrand

At Carrizo Solar, we are frequently asked the best way to wire our used ARCO 4 Volt M52L panels in large arrays. This question is important not only with our panels but any non-identical panels connected in large arrays. For small systems you may not have any wiring alternatives, but you will for larger arrays. There are two methods to wire panels for large arrays.

Series-Parallel

The first way is to wire the panels in series banks, then put the series banks in parallel. I will call this series-parallel wiring. For example, with 16 4-volt panels charging a 12 volt system this wiring would look Figure 1.

Parallel-Series

The second way is to wire your panels in parallel groups, then wire these parallel groups in series. I will call this parallel-series wiring. For example with 16 4-Volt modules charging a 12 Volt system, this wiring would look like Figure 2.

Non-Identical PVs

If all your panels were identical the two wiring methods would not result in any major differences except for the number of connections. However, wiring does become an issue when you are working with non-identical panels such as our M52L's. Although they are graded into power categories, the amperages of the M52L's will vary within each of these categories. Why is this a problem? When you connect strings of panels in series, the current in each string is limited to the current produced by the lowest producing panel. It is just like a chain – it is no stronger than its weakest link.

How does this make a difference between the two wiring methods?

See illustrations 3 through 6. Each figure shows eight panels varying in current carrying capacities from 5.00 to 6.75 amps in 0.25 Amp steps. Figures 3 and 4 show series-parallel wiring while Figures 5 and 6 show parallel-series wiring.

High-Low Pairing

The array in Figure 3 yields the lowest output current since, unluckily, the two lowest output panels (in bold) are in separate strings which limits both strings to the lowest possible current, 10.25 Amps. There is a 50/50 chance of this happening. The best that can be done would be to have all the low panels in one string and high panels in the other string for an output of 10.75 Amps as shown in Figure 4.

If the same panels are connected with parallel-series wiring, as shown in Figure 5, then the worst case occurs when the two low panels are in the same pair as shown. The chance of this occurring is only one in six. You have a much higher probability of low output using series-parallel wiring than with parallel-series wiring. Note that if you could test each panel, you would want to pair the highest with the lowest, next highest with next lowest, etc. This technique equalizes the current in each pair and gives you the peak performance as shown in Figure 6.

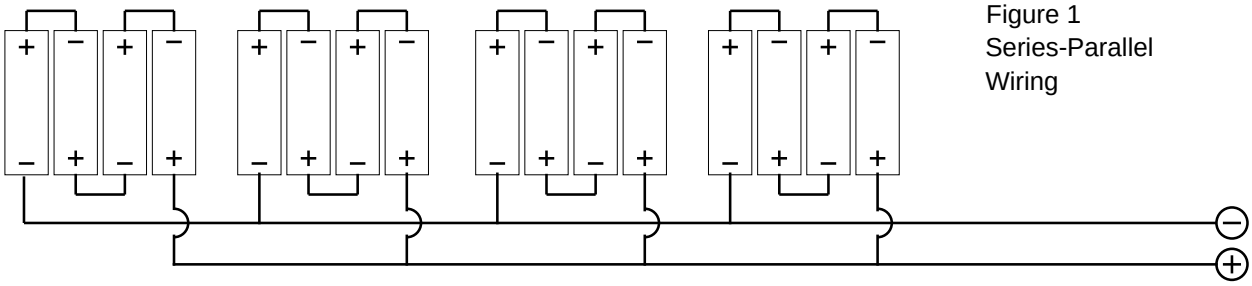

Figure 1
Series-Parallel
Wiring

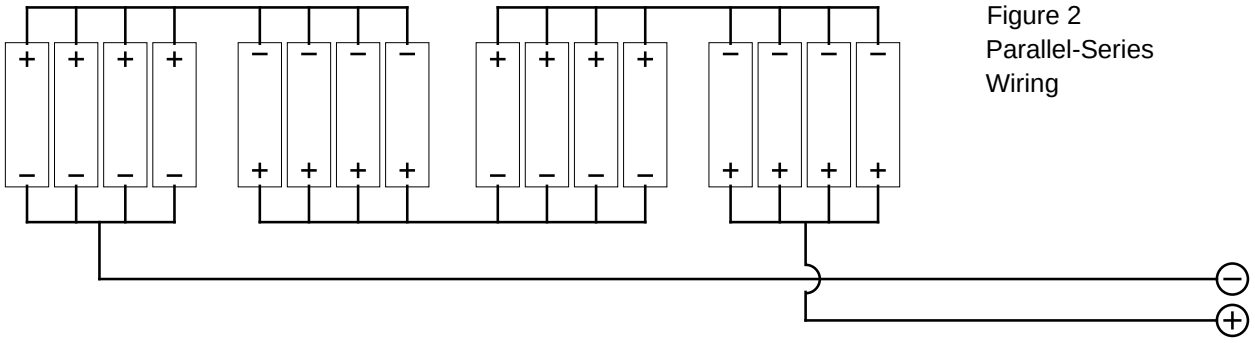

Figure 2
Parallel-Series
Wiring

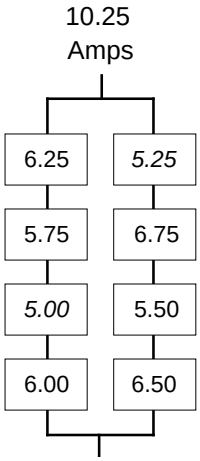

Figure 3

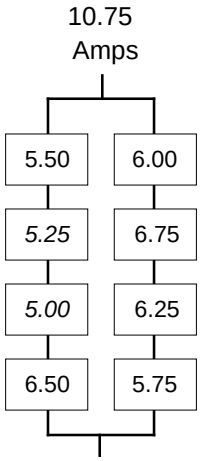

Figure 4

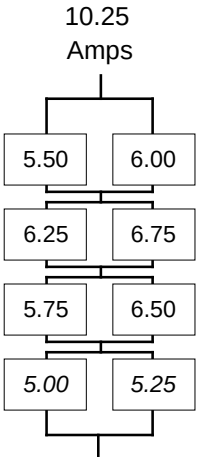

Figure 5

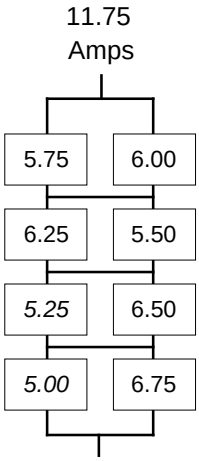

Figure 6

Testing the Bronze Modules

To verify this practice, we took 16 of our Carrizo Bronze modules and wired them as shown in Figures 1 and 2. We performed two tests on two separate days using two different sets of Bronze modules.

The tests were conducted at our plant in the Carrizo Plain. It is located at 2000 feet above sea level, half way between Bakersfield, CA. and San Luis Obispo, CA. The panels were mounted on an adjustable rack and pointed directly at the sun and allowed to heat up. The cell temperatures were recorded from a probe taped to the back of the panel. We use a PVI Inc. curve tracer to record the power output. In June 1990 this machine was checked against Southwest Institute's curve tracer and found to measure about 10% lower power output.

The global normal insolation and horizontal global insolation were taken off pyronometers located in the middle of a solar field a quarter mile to the south of the test site.

First Test

The first test was conducted on October 29, 1991. The panels were wired series-parallel first and readings were taken at 12:30 P.M. The panels were then rewired parallel-series and readings were taken at 1:30 P.M. The weather was clear with occasional breezes (see table below).

29 October 1991

	Watts	Volts	Amps	Cell Temp.	Ambient Temp.	Horizontal Insolation	Global Normal Insolation
Series-Parallel	340	17.1	19.8	39.8 °C	19.6 °C	643 mW/cm2	NA
Parallel-Series	358	18.3	19.5	38.9 °C	24.5 °C	563 mW/cm2	NA

Second Test

The second set of tests (see table below) was performed on November 12. A different set of Bronze panels were used. The setup was the same as the first set of tests. The panels were wired series-parallel and readings were taken at 11:30 A.M. The parallel-series readings occurred at 12:30 P.M. The weather was clear with a slight haze low in the sky and no wind.

12 November 1991

	Watts	Volts	Amps	Cell Temp.	Ambient Temp.	Horizontal Insolation	Global Normal Insolation
Series-Parallel	339	16.1	21.0	52.0 °C	23.8 °C	616 mW/cm2	1132 mW/cm2
Parallel-Series	370	18.3	21.8	45.9 °C	24.3 °C	604 mW/cm2	1140 mW/cm2

As you can see our tests confirmed that wiring in parallel-series will produce higher power. Our estimate is from 10% to 20% more after compensating for temperature and insolation.

Conclusion

Interpanel variations arise whenever you build an array. New panels added to an existing array, even if the new panels are from the same manufacturer as the old ones, will be different, having come from different lots. The older modules will probably have degraded with time. Used panels have a much greater variation in current output from panel to panel but they are often combined since they are a low cost solution. Panels of entirely different current ratings can also be combined using this principle as long as the panel output voltages are similar. Although you will have more connections to make in wiring your panels parallel-series, this is more than offset by the gain you receive in power. For 4-Volt ARCO M52L modules this analysis holds true for any combination of four modules charging a 12 Volt system, or any combination of eight (or seven depending on climate and panel rating) charging a 24 Volt system.

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Authors: Michael S. Elliston, President Carrizo Solar Corp., 505-764-0345 and Tom Stockebrand, PE LGK Corp., POB 10239, Albuquerque, NM 87184-0239

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Overcurrent Protection for Battery-Powered Systems

Christopher Freitas

All electrical systems eventually experience overcurrents. Over time, even moderate overcurrents can cause overheating, resulting in damage to insulation, conductors and equipment. High overcurrents may melt conductors and vaporize insulation. Very high overcurrents produce magnetic forces which can violently twist cables, crack insulators and pull apart connections.

The chance of a very high overcurrent occurring in an alternative energy system is greater than generally realized. Batteries can deliver very high overcurrents when a short circuit occurs. A single six-volt, deep cycle battery can produce as much as 6000 amps for several seconds. Many AE systems increase this potential current by paralleling several sets of batteries.

Overloads

Overcurrent situations can be divided into two categories – overloads and short circuits. An overload is an overcurrent confined to a normal current path. Sustained overloads are commonly caused by equipment malfunctions or connecting excessive loads.

Overcurrent protection devices must disconnect the loads before damage occurs, and allow for high current flows during motor starting, etc. Most system designers and installers understand overload protection requirements. Overload protection devices are easy to find and are relatively inexpensive to include in an AE system.

Short Circuits

A short circuit occurs when the current flows out of its normal path, bypassing the load. It may be caused by insulation breakdown, a faulty connection, or a misplaced wrench handle during maintenance. During a short circuit, extremely high currents may flow through system components. It is critical that overcurrent protection devices are able to handle the thousands of amps available from the batteries during the short circuit, and that they operate quickly enough to prevent damage to other system components and wiring.

Fuses vs. Breakers

Overcurrent protection can be provided by two types of devices – fuses and breakers. A breaker is often preferred, as it can also operate as a switch to turn the power on and off. Fuses are less popular but are available in a greater variety of designs and ratings. Fuses should be used with a disconnect switch which allows the fuse to be changed without it being electrically "hot." Although fuses are less expensive than breakers the required disconnect switch makes them about the same price.

Interrupting Capacity

The appropriateness of a fuse or a breaker for short circuit protection is determined by the Amps of Interrupting Capacity (AIC) rating. This is usually marked on the device or included in the product literature and often listed in "KA" or thousands of amps. Available values are from as low as 1000 amps for small breakers and up to 200,000 (200KA) amps for large fuses. Ratings given are usually for ac power. The performance on DC power will be substantially lower, with the AIC rating reduced to as low as one tenth of the ac value.

Most inexpensive DC-rated breakers are not designed to interrupt the amount of current which can occur from a short circuit of a large battery. They are intended for use with power sources that have limited amounts of current available, such as electronic power supplies. If the breaker is subjected to currents above its rating, the breaker may overheat, melt, or explode. During the time it takes for the breaker to fail, the excessive current can also damage the components intended to be protected.

Current Limiting Fuses

This special type of fuse can not only interrupt the short circuit, but do so in a fraction of a second (less than 1/120 of a second) providing more protection then normal fuses and breakers. Designed to protect inexpensive breakers with low-AIC ratings, they limit the current to a level that will not cause damage. These fuses should be used in the

main disconnect between the battery and all other system components. DC-rated current limiting breakers are not available as the mechanical interruption mechanism operates too slowly.

Testing The Ratings

I decided to test some components in order to find out what happens when a short circuit occurs in the real world. I acquired four 6-volt, 220 amp-hour electric vehicle batteries which, although old, could still provide high currents. Wired up as a twelve volt bank with 4/0 interconnects, I enclosed the batteries with concrete blocks and heavy plywood in case the testing went out of control. Two five-foot, 4/0 cables were connected from the batteries to the test area. See the diagram of the test circuit and metering on the right.

I wanted to test a breaker with a low AIC and one with a high AIC. I found a 200-Amp breaker unit rated at 5000 amps interrupting capacity sold by several AE companies. I also had a large commercial type 175 amp breaker rated at 42,000 amps of interruption capacity. For comparison, I bought several 250-amp ANN fuses and some 200 amp Class T fuses and holders. The Class T fuses are rated at 20,000 Amps of interrupting capacity for 125 VDC and are listed as current limiting. The ANN fuse was only rated at 2500 amps of interrupting capacity without a specified voltage.

In order to measure the maximum current flow, a 500 Amp, 50 milliVolt, shunt was placed in line and connected to a Fluke 87 digital meter to record the peak current for a duration of 1 millisecond. To monitor battery voltage, an analog voltmeter was wired to the batteries. The short circuit was made by closing a single pole, enclosed contact, battery disconnect switch rated for 2000 Amps during switching.

The 4/0 positive cable from the battery was connected directly to the device being tested. The 4/0 negative cable was connected directly to the 2000-Amp switch. The shunt was connected with two 4/0 jumpers to complete the circuit. The short circuit would occur when the switch was closed and would be interrupted by the breaker or fuse being tested. The combined resistance of the cables, shunt, and switch would reduce the available current, making the test more representative of a real world installation.

A video camera was used to record the results so that they could be analyzed afterwards. A fire extinguisher was also kept nearby in case of fire. With everything ready, a licensed electrician with AE experience assisted with the testing.

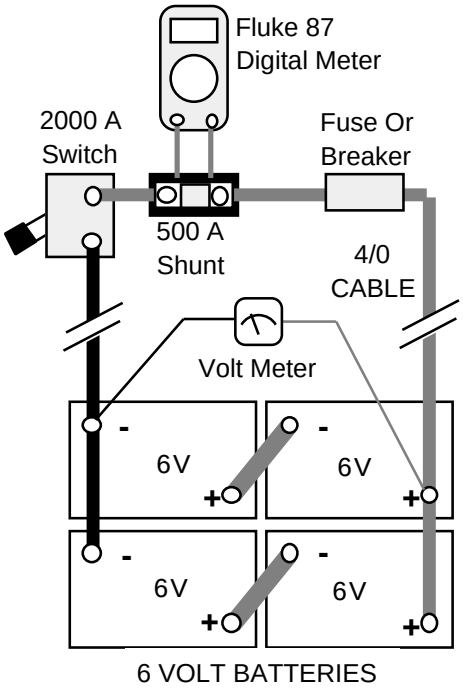
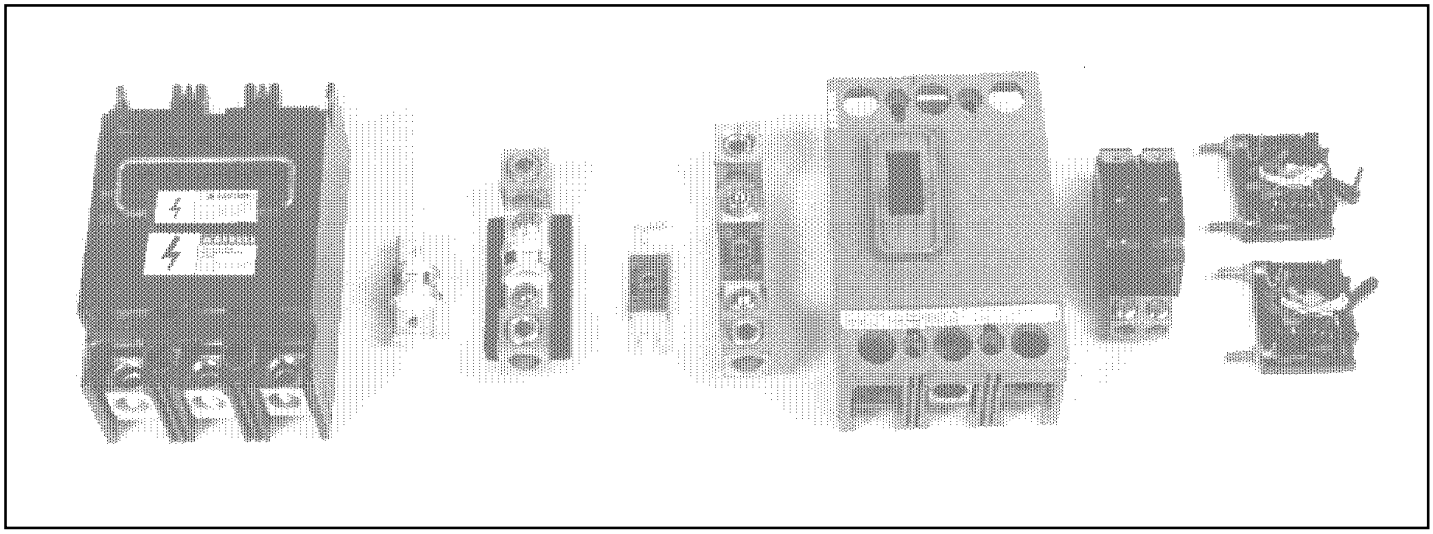


Diagram Of Test Circuit And Metering.

Testing Results

Due to the relative slowness of the Fluke 87 digital meter, peak currents may have been higher than what was recorded. We started with the 250-amp ANN Buss fuse as they were the lowest cost. They blew as expected, the meter recorded a peak current of 2920 Amps. When shorted, considerable arcing and even a small amount of smoke was observed. The voltmeter's needle dropped for an instant and then returned. We accidentally tried to replace a fuse while the circuit was still shorted, and welded a fuse onto the holder.

The second test was on the small 200-amp low-AIC breaker. This was actually a pair of 100-amp Heinemann Series AM breakers connected in parallel by cable lugs with the trip handles glued together. Each breaker is rated at 5000 Amps AIC at 65 VDC. When the circuit was shorted, the current flowed without being interrupted for approximately three seconds, at which we disconnected the short circuit. The meter recorded 3200 peak amps and the voltmeter dropped to a few volts during the entire three seconds. The breaker's handle did not move during the test. The breaker still showed continuity, so we tested it again. This time the breaker instantly popped and opened the circuit. It would not reset afterwards. A review of the video showed a flash and a puff of blue smoke coming from the side of the unit. The breaker's case was noticeably warm in several places.



Above: The overcurrent protection devices tested. From left to right: 3 pole class T fuse holder/disconnect, 200 Amp class T fuse, 200 Amp class T fuse holder, 250 Amp ANN fuse, 200 Amp ANN fuse holder, 3 pole 175 Amp high-AIC breaker, 200 Amp low-AIC breaker assembly, and 100 Amp Heinemann series AM breakers (shown disassembled). Photo by Christopher Freitas.

The third test was on the large 175-amp ITE breaker rated at 42,000 amps AIC at 240 vac. The batteries were placed on charge for several days to recover from the prior testing. This breaker simply tripped when the circuit was shorted, allowing a peak current of 2960 Amps. The short circuit was interrupted very quickly as the voltmeter's needle barely moved during this test.

The fourth test was of a 200-Amp Littelfuse Class T current limiting fuse rated for 20,000 Amps AIC at 125 VDC. When shorted, the fuse opened the circuit promptly with no external indication of stress. The digital meter recorded 1920 Amps of peak current and the volt meter barely moved during the test. No smoke or arcing was visible, and no heating of the fuse was detected.

For comparison, we decided to directly short the battery with only the shunt and switch in the circuit. This would give us an idea of the maximum available current the batteries could deliver to the devices we had tested. The switch was thrown for approximately three seconds and then shut off. The meter recorded 6960 amps as the peak current. We repeated this three times, with each additional reading lower in value. During each test the 4/0 positive cable lifted up off the ground 4 inches into the air by the forces generated from the extremely high current flowing through the circuit.

Finally, we tested another 200-amp low-AIC Heinemann breaker with only a single 100 Amp-hour, 12 Volt RV battery. After the three short-circuit tests, it also failed, allowing 2200 peak Amps.

Conclusions

Although these tests were fairly simple, some conclusions can be drawn from the data collected.

The small, low-AIC Heinemann breakers which failed were disassembled and examined. Two flexible copper connectors from the terminals to the moving contacts melted in both units. Part of the breaker's case was melted, the magnetic coils which release the contacts were discolored, and the insulation was damaged. The high currents which flowed for several seconds during the short circuit were too great for this unit to handle. Since it was not able to quickly open the circuit, very little protection was provided. The considerable arcing which occurred would be a possible hazard in a battery system.

The large, high-AIC ITE breaker worked correctly, but still allowed a high peak current to occur. When used with a larger battery bank, the peak current may exceed the ratings of other breakers and components in the system. It would be acceptable for protecting an inverter or other single device, but could not be used as a main disconnect for an entire system.

The ANN fuse opened the circuit, but also allowed a considerable peak current. The arcing of the element would be a possible hazard in a battery system.

The Class T fuse was able to remove the short circuit fast enough to prevent the excessive currents from occurring. No arcing or smoke was observed during operation, making it more suitable for use with batteries. The Class

T fuse contains a filler material which extinguishes the arc during operation. This reduces the time required for the current to be interrupted. We cut the fuse open and observed some discoloration of the filler material.

Recommendations

Every AE system must have overcurrent protection able to interrupt the maximum current available from the batteries. For most systems, the main protection should use current limiting high-AIC fuses, such as a Class T or Class R. A disconnect switch which allows the fuse to be safely changed should be included. A lower cost alternative is to mount the fuse in a fuse holder without a disconnect. Although the fuse would always be electrically hot, it normally would not be changed during the life of the system. The fuse holder should be mounted outside the battery enclosure. Fuses should not be directly bolted onto a battery terminal, as they are not designed to handle the physical stresses that can occur without the protection of a fuse holder.

Fuses which have exposed elements, such as ANN fuses, should not be used because they are not current limiting and have only 2500 amps of AIC. They also may be a significant hazard when installed near batteries.

High-AIC breakers, like the Heinemann Series CF (25,000 Amps AIC at 65 VDC) can provide overcurrent protection for individual items. They cannot be used to protect lower AIC breakers. This eliminates their use as a main disconnect in most systems.

Low AIC breakers, like the Heinemann Series AM (5000 Amps AIC at 65 VDC) or the Square-D QO (5000 Amps at 125 VDC) can be used in load distribution centers and components, but must be protected by a current limiting fuse. Using low-AIC breakers alone will not provide sufficient protection with battery systems and may be a significant hazard during short circuit situations.

Access

Author: Christopher Freitas, Ananda Power Technologies, Inc., 14618 Tyler Foote Road, Nevada City, CA 95959 • 916-292-3834

Fuses: “Overcurrent Protection Fundamentals,” Littelfuse Inc., 800E. Northwest Highway, Des Plaines, IL 60016 • 800-TEC-FUSE

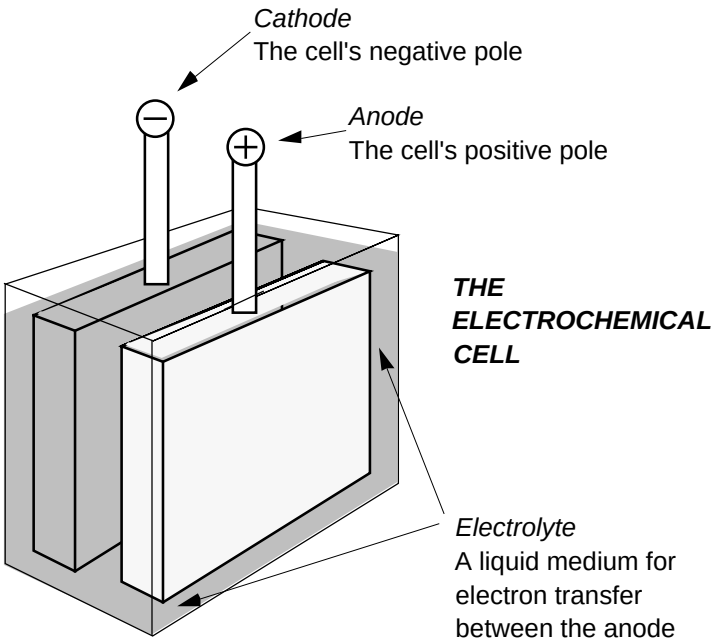
Circuit Breakers: “Quick Guide to Overcurrent Protection,” Heinemann Electric Company, POB 6800, Lawrenceville, NJ 08648 • 609-882-4800

Code: John Wiles, Southwest Technology Development Institute, NMSU , P.O.Box 30001, Dept. 3SOL, Las Cruces, NM 88003

Battery Basics

Richard Perez

A battery stores electrical energy. Batteries are chemical machines. In the battery, chemical energy is converted into electrical energy. Electricity is stored within the battery as potential chemical bonding between the battery's active materials. Batteries are simply chemical engines used to push electrons around.



THE ELECTROCHEMICAL CELL

Primary and Secondary Batteries

As a battery is charged or discharged, its chemical composition changes. In some batteries the chemical reaction is not reversible. This type may only be discharged. It cannot be recharged. Batteries which cannot be recharged are known as "primary" batteries. One example of a primary battery is the disposable zinc-carbon cell used in flashlights. Other types of batteries are rechargeable. The chemical reaction within a rechargeable battery is reversible. Rechargeable batteries are known as "secondary" batteries. They may be emptied and refilled many times. An example of a secondary battery is the lead-acid battery used to start an automobile.

How Batteries Store and Transfer Energy

A battery converts chemical energy into electrical energy. In rechargeable batteries the conversion process is reversible. Rechargeable batteries can also convert electrical energy into chemical energy.

The Cell

The conversion and storage processes take place in the basic building block of all batteries – the cell. The cell contains the active materials and the electrolyte. Most batteries are composed of many cells because the voltage potential of each chemical cell is quite low (a few volts at most). The electrical storage capacity of a cell is roughly proportional to its physical size. The larger the cell, the more capacity it has. A battery is composed of cells which are assembled together to increase the voltage or to increase the capacity of the battery.

Active Materials

The cell contains two active materials which can react chemically to release free electrons (electrical energy). Such materials are known as "electrochemical couples." The active materials are usually solid. The cell also contains an electrolyte which transfers the electrons between the electrochemical couple. The electrolyte is usually a liquid, a jelly, or a paste. Electrolytes may be either acids or bases (alkaline). In some cells such as lead-acid cells, the electrolyte participates in the chemical reaction in addition to acting as a path for electrons. In other cases, such as nickel-cadmium or nickel-iron cells, the electrolyte does not participate in the cell's chemical reaction, but merely acts as a transfer medium for electrons.

During the discharge of a cell, the active materials undergo chemical reactions which release free electrons. During this reaction, the chemical compositions of the active materials are changed. The reactants actually become different chemical compounds. When all the original active materials have undergone reaction, the cell will produce no more free electrons. The cell is "dead."

