HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

ISSUE #63

February / March 1998

$4.75 U.S.

$6.60 CAN.

Display until April 1

CRUISING EQUIPMENT / HEART INTERFACE

full page

four color

on negatives

This is page 1

HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

Issue #63 February / March 1998

Features

GoPower

Homebrew

Cover: Todd Cory works on Jefferson Public Radio's Park Mountain translator, Mt. Shasta in the background. Story on page 6.

Columns

Regulars

Access and Info

Access Data

Home Power Magazine
PO Box 520,
Ashland, OR 97520 USA

Editorial and Advertising:
phone: 530-475-3179
fax: 530-475-0836

Subscriptions and Back Issues:
800-707-6585 VISA / MC

Computer BBS:
707-822-8640

Internet E-mail:
hp@homepower.org

World Wide Web:
http://www.homepower.com

Paper and Ink Data

Cover paper is 50% recycled (10% postconsumer and 40% preconsumer) Recovery Gloss from S.D. Warren Paper Company.

Interior paper is recycled (10% postconsumer) Mirraweb Grade 3 elemental chlorine free from International Paper.

Printed using low VOC vegetable based inks.

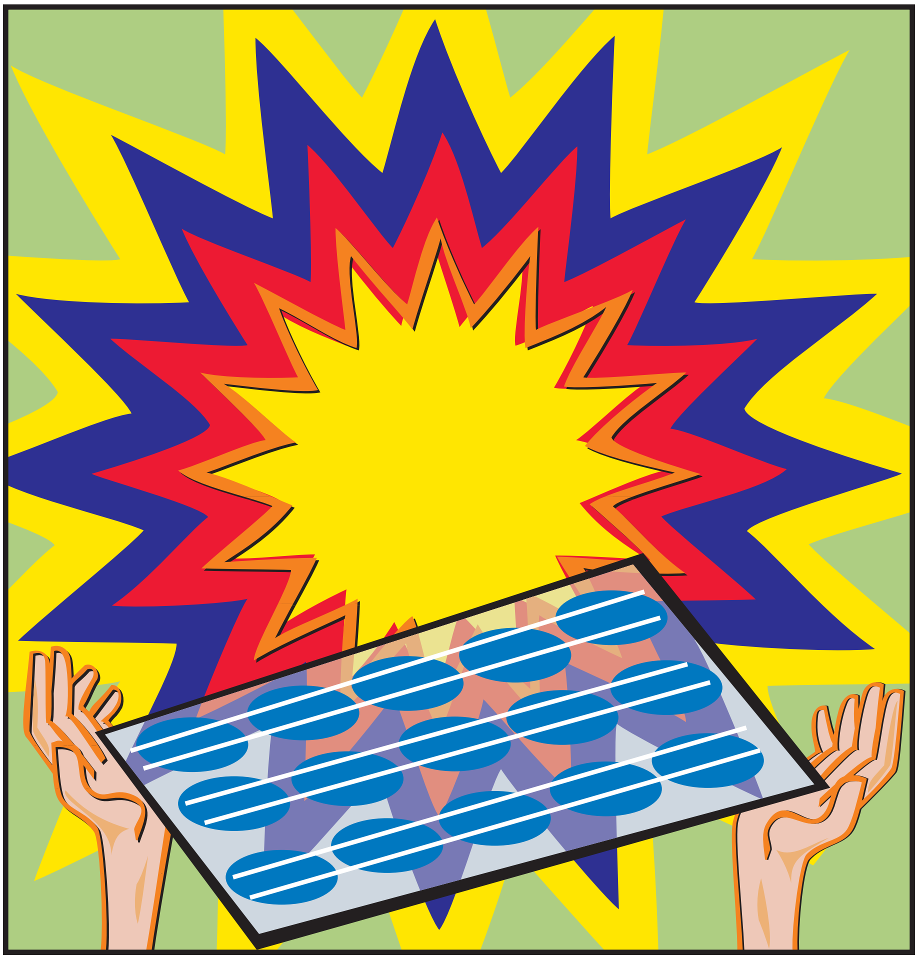
Printed by

St. Croix Press, Inc.,
New Richmond, Wisconsin

Legal

Home Power (ISSN 1050-2416) is published bi-monthly for $22.50 per year at PO Box 520, Ashland, OR 97520. International surface subscription for $30 U.S. periodicals postage paid at Ashland, OR, and at additional mailing offices. POSTMASTER send address corrections to Home Power, PO Box 520, Ashland, OR 97520.

Recycled Paper Recyclable Paper



A Wish for the Coming Year

For everyone, we wish an abundance of clean, free, renewable energy.

Who is going to grant this wish? We are.