In the rechargeable secondary cell, the chemical process is reversible. By forcing electrons through the cell in the opposite direction, the active materials can be restored to their original chemical composition. This is known as "recharging" the cell.

The cell has polarity: one of the active materials is electron deficient and is positively charged. The other active material is electron rich and is negative. The flow of electrons while discharging the cell is from the negative pole (cathode) to the positive pole (anode). During recharging the flow is reversed – the electrons flow from the anode to the cathode.

There are many different chemical compounds which form electrochemical couples. The electrical nature of the cell is determined by the electrochemical couple used. Relatively few electrochemical couples are actually manufactured into cells due to restrictions such as material cost and material availability. Two examples of electrochemical couples commercially manufactured into cells are the lead-acid reaction and the nickel-cadmium reaction. Both cell technologies have been in common use since 1850.

Energy Storage in Chemical Reactions

The science of chemistry deals with the nature of the elements and the myriad forms of bonding which can occur between them. In all chemical reactions which release energy, the materials bond in order to form a more stable structure. The idea is similar to the fact that water runs downhill. It seems that all the materials around us are seeking to form structures of the lowest energy potential – to become more stable. In batteries, the active materials can form more stable structures of lower energy by transferring electrons. The electrochemical couples in batteries may be either elements or compounds.

All elements have electrons revolving around a nucleus of protons and neutrons. Chemical bonding between elements is the exchange or sharing of these electrons. For example, sodium and chlorine are chemical elements. They are distinct materials, each with its own distinct characteristics. When they bond with each other they become salt, which is another totally distinct material. Here is a case of two elements (sodium and chlorine) chemically bonding to form a compound (salt).

When this bonding occurs the sodium atom gives up an electron to the chlorine atom. Each atom becomes electrically unstable; they become ions. These ions cling to each other from electrostatic attraction. The resulting compound is more stable than the original elements of which it's made. Atoms form ionic chemical bonds in order to reach states of greater electrical stability. The entire two-atom system has less energy.

A charged battery has energy stored within its chemical bonds. The active materials (the electrochemical couple) within the charged battery exist in such a form that the reaction between the materials releases free electrons. These free electrons are available for our use at the battery's output terminals.

Discharging

The addition of a load to the cell's output terminals allows the electrons to be transferred between the active materials. This process is known as discharging. The electrons flow as the materials seek a more stable electrical configuration. The chemical nature of the active materials changes to one of a lower energy level.

All cells tend to discharge themselves over a period of time. The electrochemical discharge reaction takes place in the absence of an external load to the cell. The path of the electrons during self-discharging is through the electrolyte.

Charging

The charging process is simply the reverse of discharging. A voltage is applied across the cell's terminals causing electrons to flow through the cell. In order to overcome the cell's internal resistance the charge voltage must be higher than the output voltage of the cell. The direction of the electron flow is the reverse of that during the discharge cycle.

The reversal of this electron flow supplies the energy necessary to return the active materials to their charged state. The chemical bonds made during discharge are broken by the charging process. The active materials regain their higher energy state. They become the original chemical compounds found in a charged battery. The electrical energy is converted into chemical energy.

How Cells are Assembled into Batteries

Most batteries we encounter are composed of more than one cell. In fact, the word *battery* means any set of devices arranged or used together. The term "flashlight battery" is actually incorrect when referring to a single flashlight cell. The *cell* is the basic indivisible unit. A battery is a group of cells.

Cells are combined in two configurations to increase the power of the battery. The first method of wiring the cells is in "series." A series electrical circuit has only one path available for the electrons. In the series configuration each cell has its positive terminal attached to the negative terminal of another cell. See page 32.

The second configuration is known as "parallel" wiring. In a parallel electrical circuit there is more than one path for the electrons to travel. In parallel configuration, the cells have their positive terminals interconnected and their negative terminals interconnected. See page 33.

In Series for Voltage Increase

All commonly used electrochemical cells have low voltage outputs. The lead-acid cell has an output of about 2.1 volts. The nickel-cadmium cell has an output of 1.25 volts. The zinc-carbon flashlight cell has an output voltage of about 1.5 volts. These are absolute limits on cell voltage. These limits are determined by the potential energy of the electrochemical reaction involved. Size is not a factor in the cells output voltage. Making the cell larger simply increases its *capacity*, while the output voltage remains constant.

Electrochemical cells are interconnected to each other in series in order to use their stored energy at higher voltages. A group of interconnected cells is called a battery. If 2 cells are wired in series, the resultant battery will have twice the voltage. If 6 cells are wired in series, the resultant battery will have 6 times the voltage of a single cell. For example, an automotive starting battery consists of six lead-acid cells (each 2 volts) in series to give a resultant battery of 12 volts.

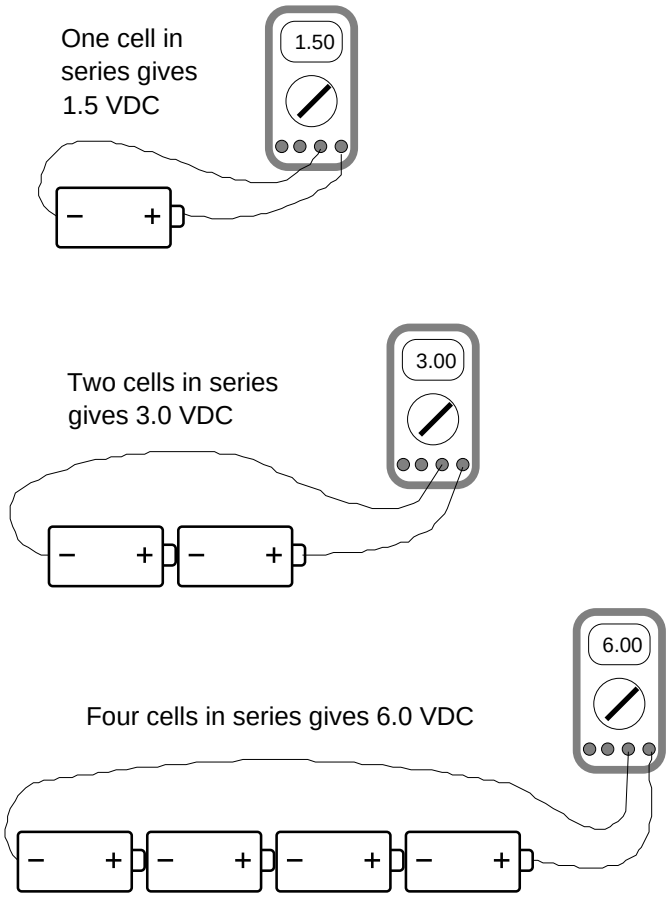
Some batteries contain all their cells in a single battery casing, some do not. Due to weight limitations very large storage batteries are usually cased as single cells. These are wired in series to produce the appropriate voltage. In some large storage batteries, up to three cells may be housed in the same case. Larger batteries are broken down into smaller units for ease of transport and handling. The basic cell in large storage batteries weighs between 20 and 800 pounds.

Another example of series use of cells is in the common flashlight. Two flashlight cells, each a zinc-carbon cell at 1.5 volts, are used in series to provide 3 volts to the bulb. If your flashlight takes 4 dry cells in series then the operating voltage of the bulb is about 6 volts. The illustration to right shows the series use of flashlight batteries.

A battery consisting totally of cells wired in series has one major drawback. The battery is like a chain: it is only as strong as its weakest link. In a series wired battery the electrons must move through each and every cell. If one cell in the series string is discharged, then the entire string is inoperative, regardless of the condition of the rest of the cells. The output power of the entire battery is limited to that of the weakest cell.

Let's say that we have two batteries which we wish to combine in series for voltage increase. Assume that they are both 6 volt batteries (each with 3 lead-acid cells in series) which we wish to combine to get an output of 12 volts. Let's assume that one battery has the capacity of 100 ampere-hours and the other has a capacity of 300 ampere-hours. The resultant 12 volt battery formed by the series wiring of the two 6 volt batteries will have a capacity of 100 ampere-hours. The smallest cell within a series wired battery pack determines the capacity of the pack. When the smallest cell is fully discharged it will not conduct any more electrons. In this state the series circuit is broken. The entire battery is dead, regardless of the state of charge of the rest of the cells.

Flashlight Cells in Series for Voltage Increase



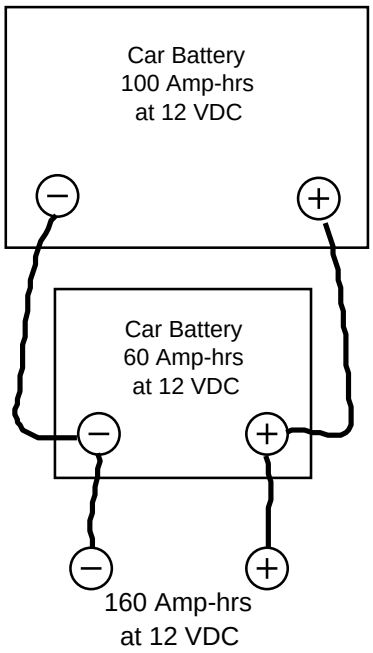
Cells in Parallel for Capacity Increase

Cells or batteries (collections of cells) may be wired in *parallel* to increase the capacity of the resultant battery. When the cells are wired in parallel the *voltage* stays the same, but the *capacity* of the battery so formed is increased. The capacity of the resultant battery pack is the sum of the capacities of the individual paralleled batteries which make it up.

For example, assume that we have two 12 volt automotive batteries we wish to wire in parallel to increase the capacity of the resultant battery pack (remember the voltage will stay the same – 12 volts). Each 12 volt car battery is cased individually. In each case there are 6 lead-acid cells in series to produce the output voltage of 12 volts. Let's assume one 12 volt battery has a capacity of 100 ampere-hours and the other has a capacity of 60 ampere-hours. The resultant battery formed by paralleling the two 12 volt car batteries will have a capacity of 160 ampere-hours.

In a parallel wiring configuration, all the *anodes* of the paralleled batteries are connected together, as are all the *cathodes*. The illustration below demonstrates the paralleling of two car batteries to produce a battery pack of larger capacity.

Batteries in Parallel to Increase Capacity



Series and Parallel Interconnection Used Together

In renewable energy applications, the entire battery pack may contain both series and parallel cell interconnection. Since renewable energy battery systems usually run on voltages between 12 and 48 volts, there is always series interconnection between cells. In some cases, the batteries which have been used in series (for voltage increase) are then connected in parallel to increase the capacity of the entire battery system.

The basic battery used as a building block in the lead-acid illustration on page 34 is the Trojan L-16. This is a 6 volt, 350 ampere-hour, high antimony, deep cycle, lead-acid battery. Each L-16 has 3 lead-acid cells in series, all enclosed within a single battery case. Each individual cell has a capacity of 350 ampere-hours. Page 34 shows how these batteries are set up for more voltage and capacity.

The illustration on page 35 shows some alkaline cell configurations used in home power systems. Although I used a NIFE HIP-10 nickel-cadmium cell as a basic building block, these configurations will work for any sized nicad or nickel-iron cell. The HIP-10 is a high discharge rate, pocket plate nicad cell with a capacity of 100 Ampere-hours. Note that ten series cells are used for 12 Volt operation and twenty series cells for 24 Volt operation. Some 24 Volt systems have upper voltage limits and use nineteen series-connected alkaline cells.

These same wiring techniques can be used to assemble battery packs of any desired voltage and capacity. The wiring method is the same no matter what type of cell or battery is used. It is important to maintain a balance within the battery pack. It is highly desirable that all the individual cells making up a series string be the same size, type, and age.

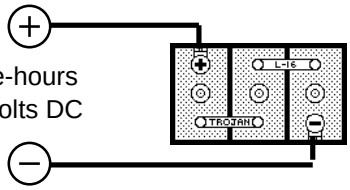
Capacity

A battery is like a bucket. When it is full, it's full and will hold no more. When it is empty, it's empty and will deliver no more. In the case of the bucket, the content is water or whatever. In the case of a battery, the content is electrical energy.

Capacity is how much electrical energy the battery will contain. The unit of capacity is the ampere-hour. Ampere-hour is often abbreviated as follows: amp-hr., A-h., and Amp-H. The larger the ampere-hour rating of the battery the larger its capacity. The ampere-hour is the product of the amount of current a battery will deliver and the time over which it will deliver this current. For example, a battery with a capacity of 100 ampere-hours will deliver 1 ampere for 100 hours. The same battery will deliver 10 amperes for 10 hours, or 100 amperes for 1 hour.

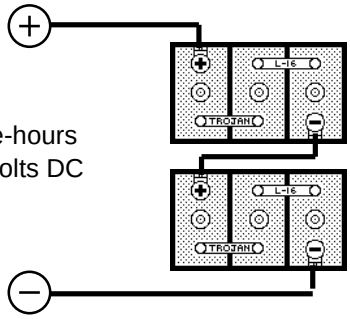
Batteries come in many sizes to suit many different applications. Automobile batteries have capacities between 50 to 100 ampere-hours. Large storage batteries in renewable energy systems have many thousands of ampere-hours. Flashlight batteries vary in capacity from 0.5 ampere-hours to 10 ampere-hours. The physical size and weight of a battery is roughly equivalent to its capacity.

LEAD-ACID CELLS CONFIGURED AS HOME POWER BATTERY PACKS



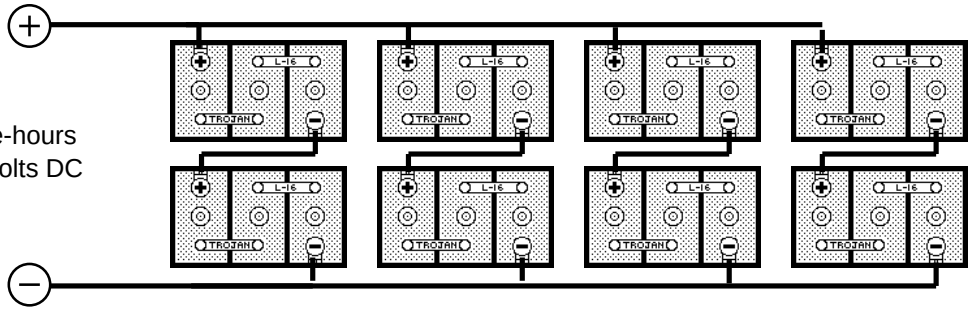
350 Ampere-hours
at 6 Volts DC

A single L-16 lead-acid battery composed of three series connected 350 Amp-hr cells yielding a battery of 350 Amp-hrs at 6 VDC.

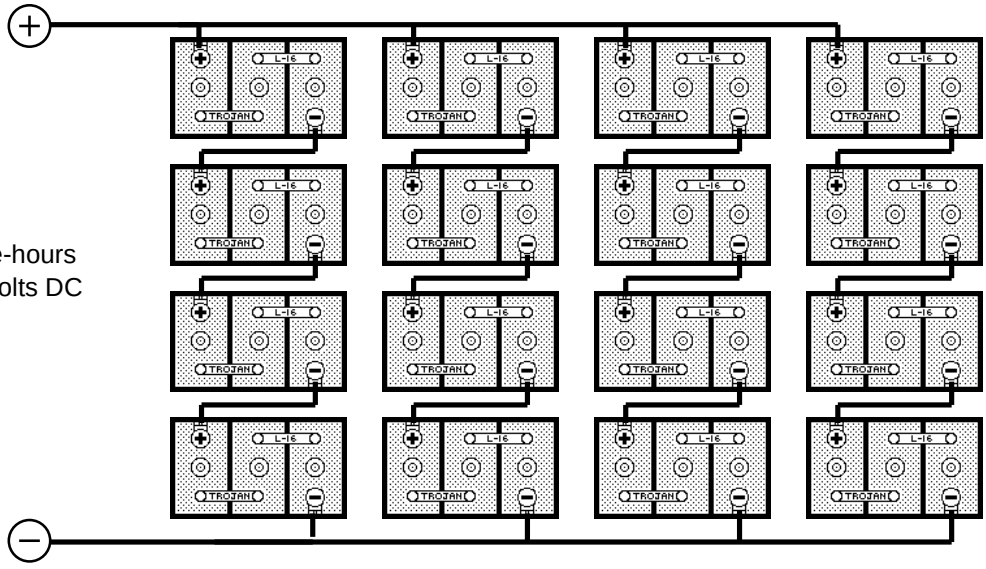


350 Ampere-hours
at 12 Volts DC

Two L-16 batteries wired into series for a resulting battery of 350 Amp-hrs at 12 VDC. This configuration is a basic lead-acid building block for 12 Volt home power systems.



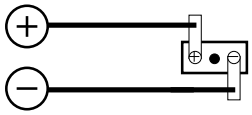
1400 Ampere-hours
at 12 Volts DC



1400 Ampere-hours
at 24 Volts DC

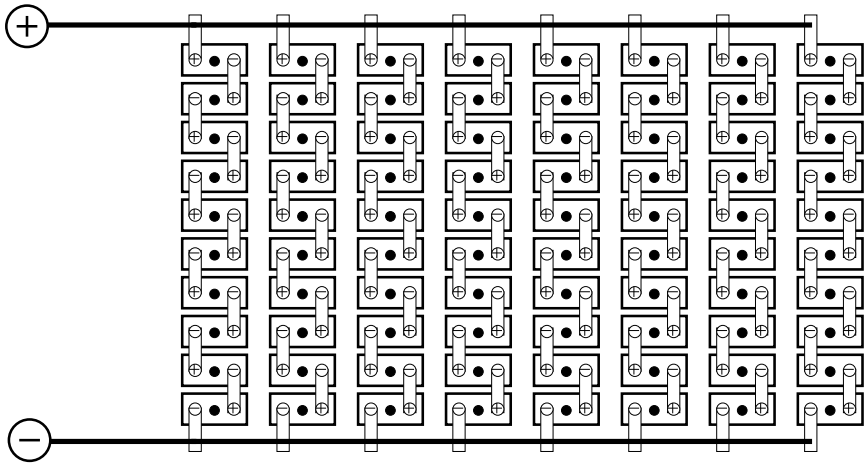
NICKEL-CADMIUM CELLS CONFIGURED AS HOME POWER BATTERY PACKS

100 Ampere-hours
at 1.2 Volts DC

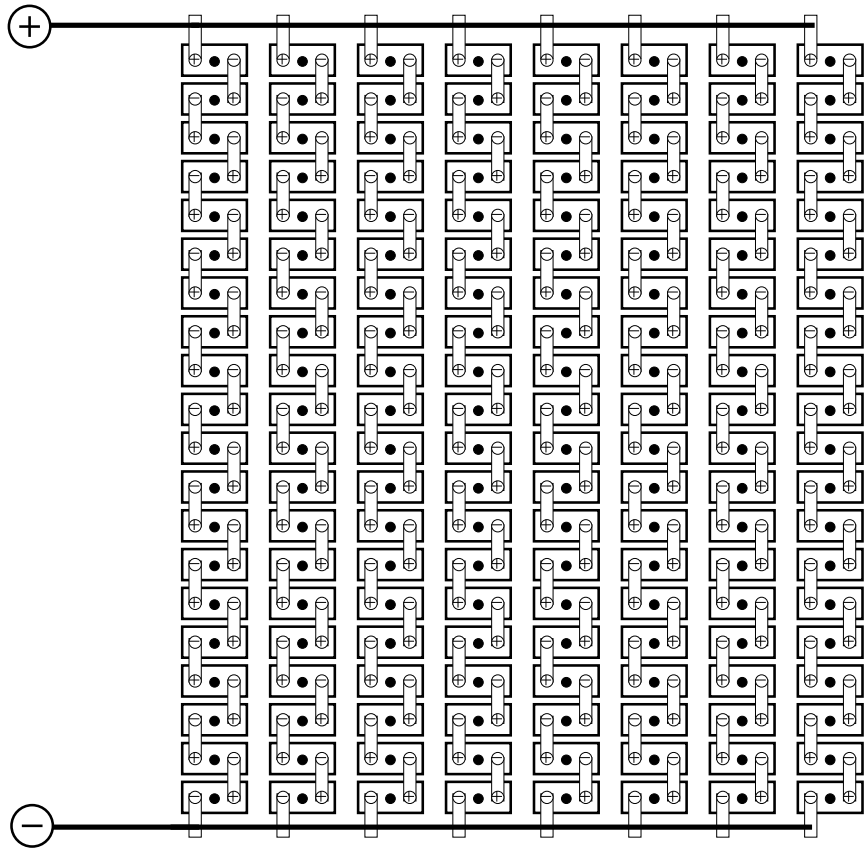


A single NIFE HIP-10 nickel-cadmium cell. Each cell has a capacity of 100 Amp-hrs at 1.2 VDC. Nicad cells can be assembled into battery banks as shown below.

800 Ampere-hours
at 12 Volts DC



800 Ampere-hours
at 24 Volts DC



State of Charge
The state of charge of a battery tells how much of the battery's electric power is available for use. State of charge is like asking, "How full is the bucket?"

A battery which has its entire capacity available is said to be at a 100% state of charge. A battery which has had half its capacity removed is said to be at a 50% state of charge. A battery which has had its entire capacity withdrawn is at 0% state of charge.

The state of charge of a battery is important because it tells us when it is discharged and needs recharging. It also tells us when the battery is full and when to stop recharging.

Rate of Charge or Discharge.
The rate of charge or discharge of a battery is expressed in terms of the battery's capacity. This is done even though the rate of charge or discharge is a current which is actually measured in amperes. This is important and can be confusing. The charge or discharge rate is expressed in amperes, as the battery's rated capacity divided by a time factor. This time factor is the amount of time during which the battery is cycled. As an equation it looks like this:

$$I = C / T$$

where:
I = Rate of charge or discharge expressed in amperes
C = Battery's rated capacity expressed in ampere-hours
T = Cycle time period expressed in hours

For example, consider a fully charged battery with a capacity of 100 ampere-hours. If this battery is totally discharged within a 10 hour period, then the rate of discharge is 10 amperes. Such a rate of discharge is known as a C/10 rate. If the same battery is discharged within a 50 hour period, then the rate of discharge is 2 amperes, or C/50. The same format refers to the charge portion of the cycle. A battery which was fully discharged and is refilled during a period of 10 hours is being recharged at a C/10 rate.

Rates of charge and discharge in batteries are commonly referred to as ratios between battery capacity (in A-h) and time. The actual amount of current used in each particular case is dependent on the battery's capacity. This allow us to express rates of charge and discharge in general terms rather than as specific quantities of current.

For lead-acids, consider C/5 to be a maximum rate of discharge or recharge. For pocket-plate nickel-cadmium cells, consider C/2 to be a maximum rate of discharge or recharge.

And from the lowly cell…
The more we understand about the electrochemical cell, the more we understand about our battery. This subject can be as deeply demented as the nature of the chemical bond, or as simple as, "A Battery is Like a Bucket." I hope you have enjoyed this short trip into the electrochemical cell. With a little encouragement, I'm sure we can delve into exactly how to operate each type of cell. I welcome your feedback.

Access
Author: Richard Perez, c/o Home Power, POB 130, Hornbrook, CA 96044 • 916-475-3179

KS Wind Full Page

Working With Nonmetallic-Sheathed Cable (Romex®)

David W. Doty

Nonmetallic-sheathed cable, or Romex® as it is often called in the electrical trade, is an excellent choice for residential wiring. It is easy to work with, inexpensive, abundant, and long lasting when installed properly.

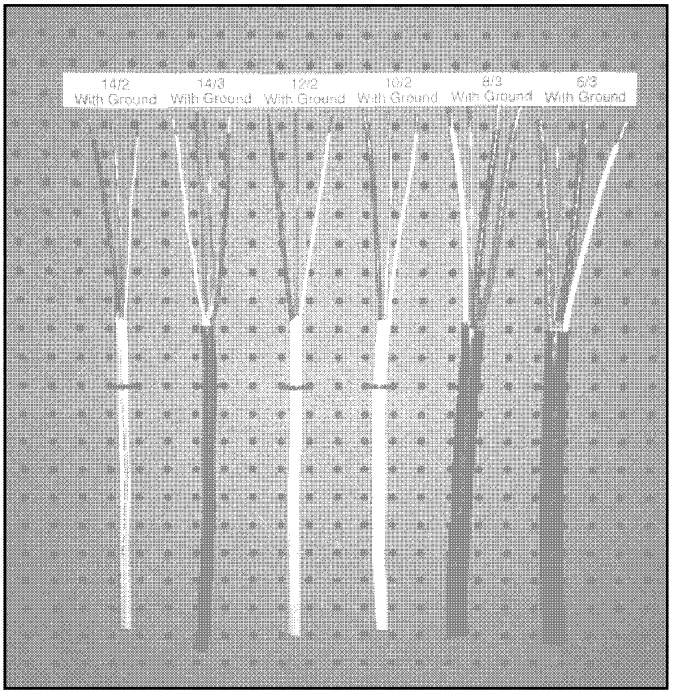
Construction

Nonmetallic-sheathed cable is a factory assembly of two or more insulated conductors covered by an outer sheath. In addition to the insulated conductors, the cable may (and usually does) include a bare or insulated grounding conductor. Cable is available with copper conductors ranging in size from No. 14 to No. 2 gauge. Cable with aluminum or copper-clad aluminum conductors is available in the No. 12 to No. 2 sizes. Although aluminum is available, I would avoid using it because of the potential corrosion problem at the connections. Photo 1 shows various types and sizes or nonmetallic-sheathed cable.

The most common type of cable is designated Type NM by the National Electrical Code® and is covered in Article 336 (NEC®-336) in the 1990 Code book. This cable has an outer sheath made from a flame-retardant and moisture-resistant material. The insulation on the inner conductors is rated at 90° C. Manufacturers designate their cable as NM-B. The "B" was added to distinguish the cable from earlier cable manufactured before the 90°C insulation rating was required. In spite of this 90°C rating, the conductor ampacity is based on a 60°C insulation rating (NEC®-336-26). The maximum rating of copper cable at 60°C is shown in table 1.

Applications

NM cable may be used in one or two family and multifamily dwellings as well as many other structures. It may be used as both exposed or concealed wiring in areas that are normally dry. It may not be embedded in concrete or used in structures exceeding three floors above grade, commercial garages, theaters, places of assembly, or motion picture studios. Type NM cable is also prohibited in battery rooms. This should be of special interest to AE users. Article 336-4 of the NEC® covers these areas where NM cable may not be used.



Above: Photo 1 shows different types of nonmetallic-sheathed cable.
Photo by David W. Doty

Table 1
Copper Wire Ampacity
60°C insulation

Wire Size	Ampacity
#14	15 amperes
#12	20 amperes
#10	30 amperes
#8	40 amperes
#6	55 amperes
#4	70 amperes
#2	95 amperes

Installation

When NM cable is used as exposed wiring, it should be installed so that it closely follows the building surface (NEC® 336-10(a)). We do not want it hanging out and catching on everything that goes by. NM cable should also follow the lines of the building. In other words, do not run it at odd angles across walls or ceilings. Running it at odd angles may save you a couple feet of wire, but it will be a very poor looking installation. Article 110-12 of the NEC® requires electrical equipment to be "installed in a neat and workmanlike manner."

Physical Protection
Cable should be protected against physical abuse where necessary. This can be accomplished with conduit, guard strips, or by other means. It must also be protected by conduit extending at least 6 inches above the floor surface where it penetrates floors in exposed applications (NEC® 336-10(b)). When run at angles to joists in unfinished basements, the smaller size cables must be run through bored holes in the joists or on running boards. Cables with two No. 6 or three No. 8 conductors and larger may be run directly across the edge of the joists. When run parallel to the joists, all sizes of cable will be secured to the side of the joists (NEC® 336-12). Holes bored in joists or studs for NM cable must be positioned so that the edge of the hole is at least 1.25" from the edge of the framing member (NEC® 300-4). This is required to prevent nails or screws from penetrating the cable. If you are using 2X4 studs with an actual size of 1.5 inches X 3.5 inches, the largest hole you can bore would be 1 inch in diameter. A 1 inch hole would have to be perfectly centered on the stud in order to maintain the 1.25 inch spacing on each side of the hole. If this spacing can not be maintained, a steel plate at least 1/16 of an inch thick must be placed on the edge of the stud or framing member to protect the cable.