Don't look to the Energy Establishment—the utilities, the utility commissions, or the government. We've been seeing their energy plans for years now—they make it and we rent it. Their motives are profit and power. They make electricity with nuclear fuels, by burning coal, and by damming rivers. Electric power production by utilities is damaging our environment while they pick our pockets and our childrens' pockets.

We make electricity from sunlight, wind, and falling water. If we, small scale producers and users of renewable energy, can make it work, then why can't the utilities? Perhaps we have different motives. Perhaps we are interested in clean, freely available energy which does not ruin our environment, and they are not.

If we really want this wish to come true, then we must rely on ourselves. We can break the utilities' monopoly on energy by making our power and by sharing it with our neighbors.
It's up to us….

Richard Perez for the Home Power Crew
at Funky Mountain Institute (42°01'02"N • 122°23'19"W) 1 January 1998

People

Jim Bell
Mike Brown
Sam Coleman
G. Forrest Cook
Todd Cory
Kathleen Jarschke-Schultze
Stan Krute
Don Kulha
Don Loweburg
Harry Martin
Karen Perez
Richard Perez
Shari Prange
Benjamin Root
Dennis Scanlin
Bob-O Schultze
Joe Schwartz
Tom Snyder
Michael Welch
John Whitehead
John Wiles
Myna Wilson

" Think about it…"

"A man can only do what he can do. But if he does that each day he can sleep at night and do it again the next day."

–Albert Schweitzer

We're your resource for reliable power from the sun, wind and water!

THE ALTERNATIVE POWER SPECIALISTS

Technical know-how & support

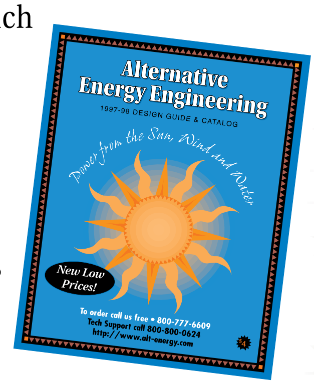
Anybody can sell you alternative energy equipment, but few have the professional experience to help you choose, correctly install and use it. We offer a Techline for customer support on hydro, wind, solar and pumping installations. What's more, we live and work with what we sell. Our homes, warehouse and offices are powered by solar, wind or hydro systems. Our experience provides you with high-quality, reliable energy products at affordable prices.

One of the largest inventories

We stock Solec/BP PV panels Trace and other inverters wind and hydro generators, SunFrost, VestFrost propane refrigerators, washing machines, space and water heaters, meters, power centers, fans, composting toilets, lights, pumps, cables, fuses, solar toys, switches and much more.

Call or write for a free catalog and design guide

We'll take you step-by-step through the process of creating a workable energy system.



TRACE ENGINEERING

new!

UX Series Inverter / Charger

- **Low cost**
- **reliable**
- **easy to use**

500 – 1400 watts

CALL FOR PRICING

Alternative Energy Engineering, Inc.
SOLAR, WIND & HYDROELECTRIC POWER SYSTEMS

Order: 800-777-6609
Techline: 707-923-7216
www.alt-energy.com

P.O. Box 339-HP
Redway, CA 95560

Solar-Powered Public Radio

Todd Cory

Above: Todd working on the Park Mountain (Weed/Mt. Shasta, CA) solar-powered translator. Photo by Michael Zanger.

This summer I again had the opportunity to work in the engineering department of our local public radio service, Jefferson Public Radio (JPR). I have been involved with JPR since 1984 as a listener, then as a volunteer engineer, and more recently several times as a paid part of the engineering department. I am quite passionate about supporting public radio. It provides one of the only outlets for the arts which would not otherwise be broadcast due to their non-commercial aspects. In addition, public radio provides an unbiased vehicle for news and information that is not dictated by commercial interests. A lot of the work I do for JPR is on a volunteer basis. In these days of federal funding cutbacks, volunteer work and listener contributions are what makes public radio possible. I encourage people to support the public radio service available in their area.

A Bit of History

Jefferson Public Radio has been serving our area with public, non-commercial radio services for over 28 years. Started as a local, college-based, public radio service for Ashland, Oregon, JPR has grown into a high quality, large and complex network serving over 60,000 square miles of Southern Oregon and Northern California (The Mythical State of Jefferson) with three (and sometimes four) separate audio program services.

Broadcasting in the Mountains

Public radio is generally found in the non-commercial, educational (NCE) part of the FM radio band from 88 to 92 MHz. While JPR does have several AM transmitters for our News and Information service, the majority of our transmitters operate in the NCE part of the FM band. These frequencies do best with line of sight transmitter to receiver paths. Our mountainous terrain has necessitated the building of individual transmitters and translators (low powered repeaters) for each community served. JPR currently has 34 translators and 11 full powered transmitters. We annually drive over 30,000 miles, maintaining equipment located on over 60 mountain tops.

Where Solar Power Comes In

Many of these best line of sight locations for translators do not include access to grid power. Many sites are actually five to ten miles from the nearest grid power access. This is where solar powered equipment comes in. JPR has six solar powered translators. The reliability of this type of installation has proven itself with average maintenance visits being in the greater than eight year range. The key (as in home solar power systems) is in the design.

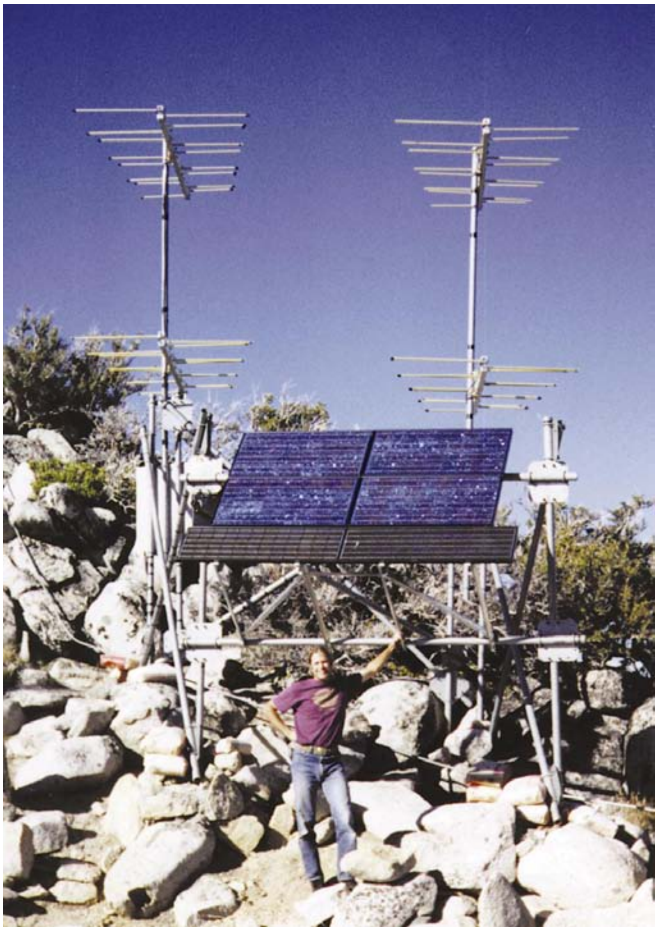
Designing the System

JPR broadcasts 21 hours per day, 7 days per week. Our precipitation is seasonal so the design must include low drain, high efficiency translator outputs and provide sufficient battery storage to operate the equipment for around 30 days with little or no sun during the winter months.

Efficiency = High Antenna Gain

It is possible to use a phased, multiple antenna output array to increase the effective radiated power (ERP) of a translator's output. We often use phased arrays of four ten element Yagi type antennas to accomplish this. To reduce the drain on the batteries during the low solar gain winter conditions, we generally use translator output modules of only 1 watt. Now, 1 watt might not sound like much power, but feeding it into a phased array of four, 10 element Yagi (Scala HDCA-10) directional output antennas creates an ERP of 32 watts. This is more than sufficient signal strength for adequate coverage of a community given a line of sight signal path. Using a low load, 1 watt output module also reduces the number and associated costs of solar panels needed to charge the batteries.

Left: The translator, in a weather tight box, is mounted on the PV / antenna structure.



Above: The antenna and photovoltaic arrays at the Boulevar Mountain translator.

We have one solar powered site that is using two 1 watt modules each feeding a set of four phased ten element Yagi antennas. This yields 32 watts ERP in two separate directions. Designing a strong mounting system for these eight 10 foot long output antennas, one input antenna, and eight 32 Watt photovoltaic modules on the top of a mountain is a major project in itself.