Support
NM cable must be supported at intervals not to exceed 4.5 feet. It must also be secured within 12 inches of a steel box or cabinet which contains a cable clamp (NEC® 336-15). When using plastic boxes, the cable must be secured within 8 inches of the box (NEC® 370-7(c)). The exception to these rules is where the cable is fished into existing finished walls, where it would be impossible to support the cable. The most common method of support is the use of staples which are made specifically for this task. These staples are available in a variety of sizes for different size cables and are relatively inexpensive. Staples should be driven in straight and in such a manner so as not to damage the outer sheath of the cable.

Bends
When bending or handling NM cable, care should be taken to prevent the outer sheath from being damaged. The minimum bending radius is 5 times the diameter of the cable (NEC® 336-14). For a #12/2 cable with ground, the minimum bending radius would therefore be approximately 2.5 inches.

Less than 50 volts
Article 720 of the NEC® covers systems operating at less than 50 volts. The minimum size wire allowed for systems operating at less than 50 volts is No. 12 copper or equivalent. For circuits supplying more than one appliance or appliance outlet, the minimum conductor size is No. 10 copper or equivalent (NEC®-720-4). You must also consider the voltage drop associated with these low voltage circuits. The maximum permissible voltage drop for branch circuits should be 3% or less (NEC®-210-19(a) (FPN No. 4)). This means that you can loose only 0.36 volts in your wiring for a 12 volt system, or 0.72 volts for a 24 volt system. For a system operating at 120 volts, you could lose up to 3.6 volts in your branch circuit wiring. Table 2 shows the maximum one-way distance in feet for #12 through #2 NM cable for systems operating at 12 volts at various current levels. For systems operating at 24 volts, multiply the distance times

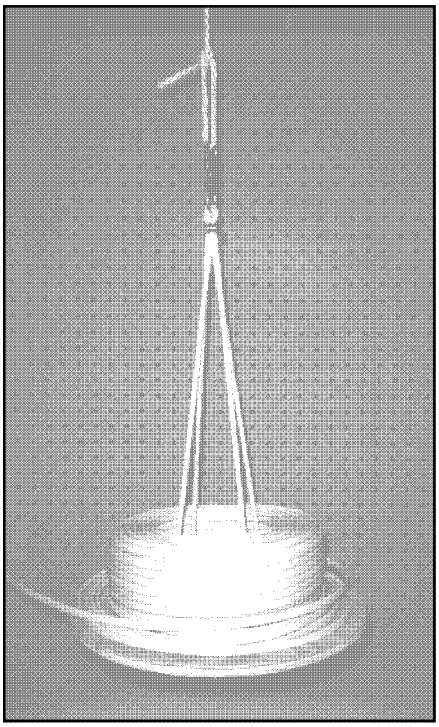
Table 2
Maximum One-Way Distance in Feet
12 Volt Branch Circuits @ 3% Loss

Circuit Amps	WIRE SIZE (American Wire Gauge)					
	#12	*#10*	*#8*	*#6*	*#4*	*#2*
2	56.60	90.11	143.29	227.73	362.17	575.82
4	28.30	45.05	71.64	113.87	181.09	287.91
6	18.87	30.04	47.76	75.91	120.72	191.94
8	14.15	22.53	35.82	56.93	90.54	143.95
10	11.32	18.02	28.66	45.55	72.43	115.16
12	9.43	15.02	23.88	37.96	60.36	95.97
14	8.09	12.87	20.47	32.53	51.74	82.26
16	7.08	11.26	17.91	28.47	45.27	71.98
18	6.29	10.01	15.92	25.30	40.24	63.98
20	5.66	9.01	14.33	22.77	36.22	57.58
25		7.21	11.46	18.22	28.97	46.07
30		6.01	9.55	15.18	24.14	38.39
35			8.19	13.01	20.70	32.90
40			7.16	11.39	18.11	28.79
45				10.12	16.10	25.59
50				9.11	14.49	23.03
55				8.28	13.17	20.94
60					12.07	19.19
65					11.14	17.72
70					10.35	16.45
75						15.36
80						14.40
85						13.55
90						12.80

2. For 120 volt systems, multiply the distance times 10.

Miscellaneous Requirements
Where NM cable enters a box, the outer sheath must extend at least 0.25 inches into the box (NEC® 370-7(c)). Also, a minimum of 6 inches of free wire is required in the box to allow for splices or connection to fixtures or devices (NEC® 300-14). Often I run across wiring done by amateur electricians where there isn't enough wire left in the boxes. They cut the wires so short that it is almost impossible to remove the outlet or switch that they are connected to. At the other extreme, if you leave too much wire, you may not be able to stuff it all in the box.

Unreeling
NM cable in the smaller sizes normally comes coiled up in a box in 250 foot lengths. For jobs that require more than a couple feet of wire, the entire roll should be removed from the box and unrolled so that the cable lies flat and is not twisted. Cable that is twisted is very difficult to pull through bored holes. Photo 2 shows a simple device, made from a piece of plywood, some rope and a swivel, to facilitate unrolling cable that comes in a box. It is hung from an overhead support (rafter or whatever) by a rope and allows the wire to be unrolled without twisting. I do not know who originally came up with this idea, but it is simple and works quite well.



Above: Photo 2 – a cable unrolling device.
Photo by David W. Doty

Stripping
If you are installing much NM cable, it's worth a trip to the hardware store to buy a tool made just for stripping the outer sheath. These tools, which are designed for flat cable, cost under two dollars and are worth the money. The sheath is removed by slitting it down the middle on one side, peeling the sheath back, and trimming it off. My favorite is manufactured by Gardner Bender, Inc. (Cat.#CR-100). The sheath can be removed with a knife, but with the tool you run less risk of damaging the insulation on the conductors.

Connections
When properly applied, twist-on wire connectors (commonly called a Wire-Nut®) will make reliable long lasting connections. It should be noted that these connectors are rated for use in dry locations only. Do not use them outdoors and expect the connection to last. There are many different brands of connectors on the market. My favorite is the Wing-Nut® made by Ideal. Its design gives you a lot of leverage when twisting them on. Buchanan also makes a connector very similar to the Wing-Nut® which is also quite good.

Sources
National Electrical Code® 1990- National Fire Protection Assoc.

Standard Handbook for Electrical Engineers edited by Donald G. Fink and H. Wayne Beaty

Access
Author: David W. Doty 14702 33rd Ave NW, Gig Harbor, WA. 98332 • (206) 851-2208

Things To Know Before Buying Solar DHW

Steve Shewmake

Shopping for a solar DHW (domestic hot water) system can leave you confused and lost in a maze of designs, equipment, and installers. Whether you buy equipment to install yourself or hire someone to do the job, here are some things you should know.

Freeze Protection
This is one of the most critical factors when choosing a solar DHW system. Freeze protection should be appropriate for your climate and elevation. Consider the worst conditions that CAN occur. It only takes one good freeze to do expensive damage. Insurance companies seldom pay a freeze damage claim on equipment with insufficient freeze protection.

Active Systems
The most common types of freeze protection for active systems are: Draindown, Drainback, Closed Loop (anti-freeze), Recirculation or "Recirc", and Manual Drain. These are also the names used to identify each type of system. Here are brief descriptions, and things to consider about each.

Draindown
This method uses an electromechanical valve or valves to drain the system when the control senses an approaching freeze condition. The collectors and all piping in the solar loop MUST drain. A minimum slope of 1/4" per foot is recommended. This includes internal piping in the collector as well. If the architecture of your house will not allow plumbing to run downhill between the collectors and storage tank, or if the panels cannot be mounted so they will drain, you should rule out this type of system.

Also, a certain amount of maintenance and system monitoring is necessary to ensure that freeze protection will function properly. For example, a vacuum relief valve in the plumbing near the collectors may need to be checked and serviced occasionally. If you have a steeply pitched roof, this may not be a simple task.

Drainback
In this type of system, the collectors and solar loop piping drain into a reservoir whenever solar energy is not being collected. Again, the collector and all solar loop piping must be able to drain. However, no vacuum relief valve is used so climbing on the roof can be avoided.

Closed Loop
In terms of freeze protection, this type is the most fail-safe. A non-freezing fluid is circulated through the collector and solar loop piping. In situations where the collector or piping cannot drain, this is a good option. Bear in mind that the heat transfer fluid, usually ethylene or propylene glycol, will need to be changed about every five years. Also, the slightest leak in the solar loop can eventually cause poor system operation and the expense of recharging.

Recirculation
In this system, freeze protection is accomplished by circulating warm water from the storage tank through the collectors when freezing approaches. This type of freeze protection should only be used in climates where mild freezes occur once or twice a year. Frequent use of this method wastes electricity as well as stored heat energy. This type of freeze protection is also rendered useless by a power failure.

Manual Drain
Although not recommended as a fail-safe method (you must remember to drain the system before cold weather), this is a simple, low cost design. This may work for you if you have a situation where solar is not beneficial in the winter months (poor exposure). Here again, collectors and piping must be able to drain.

Passive Systems
Most passive systems, even if charged with freon or anti-freeze (glycol), have water lines running to the roof unit. These lines must be well insulated. In harsher climates, some types, such as batch heaters, may need to be drained in the winter. If you live above 1000 feet elevation, stay away from passive thermosiphoning units that use electric resistance heat for freeze protection. This

can be costly and provides no freeze protection during an extended power outage.

System Sizing
System sizing is determining total collector area and storage-to-collector ratio. It depends on such factors as available sunshine, location, and most importantly, the actual hot water demand of your family, both now and in the future. For instance, a family of five, with two adults and three small children, will have a greater hot water demand when the children become teenagers. Also, make sure your system will have an acceptable storage to collector ratio. For example: a typical system might have 80 gallons of storage and 40 square feet of collector area (2:1 ratio). If the same storage capacity were used with 80 square feet of collector area (1:1 ratio), the system could excessively overheat in summer months, causing damage to system components. If 120 gallons of storage were used with 40 square feet of collector, solar hot water may seldom reach a usable temperature. Bear in mind that these numbers are used for illustration purposes. However, the 2 to 1 ratio is a good rule of thumb.

Equipment
Most solar DHW systems don't need much attention the first three or four years. Somewhere down the road, something will need maintenance, repair, and possibly replacement. Try to find out about these things in the beginning. This will save you money in the long run. Look at the equipment, especially the larger components such as tanks and collectors. Are they well built? If something looks flimsy or sloppily constructed, beware. Collectors are especially critical since they have to withstand wind, snow, and ultraviolet degradation. The question is not how long it will last, but how long will it last on *your* roof?

Power Consumption
Pumps, which are usually the only significant power users, run anywhere from 3 Watts to 48 Watts DC and 25 watts to 250 watts on 120 vac. Controls use from 5 w to 10 w, 120 vac. Electromechanical valves, such as those used in draindown systems, normally run somewhere between 3 w and 7 w, 120 vac. Expect these components to operate from three to nine hours daily, depending on time of year, weather, location, and system design.

Manufacturers and Warranties
Whether you are buying equipment, or a complete installation package, it is always good to inquire about the various manufacturers of system components. You should ask questions such as: if the folks who sold the equipment go out of business, will the manufacturer(s) be accessible for support and repair parts? What is actually covered by the warranty and for how long? Of course, warranties are only as good as the company behind them. These days, even the largest business can change or disappear overnight. A good rule of thumb: buy equipment that has components easily replaceable through more than one source.

Installation
If you are planning to install the equipment yourself, make sure you have adequate instructions, especially regarding safety and building codes. If not, find out who can give you hands-on type information during the installation.

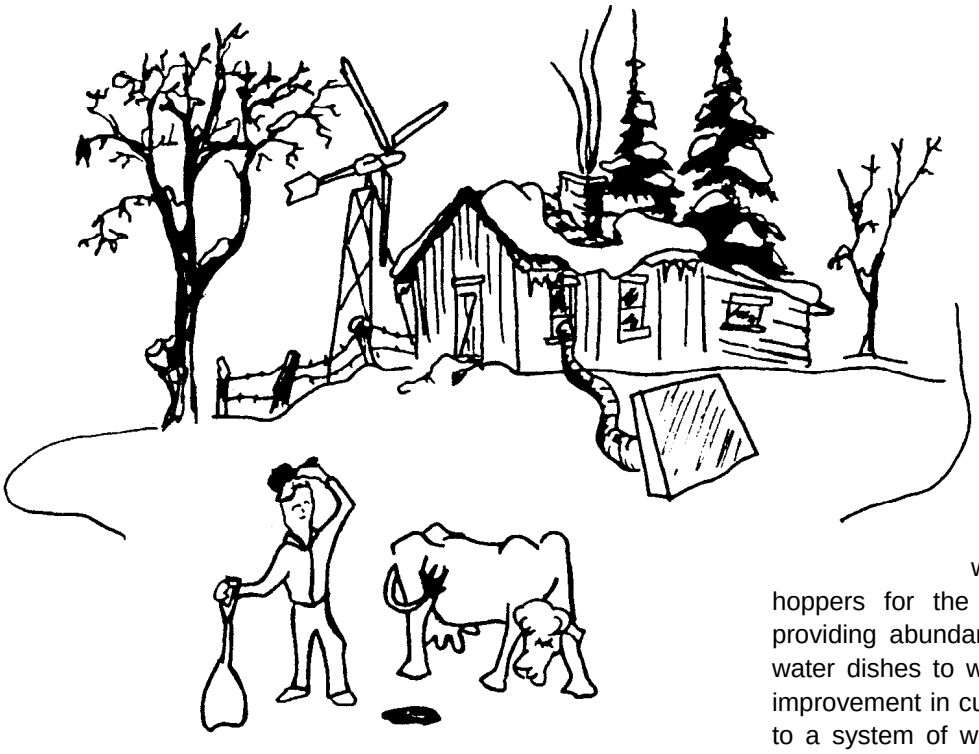
If a contractor installs your system, make sure the persons actually doing the work are qualified. Ask if it's possible to see other installations they have done and talk to the home owners. A contractor worth his salt will usually have these types of references. As a rule it's best to deal with licensed contractors. This doesn't always ensure competence, but it will give you better recourse if things go wrong.

When the job is done, ask for a "walk-through" of the system. An owner's manual should also be part of the package. This might include basic system diagrams, troubleshooting common problems and what to do in an emergency. Labelling of key components, valves and switches can also be quite helpful.

Conclusion
A solar DHW system is a long term investment. Make sure the system you buy will continue to work for you. Reliability of equipment, manufacturer/retailer support, proper installation and appropriate design, are all important things to consider before making a choice.

Access
Author: Steve Shewmake, 10607 Bragg Ave., Grass Valley, CA 95945 • 916-272-5730

Eco-Logic



More On Methane

Al Rutan, the Methane Man

In the last issue of HP, the methane article praised the ease with which gas is used – merely turning a valve to have instant vapor fuel. It takes so little effort. If gas is so easy, how does fifty pounds of stuff get pushed around without any effort? Aw...you caught the inconsistency!

The article in HP26 says that we need about 50 pounds of waste daily, a mixture of manure and carbon material to feed the digester that will turn this material into about 200 cubic feet of gas.

The focus of this article is just this problem. As anyone who has done any kind of homesteading knows, there is a hard way and an easy way to do every job. Part of the endearing quality of American ingenuity is to see how people can approach a task that is downright tedious, and by some clever manipulation, make it easier.

Easy is Better

This really became a lesson taken to heart while living at Red Lodge, Montana. I was in the middle of a project raising rabbits for market – lots of them, about 200 breeding does producing litters.

Feeding and watering this number was a time-consuming chore. I made hoppers for the hay and feed pellets early on, but providing abundant water was a drag. I upgraded from water dishes to water bottles with a valve. This was an improvement in cutting down the labor. The big jump was to a system of watering valves fed by little plastic lines from a central tank with a float valve to control both the water level and pressure on the water lines.

In one situation, the water was put into 200 little water bowls which were constantly being spilled or fouled with waste. In the other, water was supplied by a small pipeline with drinking valves in each cage. The result was the same – water to drink, but the effort needed was totally different. The two situations accomplished the same effect – abundant fresh water.

Consider the Critters

There is another consideration that must be brought to mind at this point. In the methane process, we are working with living creatures. Therefore a moral dimension must be considered if we are going to achieve a measure of serenity for ourselves in this whole process.

To have a genuine sense of well-being about the entire operation, the animals and the space for which the person is responsible must have an ongoing atmosphere of serenity. If this sounds a little bit like St. Francis of Assisi, well, so be it and no apologies. The purpose of life is not merely accomplishment, but accomplishment in a caring and respectful way.

As people, we harness the work of creatures. Some may maintain this is not right. I don't agree. I do feel strongly that the animals with which we work and upon which we depend do have the right to a reasonable quality of life. So at this point we are talking about animal rights. The concept of animal rights means different things to different

people. To me, it means that an animal has a right to a reasonable quality of life. An animal has a quality life when it feels good about itself. This is most clearly evidenced by grooming. Animals, if they feel good about themselves, groom themselves and their friends.

Quality of Life

Death for an animal, or a person for that matter, is not the worst thing that can happen. Quality of life while something is alive, be it plant, animal or person, is of major importance in the scheme of things. One who homesteads can not be mentally well off if such a person is not sensitive to the quality of life of the living things around the homestead. Are the animals feeling good, as evidenced by their grooming?

A Dilemma

Now, why make a point of this if we are talking about methane and manure? We are faced with a dilemma. On the one hand we want to collect waste with the least effort possible and do it as automatically as possible. On the other hand, we need to have a measure of sensitivity to the needs and quality of life for the animals on which we depend.

If the animal wanders about freely, it will be very difficult to collect its waste. On the other hand, if the animal is tightly caged or tied, its quality of life is virtually nil. So what's the answer?

Somewhere there is a middle ground. Chickens, for instance, do most of their pooping while they are perched at night. Milk cows leave a quantity of used grass in the gutter while being milked or held in the barn during the night.

Hogs that are totally confined don't have much of a life. Hogs that are confined only through the night will leave a good share of their waste behind when penned only part of the time.

Chickens do not do well housed on hardware cloth because their natural inclination is to peck and scratch. I've seen a roost system where the area under the roost was wired with large chicken wire mesh. The chickens could not get to the manure to disturb it after a night of roosting. They were free to roam at will during the daytime.

Slatted floors are useful for both hogs and cattle from the standpoint of cleanliness if the animals are not required to stand on them at all times. In all these design considerations for an enclosed area, the needs of the animal must be considered if we are to have happy animals.

Moving the Material While It's Warm

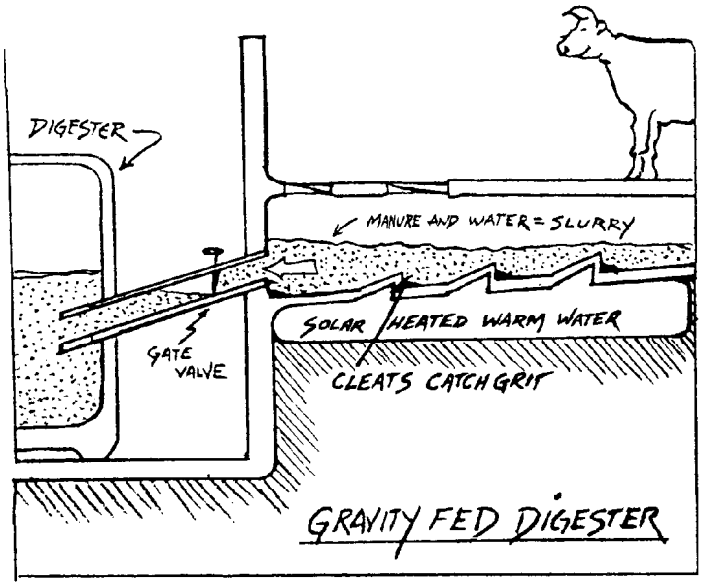
It is the matter of manure itself. How can a person move it with the least effort possible? Manure delivery systems have been devised for various types of critters, except the horse. To my knowledge, there is no device more automatic than a scoop shovel for cleaning out a horse stall.

If one DOES have animals, the feces HAVE to go somewhere. So at that point it makes a great deal of sense to turn the waste into vapor fuel (methane) and compost.

When the waste comes out of an animal, it is at exactly the right temperature – body temperature. As it lies on the ground, it cools off. This cooling during the cold time of the year is severe. The sooner the waste is transported from the animal to the tank the better. If the waste loses heat, then the heat must be restored to have the methane digestive process occur in the best manner possible.

This brings us to the biggest challenges in the entire methane procedure. How do we gather the manure to begin with? How do we gather it as soon as possible after it leaves the animal and before it cools down?

There are two natural forces that work well for us. One is gravity and the other is water. In rolling countrysides, barns are commonly built on hillsides. The hayloft is easily accessible by simply driving in rather than having to go through the labor of hoisting every bit of hay with some kind of sling mechanism. The hay is forked down to the animals below, using gravity.



Gravity Works for Free
The more that gravity can be utilized for tasks the better. The animal walks around. It can walk up as well as down. If the housing for the animals can be above the digester, then this saves work.

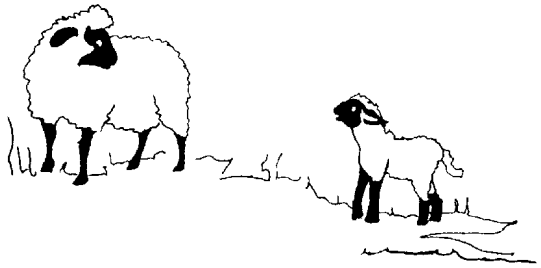
Water has long been used for transport. Since the development of the flush toilet, in the 1850's in England by Mr. Crapper (no kidding...that really was his name!), we have been using water to move feces.

Using water has a problem. What I am going to say now is exceedingly important. Many an engineer and university professor working with the methane concept cannot seem to grasp a simple fact. It is the nature of liquid – especially water – to release heat. When water is heated, it will not retain its heat. We say, "It cools down."

Water Must Be Warm
If we are going to use water in the process of transporting manure, and have it work well, we must understand that water cannot be allowed to stand around waiting for the waste. Warm water can and certainly should be used to wash down a gathering point below a slatted floor. The gathering point had better not be a holding pit in the ground because the whole thing will cool off to ground temperature. Another consideration is that in a pit the methane activity begins right away, so animals above a pit are breathing contaminated air. This is why holding pits MUST have ventilation fans if they are under confinement areas.

Think in Terms of Free Energy
How does one have warm water with which to transport? Each location will have its own plusses and minuses in working out this design problem. A person has to consider all the ways of capturing "free" thermal energy – solar, wind, whatever, and applying it to the situation at hand.

We're most likely looking at periodic washing down of a gathering area with warm pressurized water. This will both increase the force of the wash and cut down on the amount of warm water needed. The more automatic the concept can be and the less labor intensive, the more of a ideal situation a person can enjoy.



Do We Really Need Animals?
So just how practical is the thought of having animals around a homestead? The trend is increasing for relying less and less on animal parts for human food. Folks tend to become more and more vegetarian. We still need the family mule to plow the garden, a few milk goats for the delicious and healthful treat of fresh goat's milk, or a few sheep to produce wool for hand spinning and the cottage loom. There is wisdom in involving some kind of animal support in our homesteading.

Farmers who raise nothing but corn are still hooked into the food "grid" when they drive to the store for their butter, milk, and eggs. Our great grandparents would shake their heads!

Access
Author: Al Rutan, the Methane Man, P O Box 289, Delano, MN 55328

Grounding – Why?

John Wiles

Proper grounding of renewable energy systems may prevent loss of life. Proper grounding may also prevent damage to alternate energy power systems, expensive computers, telephone gear, and ham radio or other communications equipment. Proper grounding can also minimize the electromagnetic emissions from inverters and fluorescent lamps. Proper grounding may be required by law.

Establishing the Requirement

The basic fundamentals of direct and alternating current electricity have been well understood for nearly a hundred years. They apply to alternate energy power systems as well as central power plant systems. Materials, practices, and systems needed to make practical use of electrical energy have changed considerably since the days of Westinghouse and Edison, and they are continually evolving.

The National Electrical Code (NEC), published by the National Fire Protection Association, and numerous documents published by the Institute of Electrical and Electronics Engineers (IEEE) represent the best and most recent thinking on the subject of grounding. Well researched publications by Bechtel Inc. and others provide further substantiation on the need for and methods of grounding.

The Law

In areas of the country covered by the NEC, the law says that all electrical power systems will have exposed, noncurrent-carrying metal surfaces grounded. This ground is called the equipment ground and requires a third, noncurrent-carrying conductor. There are no exceptions for low-voltage, PV, wind, or hydro systems.

If the open-circuit PV module (or hydro voltage or wind generator) voltage exceeds 50 volts (generally any system rated above 24 volts), the NEC requires that one of the current-carrying conductors be grounded. This is known as the system ground.

When one of the current-carrying conductors is grounded (a system ground), surges that are induced on these conductors can quickly discharge to ground through the grounded conductor. If the system is floating with respect to ground with neither of the conductors grounded, then the induced surge of high voltage has no place to go except arc through insulation someplace in the circuit. This arc may damage insulation, and in some cases may start a fire.

These requirements for grounding are not whimsical, nor are they intended to create additional costs, nor are they imposed without thought to electronic or renewable energy systems. They are there for safety -- personnel and equipment. They have evolved over nearly 100 years and the people who establish these requirements work for some of the biggest names in the electrical power and electronics industries. Companies like Westinghouse, General Electric, IBM, and Raytheon among many others, are represented on the panels that write the NEC.

Even in Europe, the ac systems are grounded at the service entrance panel at the residence just as they are in the U.S. Europeans use far more ground-fault detectors and circuit interrupters than we do to find faults on their ungrounded distribution systems. Europeans don't ground some of their alternate energy systems, but standards and codes that are being drafted at this time will address that problem.

Grounding and Electronics

Concern has been expressed that the NEC grounding requirements are not addressing the special requirements of the electronics industry and therefore the needs of the renewable energy user. Anyone who is familiar with computers will know the absolute need for proper grounding. Multiple computers operating with modems and local area networks must have power and communications lines well grounded to the same ground system. Radio Shack sells a device that plugs into the ac outlet and contains modular telephone jacks to keep the ac power and telephone/modem grounds at the same potential and provide surge protection. There is a similar device to tie the ac power ground to the ground on a coaxial cable for antenna systems and radio frequency data communication systems. The telephone company grounds the telephone line to the ac power ground if there

is one.

All "Ham" radio operators know the need for good grounds, not only for maximum performance, but also to control radio frequency interference, and safely contain dangerous currents and voltages. Hams using PV for power may find that their PV systems are grounded through their rigs. If not, they have paid a pretty stiff price for isolated power equipment and antenna arrays.

The ballast found inside an ac fluorescent lamp will be marked; "Use in grounded fixture only." The microwave oven will have a three-bladed plug for proper grounding and it must be used to prevent microwave energy from escaping. Stereo and video systems have one side of the rf, video, and audio connecting cables grounded to the metal chassis. Outside television antennas generally are installed with grounded masts and a grounded surge arrestor is necessary for safest operation. Automobile radios used in PV systems have the negative power lead tied to the chassis as is the shield on the coaxial cable to the antenna. The chassis or antenna may be grounded. The use of any of these dc operated devices probably indicates that the dc system is grounded.