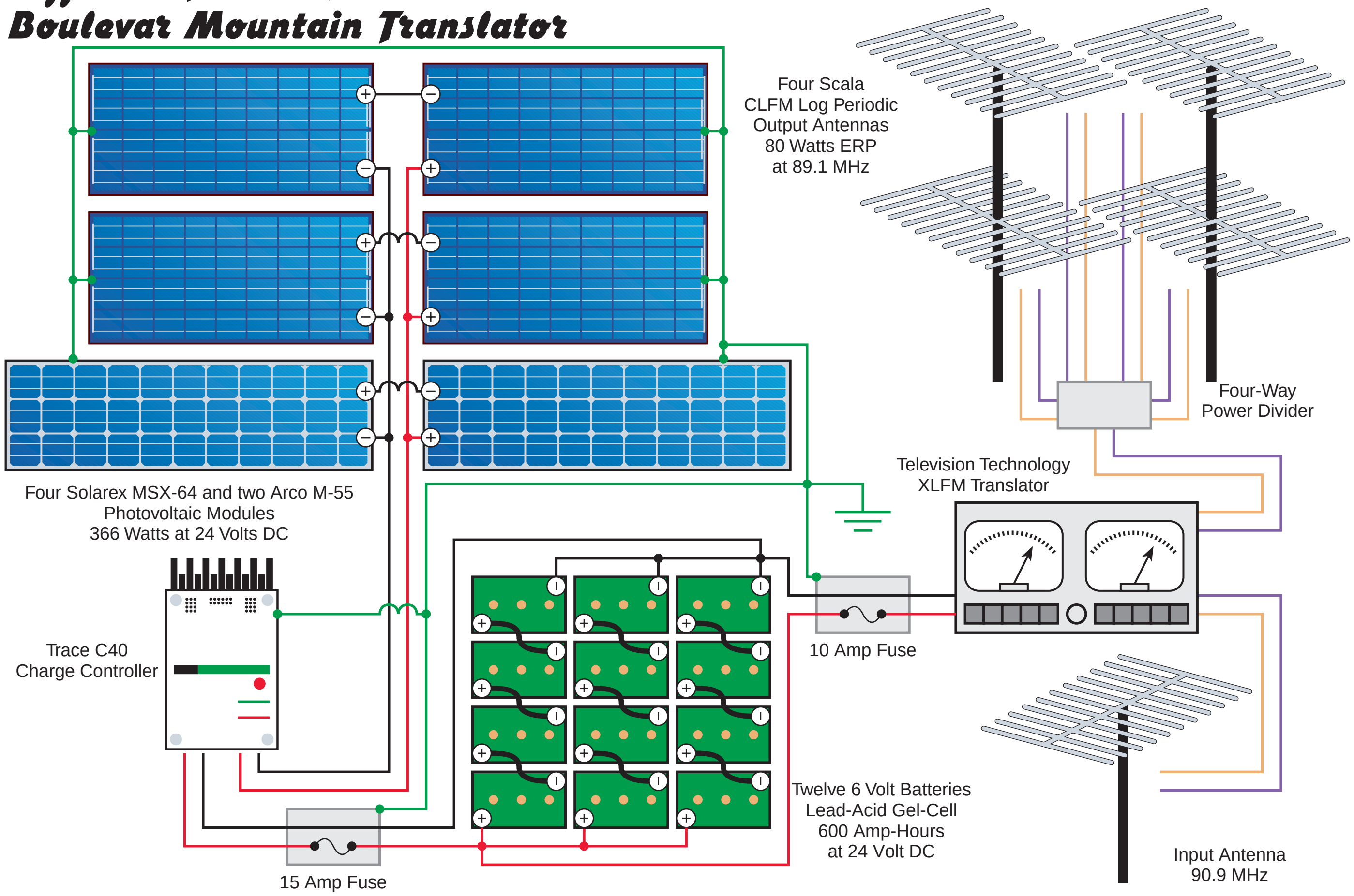
The Boulevar Mountain Translator

One of the projects I worked on this summer was rebuilding the Callahan translator. This site was originally built in 1988. Extreme weather conditions at this site destroyed it with high winds four years ago.

Design

The electrical storage system consists of twelve 6 Volt, 200 Ampere-hour, sealed gel-cell, lead acid batteries. These are configured into a 600 Ampere-hour, 24 Volt pack or 14.4 kWh of storage. As the batteries had been left without a charging source for the four years since this installation was damaged, their condition could be best described as somewhat tired. As public radio

Jefferson Public Radio's Boulevar Mountain Translator



operates with limited funding, I chose to continue to use the old batteries rather than incur the high cost of replacing the entire pack. For this reason I decided to redesign the translator from the original 10 watt output to a reduced 5 watts. This, feeding the same phased antenna array of four Scala CLFM log periodic antennas, changed the output ERP from 160 to 80 watts. This reduced load allowed me to use only six photovoltaics rather than the original eight. As we already had two Arco M-55s I needed to only purchase an additional four Solarex MSX-64s. I chose the Solarex panels because of their very rugged frames and 20 year warranty. Thanks to Tom Bishop of Sunelco, for providing the Solarex panels at a very reasonable price in support of public radio in our area.

The photovoltaics feed the battery pack through a Trace C-40 controller. This relatively new controller gets high marks from me. When using sealed batteries, it is essential that they do not get overcharged. The batteries then feed the Television Technology XLFM translator with power. With 5 watts of radio frequency (RF) output power, the translator's total power consumption is 25 Watts. As the unit automatically shuts off when the source signal is not present, I only needed to multiply the load wattage times the 21 hours we are actually on the air to get 525 Watt-hours of daily consumption. Figuring 70% of the battery capacity as available power (14,400 X 70% = 10,080 Watt-hours) the translator should remain on the air for 20 days without any solar charging at all. Given the conditions at the site, this is an adequate period to prevent excessive draining of the cells and assure that the unit will continue to broadcast throughout extended cloudy periods. Being on a mountain top and above tree line makes long solar days possible. With the batteries at a 70% state of discharge, it would take less than six days to fully recharge the batteries with the translator load still on.

Nuts and Bolts

After hauling cement and water to the site, 40 bags of ready-mix concrete were hand mixed and poured on

Right: The author in the underground translator vault at Park Mountain.
Photo by Michael Zanger.

Above: The complex structure supports translator, PV panels, and four Log Periodic antennas.

the dead-man mounting anchors. This insures that no future high winds would lift the structure off the ground destroying it again. Once the mounting structure was repaired, then came the work of mounting the new photovoltaics and four Scala CLFM log periodic output antennas to the structure. All these mounts need to be extremely strong to prevent damage from the high winds and ice/snow conditions present at this 8,000 foot site.

The translator is mounted in a weatherproof fiberglass box bolted to one of the antenna support legs. Its output module feeds the four CLFM antennas through a four way power divider. The cables feeding the four antennas from the power divider must all be the same length. Also the antennas must be precisely vertically spaced (89 inches at 89.1 MHz) to make sure the RF power reaching each antenna adds together to create the maximum gain.

This translator receives its input signal from our Klamath Falls transmitter, KSKF at 90.9 MHz. There is a separate mounting structure down the hill from the output antennas for the input antenna. This physical distance helps provide RF isolation between the input and output signals.

The batteries are installed in a separate box close to the road. Dealing with the heavy weights involved with lead acid storage batteries makes it essential to have their enclosure close to where one can drive. Using sealed batteries lessens the potential of winter freezing during low state of charge conditions.

The JPR Six

Jefferson Public Radio has six solar powered translators serving the following areas:

1 Iron Mountain; 2 directional outputs @ 32 watts ERP, 91.9 MHz, serves Coquille and parts of Port Orford, Oregon with JPR's Classics and News service.

2 Grizzly Mountain; 1 directional output @ 5 watts ERP, 89.5 MHz, serves Lakeview, Oregon with JPR's Classics and News service.

3 Paradise Craggie; 2 directional outputs @ 6 and 9 watts ERP, 91.5 MHz, serves Yreka and Hornbrook, California with JPR's Classics and News service.

4 Park Mountain; 2 directional outputs @ 5 watts ERP, 89.5 MHz, serves Mt. Shasta, and Weed, California with JPR's Classics and News service.

5 Gasquet; 1 directional output @ 32 watts ERP, 89.1 MHz, serves Gasquet and Crescent City, California with JPR's Classics and News service.

6 Boulevar Mountain; 1 directional output @ 80 watts ERP, 89.1 MHz, serves Callahan, Etna and other parts of Scott Valley, California with JPR's Rhythm and News service.

Conclusion

It has been my pleasure to help bring public radio to our listening area. When I am not working for JPR I do solar design and installation in the Mt. Shasta vicinity, so working with these solar-powered translator sites was particularly interesting for me. This is another fine example of the appropriateness and feasibility of solar energy.

Above: Ariel view of Boulevar Mtn. shows the PV / Antenna arrays (left) and battery vault (lower right).

Access

Author: Todd Cory, Bald Mountain Solar, PO Box 689, Mt. Shasta, CA 96067 • 530-926-1079
E-mail: toddcory@jps.net

Jefferson Public Radio, Darin Ransom, Chief Engineer, 1250 Siskiyou Blvd., Ashland, OR 97520
541-552-6301 • Web: www.jeffnet.org

Sunelco, Tom Bishop, PO Box 787, Hamilton, MT 59840 • 800-338-6844
Web: www.sunelco.com

Scala Antennas, PO Box 4580, Medford, OR 97501 • 541-779-6500
Web: www.scala.net

Television Technology, 5970 60th Ave., Arvada, CO 80003
303-423-1652

Trace Engineering, 5916 195th St. N. E., Arlington, WA 98223
206-435-8826
Web: www.traceengineering.com