The most popular line of home-power inverters has the negative conductor connected to the case. Ground the chassis and the system is grounded – you have no choice, even on 12 and 24-volt systems where system grounding is not required.

The entire alternating current secondary power distribution system in the United States is grounded (except for 3-phase delta transmission lines). Complete magazines are published monthly dealing with power quality throughout the world. The largest problem area is separately grounded systems that have grown up over the years as various electronic devices have proliferated. The separate grounds being used for each individual system (the telephone system, the computer systems, and the radio communication system) have created quite a mess. Each system requires a ground for proper operation and safety. The best available solution (even Radio Shack knows about it) is to tie all the grounds together at a single point and provide surge protection from each service to the common ground. The NEC requires that all grounds (ac, DC, equipment, and communications) be connected to the same ground rod or if multiple ground rods are used, they be bonded together. The electronics industry who deals with this problem daily completely agrees.

Uninterruptible Power Systems (UPS) is one of the fastest growing industries in the country (far bigger than the PV industry). An UPS is nothing more than a battery bank, a charger, and an inverter with lots of electronics – just like PV. All are well grounded.

Grounding Benefits for Renewable Energy Systems

If PV or other alternate energy systems are properly grounded with both equipment and system grounds, a number of beneficial conditions will occur. Safety will be increased and the legal requirements of the NEC will be met. The system will be less likely to cause fires from short circuits. Radio frequency interference from inverters will be reduced – especially when the battery cables are in grounded metallic conduit. Compact and regular fluorescent lamps will start more reliably and produce less radio frequency interference. (Quicker starting of both ac and DC fluorescent lamps means longer life.)

Systems that are not grounded require two-pole disconnects. The one-pole disconnects allowed in a grounded system save far more money than the cost of the ground rod which had to be used anyway to comply with the equipment grounding requirement. (WARNING: Battery banks, especially those over 50-volts, should have two-pole disconnects in either grounded or ungrounded systems because of the danger from shock due to the electrolyte film and the danger of explosions from hydrogen gas. This is not an NEC requirement, but battery and PV industry personnel recommended it.)

Proper grounding does not cause problems in RE systems. Old stories of wind towers falling down with electrolyzed tower supports have been traced to improper grounding techniques or the use of the metal tower as a current-carrying conductor. Good grounding practices coupled with the proper use of overcurrent devices will provide equipment protection when faults do occur.

In Home Power Magazine 28, grounding methods will be covered.

Access

Author: John C. Wiles, Southwest Technology Development Institute, POB 30001 / Dept 3SOL, Las Cruces, NM 88005 • 505-646-6105

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

IEEE Green Book-Grounding, The Inst. of Electrical & Electronic Eng., 345 E. 47th St., New York, NY 10017

Power Quality Magazine, Intertec International Inc, 2472 Eastman Ave, Bldgs 33-34, Ventura, CA 93003-7079

Photovoltaic System Grounding and Fault Protection Guidelines, Bechtel, Research and Engineering Operation, San Francisco, CA

5 great! Print them all and add more!

4 Really good, print all

3 good, but I wouldn't miss some articles

2 its okay – just pick the best few and print them

1 rarely useful – don't reprint any of these

Dear Home Power Reader

Many of you have asked for a durable form of Home Power Magazine where the info is organized and easy to find. The four years since HP #1 have seen each issue with more solar, water, wind, and more. Still, it's nice to go back to earlier issues for basics, designs and schematics, and success stories in different places. Several early issues (#1-3 and #5-9) of Home Power are out of print, and there's only a hundred copies left of #4 and #10. What should we do?

We envision a book that groups the information in HP issues #1 through #10 and more by subject. We would correct and update all the old information and add new info. No pertinent data would be lost. All would be indexed, referencing the original issues. Appendices would include technical tables and our database of 900 RE businesses.

But what do you think? What would be useful and worthwhile to the Home Power Reader? What kind of articles do you get the most use from – system articles, homebrew, specific technical articles, letters, or what? What should we add and what should be left out? Would you prefer a durable hardbound cover, less-durable but less-expensive soft-bound, or a do-it-yourself hole-punched in-a-binder version. And how much money would the compiled information be worth?

We appreciate your input! Please fill out the following survey, fold it up, stick a stamp on it (or include it with your renewal), and drop it in the mail. The results will be published in issue #29 (two issues away). Thank you!

Reader's Survey on compiling out of print info

What kind of writing do you like the best? Please rate the categories by using the 5-point scale to the left. Please put your rating number in the box immediately to the left of the category.

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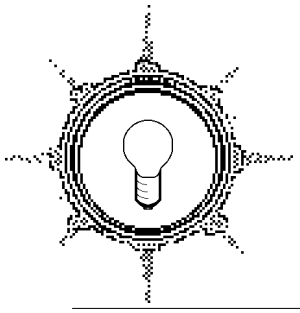

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The following information regarding your usage of alternative energy will help us produce a magazine that better serves your interests. This information will be held confidential. Completion of the rest of this form is not necessary to receive a subscription,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

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

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

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

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

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

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

☐ **Photovoltaic power**
☐ **Water power**
☐ **Wind Power**
☐ **Other**

HP#27

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

NOW	FUTURE		NOW	FUTURE	
☐	☐	**Photovoltaic cells**	☐	☐	**Gas/Diesel generator**
☐	☐	**Wind generator**	☐	☐	**Batteries**
☐	☐	**Water power generator**	☐	☐	**Inverter**
☐	☐	**Battery Charger**	☐	☐	**Control systems**
☐	☐	**Instrumentation**	☐	☐	**PV Tracker**

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& TAPE

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

☐ Check here if it's OK to print your comments as a letter to Home Power.

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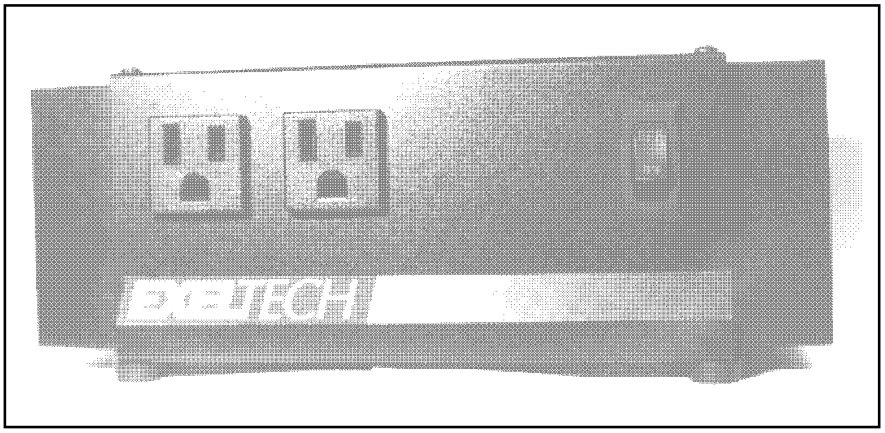
Things that Work!

Things that Work!
tested by Home Power

Exeltech's SI-250 Sine Wave Inverter



Above: the Exeltech SI-250 sine wave inverter.
Photo by Richard Perez.

tested by Richard & Karen Perez

The big news is completely clean, glitch-free audio and video from inverter power. This inverter makes **sine wave** power. In our test we powered a variety of stereos, radios, TVs, VCRs, and even a satellite TV system. All delivered noise-free performance. Gone was the annoying audio buzz on the stereo, gone were the black lines on the TV screen, all gone!

It makes Sine Waves!
The Exeltech SI-250 inverter takes battery-stored 12 VDC and turns into 120 vac sine wave power. The SI-250 is rated at 250 watts rms continuous output (2.12 amperes rms). This inverter makes true, smooth, sine wave power, not the modified sine wave power produced by almost every other inverter.

Modified sine wave inverters work well, and are ultra efficient and reliable. But they ALL have one major problem. When delicate electronics like VCRs, TVs, radios, and stereo are fed modified sine wave power, they have glitches. The sound portion of the program has a loud and obnoxious buzzzz that underlies everything. On the video screen, whether fed by a VCR, broadcast TV, or satellite TV, there are thin horizontal noise lines marring the picture. We've gotten used to the fact that modified sine wave inverters don't power entertainment electronics very well. We've learned to live with the noise and glitches. Well now we don't have to take it more!

The SI-250
This is a small inverter designed for use with a 12 Volt battery. It measures 3.5 inches high by 4.5 inches deep by 9 inches wide and weighs 3.5 pounds. The supplied documentation is adequate and contains a full set of technical product specifications.

The voltage operating range of this inverter is 10.5 to 16.5 VDC, making it nicad, nickel-iron, and lead acid compatible. We operated it at 16.8 VDC with no problems. The surge rating of the inverter is 350 watts for three minutes, but we got 380 watts out for 7 minutes and 7 seconds (room temp 78°F.). The SI-250 is equipped with over voltage protection at 17.5 VDC, and under voltage protection at 10.5 VDC. It is fully protected against any output overload or short circuit.

The Test System
We wired the Exeltech SI-250 into a 600 Ampere-hour, 12 Volt nicad battery system. This system is sourced by a PV array of sixteen modules. During our test we set the voltage regulator to maintain a voltage of 15.15 VDC.

Testing the SI-250
We used Fluke 87, true rms reading, digital multimeters to make the measurements. We inserted a 100 Ampere, 100 milliVolt shunt in series with the inverter's negative power line to the battery for DC current measurement. We also hooked up a Tandar oscilloscope so we could watch the inverter's output waveform. We used 120 vac incandescent light bulbs as loads for the generation of the data shown on the table.

The first thing we noticed was the inverter's waveform on the oscilloscope. It was a perfect, smooth sine wave. To see this sine wave, made by an inverter, was a thrill for all of us. We then proceeded to put the inverter through its paces, and produced the data in the table below.

The Exeltech SI-250's Performance

This inverter exceeds every specification of its maker. A quick look at the data will show that its voltage output (both peak and rms) was extremely stable. We have never before tested an inverter with this degree of stability. We stared, fascinated by the inverter's waveform on the scope. Even during overload, the inverter's waveform stayed as smooth as a baby's behind. We also ran a variety of inductive loads, like a VCR, a 21" TV, and a satellite TV system. The inverter's waveform never varied from a perfect sine wave. In actual fact, this inverter puts out power that is far more pure and stable than any available from a commercial utility.

We measured the inverter's no load current at 0.74 Amperes. No load power consumption was 11.2 Watts DC. We were able to operate 280 watts of lightbulbs for twenty minutes without shutdown. We repeatedly overloaded the inverter with a 1,500 watt electric heater and the Exeltech protected itself against damage. We measured the inverter's peak output at 6.89 amperes rms with a Fluke 87 in 1 millisecond record mode. This amounts to a surge power output of 810 watts.

The efficiency of this inverter is less than the modified sine wave types. We don't get something for nothing. Our data shows efficiency in the range of 65.7% for a 23 watt load, to 81.9% for a 132 watt load, and an efficiency of 81.3% for 281 watts output. This is about 15% less efficient than modified sine wave inverters.

Performance on all of our delicate electronics was and is outstanding. In our opinion, the increase in pleasure produced by buzz-free music and glitch-free video far outweighes the SI-250's lower power conversion efficiency. When we watch a movie on the VCR and big 21 inch Sony TV, we use an additional 75 Watt-hours of power from our system when using the SI-250 inverter instead of a modified sine wave inverter. This is about the daily production of one-third of one of our PV modules. We think the increased power consumption is worth the noise-free performance.

Applying the SI-250

This is not a whole-house inverter. It only puts out 250 watts. It has no sleep mode, and high no-load power consumption. This inverter is suited for one thing – powering noise sensitive electronics. It is best suited as a second inverter for those of us who already own large modified sine wave inverters. We use our SI-250 exclusively on our audio, radio, TV and video equipment. Here it gives us better music and better video than we have ever had from our PV/Wind system.

EXELTECH SI-250 Sine Wave Inverter Test

INPUT DATA on the 12 Volt DC side				**OUTPUT DATA on the 120 vac side**				**Inverter Efficiency**
Volts DC	**Amps DC**	**Watts DC**		**volts peak**	**volts rms**	**amps rms**	**watts ac**	**%**
15.17	0.74	11.2		164.0	117.8	0.000	0.0	0.0%
15.17	2.32	35.2		164.0	117.9	0.196	23.1	65.7%
15.16	3.47	52.6		164.0	117.8	0.334	39.3	74.8%
15.15	5.01	75.9		163.6	117.8	0.503	59.3	78.1%
15.15	7.66	116.0		163.6	117.8	0.800	94.2	81.2%
15.16	10.65	161.5		163.6	117.8	1.123	132.3	81.9%
15.16	12.29	186.3		163.6	117.8	1.292	152.2	81.7%
15.06	15.77	237.5		163.6	117.7	1.634	192.3	81.0%
15.01	17.65	264.9		163.6	117.7	1.806	212.6	80.2%
14.99	19.16	287.2		163.6	117.7	1.940	228.3	79.5%
14.90	21.18	315.6		162.8	117.7	2.180	256.6	81.3%
14.80	24.47	362.2		163.2	117.7	2.389	281.2	77.6%
14.85	25.28	375.4		162.0	117.3	2.407	282.3	75.2%
14.74	31.34	462.0		162.8	117.5	2.908	341.7	74.0%
14.54	36.54	531.3		162.4	117.4	3.240	380.4	71.6%

Conclusions

The era of sine wave inverter is here. The Exeltech SI-250 is the cleanest and most stable inverter we have ever tested. At a cost of $395, it is well worth having just as a second inverter to power just the audio and video gear. We use ours daily and sometimes plug our entertainment electronics back into one or other of the four modified sine wave inverters we use. We hear and see the noise and glitches that ruined our entertainment for years and immediately plug our fun back into the Exeltech!

Access

Authors: Richard & Karen Perez, c/o Home Power, POB 130, Hornbrook, CA • 916-475-3179

Maker: Exeltech, Inc., 7018 Baker Blvd., Fort Worth, TX 76118 • 817-595-4969

Things that Work!

Things that Work!
tested by Home Power

Steamco Solar Electric's SPM2000 System Power Monitor

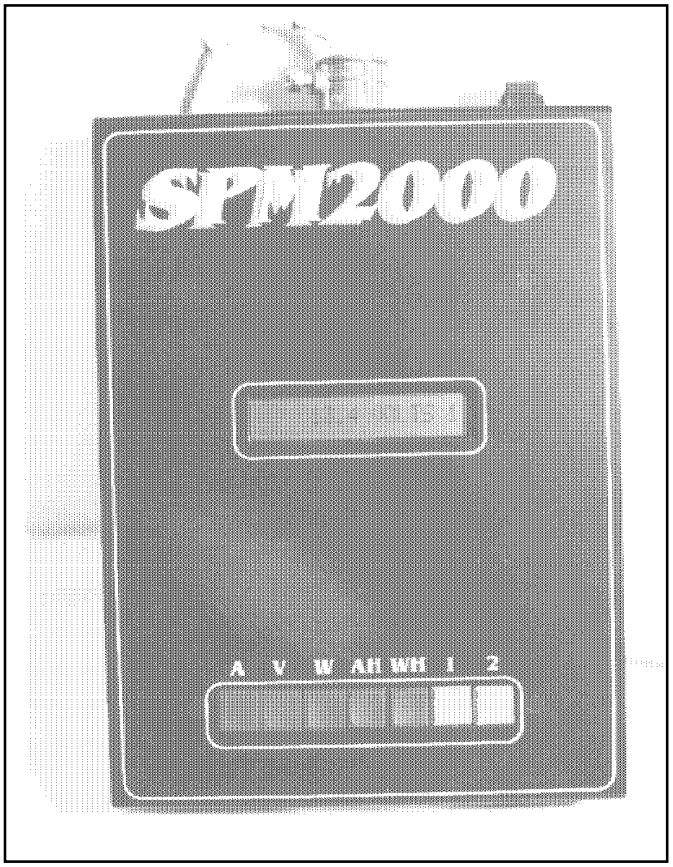
tested by Bob-O Schultze

The SPM2000 offers more functions than the average Ampere-Hour *cum* Multimeter system monitors on the RE market today. It displays Volts, Amps, Watts, Amp-Hours, or Watt-Hours on each of two separate channels. The advantage of this system is that it can be configured to measure both power produced and power consumed, monitor two different power inputs, or the power consumption of two different loads, or whatever your needs might be.

Shipping and Documentation

The SPM2000 arrived at HP's test site in a standard cardboard shipping box with the meter itself well protected by a generous amount of plastic bubble-wrap.

The 19 page manual is easy to read with large 14 point type (no squinting) and a good table of contents. Four pages of easy to understand schematics describe the basic shunts-to-meter connections and examples of various monitoring schemes. I particularly liked the two pages in the back devoted to the Troubleshooting Guide. With a minimum of six wire connections between the meter, the shunts, and the battery bank, plus the many possible variations of input/output configurations, the extra help for the do-it-yourselfer is much appreciated.



Above: the SPM2000 System Power Monitor.
Photo by Richard Perez and Bob-O Schultze.

Specifications and Installation

The SPM2000 comes complete with two 200 Amp, 100 mV. shunts. The shunts are supplied as an assembly with one end of both shunts bolted together with a thick copper buss bar. An in-line 1 Amp fuse, and about six feet of hook-up wires complete the kit. Unless you want to mount the monitor further than six feet from your battery bank, there is nothing else to buy. The meter itself is 6 inches wide, by 8.25 inches tall, by 2 inches deep. The all-metal box is designed for surface wall mounting and is electrically grounded to the battery negative terminal. Wire access is through a 1/2 inch EMT conduit connector which makes it ideal for NEC compliant systems.

The SPM 2000 will monitor either 12 or 24 VDC systems and is internally protected against reverse polarity in case of an installation "Oopsie!"

The monitor has an operating range of 10.0 to 40.0 VDC and an internal power consumption of 90 mA. It will display Amps to 199.9, Volts to 40.0, Watts to 7996.0, Amp-Hrs to 999999.9, and Watt-Hrs to 999999.9. I thought those last measurements were a bit much until I

used the SPM2000 for a 60 day consumption test of a SunFrost RF-16 and racked up over 31,000 Watt-Hrs! An easily accessed manual push-button clears accumulated Amp and Watt Hours.

Function and Measurement

The SPM2000 is easily operated. The LCD (Liquid Crystal Display) is large and very readable. A display contrast adjustment is provided to maximize readability under different lighting conditions. A horizontal row of push-button keys below the display select the function to be displayed. The keys are marked A, V, W, AH, WH, 1, and 2. When the corresponding key is pushed, the display will read Amps, Volts, Watts, Ampere-Hrs, Watt-Hrs, Channel 1, or Channel 2 respectively. For example, a display reading "4.5 AMPS 1" would indicate 4.5 Amps were flowing through Shunt #1. Pretty straightforward.

Using a Fluke 87 as the standard, measurements confirmed that the SPM2000 performed within the manufacturer's specifications for accuracy.

Warts

Just one problem and it's more of an omission. I'd like a backlight on the display. Most instrument installations are close to the batteries, controllers, etc. Usually, the places where those things live are in a shed, under a stairwell, or in some other poorly lighted area. A system monitor that is easy to see is going to be looked at more often.

Conclusions

I liked both the performance and the flexibility of the SPM2000. High quality components are used throughout and the monitor carries a full two-year parts and labor warranty. At a retail price of $399, the SPM2000 isn't cheap, but in this case you get what you pay for.

Access

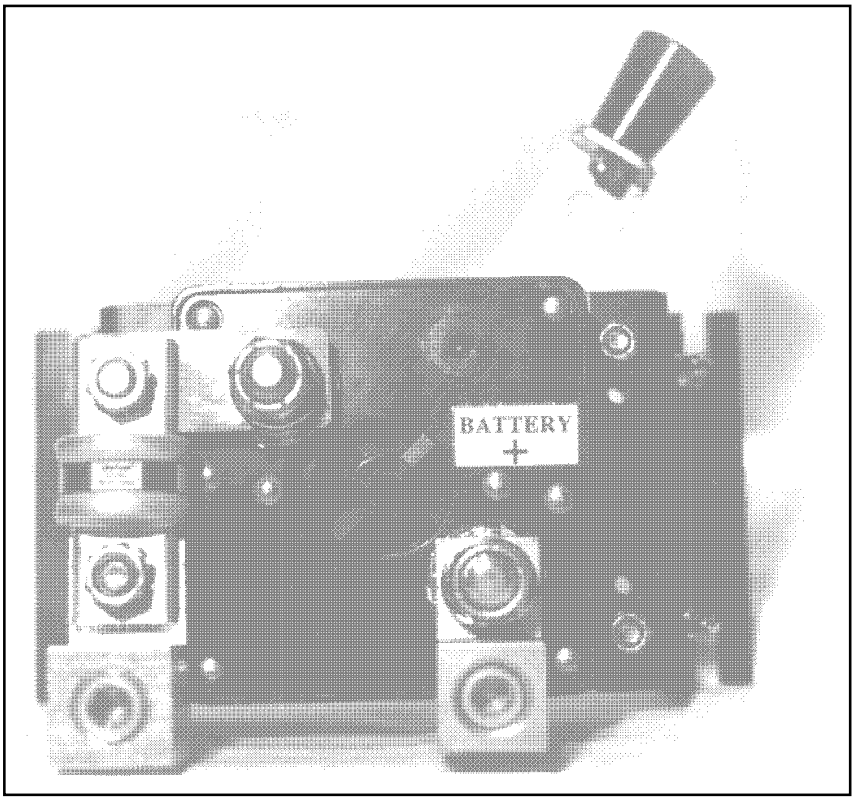
Author: Bob-O Schultze, Electron Connection, POB 203, Hornbrook, CA 96044 • 916-475-3401

Maker: Steamco Solar Electric, 2700 Cantu Lane NW, Bremerton, WA 98312 • 206-830-4301

Things that Work!

Things that Work!
tested by Home Power

Ananda Power Tech's Safety Switch



tested by Richard & Karen Perez, and Sam Coleman

THE BIG SWITCH. Everyone familiar with electricity knows about the BIG SWITCH. The Big Switch is what you pull when things don't go right, when electrical heaven and hell crashes in ruin about your feet. Ananda's 400 Ampere fused safety switch protects inverters, batteries, homes, and humans from catastrophic electrical failures.

So why a Big Switch?

When you have a battery you have a tiger by the tail. Even a small battery of a few hundred Ampere-hours can deliver thousands of Amperes of short circuit current for several seconds. Short circuits in the high current, low voltage wiring surrounding batteries and inverters can cause fires and even explosions. The main areas needing protection are the battery cabling and the cables from the battery which feed the inverter. These circuits can routinely transfer more than 300 Amperes of current. The National Electric Code requires, and common sense agrees, that these high current lines should have a fused disconnect. The Ananda Big Switch is up to this job.

About this Big Switch

Ananda Power Technologies designed this switch with inverters, operated from low voltage batteries, in mind. This switch will handle 2,000 Amperes of current. The model we tested (SF 400 T) is equipped with a 400 Ampere, DC Rated, Class T, current-limiting fuse.

The Ananda Big Switch measures 7.5 inches wide by 7 inches tall (including switch lever) by 4 inches deep. It is very solidly made and you should give it to your kids when you're done with it. The Big Switch is fitted with 250 MCM lugs which easily accepted the massive 0000 copper cable we used. The switch is activated from above by pulling a lever. The switch is enclosed in a plastic housing to prevent accidental electrical contacts.

The Big Switch Test

We installed the Big Switch in line between a large inverter and a 600 Ampere-hour, 12 Volt nicad battery pack (60 Nife HIP-10 cells in series/parallel). We used the 0000 copper welding cables, also made by Ananda, as interconnects. These five foot cables have massive soldered ring connectors. We inserted a 500 Ampere, 50 milliVolt, shunt in line to measure DC current flowing thorough the Big Switch.

We loaded the inverter and measured both the current flowing through the switch, and the battery voltage.

Simultaneously we also measured the voltage loss across the entire switch, fuse, and two associated 250 MCM connector assembly. Fluke 87 DMMs were used as measuring instruments.

The BIG SWITCH - a 400 Ampere fused safety switch for inverters made by Ananda Power Technologies

MEASURED DATA				CALCULATED DATA			
Switch Current Amps DC	Switch Voltage Loss mV.	Battery Voltage VDC		Power into Switch Watts DC	Power lost in Switch Watts DC	Switch Efficiency Percent	Switch Resistance Ohms (Ω)
4.0	0.95	13.91		55.64	0.004	99.99%	0.000238
7.0	1.50	13.89		97.23	0.011	99.99%	0.000214
12.0	2.30	13.88		166.56	0.028	99.98%	0.000192
15.0	2.80	14.03		210.45	0.042	99.98%	0.000187
15.5	3.00	13.57		210.34	0.047	99.98%	0.000194
21.0	4.30	13.85		290.85	0.090	99.97%	0.000205
122.0	24.00	13.06		1593.32	2.928	99.82%	0.000197
139.5	28.80	12.65		1764.68	4.018	99.77%	0.000206
297.0	63.10	12.00		3564.00	18.741	99.47%	0.000212
330.0	70.30	11.58		3821.40	23.199	99.39%	0.000213

Test Results

The table below shows the data we collected from operating the Big Switch and some interesting data we derived from our measurements. The bottom line is that we ran over 3,800 Watts of power (330 Amperes at 11.58 Volts DC) through this switch and it was 99.39% efficient (70.3 mV loss across the entire assembly). The performance of the Ananda Big Switch is outstanding! The entire assembly, including the actual switch, the fuse, and all the connections, had a median resistance of 0.0002057 Ohms during our entire test. The entire Ananda Big Switch assembly has less electrical resistance than four feet of 0000 gauge copper welding cable!

In the past I have not been interested in most "protection" devices marketed to home power folks. These devices were too cheaply made and had too much loss in high current DC circuits. The Ananda Big Switch has changed my mind. With an efficiency of 99.39% at 330 Amperes, we can have the safety of a fuse and a disconnect switch anywhere we need it without losing appreciable power in the protection device.

Conclusions

We at Home Power probably take home less pay that most of the folks who read this magazine. For us to plonk down $325 of our very hard earned bucks for this Big Switch, you must know that it works and is worth what it costs. I know this is a lot of money, but then the folks at Ananda make less than either you or me. We priced a similar fused disconnect from an electrical supply house and the wholesale price was over $600 (retail was $1,480).

When it comes to over current protection and switching high current, the Ananda SF 400 T is the best device I have ever seen, tested, or even heard about. I sleep easier knowing it's on the wall of our power room.

Access

Authors: Richard & Karen Perez, and Sam Coleman, c/o Home Power, POB 130, Hornbrook, CA 96044 • 916-475-3179

Makers: Ananda Power Technologies, Inc., 14618 Tyler Foote Rd., Nevada City, CA 95959 • 916-292-3834.

Renewable Energy and the Online Computer World

Don Kulha

The past two issues of Home Power have mentioned the computer availability of alternative energy information "online" via FidoNet and Echo computer conferencing. These will be new terms to many of you, and I'll try to explain them and their growing significance.

Information by Computer

Nearly 20% of U.S. homes currently contain a personal computer. One of the peripheral devices commonly hooked up to these computers is a modem. A modem allows the computer to send and receive information over standard telephone lines. The modem translates digital signals available at the ports of the computer to analog signals compatible with the telephone network. These analog signals travel through the phone system and are received at the other end by another modem that converts them back to digital pulses and feeds them to another computer.