BP SOLAR

Two page spread covering
pages 10 and 11

four color

on negatives
this is page 10

BP SOLAR

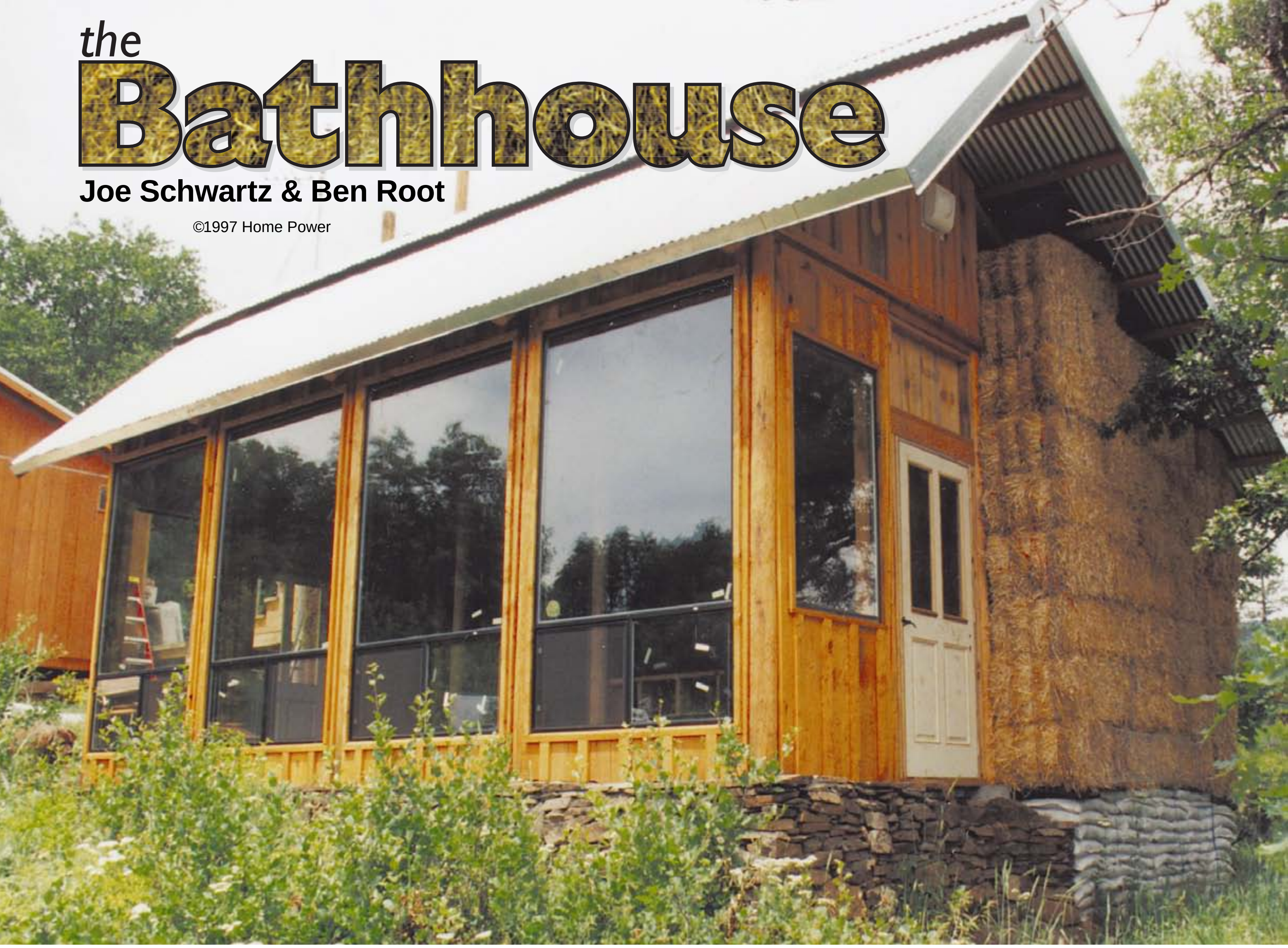
Two page spread covering
pages 10 and 11

four color

on negatives
this is page 11

the Bathhouse

Joe Schwartz & Ben Root



The spring was the deciding factor when we bought our homestead on Agate Flat in 1970. A good supply of clean, reliable water is an essential ingredient in any homestead. We hauled water, by hand, over one thousand feet from the spring to our cabin. A standard load was two, five gallon jerry cans. We had no hot water heater, shower, bath, dish washer, clothes washer, or even a cold water faucet over the kitchen sink. We were happy with the two to four, five gallon jerry cans of water we hauled daily. The water was pure, on site, and ours. Hauling the eighty-plus pounds an 1/8 of a mile was exercise. We were happy to expend the effort if it meant we got to live on Agate Flat instead of in the city.

Over the years our water demands and expectations grew. We added gardens and various animals (cats, dogs, pigs, turkeys, cows, chickens, goats, horses, and mules) to our homestead—all of them wanted watering daily. During that over twenty year period, I calculate we hauled, by hand, over 1,200,000 pounds of water. Eventually, in 1992 we drilled a well, added a 5 gpm solar-powered pumping system, and storage tanks for 2,700 gallons of well water. This well water now gravity flows to our buildings, stock tank, and gardens.