In the early days of microcomputers, this capability was considered an arcane magic reserved for wizards and hackers. Over time, standards were developed. Modems and the software used to manage them have become very reliable, much easier to use, and are no longer considered the exclusive realm of the digital wizards. This development signified the beginning of a revolution that is rapidly changing the way people communicate, obliterating international boundaries, and even changing the course of history.

Modems and Democracy

During the recent attempted coup in the former Soviet Union, digital telecommunications such as the modem played a vital role in its failure. The coup leaders did not shut down the digital communications links which had recently been established in the Soviet Union. These links allowed the peoples of the soviet republics to communicate with each other and the world, and were used to expose the bankrupt nature of the attempted coup. These networks were literally filled to capacity with freely flowing information. Just a few years ago, the info would never have moved at all.

The freedom of information flowing between people makes digital communications a tool of growing importance both in the U.S. and abroad. Access to information is a great enabling and empowering capability which may be the greatest boon of the microcomputer revolution. Today, educators use this technology to reach students and businesses exchange vital information on a timely basis. We can use it to discuss alternative energy, and to share and pool our collective knowledge.

Organized Communication – all shapes and sizes…

We share information via many avenues. There are commercial information services such as Compuserve, Genie, British Telecom Tymnet, and Prodigy which serve hundreds of thousands of subscribers. There are also noncommercial amateur systems and networks that carry much the same type of information.

The most common capabilities offered by these services, whether commercial or amateur, are message exchange and file transfer. Messages can be posted to share information, espouse opinions, ask questions, or answer those posted by others. Files, which can be in the form of information, computer programs or pictures, can be captured (downloaded) or sent (uploaded) and thus widely shared.

Bulletin Board Systems (BBS's) are the most common avenues of digital communications. These are usually run by dedicated hobbyists who share a vision of free and unrestricted communications. Nearly every community will have one or more such systems, many of which are linked together into amateur communications networks. The power of these networks is that they amplify the capabilities of the individual systems by making it possible to link more people and share their contents more widely.

FidoNet is one such network. It links over 12,000

individual BBS systems scattered around the globe enabling them to exchange messages and files. The network provides a means whereby discussion areas on individual local BBS systems can be pooled and combined. This capability, called echo mail or echo conferencing, is tremendously useful and very exciting. Most BBS systems will have multiple individual message or discussion areas set up relating to particular topics. Messages posted in these discussion areas, when linked into "echos," are shared between BBS systems via the network.

A message posted on a local BBS system will be processed and copies of it will show up on all other BBS systems participating in that echo. Any replies or new comments entered on other participating systems will propagate around the network and make it back to the local system. Geographical or political boundaries are basically meaningless to the network. The "pooling" of echo conferences is their great strength. You might enter a message on a BBS local to you and get a reply from someone else using a system located across the state, continent, or around the world. This synergy opens many exciting possibilities for sharing and collaboration. One is our new conference dealing with alternative energy and topics inspired by the work of the fine folks at Home Power magazine.

Alternative Energy hits the lines

Last July, just prior to SEER '91, I started casting around FidoNet, soliciting other BBS system operators to make an echo conference on alternative and homebrewed energy available to their local usership. We now have about three dozen participating systems scattered around the U.S. and are in contact with others in Canada and Australia who would like to join us. The folks at Home Power have also generously provided us with the text and picture files from the first 10 issues of Home Power magazine. These are carried online as downloadable files by several of the systems participating in the echo conference. The text of the articles is available as straight (ASCII) text. The diagrams and charts have been converted to "MacPaint" format files for which viewer software for most types of computers is available (usually freely available for download on the same system).

To date, over 500 messages have flowed through the echo. More BBS systems and participants are joining us on a weekly basis. The echo discussion has run the gamut of AE topics ranging from PV panels and batteries to low-head hydro power and solar thermal steam turbines. I personally find this tremendously exciting and enlightening and can't wait to see what the future has in store for us.

Come join us!

For those of you who have computers, modems, and access to a phone line, joining the conference is simple. Look at the list of participating systems, call one, and follow the online prompts and directions. Since participating systems operate on software that may differ from system to system, it's hard to be more specific than that. Generally once you are online, the system will ask you to answer a few questions so it can identify you on subsequent calls. It then presents a main menu. You will usually choose to switch to the message submenu from the main menu, and then select the menu of message area topics from which you will choose the AE or HOMEPOWR (the FidoNet designator) echo.

If you have a computer but no modem, we can give you a few tips to help you get started. The most common and affordable type modem is called a "2400 baud" modem, which can send or receive about 240 characters per second and will suffice for most purposes. These should cost no more than $150 and may cost as little as $75 for an internal card that installs in IBM compatible computers. You will need software appropriate to your computer, and possibly a cable to connect the serial port of your machine to the modem. These will generally be available for a moderate cost from the same place you purchase your modem. If there is a local "users group" that focuses on your kind of computer, they can be an invaluable source of information, low-cost software, and help.

Most, if not all, systems you call will require that you initialize your software to a set of operating parameters. These are usually "8/1/N-Full Duplex" or eight data bits, one stop bit, and no parity. Your software will probably be preconfigured to these settings when you get it. All this might sound a little intimidating at first, but the whole process is really quite simple and worth the trouble. It will open up a new world of communication possibilities that will serve you well.

Welcome to the future, to Cyberspace and the online community. We are shaping the future with how we use this medium and folks of the "Home Power" clan have important contributions to make. We look forward to your joining us online.

Access

Author: Don Kulha, POB 7518, Santa Rosa, CA 95407 • 707-526-9473. Don is the system operator (Sysop) of Sonoma Online, the oldest public BBS system in Sonoma County, CA. It has been in operation over seven years,

has taken over 61,000 calls, and serves 800+ users. Sonoma Online operates as a community information resource and the Wine country systems hub for the FidoNet network in northern California.

The following is a list, sorted by state, of systems currently participating in the HOMEPOWR echo conference. If you use a BBS linked to the FidoNet or RBBS-Net that does

Humanity Net, Chico, CA, Michael Favor, 1-916-891-1920
Wildfire, Chico, CA, Bob Campbell, 1-916-345-4253
Net 208 NEC, Manteca, CA, Kenneth Roach, 1-209-823-0093
CrossWinds, Orland, CA, Charlie Anderson, 1-916-865-8462
BlueStar, Paradise, CA, Dan Mohrbacher, 1-916-872-1444
Sonoma Online, Santa Rosa, CA, Don Kulha, 1-707-545-0746
The Outland, Santa Rosa, CA, Shad Muegge, 1-707-575-0636
The Reservation BBS, Coventry, CT, Dolores Jensen, 1-203-742-7205
Energy, Rockledge, FL, Danny Burdick, 1-407-690-0032
FOG LINE BBS, Des Moines, IA, Dan Buda, 1-515-964-7937
The Silver Dragon Inn, Loves Park, IL, Roy Feltner, 1-815-633-6455
The Liberator BBS, Lafayette, IN, Terry Jacot, 1-317-429-5400
EchoMaster, Temperance, MI, Jim Dunmyer, 1-419-475-2241
Pro Photographers BBS, Minneapolis, MN, John Abbott, 1-612-341-8172
QwikCom, St Charles, MO, Bill Clark, 1-314-928-7262
OneNet, St Louis, MO, John Baltzer, 1-314-776-4228
EARTH*Net BBS, Chapel Hill, NC, Lawrence London, 1-919-929-3346
REDCON, Raleigh, NC, Amnon Nissan, 1-919-859-3353
InterVision, Francestown, NH, Mark Hochman, 1-603-547-6485
Cuckoo's Nest BBS, Hudson, NH, Gordon Green, 1-603-880-1658
RTC-BBS, Medford, NJ, Terry Rossi, 1-609-654-4991
N Nevada Echo Coord, Sparks, NV, Dennis R Thieme, 1-702-359-1633
The Glass Bead Game, New York, NY, Terry Ross, 1-212-947-0899
Latent Heat, Rochester, NY, Tom Rieger, 1-716-647-2743
Mother, Rochester, NY, Phillip Dampier, 1-716-256-0782
W-FL Teacher Resource Ctr, Stanley, NY, Jack Crawford, 1-716-526-6495
Mike's Maze, Webster, NY, Mike May, 1-716-872-0128
EarthNet Info, West Islip, NY, Byron Arnao, 1-516-321-4893
End User BBS, Pittsburgh, PA, Jack Betz, 1-412-466-9380
The Voyager BBS, McCook Lake, SD, Jeffrey Preston, 1-605-232-4648
Micro Applications, El Paso, TX, Dick Gladden, 1-915-591-1090
Southern Crossroads, Grapevine, TX, Dean Lachan, 1-817-481-8984
The Helix Bbs, Seattle, WA, Scott Parks, 1-206-782-3365
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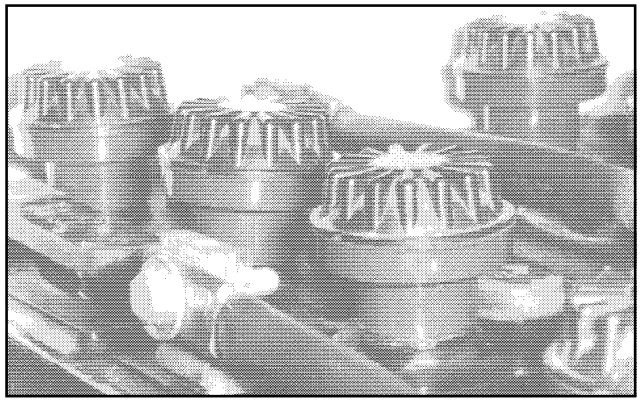

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Tech Notes:

Solar Thermal Energy – Delivering the Heat

Tom Lane

Catching the sun with solar hot water collectors is a good investment for most homes in the United States. Solar water heating is a great investment compared to electric or Liquid Propane (LP) gas water heating if the rate exceeds $0.07 a Kilowatt-hour or $1.15 a gallon for LP gas. It is not cost-effective versus natural gas. As part of a new home mortgage or home improvement loan, the after-tax rate of return on investment will typically be over 18% per year, even for two people. The monthly savings will be far greater than the small increase on the home mortgage or home improvement loan. Besides increasing the equity in your home, the best part is that a dollar saved on hot water is typically equivalent to $1.30 of taxable income. The interest on monies borrowed from the bank is a tax write-off as an itemized deduction. It is like buying real equity instead of renting a service from the utility.

Solar hot water is now cost effective in grid-connected homes, unlike solar electric power. However, a buyer needs to understand the rating of solar thermal collectors and the efficiency of solar thermal collectors. System efficiency depends on adequate storage capacity and time of day you use the hot water.

Converting BTU's to Watts

All solar thermal collectors and systems are rated in British Thermal Units (BTU's). One BTU is the amount of energy it takes to raise one pound of water one degree Fahrenheit. There are 8.34 pounds in a gallon of water, so it takes 8.34 BTU's to raise one gallon one degree Fahrenheit.

To convert BTU's to watts-hours, the common electrical energy term, multiply the BTU rating of a solar system or solar collector by 0.2931. This multiplier will convert BTU ratings of solar collectors or solar systems directly into watt-hours for a better comparison in energy consumption and production. With this figure you can calculate how many kilowatt-hours (Kwh) a solar system will produce over the period of one year (divide by 1000 and multiply by 365). Then multiply the Kwh's generated per year by your local utility rates, which range from $0.07 - $0.15 per kilowatt-hour. This gives a rough idea of how much your system will save in utility bills over one year. That savings will directly relate to your investment in solar hot water and make you an intelligent shopper for good value.

SRCC and FSEC Ratings

There are two agencies that rate solar thermal collectors. One, a branch of the National Solar Energy Industries Association, is known as the Solar Rating and Certification Corp. (SRCC), 777 N. Capitol St. Ste. 805, Washington, DC 20002, 703-524-6045. Send $35 for their ratings of all thermal collectors and systems they have tested. The other is the Florida Solar Energy Center (FSEC), 300 State Road 401, Cape Canaveral, FL 32920, 407-783-0300. Their Thermal Performance Ratings Catalog is free. They will also send you, upon request, a one page summary sheet of information on a specific system or individual collector. FSEC is presently the only lab nationwide that is testing solar thermal collectors. Both SRCC and FSEC ratings are based on all day, clear sky conditions similar to the rating condition for solar electric modules.

System Ratings

Sometimes you can get a total system's rating from a particular manufacturer, especially on passive hot water systems. For example, the Copper Cricket is rated at 22,000 BTU/day and the PT-40-CN by Thermal Conversion Technology is rated at 24,208 BTU/day by the SRCC. Let's convert these ratings to kilowatt/hrs by multiplying by 0.2931 and dividing by 1000. The Copper Cricket uses sun energy the equivalent of 6.44 Kwh per day, and saves 6.45 Kwh/day from the electric bill. Likewise, the PT-40 saves 7.10 Kwh/day. How does the cost of a system compare to the savings per year? Assume 365 clear sky days per year and a cost of $0.10 a Kwh from the utility.

CopperCricket=6.45 Kwh/day x 365 x .10= $235 per year.

PT-40 = 7.10 Kwh/day x 365 x .10 = $259 per year.

Let's look at system cost (not including installation) divided by savings per year to get simple payback. In this example, we won't consider the time value of money, increasing fuel cost, or that money saved is worth more than money earned. The Copper Cricket sells for $2180 and needs a 52 gallon tank which sells for $160 for a total of $2340. The PT-40 sells for $1500 and if we add a 52 gallon tank for $160 it would cost $1660. Copper Cricket = $2340 divided by $235 for a 9.95 years simple payback. PT-40 = $1660 divided by $259 for a 6.41 years simple payback.

These figures can be modified by adding the cost of installation to the system cost before you divide by savings. You can also reduce the savings because there are not 365 clear days in a year. However, figuring simple payback enables you to rate system cost vs. expected savings so comparison among the various solar water heaters can be made.

Collector Ratings

The Thermal Performance Ratings by FSEC is a good approximation of what a thermal collector can deliver daily in savings if system information is unavailable. (see figure at right) For example, an American Energy Technologies, Inc. (AET) collector tested at the intermediate temperature rating is rated at 38,100 BTU/day. The 38,100 BTU/day x 0.2931 = 11,167 watts-hours/day which equals 11.17 Kwh per day. If you pay $0.10 per Kwh for electricity, this means a savings of $1.12 a day or $408.80 per year ($1.12 x 365). Two 4 x 10 foot (2 x 40 square feet) collectors would double the savings provided that the storage tank is adequate and the system was sized for five to seven people who need about 80 sq. ft. instead of two or three people who need about 50 sq. ft.

Solar collectors and solar systems are tested under ideal clear sky conditions to maximize BTU production. For active open-loop systems and active closed-loop systems that use a heat exchanger, the best way to get the most BTU's for your money is to have adequate storage. You need 1.5 to 2.25 gallons of water for each square foot of collector area to maximize collector efficiency. Solar storage tanks are manufactured in 80, 100, and 120 gallon sizes, and solar collectors are manufactured in 4 x 6.5 (26 sq. ft.), 4 x 8 (32 sq. ft.), and 4 x 10 (40 sq. ft.) sizes. Matching collector area to tank size and finding the ratio that falls within a system's optimum range is relatively straight-forward.

For example, take two tanks, one 80 gallon and one 120 gallon, both filled with 70°F water. A single 4 x 8 (32 sq. ft.) collector under testing will raise the 80 gallon tank 55 degrees to a temperature of 125°F; the ratio of 2.5 gal per sq ft is high – not enough collectors for the amount of storage. Two 4 x 8 (64 sq ft) collectors will raise the 80 gallon tank 85 degrees to a temperature of 155°F; the 1.25 ratio is low – not adequate storage for amount of collector area). If a 120 gallon tank had been used with the two 4 x 8 collectors (ratio of 1.88), it would raise the 120 gallons a total of 80 degrees up to a temperature of 150°F. The ratio is 1.87 – just right.

Let's look at increasing storage size and see what this means in equipment cost and dollars saved.

Equipment Specifications

80 gallons of water at 70°F with 64 sq. ft. collector area gives 1.25 gals/sq ft ratio and temperature rise of 85° F per day.

120 gallons of water at 70°F with 64 sq. ft. collector area gives 1.87 gals/sq ft ratio and a temperature rise of 80° F per day

Calculations

For 80 gallons of water at 70°F with 64 sq. ft. collector area (1.25 gals/sq ft ratio) and temperature rise of 85° F per day, the savings will be $606.71 per year.

80 gals x 8.34 lbs/gal = 667 lbs, x 85 degrees = 56,712 BTU's, x 0.2931 factor = 16,622 watt-hours, ÷ 1000 = 16.62 Kwh, x $0.10 (equivalent to LP gas at $1.60 per gallon) = $1.66/day, x 365 = $606.71 per year.

Florida Solar Energy Center
THERMAL PERFORMANCE RATINGS
Intermediate Temperature Ratings

Model#	Area Sq. ft.	BTU/Sq.ft.	BTU/Day
AP-2600	25.20	960	24200
AP-3200	31.66	970	30700
AP-4000	39.49	965	38100

The Florida Solar Center Intermediate Temperature Rating for a 4 x 6.5 (AP-2600), a 4 x 8 (AP-3200), and a 4 x 10 (AP-4000) collector.

SRCC Rating Model AP-4000
COLLECTOR RATING NUMBERS
Thousands of BTUs per Day per Panel

ΔT(°F)	2000 BTU/ft2	1500 BTU/ft2	1000 BTU/ft2
A (-9)	57.48	43.33	29.26
B (+9)	53.44	39.29	25.22
C (+36)	46.24	32.20	18.57
D (+90)	30.74	17.75	5.84

SRCC ratings for a 4 x 10 collector
Based on sky and weather conditions.
The 2000 BTU/FT2 is a clear day rating.
The 1500 BTU/FT2 is a mildly cloudy day.
The 1000 BTU/FT2 is a cloudy day.

Category A is for Pool Heating Collectors.
Category B is typical for Summer type conditions.
Category C is typical for Spring/Fall conditions.
Category D is typical for northern Winter conditions.

For 120 gallons of water at 70°F with 64 sq. ft. collector area (1.87 gals/sq ft ratio) and a temperature rise of 80° F per day, the savings will be $856.54 per year.

120 gallons x 8.34 lbs/gal = 1001 lbs,' x 80 degrees = 80,064 BTU's, x 0.2931 = 23,466 watt-hours, ÷ 1000 =23.47 Kwh, x $0.10 (equivalent to LP gas at $1.60 per gallon) = $2.35 per day, x 365 = $856.54 per year.

Comparisons

The 120 gallon tank typically costs $120 to $150 more than an 80 gallon tank and will give you a return on that investment in less than one year!! The $857 saved would be an example of simple payback for an active open loop system. An open loop solar water heater is one where the water in the tank is heated directly by the solar thermal panel on the roof without using a heat exchanger. If we use a closed loop solar water heater, less than $857 would be saved due to efficiency losses in the heat exchanger. Our savings is reduced by 5% if a double pump counterflow external heat exchanger was used, by 15% to 20% if the tank had the heat exchanger built into the tank walls or inside of the tank, and by 35% if an external thermosiphon heat exchanger was used. Another loss to consider is if your system uses an ac pump and controller instead of a DC pump and PV panel. In this case you can subtract an additional 8% from the $857 noted above.

If we use the active closed-loop system with an integral heat exchange tank with a DC pump and solar electric panel (described in Home Power #25), then the total system cost would be about $1800. The $857 saved would be reduced to $686 for the integral heat exchanger tank losses compared to an open loop system. If we spent an extra $150, increasing the system cost to $1950, and used two 4 x 10 collectors instead of two 4 x 8 collectors, the additional heat delivered to the heat exchanger would overcome the 20% savings reduction (heat exchanger efficiency loss). IMPORTANT NOTE: Installation costs and realistic projections for weather conditions will typically double the simple payback time.

Two 4 X 8 Collectors

$$\text{Simple Payback} = \frac{\$1800 \text{ system cost}}{\$686 \text{ savings}} = 2.64 \text{ years}$$

Two 4 X 10 Collectors

$$\text{Simple Payback} = \frac{\$1950 \text{ system cost}}{\$857 \text{ savings}} = 2.28 \text{ years}$$

Understanding Thermal Efficiency

Simply looking at a SRCC or FSEC collector ratings does not mean that the collector will put those BTU's into storage. The storage may be inadequate or the heat exchanger may be inefficient. There are three factors involved in the efficiency formula for a solar thermal collector: insolation, ambient air temperature, and inlet temperature.

Insolation is the amount of sunlight hitting the collector (measured as power per area). Ambient air temperature is the temperature of the outside air. The inlet temperature is the temperature of the fluid entering the solar collector.

The efficiency drops as the ambient air temperature drops or the entering water temperature rises, or both. You obviously cannot change the ambient or outside air temperature, nor the amount of incoming sunlight. However, we can affect the inlet temperature by several strategies.

Increasing the Efficiency of Solar Water Heaters

1) Keep the storage-to-collector ratio within 1.5 to 2.25 gallons per square foot. For space heating the best ratio is 1.75 to 3 gallons per square feet.

2) Do laundry or dish washing between 9 AM and 3 PM using hot water while the sun is shining on your collector. This will increase the BTU's collected each day by lowering the temperature of the water entering the collector. In fact the ratio of collector area can drop to 1.25 gallons to square foot if at least 50% of your storage is used from 9:00 AM to 3:00 PM. This strategy is usually found in commercial applications where the load occurs during prime solar time.

If you cannot find any collector ratings for the collector you are considering buying, the maximum that any flat plate or evacuated tube solar collector can generate under a clear sky is about 970 BTU/sq ft/per day.

Summary

Just as proper battery storage and inverter losses must be figured for solar electric systems, factoring volume storage to thermal collector ratios, and heat exchanger efficiencies achieves the proper system balance. A common mistake is buying a system that is too small. The installation cost will be essentially the same whether it's a 52 gallon tank with 32 sq. ft. collector or a 120 gallon tank with 80 sq. ft. collector. Plan on 20 gallons per person and 14 sq. ft. of collector area per person. As an investment, stick with a minimum of 80 gallons and 40 sq. ft. on an open loop active system for two people; allow 52 sq. ft. on any system that uses a heat exchanger.

A solar system offers you real savings and real equity for your money instead of an overpriced service from your local utility to heat your hot water. The choice is not about spending money, but what you are getting in return for a monthly investment you are already making. We will eventually learn about the investment value of solar thermal and learn to think like accountants instead of dazed consumers. Then, we will be on our way to saying "grid riddance" to utility companies and starting to repair the environmental damage to our planet.

Access

Author: Tom Lane, Energy Conservation Services of North Florida Inc., 4110 SW 34th St. Ste. 15, Gainesville, FL 32608, 904-373-3220

Tech Notes:

Battery Safety

Richard Perez

Batteries are full of dangerous chemicals. If batteries weren't filled with reactive materials, then they wouldn't work. As long as these chemicals stay inside the cells, then everything is fine. Here's what to do if the nasty stuff inside gets out.

Experience is a hard school…

On December 27, 1991 at 10:20 in the morning, one of our lead-acid cells exploded. The battery had been recharging all night, pushed into gassing by our wind turbine and 50 mph winds. The sun rose bright that morning and the PVs added even more power to the battery. I was outside the house, about thirty yards away, pumping water for the horses. I heard what sounded like a rifle shot inside the house. I ran up and discovered that one of the lead-acid cells had exploded. The side and upper edge of the cell was blown into small bits and three quarts of fully charged sulfuric acid electrolyte were draining on the wood floor. Acid had been sprayed over the wall, over an inverter, and over two more battery packs composed of nicad cells. It was a monster mess and it caught me totally unprepared. I summoned aid from Bob-O Schultze who lives six miles away. He gathered up all the rubber gloves and baking soda in the neighborhood and rushed to help clean up the mess.

I still don't know why the cell exploded. I assume that the cell developed a short circuit, inside the cell, which sparked, and this spark ignited the hydrogen gas inside the cell causing it to explode. While no one was hurt and the only major losses are the exploded battery and a section of our floor, it made me acutely aware of battery safety. Here's what this fool learned from the hard school of experience.

Basic Equipment

We need some basic equipment to deal with any type or size of battery accident. Locate all this equipment in the entrance to the battery room, or close to the battery area. First buy a fire extinguisher for chemical and electrical fires (rated ABC). Halon gas fire extinguishers work well. Protect your body with rubber gloves and safety glasses. Use the heavy-duty industrial strength rubber gloves that come up to the elbows. Don't fool around with the lightweight kitchen models sold in supermarkets. The best type of safety glasses are actually goggles which fit around the face firmly. For those wishing to clean up in style, wear a lab coat. We have two standard chem lab smocks for battery nerding occasions. Neither acid or caustic electrolytes will eat these lab coats.

When electrolyte spills from a cell, the primary jobs are containment and neutralization. Neutralization means adding a chemical to the electrolyte that renders it relatively harmless and stops it from eating holes in the floor. In order to tell if the electrolyte is really neutralized (pH 7), we need to have some litmus paper on hand and know how to use it. If you don't know about neutralization and litmus paper, get a high school chemistry book from your library and look it up.

Neutralizing the Electrolyte

Different types of batteries have different electrolytes. The chemicals we need to naturalize the electrolyte are different for lead-acid cells and for alkaline cells (nicads and nickel-iron). In either case, we should have on-hand, with the fire extinguisher and rubber gloves, a sufficient quantity of the neutralizing chemical to handle a large electrolyte spill.

Lead-Acid Cells

Lead-acid cells use an electrolyte that is a 25% solution of sulfuric acid in water (pH ≈ 1). The best neutralizing agent for this acid electrolyte is baking soda (sodium bicarbonate). Baking soda is cheap and available from any supermarket. The amount of baking soda you will need depends on the size of your lead-acid battery. It takes two pounds of baking soda to neutralize one quart of lead-acid electrolyte. A 12 Volt lead-acid battery with an electrical capacity of 700 Amp-hours will contain around 30 quarts of electrolyte. This mean 60 pounds of baking soda to neutralize all the electrolyte in the battery. In reality, electrolyte spills usually happen in smaller quantities, so having on hand 10 pounds or so of baking soda will handle spills up to five quarts. Baking soda has the additional advantage of being a dry powder. Adding it to the electrolyte makes a dryer mixture that doesn't spread about the area so easily. When baking soda is added to the spilled electrolyte, the entire mixture fizzes and gives off carbon dioxide. This carbon dioxide gas is also an effective fire extinguisher. So if the battery is on fire or exploded, pour baking soda all over the thing before it does any more damage.

Alkaline Cells

Alkaline cells use a 22% solution of potassium hydroxide in water (pH ≈ 13) as an electrolyte. Alkaline cells use an electrolyte that is a caustic base – the chemical opposite of the acid electrolyte used in lead-acid cells. Neutralizing the electrolyte in nickel-cadmium or nickel-iron cells is

accomplished by adding an acid to the electrolyte. The most available, effective, and inexpensive neutralizing agent is Muriatic acid (a 31% solution of hydrochloric acid in water). It takes slightly less than one quart of Muriatic acid to neutralize one quart of spilled alkaline electrolyte. Our local swimming pool supply store sells Muriatic acid for $13.95 for four gallons. Swimming pool people use it to adjust the pH of the water. Muriatic acid is dangerous in its own right and needs to be stored where it is safe. This means in unbreakable containers and locked away from children. Slowly add an equal volume of Muriatic acid to the spill. Be careful not to add to much Muriatic acid to the spill, or you will have an acid spill instead of a caustic spill. Use litmus paper to determine when the spill is neutralized. The byproducts of this neutralization process are potassium chloride (a benign salt) and water. The neutralization is mildly exothermic so be prepared for some heat to be released. If you get alkaline electrolyte on your skin, wash it off with vinegar.

Batteries in Living Areas

The exploding cell made me instantly realize that living areas are dangerous places for batteries. I have a very firm grasp of the obvious. We had just finished building a ventilated battery room when the explosion occurred. We are moving all of our batteries into this room. It is equipped to handle chemical disasters like cell explosions and cell melt downs.

Safety First!

I have lived with storage batteries since 1970. This is the first accident we have ever had with our system. It could have been very nasty. I wasn't prepared with the basic materials and equipment. So save yourself a few gray hairs and learn from the experiences of this fool.

Access

Author: Richard Perez, c/o Home Power, POB 130, Hornbrook, CA 96044 • 916-475-3179

On Being Confused

Therese E. Peffer

Do you get lost in the discussion of watts, Amp-hours, inverters, controllers, PV, UL, vac, and VDC? How does someone new to renewable energy put it all together? It helps to think small and simple. To get myself started (and explain to my folks what the heck this solar stuff is all about), I decided to take the first step at designing my own teensy system.

Defining energy wants and needs

The first step is finding how much energy is needed. Both electrical and thermal energy should be considered. Some appliances, such as refrigerators, run on either propane or electricity. Energy needs will make a long list for a house, and a smaller list for recreational vehicles. My space is pretty simple: a place where I will hang out and sleep. I will limit my discussion to electrical needs, and not worry about cooking, space heat, and hot water. But I'll think about it – let's see, solar thermal, propane, wood heat, hydrogen…

Figuring out the total electrical load requires making a list of appliances – anyone can do this. I will need a few lights, and I'd like to play my cassette player/AM/FM radio. I have a clock radio, but could use my wind-up (mechanical) clock. If this were a house or RV, the needs and wants would be different. For a house, one could add more lights, refrigerator/freezer, radio/stereo, computer, microwave, television, blender, toaster oven, etc. An RV might have a few of these items, too.

To invert or not invert?

For appliances that use 110 or 120 volts ac (alternating current), I will have to use an inverter, a device that converts the electricity from 12 Volts DC (direct current) from the batteries or the source to 120 vac. (The lower case vac and upper case VDC adheres to convention). Here's another decision to make – I could use DC lights. My cassette player / radio will run on either, and I don't need my clock radio. I must compare the cost of an inverter with the expense, availability, and quality of DC lights. I need to consider other DC versus ac appliances in case I expand my system in the future. Choosing an inverter depends on how much energy is used, and the sensitivity of appliances. Some appliances (radio, computer, television, lights) will buzz or hum on certain inverters, or not work properly at all.

How much?

How much energy will I consume? How much storage will I need? It depends upon my use. Now I get to check the back and undersides of my favorite appliances to read how many watts of electricity they draw. Anyone can do this – this is a good exercise for those who want to conserve as well as those planning a system.

I have a Panasonic compact fluorescent light; the box says it uses 18 Watts, equivalent to a 75 watt incandescent light. Since Watts = Voltage x Current, I can calculate how much current the light is drawing.

120 volts x current (in amps) = 18 w

Current (in amps) = 18 w / 120 v

Current = 0.15 amps.

I'll use natural light as much as I can, but I will need light at night – 2 to 6 hours per day (consider long winter nights, and dark stormy days). To figure amp-hours of usage, multiply 0.15 amps x 6 hours = 0.90 amp-hours per day.

It turns out this figure isn't exactly right; I learned a few lessons here. The box lists the current drawn at 0.26 amps. Why the discrepancy? I wondered, too. Richard said the ballast on the light uses some electricity; the wattage rating is for the light bulb. Another mistake is that the inverter as well as the utility (in the U.S.) delivers electricity at 117 volts on the average. This changes my figures to 0.26 amps x 117 volts = 30.4 watts – a far cry from the 18 watts listed!

After a consultation with the Wiz, I realized that my calculations reflect the current drawn from the utility or inverter, and not from the battery to the inverter. If the light or boom box was plugged into the utility grid, I could measure ac amperes and volts to find wattage. In a stand-alone system, you are your own utility. I must figure the Amps and Watts drawn from the battery. For those on the grid who want to calculate the amount of energy used, use the wattage listed on the appliance. Since I'm figuring for my off-grid system, I need to add about 10% to compensate for the amount the inverter consumes. It would be more accurate to measure the volts and amps directly.

If I have my light on for 6 hours a day, using power from the utility, I will use 0.26 amps x 6 hours = 1.56 amp-hours. Figuring in watts would be: 30.4 watts x 6 hours = 182.4 watt-hours a day. For my stand-alone system, I add 10% of 30.4 to 30.4 watts to get 33.4 Watts DC from the battery. Multiply by 6 hours to get 200 Watt-hours per day.

This exercise piqued my curiosity. When I lived in Berkeley, (and paid $0.11 per kilowatt-hour), I used mostly incandescent lights. I took a look at Home Power

Type of light	Volts DC	amps DC	Watts	W-hr/day	kW-hr/year	cost/yr	lifetime
Incandescent GE 60W	15.15	5.01	75.90	379.51	138.52	$15.24	1500 hrs
Compact fluor Panasonic T18W	15.18	1.80	27.32	136.62	49.87	$5.49	9000 hrs
Compact fluor Osram EL-R15W	15.16	1.76	26.68	133.41	48.69	$5.36	10,000 hrs

issue #20 – the article on efficient lighting – and decided to run my own test and actually measure amperes of current consumed. Would it pay to purchase a more efficient light? For those wanting to conserve: compare regular incandescent lighting with my compact fluorescent and another compact fluorescent brand (see table above).

The lights were run on an Exeltech 250 watt sine wave inverter. I assumed a use of 5 hours a day, 365 days a year. Cost was based on $0.11 per kilowatt hour from the utility grid near the San Francisco area. (The cost for those off the grid would be much higher).

After 10 months, my "18W" light paid for itself in savings (figuring about $0.50 for an incandescent that lasts 6.5 months versus my light at $8.00 that will last 4.9 years!) You could read by the light of one Osram for 5.5 years ($21.50 each, plus lifetime cost of $29.35), or use 10 incandescent light bulbs ($5.00 total and $83.49 for the lifetime cost)! The savings ($88.49 - $50.85 = 37.64) is almost enough to purchase two more Osrams.

Next appliance – the Boom Box

Next, I checked my tape player/radio. I have to admit, I had fun doing this. I don't remember ever reading the back of my boom box so carefully. In the city, hooked up to the utility grid, I didn't care how many watts or amps it drew. The back of the box reads "ac 120v 22w, DC 12V, 8 D cells, UL listed." I will run the box on DC, not through the inverter.

Calculating with these figures, I get: DC, 22 W / 12 V = 1.8 Amps. If I were on the grid, I would calculate: 22 w / 117 v = 0.19 amps. (On the inverter: assuming that the inverter is about 90% efficient (it consumes 10% of the DC input – only 90% of the electricity feeds appliances), 10%(1.8 amps) + 1.8 amps = 2.0 amps). If I have it on for 6 hours, I will use 11 Amp-hours (on the inverter, 12 amp-hours).

I was able to run some actual measurements. I don't have a plug for DC power yet, so the measurements were on inverter power. On the Heart inverter, there was a distinct hum. Some results were fairly obvious: the tape player uses more power than the radio, and high volume takes more juice than low volume. I also took readings with the boom box plugged into the Exeltech inverter. No hum!

Another discovery was that my boom box is a phantom load! That is, when the power is turned off, but it is still plugged in, my box is still drawing power! I recorded 11.5 watts drawn from the battery, and 2.6 watts from the inverter. What does this mean? If I left my boom box plugged in but turned off back in Berkeley, then I would pay about $0.21 a month. Not substantial until you think of all the other larger phantom loads (television, microwave with running clocks, stereos, etc.) and add them all up – quite a price to pay for appliances waiting to be used! For those living off the grid, phantom loads can drain your battery if you're not careful! In order to save 276 watt-hours a day (11.5 watts x 24 hours), I will unplug my boom box when not using it, or put it on a plug strip that I can turn off when I'm done listening.

My measurements were 13.8 Watts (15.15 Volts x 0.91 Amps) with the radio playing at a reasonable level, and 16 Watts (15.24 Volts x 1.05 Amps) to play a tape. The "22 watts" printed on the boom box assumes playing a tape at a screaming high volume, but is a fair figure to use if you don't have a volt or amp meter. To figure amp-hours, I'll use 1.05 Amps x 6 hours = 6.3 Amp-hours per day.

All Together Now!

For 1 light and 1 boom box, I will need about 1.8 Amps for the light and 1 Amp for the music. Multiply by 6 hours gives 16.8 Amp-hours at 15 Volts. This is equivalent to (27 W + 16 W) x 6 hours = 43 W x 6 hours = 258 Watt-hours per day from the battery, using my measurements. (If I hadn't had a meter and just used calculations: 30.4 w for the light and 22 w for the music = 52.4 watts. Multiply by 6 to get 314 watt-hours from the grid. Add 10% to get 57.6 Watts times 6 hours = 345.8 Watt-hours from the battery.) Making calculations gives an estimate.

The next step

Now I have an idea of energy use for one day. For those who want to conserve, figuring energy loads shows where your energy bill goes. For those planning a renewable energy system, it is only the first step. The next step is to plan the source of energy. I'll probably use electricity from the sun. One photovoltaic panel will give me about 45 - 50 watts per hour of full sun, stored in a battery. Six hours of sun and one panel gives 6 hours of light and music a day!

I haven't discussed priorities – what if I want to use my 1500 W toaster oven (for three minutes, about 75 watt-hours). Do I want to expand my system? I haven't talked about batteries. Battery Basics on p. 30 explains about amp-hour capacity, but how many rainy days can I last without sunshine? Nor have I discussed controls, regulation, instruments for measuring, wiring, location of batteries, or what happens when I leave for a week or two. I haven't priced anything. What I have just done was a small step. Richard has a computer program to list, prioritize, and calculate the energy load, and compare the energy source and storage! However, it helps to list and calculate just a few appliances if only to be able to ask the right questions. To think a little more clearly. And to appreciate all the nuances of setting up a system.

Conclusion

Now I have taken a minor step. It is far from installing my system, but it was a good exercise. Sometimes in reading this stuff, I get lost in the amps, watts, and other jargon. It helped to realize just what a single light bulb uses. For those who are interested in living on renewable energy, this exercise is necessary to plan and execute your system. For those who wish to conserve, it helps to spell out the lights, stereo, and other appliances in terms of energy usage. You can put a price tag on it by calling your utility or looking at your bill to see how much you are paying per watt. See how much your television draws when you are not using it, and see how much you'd save every month by putting it on a plugstrip. Replace an incandescent with a compact fluorescent light, and note the savings!

Access

Author: Therese Peffer, c/o Home Power, POB 130, Hornbrook, CA 96044 • 916-475-3179

Kids Corner

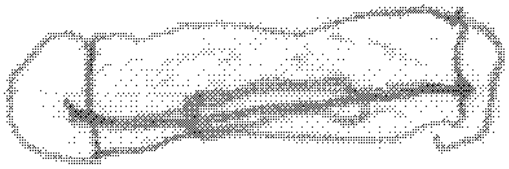
How We made Our Solar CooKer

By: Agustin

A solar cooker saves energy. To build a solar cooker you need a couple of items. You need tin foil, an oatmeal box and a wire.
Cut the oatmeal box in half the long way. Then line the box with tin foil. Make two holes at the ends of the box. Then run the wire though the two holes.
Now stick the wire though a hot dog and place the cooker in the sun. After about one hr and a half take the hot dog off the wire then Chow Down!

by Martina

Fourth Grade, Penasco, NM



Friday Brad Rose came to our school we made solor ovens. We made hot dogs. We got an oatmeal box and cut it in half. Then we cut a piece of wire of a hanger and put it across the solar oven like these. [see picture] Then we put alumenem foele inside. Then we put a hot dog in the wire and waited for it. The solor oven also helps to not pollute the earth and doesn't use gas, coal, or oil. It saves energy.

Ignacio
Fourth Grade, Penasco, NM

Don't Waste Fuel Money: Make a Solar Cooker

Frank

Last Friday, Mrs. Compton's class and ours made solar cookers. We cut an oatmeal box in half and after we did that we put tin foil on the inside. Then you put a piece of coat hanger therw the to sides so that most of it was in the middle. But before you did that you had to scrub the piece of coat hanger with sand paper to get it clean. The reason you had to do that is because so then all of the paint would get off. If you didn't do that the sun wouldn't be attracted to it. Because if you have all of the paint off it is a sord of black color and the sun is most attracted to black. Well after you did that you had to put a hot dog on the wire. You put it outside and pointed it deirectly at the sun and the sun rflects the heat on to the foil and while the foil is reflecting it back the hot dog is geting roasted.

Amanda

Fourth Grade, Penasco, NM

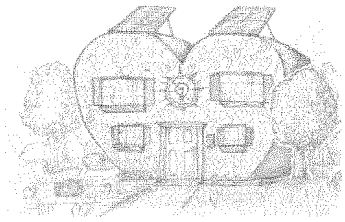
Generator
Generator, generator,
Clank, clank, clank,
Your gas is running low,
I better go to the bank!

by Rocky Riewerts,
Third Grade, Forks of Salmon, CA

Hey Kids!
This page is for you. Send us your pictures and stories about solar power, and we'll print as many as we can.

Therese Peffer
Home Power

Home & Heart



Kathleen Jarschke-Schultze

SunFrosting

Now that we have had the SunFrost RF-16 on line for awhile I have a few comments. I still love it. Some ice does build up on the ceiling and back wall of the freezer and a lesser amount on the back wall of the fridge. This was all explained in the owner's manual and, as with everything else, it was right on. The only problem is that you don't want to let your lettuce touch that back wall or it gets downright slimy. I solved this problem by purchasing some rectangular plastic baskets that fit on the shelves. Cheap and easy.

Ice cream is a real delicacy in the rural lifestyle. Before the SunFrost we bought it, or made it, and had to eat it all right then. Since then we can get ice cream and keep it for a while. Not long, of course. Well, that freezer door has opened a whole new world for us. For Christmas I got Bob-O a Salton Big Chill Frozen Ice Cream/Delight Maker. It makes up to a quart and a half at a time. There is a inner canister that you remove from the case and place in the freezer for 9 to 12 hours to get cold. (We just keep ours in the freezer in case we want it. Remember, a full freezer uses less energy.) Then you put in your custard, or fruit juice, or egg nog or whatever. The canister goes into a larger case, to protect you from the cold. A paddle is inserted, lid goes on and the crank goes into that. Now crank it 3-5 times every 5-6 minutes for 20-30 minutes and you have something wonderful.

Co-op Options

I heard from several readers regarding natural food distributors in their areas. Bill Roush of Solar Electric Systems in Fairway, Kansas recommends Ozark Warehouse (see Access). Also, I would like to add an excerpt from a letter I received from reader Phyllis R. Girouard. She and her friends use Blooming Prairie Warehouse for their bulk food needs.

"Blooming Prairie serves a large area here in the Midwest with an ever-expanding line of natural foods, nutritional supplements, organic produce, health and beauty aids, and household goods. Here in the relatively small town of Chadron (population a little over 5,000), we have both a buying club and a store front co-op purchasing from BP. The truck comes in every other month. For those of us who live at least 100 miles from a good sized city, buying clubs provide us with a wonderful source of good food at incredibly reasonable prices. It is always fun to show up at a potluck with some exotic item (yesterday it was hot raspberry mustard) and elicit amazed comments about 'Where did you ever get that?' "

Solar Food Drying

Phyllis goes on to describe her solar oven and how she uses it. She also sent along a newspaper clipping showing her demonstrating her oven to a tour group visiting her organic garden.

She would love to see something in Home Power on how to build a simple solar food dryer. Well, so would I. Her point that canning and freezing your produce takes a lot of space and energy is well taken. I want to hear from any readers who have developed a solar food dryer. If we can get it into the next issue people will have time to get it together before the garden starts producing. I look forward to testing some dryers. Send me plans, ideas, pictures, or diagrams.

Winter Dreams, Spring Greens

I have been receiving a lot of gardening catalogs in the mail lately. I love to browse through them. I have planted my garden many times over in my head. First, I go through the catalog and circle everything that I want in red. Then after a couple of days I go back and realistically choose from those plants and seeds what I can grow here in my area.

One of my favorite catalog of dreams is Seeds Blüm (pronounced 'Bloom'). They have an amazing variety of heirloom seeds, like Wren's Egg and Jacob's Cattle beans, Ragged Jack kale, Oxheart tomato, Moon and Stars watermelon, China Rose radishes and Shoepeg corn. There are all kinds of plant lore and advice throughout. Many books are offered on all subjects relating to gardening, food storage and preparation.

They have a Garden to Garden Network that lets you become part of what they are doing. You can have a Trial Garden, Gardener's Choice, Grassroots Garden Research or Seedgrow. Each program is different. You could further the cause of plant genetic diversity by becoming a Seed Guardian or a Seed Multiplier. If you are an experienced gardener you can become an Area Advisor. If you lack experience you can contact an Area Advisor with any questions you may have. For only $3, it's 99 pages of inspiration and information.

Gophers & Garlic

I have received several requests for my catalog of open pollinated seeds. I don't have one. I don't sell seeds or plants. The seeds I save are for my own use. I used to grow and sell organic garlic. I am currently growing several different varieties of garlic and shallots, building up my seed supply so that I can sell garlic again in the future. I am very interested in different varieties of garlic. So are the indigenous gophers. If anyone has an organic gopher cure please tell me, I am desperate.

I currently grow elephant garlic, California White, Silverskin and Homestead garlic. The Homestead garlic was brought to Agate Flat in the late 1800s by homesteaders. Karen Perez saved some from an abandoned homestead and cultivated it for several years getting heads of over a pound using organic intensive methods. She didn't have time to garden after starting Home Power so the garlic went wild again.

Last year she and I were able to find two small clumps of the garlic with very small cloves. I planted it in the Fall and in Spring it came up. It is a red skinned garlic and I think it may be a Rocambole type as all the heads have stiff necks and they actually coil around as they grow up. The cloves are a little bigger this year and I have again planted them. I have also planted the small corms that grow at the top of the garlic bloom. By next year I expect to have good sized heads.

Access

Author: Kathleen Jarschke-Schultze grows garlic and battles gophers at her home on the California-Oregon border. c/o Home Power Magazine, POB 130, Hornbrook, CA 96044 • 916-475-3401

Sun Frost, 824 L St., Arcata, CA 95521 • 707-822-9095

Ozark Warehouse, Box 1528, Fayetteville, AR 72702 • 501-521-2667

Blooming Prairie Warehouse, located at 2340 Heinz Rd., Iowa City, Iowa 52240 • 1-800-323-2131 (from 12 to 5 PM only, mornings are for order placement).

Seeds Blüm, Idaho City Stage, Boise, ID 83706 • 208-336-8264 9 am to 2 pm, Mon. thru Thurs. MST FAX 338-5658 Help Line • 208-342-0858 8 am to 5 pm Mon. thru Thurs. MST

No renewal notices will you find
So to trees we can be kind
Your mailing label check now fast
For this issue could be your last!

Movin' Pitchers

Paul Wilkins

VIDEO REVIEWS

Mike Brown's Electric Vehicle Components Primer
If you are interested in seeing what it takes to put an EV together, then this videotape is the way to go. Mike talks about batteries, controllers, suspension, brakes, and other EV parts. Mike has been in the automotive field a long time and is one of the first people in the *resurgente* EV sector. He has done a lot of R&D out of his own pocket, and has developed kits for transforming RABBITS and other "econo-boxes" to EVs. One of the best parts of this video is seeing the motor controllers and other pieces of equipment that make up an EV. This 92 minute tape is $35 and includes Electro's parts catalog.

For the dedicated EV freaks, Electro Automotive has more car stuff from the Northeast Sustainable Energy Symposium in November 1991. The production values are better than last year's according to the producer. I will have a review of them in the next issue. I saw the originals and they were very interesting.

Hydrogen Video
The American Hydrogen Society has produced a nifty 8 minute tape called *The Solar Hydrogen Economy:* a good overview of what is being done on this energy front; cars, buses, planes. Citing such sources as BMW and Lockheed, it makes the point that the industrial infrastructure already exists to make a hydrogen economy work. This tape is an excellent tape for teachers It also shows ocean windfarms, ocean tidal electric conversion and a good explanation of the Hindenburg accident. Good production values. $14.98

In the Works
In October, I taped the Solar Technology Institutes' Advanced PV Workshop with Johnny Weiss, Ken Olson and Richard Perez. It is not edited yet, needs some titles and a little cleaning up. When it is done, it will be 17-20 tapes and will be announced here. STI will market it.

I am beginning to assemble a tape called *PV In Suburbia*, that looks at PV systems which displace grid power in towns. This will include John Wiles in Las Cruces, me in Santa Fe, and more depending on how many other tapes show up to be included. Don't be shy, if you have any tape on city systems, send it to me.

A note on video quality
Producing broadcast quality video is expensive and time consuming. Equipment is expensive and the people operating the equipment get $50+ per hour. VHS is very popular because for a few thousand dollars you can have enough equipment to do a pretty good job. Well, a lot of folks can't afford even that. So they grab their "consumer level" camera and go shoot what interests them. Using a couple of decks and hopefully an editing controller, they cut all the redundant stuff and make a tape that communicates. My point is that "Broadcast Quality" is for those who can afford it. Other, poorer small producers will be giving current information, and information is the entire point. If you can see what is going on, and understand the audio, that's what is important. You won't see any video busted by me for editing glitches.

Please allow me to introduce myself…
I have been using RE for a dozen years now. I have been writing articles and booklets since 1895, editing and publishing the *PV Network News*. *Solar Electricity Today* started out as the *PV Network News'* yearly resource directory. It is based on a booklet I started in 1981 with about 30 sources. The last *SET* has over 800 sources. From 1982 to 1987, I made Solar Works controls and regulators for wind, solar and water pumping. I have had the same phone for 11 years and rarely hear from my customers.

In 1986, I acquired a video camera and deck and started doing videos about PV and renewable energy. The first Video, *PV Places,* is a tour of PV systems showing applications from homes, offices, shops, RVs, water pumping, and a remote control model airplane. There a few rough edges in this production. Next was RETSIE (the renewable energy trade show) where I had manufacturers give their briefest speech on their products. No longer available. Next was Windcharger Repair, for the 200 watt WINCO wind generator. How to take one apart, diagnose problems, and put it back together. Windy Dankoff and I did *A Short Course In PV* which discusses PV from modules through growing systems applications. Two years ago at an RE conference in New Mexico, I taped John Wiles who writes Code Corner for HP. Called *PV Meets The Code*, John covers switching gear, fusing, and connections with a fast moving slide show of acceptable vs. nonacceptable equipment and methods.

Access
Author: Paul Wilkins, 2303 Cedros Circle, Santa Fe, NM 87505 • 505-473-1067
Electro Automotive, POB 1113, Felton, CA 95018 • 408-429-1989
American Hydrogen Society, 219 S. Siesta Ln., Ste. 101, Tempe, AZ 85281 • 602-921-0433

H A P P E N I N G S

Sun Day 1992
Public Citizen and nearly 200 citizen groups (including Midwest RE Assoc., Great Lakes RE Assoc., Redwood Alliance, and just about every RE Assoc. and environmental group you can think of), businesses (including Jordon College, Snowbelt Solar, Lake MI Wind & Sun, Integral Energy, Solsource & Home Power), government officials and others announced plans to sponsor SUN DAY 1992: A Campaign for a Sustainable Energy Future. The organizations, located in 39 states and the District of Columbia, collectively represent over two million members.

The sponsoring organizations are advocating a national energy policy that, at a minimum, reduces the total energy use by 10 percent and tripling the current contribution of renewable energy technologies by the year 2010.

SUN DAY 1992 is a campaign primarily being built upon activities initiated by individual citizens and local and state-level groups, rather than as a centrally directed and managed program. It will include at least one national day (Earth Day-April 22, 1992). The focus of SUN DAY 1992's sponsors will be developing local and state-level coalitions to advocate for policies supportive of SUN DAY 1992's goals.

Rather than just one-day, one-shot events SUN DAY 1992's sponsors will encourage, support, and launch ongoing educational programs, attracting media support, organizing, and other activities before, during and after Earth Day 1992. Some participating organizations will provide information, encourage model programs, legislation and government policies, lobbying Congress, conferences, and distributing information to grammar schools, high schools, and colleges.

For more information and to find out how you can help, contact: Public Citizen, attn. SUN DAY 1992, 215 Pennsylvania Ave SE, Washington, DC 20003 or call 202-546-4996

A Solstice Celebration of Sun Power
The 3rd annual Midwest Renewable Energy Fair is June 19-21, 1992 at Amherst, Wisconsin. The Energy Fair introduces the public to a wide spectrum of renewable energy technologies and their contemporary applications. The Energy Fair is a fun and educational experience for individuals and families. At the Energy Fair you will have the opportunity to: • watch wind and solar power actually power the fair • see, handle and purchase products that will help you conserve energy, protect the environment, and save money • attend informative hands-on workshops (beginner to advanced) presented by experts from across the country • walk through a model home demonstrating energy efficient construction and appliances, and renewable energy, power and heating • see vehicles powered by alternative energy • network with others who share similar interests • dance to live music played on a solar and wind powered stage Have Fun and More!

The Midwest Renewable Energy Association is accepting workshop proposals until March 1, 1992. Please include a brief description and outline with your proposal.

For more information about the Energy Fair contact: Midwest Renewable Energy Association, 116 Cross St., Amherst, WI 54406, 715-824-5166.

Union of Concerned Scientists (UCS)
The Union of Concerned Scientists (UCS) has announced a year-long campaign to change the public perception of solar power, wind power, and other renewable energy sources. UCS will help interested people to plan and carry out educational activities and political actions that promote greater use of renewable energy.

Although the public likes the idea of using renewable energy (RE), most people, including industry leaders, utility planners, and government officials, think of renewables as futuristic, backyard novelties. In actuality, RE technologies could provide a much greater share of the nation's energy supply. However, current energy policies have prevented renewables from penetrating energy markets in a significant way.

The first step in changing the policies is to help people understand the tremendous potential of RE technologies. Public education will be a major focus of the "Renewables are Ready" campaign. UCS activists will also focus attention on policy-makers and work on changing the regulatory climate to encourage the growth of renewables.

If you would like more information on how to get involved please contact the Union of Concerned Scientists, 26 Church St., Cambridge, MA 02238, or call them at 717-547-5552.

Hands-on Solar Workshops
The '92 Solar Home Program at the Solar Technology Institute in Colorado offers a series of How-To and Hands-On Workshops. Learn to design and build state-of-the-art solar homes that are self-reliant, thermally

efficient, healthy to live in, and environmentally conscious.

Solar Home Design & Construction-May 4-14, Micro-Hydro Electrical Systems-May 18-21, Wind Power-May 26-29, Practical Hydrogen-June 1-4, Photovoltaic Design & Installation-July 6-17, Advanced PV for Remote Homes-July 20-30, Photovoltaic Design & Installation-Sept 7-18, Advanced PV for Remote Homes-Sept 21-Oct 1, Micro-Hydro Electric Systems-Oct 5-8, Solar Home Design & Construction-Oct 12-22, Advanced Passive Solar Design-Oct 26-Nov 5.

These workshops are for owner builders and persons seeking careers as solar professionals.

For a detailed description of SOLAR HOME PROGRAM WORKSHOPS, costs and scholarship information; write Solar Technology Institute P.O. Box 1115, Carbondale, CO 81623-1115 or call 303-963-0715.