By the fall of 1996, we were ready to tackle obtaining the conveniences most Americans take for granted—hot showers and a clothes washer. We needed a building to house these systems, and the composting toilet to end over twenty-five years of outhouse use. Karen, being Karen, saw no reason not to have a small greenhouse as well. To complicate matters, Agate Flat is not a wimpy environment. We get four distinct seasons, from fry-your-butt in bone dry summers, to freeze-your-butt in four feet of snow winters.

Above: Working our way up, post and beam on concrete piers.

Enter Ben Root (the designer) and Joe Schwartz (the builder). We all wanted to minimise the use of energy intensive building materials, fossil-fueled excavation machines, and anything which cost too much money. We asked them to design and build an energy efficient building—a home for our solar showers, Karen's herb garden, and our PV-powered clean clothes machine. Here is what they have accomplished…. Richard Perez

Funky Mountain Institute is a study in dualities. Plywood cabins house high-tech computers. The electronics bench is in the living room. The extensive electrical power system operates flawlessly yet bathing is a bit of an adventure. Bucket bathes are effective, even romantic, but take bravery in the winter time.

Below: Face it south!
Getting our solar orientation right.

Defining needs

At the time of writing, it has been just over a year since we broke ground on a project to create a centralized water use facility, i.e. a bathroom, here at Agate Flat. The initial goal of the project was to provide facilities for efficient and pleasurable bathing. From there stemmed the desire for an indoor (composting) toilet and a clothes washer. Being RE nerds, we wanted the building to also act as a test bed for various solar hot water technologies.

The initial sketches were of a simple, modular, stick-framed structure. Cheap and dirty. Quickly the project grew. Winter time bathing required a space that could be heated; that means insulation. The list of appliances grew too, pushing the plans to expansive multi-story structures. Greenhouse space was mentioned. Things got complex and expensive. We backed up, trying to simplify our needs. But as each element was added we said "Well, if we're gonna do X, why not do it right and add Y?" the project grew again. And again we backed up.

In the renewable energy tradition, we felt that the building should be energy efficient, and as low an impact on the environment as possible. Alternative building techniques seemed attractive, but fears of unproven technologies and our own unfamiliarity made us hesitate. Slowly, as Ben ran computer drawings back and forth between Karen and Richard (as clients) and Joe (as builder) a plan came together.

Puzzle Pieces

Prior to any construction related decisions, certain pieces of the project were pre-defined. A long list of appliances had to fit, function, and interact with each other and the HP crew. An insulated shower stall built by Larry Schusler at Sun Frost awaits testing. An old enamel tub and sink were pulled off the junk pile and designed in. The tub would provide a luxurious soaking experience once nestled among the trellaced plants and garden beds. The Staber washing machine will take a huge time-consuming chore out of Karen's already too hectic trips to town.

The hot water system itself will be expansive. A propane tank-style water heater act as back-up and is last in line before the hot water loads. Ahead of that lies two pre-heat tanks, each supporting a separate solar hot water system. The goal is to provide flexible configurations for solar water system

Above: Dirt bag retaining wall/footing along north wall and under future bathing deck.

Below right: The north-east corner showing dirtbags and strawbale wall.

tea kettle within reach of the bathtub. In the future this may be replaced with a more efficient stove with a hot water loop.

The biggest and surely the most challenging appliance to incorporate into the building design was the composting toilet by Advanced Composting. The tank is capable of ten full time users and stands thirteen feet tall. This two story appliance was a real sticking point in keeping the building design simple. The “Tower of Turd” allows access to the toilet, via deck, from nearly the same elevation as the house. Located on the north-west corner of the building it became a creative and fun element in the final building design. Thanks to Richard and Karen for accepting our funky solution.

These appliances were fit together like puzzle pieces. We wanted to keep the building small and the plumbing centralized, but things had to function. The trick was to arrange these components in a layout around which an efficient building could be built.