Hands-On Workshops in Maine
The Maine Solar Energy Association has started a series of hand-on solar workshops all around the state of Maine. The purpose of these practical, one day events is to de-mystify solar energy by showing the participants that it is practical today to use the sun to heat your home, make your hot water, furnish your electricity, and even cook your food and grow your vegetables out of season. In the past year we have had a very successful passive solar architecture workshop in Bangor, a solar greenhouse & sunspace workshop in Falmouth, and two photovoltaics workshops. The participants of the photovoltaic workshops actually constructed solar cell modules that they could take home for the cost of the parts. Some people made small solar battery chargers. Several participants assembled large 35 watt power modules.

In the coming year the expanded schedule of workshops will include; solar air heating, solar water heating, solar cookers and ovens, solar electric home, passive architecture, greenhouses and sun spaces, and the immensely popular photovoltaics workshop. The fee for each of these workshops is $25.00, which includes lunch.

For information on sites and dates contact Richard Komp, Maine Solar Energy Association, RFD Box 751, Addison, ME 04606, 207-497-2204

NE Sustainable Energy Assoc.
Over 40 cars, powered by the sun, will race from Albany, NY to Boston, MA May 18-23 1992, 4th Annual American Tour de Sol, Solar and Electric Car Championship. There will be ten free educational displays of these innovative non-polluting cars along the route. For information about the display nearest you, please contact NESEA, 23 Ames St, Greenfield, MA 01301 or call 413-774-6051

Minnesota Energy Council
The MN Energy Council will hold a number of conferences on new technology in energy and environmental management for housing, small buildings, small business and municipal buildings, aimed at professionals and business people. For more information contact: Roger Peterson, Minnesota Energy Council, Box 8222, St. Paul, MN 55108 • 612-378-2973

Solar Electric Classes in Nevada
Solar Electric Classes for a max. of 4 students for more personal attention. Taught at remote Solar homesite. 2 day class choice of 4th weekend of Feb., Mar., or April 1992. Class will be full of technical info, product evaluation, sizing systems, etc. Students will build a solar system. $75. For Info SASE to Solar Advantage, 4410 N. Rancho Dr. #148, Las Vegas, NV 89130, 702-645-6571

North San Francisco Bay Chapter of the Electric Auto Assoc.(EAA)
All interested persons are invited to the meetings of the North San Francisco Bay Chapter of the Electric Auto Assoc (EAA). The meetings will be held on the third Saturday of each month at the Citibank conference room in Novato, CA. Contact Andy Clary, 1710 Greeneitch Ave., Santa Rosa, CA 95401, 707-526-7692 from noon to 5 pm for meeting and membership information. For information on the EAA and the chapter nearest you send an SASE to 1249 Lane St, Belmont, CA 94002 or call 415-591-6698, 415-685-7580 or 408-371-5969, weekdays 10 AM to 5 PM Pacific time.

AMERICAN SOLAR ENERGY SOCIETY (ASES)
ASES has issued its call for papers for the June 13-18, 1992, SOLAR 92: THE NATIONAL SOLAR ENERGY CONFERENCE, Cocoa Beach, Florida. The conference is the 21st American Solar Energy Society Annual Conference and included the 17th National Passive Solar Conference. Papers are solicited which detail recent and current work in the field of solar energy conversion and utilization. For more information and a copy of the detailed Call for Papers, contact: American Solar Energy Society, 2400 Central Ave., Ste G-1, Boulder, CO 80301, 303-443-3130, FAX 303-443-3212

Free Fowler Solar Electric Inc. Workshop
On April 11, 1992, Jeffrey Fowler, author of the "The Solar Electric Independent Home Book" and his wife Leatrice Fowler will hold a free workshop on solar electricity. The workshop will cover present remote homes and cabins using solar electricity now, and future possibilities.

Efficient lighting and other forms of conservation will be covered. Product display will feature a wide range of solar electric components. Efficient lighting and alternative energy books will be stocked for sale at the workshop. A lecture and slides will be presented from 9:30 AM to 12:30 PM, lunch (BYO), product display and questions will be from 12:30 PM to 3:00 PM at The Harris Center, Hancock, NH 03449 (20 miles NE of Keene, NH) For more information call 413-238-5974 or 603-525-3394

Florida Solar Energy Center (FSEC)
1992 Workshop Schedule (subject to change). All sessions will be held at the FL Solar Energy Center, 300 State Road 401, Cape Canaveral, FL 32920. Photovoltaic System Design Workshop: Learn about solar electric technology and the proper way to design stand-alone PV systems. The registration fee is $300; target audience: solar industry, engineers, government agency reps and interested individuals. Dates are Feb. 12-14, May 12-14, Sept. 15-17, Dec. 9-11, 1992. For more information about any of the FL Solar Centers workshops call JoAnn Stirling at 407-783-0300, ext. 116.

FSEC is also co-sponsoring a SunDay Challenge AE Vehicle Rally on June 14, 1992 in conjunction with the 21th American Solar Energy Society Annual Conference & Solar 92 in Coco Beach, FL. The rally will include commuter and solar/electric vehicles. The Rally will be limited to 40 cars with a limit of 10 cars per each of the four classes. The registration fee is $10 per vehicle. Prizes will be awarded. For more info contact FSEC.

The FL Solar Energy Center is also offering a DOS-based IBM (and compatibles) computer program called Sunpath 1.0 (for $35 which includes docs, 3.5 and 5.25" floppy disks, and S&H. The user-friendly program calculates the position of the center of the sun in the sky at locations, dates, and times specified by the user and outputs the results to the screen, a print file and to ASCII files suitable for importing into graphic plotting programs. For more info contact, Dr. Ross McCluney, 407-783-0300, ext. 134.

SEER 92
Solar Energy Expo & Rally 1992 in Willits, CA will be held August 7-9, 1992. For more information Contact SEER '92, 239 S. Main St, Willits, CA 95490, phone, 707-459-1256

Sunnyside Solar Workshops
Photovoltaic Home Electric Systems: Seminar and Workshop is a comprehensive one day introductory program for those interested in considering the use of PV for a residential application or with a general interest in the field. 1992 dates include: March 21, April 11, June 6, July 11, August 1, Sept. 19, Oct. 3, & Oct. 24. The registration fee is $95/person. Advance registrations are required and are limited to the first eight deposits of $35 received for each program. Brochure available. Discount for 2nd person. For more info contact: Sunnyside Solar, RD4 Box 808 Green River Rd, Brattleboro, VT 05301 or call 802-257-1482

AlTranEx'92
Inter'l Alternative Transportation Expo, Sept. 9-13, 1992 at the Santa Monica Civic Auditorium will feature The Endurance Electrathon (EV Endurance Competition); Exhibits of electric cars, natural gas, alternative fuel-flexible, solar, hybrids, conversions & human-powered vehicles, photovoltaic & energy efficient products, and environmental organizations; Seminars on: The Magic of Solar Electric, Natural Gas and Alternative fuels, Energy, Health and the Environment. The Expo is being held in association with Alternative Transportation News, Energy West Publishers, & Greenbrokers. For more info contact; Greenbrokers, 279 S Beverly Dr, Ste 369, Beverly Hills, CA 90212 or call 310-285-0093.

Solar Energy Symposium 92
You are welcome to take part in the "Solar Energy Symposium 92" on April 18 and 19, 1992 sponsored by College of the Desert just 15 miles off Interstate 10 on Monterey Avenue.

College of the Desert is located in Palm Desert, California which is the hub of the Coachella Valley with Palm Springs on the west and Indio on the east. The area has a population of 200,000 and has 15,000 motel rooms – enough for everyone.

The event will feature solar and electric car displays as well as electric vehicle components, the latest energy conservation and renewable technologies and many other exhibits.

Please join us and accept our invitation and be a part of the solution to our energy dilemma. For more information, contact, George Smith Jr. at (619) 346-8041 FAX# (619) 341-8678, College of the Desert, 43-500 Monterey Avenue, Palm Desert, CA 92260

In plain English we do say
Subscriptions do run out some day
So if wanna stay with the Crew
Let me tell ya what ya gotta do
Check your mailing label!

the Wizard Speaks…

Permanent Magnets

Permanent magnets are those that keep their magnetic properties in the absence of an external field. They occur in nature as lodestones. Magnets are made by applying an external magnetic field to the substance to be magnetized. This causes the magnetic field generating elements of the substance to align within the external field. When this field is removed, these elements remain aligned rather than returning to a random distribution.

The elements that align are called magnetic domains. These are magnetic regions within the substance whose constituent elements are so distributed so as to produce a vector sum magnetic field which is greater than zero. Before alignment the vector sum of all domains is equal to zero. After alignment it is greater than zero.

In this process the elements of each domain act as a group. This allows for even further alignment within each domain. If the domains could be broken down into their basic elements, more powerful permanent magnets could be created with the application of the same on a lesser amount of external energy. Some methods of preprocessing these substances include heat, pressure, electromagnetism, and high energy photons. Such preprocessing might be able to break down the domain into smaller sets.

Letters to Home Power

We Print 'em Unedited.
Selected & Entered by
Kathleen Jarschke-Schultze

Light in the Forest

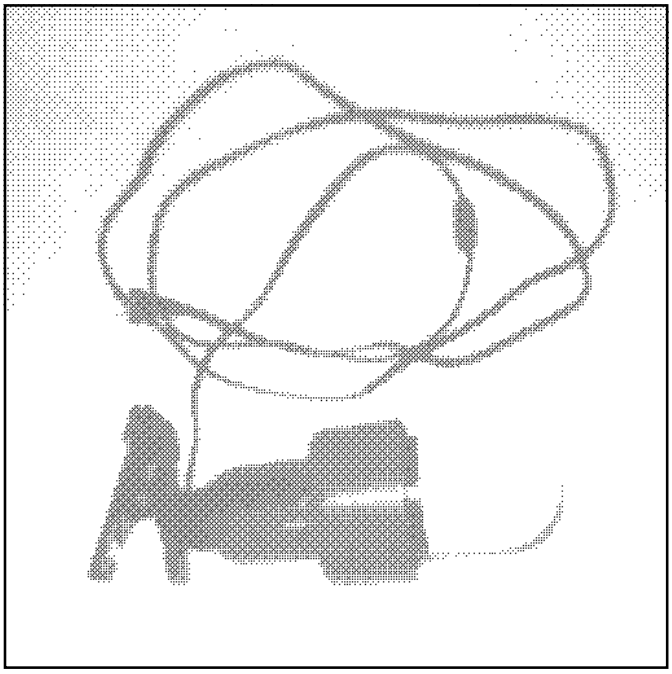
Hi HP Crew, Thanks again for your wonderful magazine! AE is now! I've been living with Kyocera solar power and a Honda generator as backup for 7 years now. I use the generator only a few times a year. When I use the generator it's usually to see if it still works. Have to run it every once in a while to keep it happy. Here's something campers may be interested in. I tried something different this last summer while on a camp trip to a remote part of Sequoia National Park. I brought along my PowerStar 200 inverter, 100' extension cord and a Panasonic 18 watt Electronic Light Capsule mounted in a portable housing. The housing has a clip that can attach to anything 1 1/2" or smaller. I plugged the PowerStar into my cigarette lighter, ran the cord into camp, clipped the lamp on a branch over the cooking table and turned it on. It takes a little while for the capsule to warm up (2 to 5 min). It was in the low 30s. After it warmed up we had more light then we've ever had in a remote camp. It was great! Everyone loved it! Cooking in this good light was much easier than using hand held, white gas or propane lights. We ran the light for about 4 hours the first night and 5 the second. I was a little worried about being able to start my truck in the morning. No problem! The truck battery still had lots of power. I will be using this set up from now on. It adds a whole other dimension to night life in camp. Enclosed is a photo of capsule and housing. Note the capsule actually touches the plastic housing. This is not a problem. The capsule puts out little heat.

Here is my renewal for another 2 years. Keep up the good work with HP! Sincerely, Rick Nieme, POB 13152, Coyote, CA 95013

Great idea, Rick. Brings back memories of cooking RiceARoni on a Coleman camp stove while holding a candle with one hand, to see what I was doing. What an improvement. It would be handy to keep in the car for an emergency light too. - Kathleen

Exhorting Exides

Dear Richard, I appreciate your advice re. the Exide battery problems. These batteries, now over 8 years old, appear to me to be going out. Even a heavy charge with my generator – 50 amps or so, will no longer bring the voltage up to 28 Volts. After a fair amount of charging, I can get them to about 27.5 Volts – but they do a lot of heavy gassing in the process. (I can recall when they would hit 30 volts with no problem). If I get them to 27.5 volts and remove the charger, they will drop back to 26 volts immediately. A load of even 10 amps or so, at this stage, will drop the voltage to about 25.2. At this small discharge rate (remember these are 750 AH batteries) the voltage will drop to about 24 within an hour or so. Further discharge and the voltage will drop to about 23.8. At this 23.8 level, if the charge is resumed then the voltage will IMMEDIATELY jump to 26.5 or thereabouts. Remove the charging source and once again the voltage will drop back to around 24.8 or 25 volts. However, if I allow the wind turbine or the solar array to charge the batteries while they are being discharged, then this float condition will allow a voltage of between 25 to 26 volts – depending on whether the charge current exceeds the load or not. When the wind is strong, you can see the battery voltage 'follow' the wind peaks – up as the wind gusts and back down if the wind falls off. In other words it appears to me that the batteries are responding rapidly to charge and discharge loads and not really taking any of the charge and holding it. Again, let us say that there is a strong wind, 40 amps or so, and this continues for a couple of hours. A couple of kilowatt hours are pumped into the batteries, the batteries are just not taking this power – because if you try to draw out even half of what is supposed to have gone in, it just isn't there.



Above: Rick Niemi's solar camp light. Photo by Rick Niemi.

Also, if we get a dead still night, with no charge going into the batteries, I would run out of power half way through the night. Although the load would only average about 300 watts or so on the inverter. I won't bore you with more because it seems to me that all the elements of a sick battery are here.

But more alarming, even to attain 27 volts with a heavy charge going in, the gassing is tremendous (Does a battery gas more as it ages?). This gassing has caused explosion of the Hydrocaps, splitting of the battery tops and, in one case the four corners of the battery split from the top down to a length of about 5 inches! And electrolyte all over the place is not pleasant!

This long epistle is no longer for the purpose of getting your advice on what to do! But merely in the hope that some of my experiences with these batteries might be of help to you should you experience some similar problem in the future. Incidentally, these Exide 750 AH batteries are very poorly made. Both the tops and sides, particularly the sides are made of extremely thin material. Paper thin it seems. The cells themselves, if not strapped into a close fitting plastic framework, could never take any kind of stress. One would have thought that this size of cell which is about 6 inches square, 29 inches high and weighs over 100 lbs., would have been in a rugged case of similar material and construction as for an automobile battery. And I paid well over 4000 dollars for the set (24V).

Anyway, after some consideration, I have purchased 12 ex-telephone cells from Northwest Energy. In the hope that these 2000 AH cells will allow me to demand a very shallow discharge trough – something like 20% while at the same time giving me sufficient capacity within the parameters of the 'gentle' discharge cycle. In actual fact, with the wind and sun, on an average day, producing somewhere around 12 KWH per day, the batteries should be virtually on float 90% of the time.

Hope I have not bored you too much! I really must get a Xmtr fired up on 20 Meters so that we could arrange a QSO some day!

P.S. The freight charges (Truck to Miami) SHIP to here from Miami, amounted to more than 1/2 of the cost of the batteries themselves – I sure hope they are good! Best Regards, Frank Delisle, Carib Aviation Ltd., POB 318, St. John's, Antigua, West Indies.

Hello, Frank. Yes lead-acid cells gas at lower voltage when they age. I don't really know why, but we've noticed this as have many others. Keep us posted on the cells from Northwest Energy. – Richard

Solar Sailor

People – Yes, we sailors do know our solar. To me, sailboats and boat-livers have pioneered actual solar use, from power to hot water to propulsion. We are aware of the great advantages possible by using the sublime forces of the wind, tides and currents, and the sun. Each boat is its own little world and must budget power accordingly. There's no "jump start" at sea. I would be happy to write for you concerning marine uses of solar power. Really this should be a regular feature in every issue.

I spend half the year in Florida building and using solar systems and the balance in Maine at a Solar engineering commune that helps poor woods people get power. In Maine, folks don't have to get off the grid, as they never could afford to get ON it.

The point is that I am aware of what is happening with solar applications in boats and homes.

On boats we use techniques and take them for granted while they remain experimental for home use. Cruising boats are a great test bed, sailors communicate a lot between themselves and products "shake out" quickly in this harsh environment.

Look to the boats for the cutting edge. Thanx, Russell X. Braen, 1124 Ave C, Riviera Beach, FL 33404

We are getting more mail from our readers afloat all the time. If you would like to submit an article, read 'Writing for Home Power' in Issue #24, page 84 for guidelines. We'll be happy to consider your article for publication, Russell. A great deal of our information comes from readers who are do-ers, like yourself. - Kathleen

Hot Ideas

Dear Home Power Magazine: Enclosed please find a check for $10.00 to renew my subscription. I read every issue cover-to-cover several times. My girlfriend sighed as she handed me the latest issue fresh from the mailbox and made some comment about losing me again to Home Power for a couple days.

I would like to be able to tell you that I am basking in PV created light from my 12 panel Kyocera array atop two Zomeworks trackers which have helped to cool the drink I just took out of my Sunfrost fridge. But, alas, here in the recession-plagued Northeast the mortgage and health insurance don't leave many excess dollars. But, still I have come up with a couple of insanely simple ways to conserve and reduce grid use. When the weather allows, my morning shower is solar heated via the GARDEN HOSE. I have roughly 100 feet of green and red garden

hose laid out in the back yard with a spray head on the end and I put the end of it through the bathroom window when I am ready for my shower.

The 100 feet of hose gives just enough water for a warm if conservative shower. It just starts to get cool at the end. Another 50 to 100 feet of hose would be just right. Recovery time in full sun is amazingly fast – about 20-25 minutes – and that is with lengths of green hose and red hose. There were a couple of days in mid summer when the water coming out of the hose was too hot to use. If you use black hose you'll need to be creative and hook it up to a mixing valve to mix in cold water or you'll fry for sure. Black hose and a mixer would also allow for a shorter length of hose. At laundry time, I run the hose through the basement bulkhead door and use the warm water for the washing machine. The present length of hose only allows for about half of the water necessary for a load. Here, black hose would be greatly beneficial.

I recommend using high-quality hose, not the cheap plastic stuff. Sears sells hose of varying quality. Their best hose comes with a lifetime warranty but they caution the user not to leave it in the sun. Who uses garden hose in the shade, anyway? The life of the hose will be lengthened if the user remembers to turn off the supply valve after use. More than once I have come home to find aneurisms in the hose where heat and constant pressure found a weakness in the hose. The only other caveat is to move the hose around in the yard every couple days if you value the appearance of your lawn (assuming of course that you have one). Failure to do so will leave tracks of yellowed grass across your yard.

In the winter, when I must resort to the Aquastar 125 tankless propane-fired heater, I utilize the essence of simplicity in grey-water heat extraction to recover the heat in the shower water. I close the drain and let the water build up in the tub. I leave the water there for a few hours until it has given up its heat to the air and then let it drain out. Why waste all that heat to the sewer or septic tank?

The only two drawbacks here are: 1) grey-water around your ankles (rinse it off if it bothers you) and 2) Much more frequent need to clean the tub (I need the exercise anyway and I use cold water to do the cleaning).

Just think how much energy would be saved if everyone did this. In larger households showers can be staggered to allow time for the water of the preceding shower to give up its heat. Thanks for a great cutting-edge magazine! Thomas J. Brandolini, 17 Rowell Rd., East Kingston, NH 03827 • 603-642-4263

Tom, if we could get everyone to do the right thing the world would be a lot different place. We all must do what we can when we can. You have certainly given us easy, viable ways to conserve heat and energy as related to water in the home. Keep up the good work. - Kathleen

Protect Your Potential

Hi Richard: First let me wish you and Karen a very happy, safe Christmas and New Year season. I met you both in Amherst at the Midwest Renewable Energy Fair (in both 1990 and 1991). I have long been a reader of your publication – back when it was a free magazine.

Thank you for your very informative article "Careers in Renewable Energy" (issue #26). I read your article with great interest, as I found many parallels between the Renewable Energy business and my small business of Architecture Design and on site land use planning.

We specialize in passive solar design – good cents energy efficient homes and super insulated homes mainly.

Like the Renewable Energy industry in your article, we too are in our infancy and we too find it very hard to generate a continuing client flow (as well as cash flow) over time or to build a business on repeat clients. Advertising seems to be the key to this problem, but with poor cash flow its hard to maintain an effective advertising campaign over an extended period of time.

Yes, I am still struggling and yes, I am still learning from my mistakes, but I do believe I could help others in their infancy. Other than the obvious and necessary trappings of starting a new business I have found the following issues and items to be very important in the operation of my small architecture design and planning business.

1. Define your business services – Let the client know (in writing) what he or she is paying for, and more importantly what he or she is not paying for.

2. Protect your drawings and design work – never relinquish or surrender your master drawing sheets. I have found some home builders (my clients) will use my work as stock or off the shelf drawings and will use them over and over again with no just compensation to you for your work or design services.

On each and every sheet of your drawings place your copyright protection clause and point this clause out to your client before the start of construction.

The clause I use on my drawings reads as follows:
1) When you as our client request and purchase the services of Contemporary Designs, we grant to you, our client, the right to use all Service documents and

drawings to construct a simple house or building.

All blueprints, plan drawings (which includes floor plans, elevations, sections and details), sketches and written documents are the sole property of Contemporary Designs and are protected under Federal Copyright Laws, Title XVII of the United States Code and Chapter 37 of the Code of Federal Regulations.

Contemporary Designs retains title and ownership of all service documents and drawings. These service documents and drawings cannot be copied or reproduced by any means for any purpose, in addition these service documents and drawings cannot be used or resold to any person or persons without the written permission of Contemporary Designs.

3. Protect your business and yourself against legal suits – never specify structure components (unless given in the building codes or engineered by a licensed engineer with his or her seal) on your drawings – items like beams, columns and concrete reinforced footings.

The statement of use on my drawings for wood trusses reads as follows:
1) Contemporary Designs does not provide engineering or design services for roof or floor trusses. These services shall be provided by the truss manufacturer or supplier.

In addition, Contemporary Designs takes no responsibility for the engineering or design decisions of the truss manufacturer or supplier.

Of course there are many, many more items and issues to consider when starting a new business, but most of these considerations are common sense issues, common to nearly all businesses.

So Richard, like you, I don't have a crystal ball or a Wizard in my back pocket. But I do see a growing need and life long opportunity for the Renewable Energy Industry and related architectural design and planning profession. An opportunity and business a couple can build over time. But one must bear in mind, this is still an infant industry and like all infants they take time and a great deal of understanding and care.

I thank you again for your and Karen's hard work and let's look forward to an even better 1992. Sincerely Yours, Russell K. Klug, Contemporary Designs, 218 W. 11th Ave., Oshkosh, WI 54901-6410 • 414-426-0963

This is very good information, Russell. Thanks for sharing it. It is important to protect yourself and your clients in any business. It is essential in fledgling industries like architectural design and RE related companies. - Kathleen

Thanks for the flowers, Russell. It seems to me that renewable energy and business are both necessary. After all, if no one uses PV modules, then all the info and swell benefits are worthless. Knowing how to use PVs is meaningless if you can't buy a module. – Richard

Biogas Books
Dear Home Power, I was very interested to read Mr. Rutan's methane gas article. His is one of the clearest and most experienced summaries I've seen, and I look forward to more of his writings. If you or your readers would like to learn more about biogas in the third world, I recommend 'A Chinese Biogas Manual" (available from VITA, 1815 N. Lynn St., #200, Arlington, VA 22209 • 703-276-1800). This handbook was directly responsible for the construction of several million biogas pits in China. VITA publishes two other biogas booklets, '3-Cubic Meter Biogas Plant' and 'Understanding Biogas Generation'. Both are informative and include good bibliographies.

Another progressive application of methane is in natural gas vehicles. This idea isn't new – remember the "chicken manure-powered car"? – but it is now receiving widespread promotion and technical support. The 1990 Clean Air Act gave NGVs a big boost by requiring cleaner cars in ozone polluted cities. A nationwide switch to NGVs would nearly eliminate coastal oil spills and groundwater contamination from leaking underground storage tanks. Natural gas is a domestic resource, and though it's mostly nonrenewable today, that could change as we become wiser about using what we now waste. Some developments in this field are covered by the American Gas Association's Natural Gas Vehicle Newsletter (Bi-monthly, $192/year, but free to government agencies and gas utilities. AGA, 1515 Wilson Blvd., Arlington, VA 22209 • 703-841-8558). Keep the love and sunshine goin' round. L.J. Aurbach, 2811 McGill Terr. N. W., Washinton D.C. 20008

Thanks for the info, L.J. Be sure to read Mr. Rutan's article in this issue on yet another, but important aspect of methane production. - Kathleen

Packing Problem
Dear Richard, I deeply appreciate Home Power Magazine. Thank you and all those working with you.

I have a suggestion for Things That Work! articles. In them, the author seems to praise the packing that the equipment comes in regardless of whether it is molded styrofoam, bubble pack or styrofoam peanuts. There are major environmental problems with these packing

materials even the ones that do not use CFCs (which are depleting the earth's protective ozone layer) as their blowing agent during the manufacturing process. And yes, we are reusing them when possible but they, in actuality are usually re-used only once.

Oil based packaging is really not biodegradable in our lifetime. It is made from a non-renewable resource and is a litter problem and a wild life hazard.

So far, the alternatives (such as popcorn, shredded newspaper or molded cellulose) aren't totally perfect either but then living with limitations, paying more up front for long term savings and living by our environmental ideals is not new for us.

Please encourage packaging that works! Two year sub enclosed. Thanks again. Rob Harlan, 42451 Road 409, Mendocino, CA 95460 • 707-964-6104

We do encourage packaging that works, Rob. A lot of the gear we are talking about sending through the mail or shipping companies are expensive electronics that need real protection. We bought a hot air popper and organic popcorn to use in shipping but we rarely get to use it. We get so many styrofoam peanuts that by reusing them for packing we don't need anything else. One of our advertisers, PowerStar Products Inc., sent us an item packed in cornstarch squigglies. We applaud their effort to protect the earth. The cornstarch peanuts will disappear if you put them in water. It is non-toxic packing. They have already been used to pack a shipment we made to someone else. We are currently looking into where to get this kind of packing material. - Kathleen

Passive vs. Active

Dear Richard, Your magazine is terrific, keep it up! I must comment on one article however that is significantly misleading. I hope you will be able to publish this so as to set the record straight.

Passive vs Active Trackers. In your comparison of active and passive trackers (Things That Work: Wattsun PV Tracker Issue #25) you may have overlooked a few critical points: Reliability, Accuracy requirements, Output comparison, Tracking and ease of assembly.

Reliability. I have had a lightning strike a few feet from my passive tracker; it was unaffected, of course. It did take out some nearby electronics however. Of course along the Pacific coast lightning may not be a problem, but it sure is around here in Albuquerque. As a result of this experience I now make sure that any electronics I install outdoors will withstand high voltage arcs (30-50 KV from a CRT tester -- like a cattle prod) at least to the case. I wonder if an electronically driven tracker would survive nearby lightning?

Accuracy. This is not very pleasant for a flat plate collector. The array output varies as the cosine of the angle of incidence so and array pointing 10 degrees off will have its output diminished only 1.5% and at 15 degrees error the output is down only 3.41 percent! At 20 degrees off it's down 6 percent which shows there is no point tracking in the declination (N-S0 direction since you get less than this error on the average (about 10 degrees) by adjusting just twice a season at the equinoxes.

Comparison. What is needed is an accurate comparison by a third party (how about you?) of the two systems for the TOTAL energy gained during a normal year rather than a misleading statement that the two axis tracker is 40% better than a fixed collector which is only true for a few days in the middle of summer. (Who would ever use a fixed array, anyway, even if it weren't a tracker, PV prices being what they are.) An accurate comparison would show an 8 or 9% improvement for which I for one would not be willing to pay the cost in dollars and low reliability for the more complex two axis electronic system.

Winter and morning tracking. Sluggish tracking is NOT caused by the cold. (If it were, hot air balloons would not work well in the winter either.) It is caused by wind and low or hazy sun since it's the temperature DIFFERENTIAL between the two sides that determines the torque available to turn the array. In the AM this difference is low because the sun is weak, so the energy is lost because slow sun acquisition is very little at that time.

Assembly. It took me 10 minutes to get my tracker out of the box and onto the pole. Indeed one big reason for buying the pre-welded assembly was the lack of hassle of obtaining a trouble free mounting system after having wrestled with some setups of my own. Tom Stockebrand, P. E., 1013 Tramway Ln. NE, Albuquerque, NM 87122 • 505-292-4261

Thanks for your opinions, Tom. I still maintain that the Wattsun will outperform thermally operated trackers. I am ready to put up a thermal tracker right next to the Wattsun, put the exact same panels on it, and monitor the output of both trackers with Ampere-hour meters. How about it, thermal tracker makers, anyone want to accept the challenge? – Richard

High Heat

Dear Richard, I have been a reader of your magazine since issue #4 and have always enjoyed your fine magazine and the articles you select.

I am writing you this letter in reference to issue #25 and the article by Tom Lane entitled "Solar Hot Water." Tom's ideas and system directions may work great in the Florida area, and 2,000 plus customers sure indicate that they do. However, I live in Colorado, at an altitude of 8,500 feet above sea level and I think that you ought to mention to your readers that at altitudes above about 4,800 feet, Tom's system will be in for some MAJOR problems...

At altitude, even when you have cloudy days, ...days when my eight 45 watt Solavolt panels combined aren't putting out more than 2 amps total, we still have solar infra-red infiltration great enough to heat water in the water panels up in excess of 130 degrees. If I were to follow Tom Lane's plans, my pump would never come on, and I would literally boil the water in my solar panels.

I too believe that a good system will pay the average household back in saved $$$ in two to four years, but I would say that a differential controller in the system is a must have item, if one plans to install such a system at altitude.

I have taken a course here in Colorado at the local Community College on solar, and I have the dubious distinction of having the first building department "approved" solar hot water system in Arapahoe County, Colorado. I too have installed or assisted many different systems here.

Keep up your fine publication, and know that I will continue to read your magazine from cover to cover every other month. Why don't you go monthly? Sincerely, H. Allan Burns, POB 97, Silvercliffe, CO 81249

Hi, Allan. Renewable energy is site specific. What works well in one environment may only last a week in others. Thanks for sharing your info. As for going monthly, I don't think so. We are interested in quality. We are also up to five people full time to deliver this quality to you on a bimonthly basis. We'd need four times the crew to do it monthly. People who are delirious and committed enough to work with the HP crew are hard to find. Richard

Temperate Panels

Dear Mr. Perez: I imagine I am not the only one to have sent you a letter of congratulation on your article "Home Power Measures PV Performance." I hope that you continue your evaluation next summer.

A practical question I have for you is this. Have you been able to establish what the temperature difference is between a panel at 50° C and the ambient? I realize that the presence of wind (or breeze) will be a contributing factor, but it would be nice if you had some data on the subject. It will help estimate the "worst case" condition in areas like the desert Southwest.

I did a lot of calculations based on the graphs you published, and I have come with derating factors well in excess of the 0.4%/C above 25° C which I thought was a good approximation. Have you looked into this derating factor? I am afraid that reading the values from the axis might introduce a sensible error in this calculation. Sincerely Yours, Hector L. Gasquet, 10909 Bill Collins, El Paso, TX 79935

Hello, Hector. You will find that a PV module will run about 20°C hotter than the ambient air temperature on a windless day. On windy days we have seen modules producing full power and only about 5°C. hotter than the ambient air. Figure on a power loss of about 1% per degree Centigrade above 25°C. – Richard

Paper Caper

Greetings! I was finally able to pick up a copy of HP (#25) locally when an environmental products store opened recently, here in the Hampton Roads area. It doesn't explain why I haven't subscribed yet, but that'll come soon, plus there is an order for back issues on the way!

As an advocate of alternate/renewable energy for MANY years, I find myself agreeing with about 80% of what I read in HP and related publications. I DO have a question about a recurring comment made by you folks, usually in your replies to letters. It has to do with not sending out things like renewal notices, etc., so's you can cut down on paper usage and "save a couple of trees." I view the effect as causing more harm than good. Each time someone misses a renewal and goes without an issue until he/she realizes it, that's another "pass around" issue lost which could otherwise influence the one or two folks locally to make the switch, start a subscription, write a Congressman, etc. Almost an exponential effect. Additionally, how do you make up for lost opportunity? It might have been THE one. The fewer snags in getting the word out, the more folks get on the bandwagon, the more the industry grows, the SOONER we can save our resources on a large scale. You want to save a couple of trees (literally a couple) now? Okay...it might cost more in the long run.

There's also the give and take aspect of subscriptions. You expect us to tell you when our address changes... we expect you to tell us when our renewals are due.

Lastly... if you are concerned about excess paper usage, either get the paper with a high content of recycled already in it, or get your paper from a mill which grows

trees especially for paper products. That way you don't get the guilt about using "old growth."

Otherwise, I'm very impressed with the quality of the magazine in virtually all aspects, especially the broad advertising base. Keep it up!!! Respectfully, E. R. Fuhrmann, ETC(SS) USN, Naval Guided Missles School, Dam Neck Code 5017, Virginia Beach, VA 23461-5250

Hi, E. R. We get a mixed response to our renewal policy of printing expiration info on the mailing label instead of sending notices. Barkwheat's reminder to check your mailing label got pretty good response in the last issue. We hope subtle reminders will prevent missed issues. We pay the Post Office for change of addresses. The Web Press used to print HP's interior requires paper of certain tensile strength. Currently, no recycled newsprint will do the job. Recycled bookstock is available, but is bleached and heavier; this would more than double printing costs, and increase mailing costs and pollution. Rumors are flying about stronger recycled paper and non-chlorine mills, and we're following them up! -Karen and Therese

International Interest

Dear Home Power Folks: The past six months have been incredibly busy and productive for us. Completely the second hull of our 31' Wharram catamaran has been top priority. Finally, last week we rolled out #2 and joined the pair with laminated hollow varnished wood beams which we built 5 years ago. There's still much to do: hatch covers, decks, cockpit, rigging. etc. But, we're getting real close. Hope to be sailing by spring.

Our boat shop has operated on photovoltaic power since January. I connected 4 marine batteries to four K-51s the day the world invaded Bagdad. Sure is a great feeling cutting plywood panels with my worm-drive Skilsaw. Now that's a battery powered tool with some real teeth. The Trace 2010 serves up plenty of 110 VAC with no complaint. A 12 VDC Flojet provides water from a shallow sandpoint, while a Paloma propane water heater provides welcome hot showers.

Among the steady stream of visitors this past summer I noticed many non-Americans. Seems like folks are really moving around, exploring. In just a few months we've developed more than a passing acquaintance with a Russian couple, a Dutch sailor, a British innkeeper and her Aussie boyfriend, and three Asian Indians. A remarkable influx of interesting people for this somewhat remote coastal resort area. Every encounter is a story in itself, but let me describe briefly, the Indians.

On an East-West tour across the US with an international group called Peace Trees, these three young men were curious to see alternative energy developments. Their home is the Sri Aurobindo community in Auroville, near Pondicherry. Theirs is an international community with various income producing business ventures, including the custom manufacture of uninterruptible power supplies. From New York City to Seattle my new Indian friends did not see any alternative energy applications. They ended up working through the month of August here in Nahcotta, at a neighboring restaurant, the ARK, which happens to be one of our oyster customers. So we made a lasting connection with our mutual interest in alternative energy. Grid power in their homeland is not reliable, so they enjoy a strong market for their products. These guys work in a shop in a spiritual community (3-4,000 members) that actually builds the inverters used in the uninterruptible power systems which they sell, install and service. They scrutinized our system carefully, giving the Trace high marks. They considered their Indian produced PV panels (typically 30 watts) to be of lesser efficiency and less finished in appearance than our Kyoceras. The Zomeworks Track-Rack fascinated them, as they routinely use fixed roof racks.

Sometimes I feel discouraged by the immensity of environmental problems facing the US. Then occasionally my hopes are lifted by the surge of interest in conservation and renewable energy. It is especially encouraging to learn that the interest in renewables is truly global.

P.S. No absolute need to print this letter. I won't be deeply hurt, although the Letters section is what I usually read first. In many cases I think the Letters could be improved with a bit of editing. Trim the extraneous. That's my only criticism of HP, and a small one too. No need for for a brutal machete job like the Time-Newsweek editing, just a little focusing. and more of 'em. Keep up the good work. Pacifically, Larry and Marge Warnberg-Welling, POB 43, Nahcotta, WA 98637

Hello, Larry and Marge. Take heart. If we've gotten ourselves into environmental trouble, then we will get ourselves out! Keep on trying. We are making a difference. On editing…well, it's kinda like eating peanuts: difficult to know when to stop. So rather than be tempted to put words in our readers mouths, or worse yet leave them out, we print every word of every letter. – Richard

Doin' It

Hi Friends, I like Home Power just as it is. It's the best magazine ever printed on Home Power and How to do it. I have all the issues and wouldn't part with them for any amount of money. I have an old satellite tracker I'm going

to use for my Photovoltaic panels whenever I can afford them. I now use a 8 HP Wisconsin gas engine that runs a 120VDC gen and a 12 v Delco alt. plus a marine deep cycle batt and a 400 watt Tripplite inverter. I built the entire system and have only $200 invested. Thank you for all the info in Home Power. Never on grid, Jim Carr, Rt 2 Box 475A, Rush, KY 41168

We salute you, Jim! You inspire us! - Kathleen

Phone Home

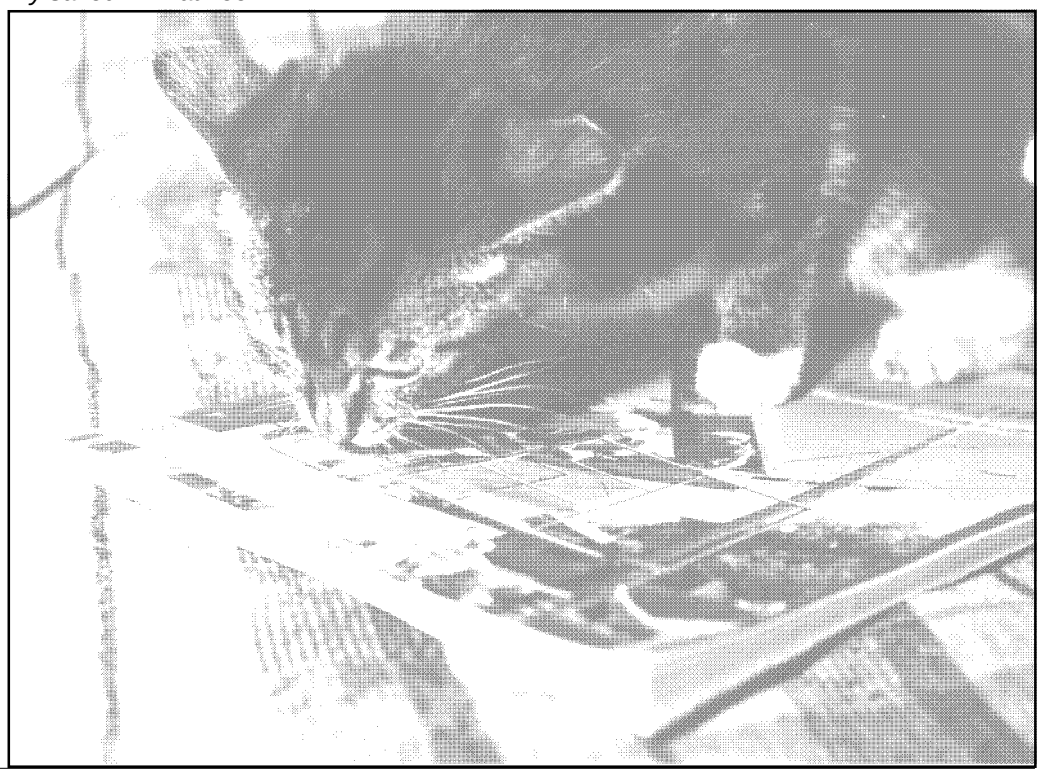
Hello Richard- We realize that many of your advertisers are selling telephone answering machines in their catalogues for the LOW price of approximately $100 or more. We feel that this is a rip off and wish for you to tell your readers that they can save a few pennies by shopping Wal Mart or K Mart. We notice that they have several to pick from, we are currently using Unisonic Products Corp of NY which we paid, not on sale, $39.95....Need I say more? These units come with a converter to change the 110 volts AC to 9 volts DC.

Of course there is no guarantee that other models will or will not work it all depends on the transformer. Of course you will need an adapter to go from your 12 volts to 9 volts, which you simply plug into a cigarette lighter plug and set the voltage for 9 volts. You can buy these adapters from Radio Shack.

We would appreciate you printing this and we are sure that your readers will also like to know about this, so they will not continually get ripped off. Sincerely, Charlie Collins, POB 852, La Verkin, UT 84745 • 801-877-1061

Thanks for the info, Charlie. A penny saved... - Kathleen

Betty Boop checks her mailing label. Have you checked yours?



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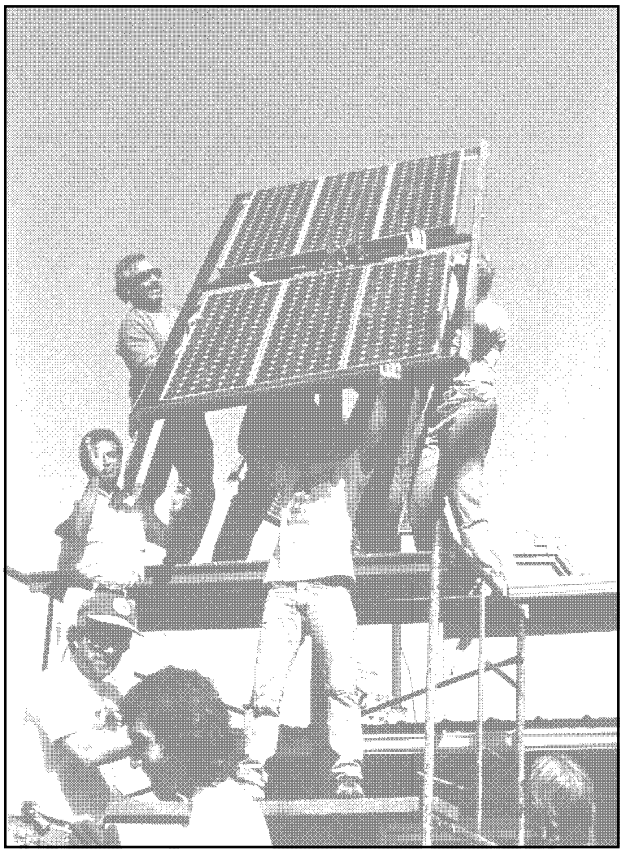

Workshop Schedule
May 4-14 Solar Home Design and Construction
May 18-21 Micro-Hydro Electric Systems
May 26-29 Wind Power
June 1-4 Practical Hydrogen
July 6-17 Photovoltaic Design and Installation
July 20-30 Advanced PV for Remote Homes
Sept. 7-18 Photovoltaic Design and Installation
Sept. 21-Oct. 1 Advanced PV for Remote Homes
Oct 5-8 Micro-Hydro Electric Systems
Oct. 12-22 Solar Home Design and Construction
Oct. 26- Nov. 5 Advanced Passive Solar Design

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Q&A

Power Digestion
Is there any way to get a list of devices that digest inverter power? The information on printers and copy machines is about all I have ever seen. I would be glad to contribute to this information pool. For example my two year old oil fired furnace required a 3 MFD capacitor across the input leads. Without the capacitor the electric eye saw the modified wave of our 2012 as a flame irregularity and shut the burner down in 45 seconds. With a capacitor, no problem. Debby is, at this very moment, trying out a bread machine she got for Christmas. It is a digital device that looks like R2D2 from the Stars Wars movie. So far it is running just a bit fast. Will let you know. Nelson and Debby Henne, RD#1 Box 104, Robsonia, PA 19551

We are compiling such a list. Please send us data on inverter friendly appliances. We are interested in make and model of the appliance and also make and model of the inverter which power it. We will act as a clearing house for the data and publish it when the time is ripe. – Richard

No Control
A Philips Earth Light SL-18 caused trouble with my TV remote control. With the Philips light on in the room with the TV, the remote control would not work. The TV remote is infrared and runs at 56 KHZ. The lamp must operate at 56KHZ, or 56KHZ is a multiple of the lamp frequency. So, it is not easy to get into to change the oscillator frequency. Lowell Wilson, 1104 Wentland Dr., Mason, MI 48854

Interference problems such as this one are common. Tweaking the light is a very remote possibility. I suggest the Osram EL series of compact fluorescents. These Osrams have passed the "Class B" FCC tests for radio interference. They are clean and will stay out of your remote control. – Richard

Demand Heaters
I been talking to various dealers and plumbers here in North Florida about ON DEMAND WATER HEATERS. ALL of them say NO because of the high failure rate of them? When I ask what type of failure occurred, I get a ho-hum answer.

Would you place an article in your magazine, asking what problems occur in Northern Florida with ON DEMAND water heaters? Is it the heavy lime deposit (seeing most of Florida is sitting on coral beds) which come with our water supply!

I was reading one article where the person said that her sub. ran out and, lo and behold, I looked and my sub. had run out also. Folks, keep up the good work. May God bless Y-all, Donald H. Boudreau, RT # Box 5234, Crawfordville, FL 32327

Let's hear from some readers in Northern Florida who have On-Demand water heaters. What is the story out there? Write to us or get in touch with Don. And good work, Don, checking your sub in time. - Kathleen

Panel Parameters
I've got a couple of Solarex 6W panels, but I'm not sure how to install them. Should they be installed inside a glass enclosure, or can they withstand the elements directly? Sincerely Yours, Mitchell Lee/KB6FPW, 172 North 24th St., San Jose, CA 95116

Well, Mitch, if your panels have aluminum frames and are not amorphous, you have nothing to worry about. Solarex panels have a ten year warranty and can withstand all types of weather. They can, however, be broken by a direct hit, i.e. a rock, baseball bat, hammer or even a long drop off a roof. Make sure your panels are securely anchored to avoid accidents. Even if the tempered glass on your panel is broken by accident, in most cases the panel will still work. In HP #21, page 12 there is an article on how to repair the broken glass of a solar panel. The plastic framed, amorphous panels are prone to degradation due to exposure to the elements. While I don't know how much, it seems to be a lot in the first year.- Kathleen

Alternate Windcharger
Has anyone ever mounted an alternator on a Windcharger unit. I've just moved to a place off the grid. There is a derelict Windcharger 3220 in pieces on the place. The prop is useable and is 11 or 12 feet long. Since I have a 12-volt battery bank and a 12-volt inverter I am not interested in the 32-volt generator but wish to use an alternator instead. I've read Michael Hackelman's books, but how do I choose an alternator and drive train (I'm leaning towards a gearbelt) for my application? Any advice would be much appreciated. Peter Donovan, 66636 Zumwalt Rd., Enterprise, OR 97828

Peter, The original Windcharger 3220 was 1000 to maybe 1200 watts in capacity. They were gear driven units, with a bull gear attached to the blades, and a smaller gear attached to the blades, and a smaller gear attached to the 32 VDC generator, both in an oilbath gear

box. The 1000 and 1200 watt units, with a 10' to 12' rotor, typically had a gear ratio of 4 to 1. The larger 1500 watt four-blade units had a gear ratio of 6 to 1. There were also a few 5 to 1 gear ratios out there, too.

I don't know of anyone who has ever connected an alternator up to a Windcharger gearbox. The generator bolted to the gearbox and was gasketed so that the gear box didn't splash all of its oil out. While anything is possible, it seems a formidable task to retrofit an alternator to the gearbox, I'm not sure how you'd approach getting a timing belt in there, and then adjusting the tension on the belt.

You mentioned that you still had the 32 volt generator, but that you wanted to run the unit at 12 volts. Why not have the generator rewound for 12 volts. That would save an awful lot of screwing around mixing and matching parts. Another idea would be to use the generator as is, hook it up to your 12 volt battery bank along with a blocking diode, and put a variable resistor in series with the field. Check the ohm reading of the field. Let's say it's 15 ohms. I'd try something in the 10 to 30 ohm range. If the blade stalls and won't come up to speed, add more resistance. If it seems to be spinning too fast, decrease the resistance. While you won't get as much total power out of the generator as you would if you rewound it, you'll still get your rated current, in your case, 25 to 35 amps.

By the way, if anyone else has ever succeeded in marrying a Windcharger gearbox and an alternator, I would also like to hear about it. – Mick

My Question...

Dear Sirs, I am building, in North Carolina, a 24' x 48' owner built home. The roof slope will be the standard 4" in 12" rise running East West, one slope facing South, one North. I plan the home to be totally off the grid using the Trace 2012 or the PowerStar 1300 inverter. I think the PowerStar can power phantom loads such as clocks better than the Trace. Please comment.

My question, can the PowerStar or Trace start and run a 1/2 HP surface-mounted deep well pump in a 39' well at 115 volts? Next question is about hot water. With two people in the house would a tankless hot water heater at $500 work better and cheaper than a 40' solar water system with 80 gal. tank at system cost of $2,000? (As shown on page 37 of HP#25.) Keep in mind cost of future LP gas and sunless days in winter. I plan to put my solar electric modules on my 4" in 12" sloped roof. I will NOT track the sun. My question is what penalty in lost power will I pay for the fact that the solar panels will not be inclined at the best angle for the sun? I plan to use 30 amps of panels on a 1320 AH 12 volt bank and invert all power to AC except possibly for a Kenwood TS 440 Ham radio on HF and a 2 meter radio. The batt bank will be in the attic. Could I power a 600 watt pep output Ameritron AL 811 Ham amplifier on the PowerStar 1300? Will my TV and music system be hum free on the PowerStar power? Will my AC clocks keep time?

I plan to ground one leg of my AC power as per the NEC and custom in North America. I plan one AC circuit that will power two bathrooms and two outside 120 volt outlets. My last question is, will the GFI I will use on that circuit as per the NEC work correct on the Powerstar or Trace modified square wave output? I plan to wire so that one GFI will protect both bathrooms and both outside outlets, with nothing else on the circuit. Or, could I put the GFI at the PowerStar and thus GFI protect the whole house with one GFI? I have enclosed a S.A.S.E. and I like my sub to HP. It is money well spent. Very Sincerely, R. D. Carter, POB 418, Vass, NC 28394

Hello, R.D. Yes the PowerStar is better at powering "phantom loads" like clocks; it's efficient and won't go to sleep on small loads. The clock may keep correct time, or in some cases run double time, depends on the power supply in the clock. In general, you are better off with a battery powered clock (more reliable and less power consumption). Either inverter will run a 1/2 hp pump. Not having solar data for your neighborhood, I can't say if the solar hot water is a better deal than the instant gas fired heater. I suspect that it is. Your roof angle is right on during the summer and will cost you about 20% power loss during the winter. The PowerStar 1300 will run the Ameritron AL 811 RF amplifier. It is very unlikely that all your TV and music will run smoothly and totally without interference on any modified sine wave inverter. If you really want clean video and audio check out the Exeltech inverter on page 53 of this issue. We have used GFI breakers and outlets on Trace, Heliotrope, PowerStar, Exeltech, and Heart inverters. If they last a week, then they go on indefinitely. Some GFI devices fail during the first week. We've used the Leviton GFI outlets with success. – Richard

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Ozonal Notes

Cash Back and No Sales Tax!
California passed legislation (SB 2600) in 1990 that establishes the first tax incentives which can make buying a non-polluting "Certified Pure Electric Vehicle" not only good for your conscience but good for your bank account. Until a few months ago this didn't mean much as there were no California "certified pure" EV conversion kits available.

Home Power usually does not print "press releases" from manufacturers. We are making an exception because this "press release" is truly exciting and a real first.
Karen Perez

"On December 9, 1991, California State Assemblyman Sam Farr attached the first California "Certified Pure Electric Vehicle" kit label under the under the hood of an ELECTRO AUTOMOTIVE VOLTSRABBIT™ diesel-to-electric car in Santa Cruz, CA.

The certification allows EV builders or buyers to claim a $1,000 cash back on their state taxes, sheltering around $10,000 of California income.

Builders can pass the one-time-per-car credit along to buyers, providing incentive for professional mechanics to convert several cars for sale, each car with a one-time "$1,000 cash back" available to buyers up to the total fund limit of $750,000 per year until 1995.

Certified kits and certified cars are exempt from sales tax and use tax, including local millrates.

Assemblyman Farr, who helped electric pioneer Mike Brown and his Felton, CA company over the bumps that occur in any new regulatory trail, said 'I'm very proud to have played a role in helping a Santa Cruz constituent become the first Certified Kit supplier in the nation... This gives consumers the incentive to try another option: recycling their cars into electric's, rather than sending them to the landfill and waiting for Detroit or Tokyo to build new electric's a few more smog-filled years from now.'

Brown pointed out that 'the cost of a VOLTSRABBIT™ conversion will be about $9,700 including batteries and labor from your favorite mechanic, before taking the tax credit. Major manufacturers have been citing $25-30,000 for new cars, and not until the mid-1990's.'

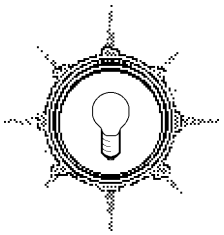
California's leading-edge legislation creates the first tax incentives which benefit professional mechanics, new conversion shops, and the end-user of an electric car, the beleaguered taxpayer/commuter. Previous EV incentives have gone to established EV producers and researchers.

Electro Automotive's kits allows certification of any conversion of a 1991 or older vehicle originally weighing 2,800 lbs. or less."

Access: Electro Automotive, POB 1113, Felton, CA 95018, 408-429-1989

Home Power's Business

"The man who on his trade relies
Must either bust or advertise."
Thomas Lipton - 1870.



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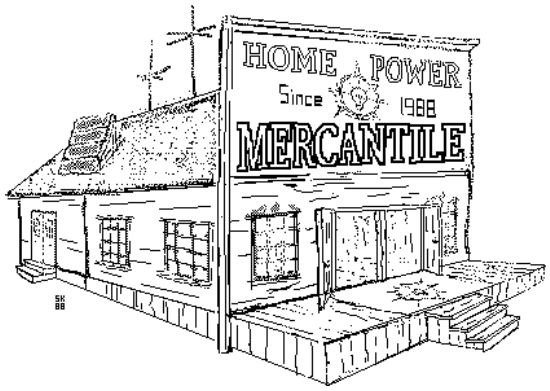

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