Materials

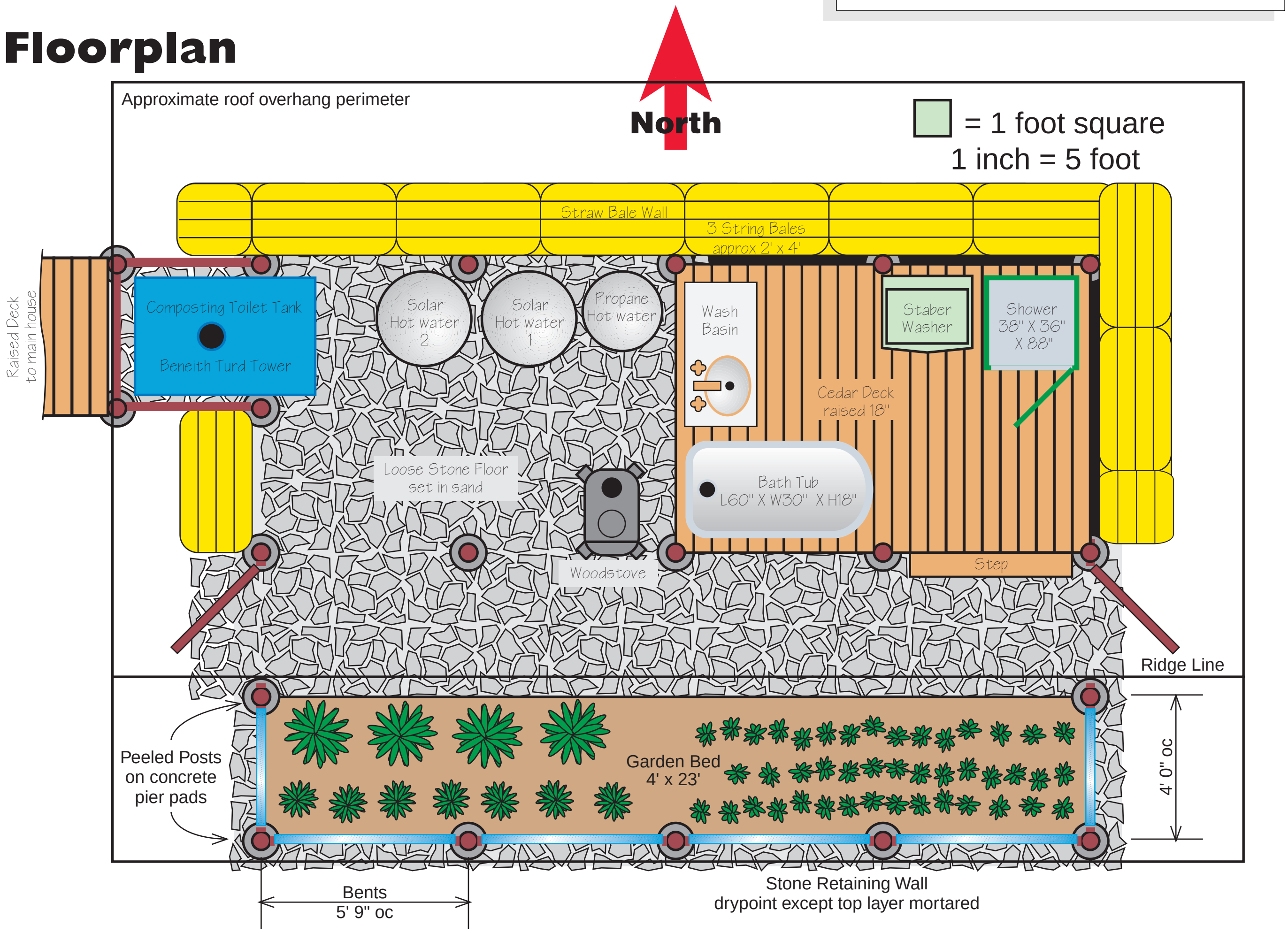
Once the desired appliances were sorted out, we began to ponder the building itself and the materials required to build it. Our choices of building materials were based on two main theories. 1 Save energy. 2 Save money. We figured that we could accomplish both by using materials low on the consumer chain.

First we looked for local materials indigenous to Agate Flat. The mud here is great (unless you’re trying to drive through it) and stone is everywhere. Building with on-site resources makes good sense, just ask the indigenous peoples of the world. The materials are free, accessible, and create structures that compliment the local landscape.

testing. The best performing unit will stay at Agate Flat. Challengers will come and go. The system will allow any combination of series or parallel arrangements of the three hot water sources, and the ability to work on any part of the system without taking the rest of the system down. Plumbing will all be exposed and accessible, “submarine style” as Richard likes to say. Look for a complete discussion of the hot water system in a future article.

For now an old cast iron wood stove will provide back up heat. The cute, but rusty little unit, from Karen and Richard’s original cabin, means a

Floorplan



We also scouted for recycled materials. Salvage means spreading out the embodied energy, and cost, of a product over a longer period of time. Second hand can be hit or miss, so start in advance. You'll find materials with character as well as save money. Besides, what a perfect excuse to go yard saling. When we did buy new, we attempted to use materials that were as unprocessed as possible. The energy saved was evident by the money saved.

Glass

Passive solar heating was a must-have for us solar bozos. The 16 foot by 24 foot building is layed out long on the east-west axis providing a large south wall for solar gain. Good windows were on top of the wish list. We found a window manufacturer that had four blemished, five foot by eight foot, double pane, low E, operable windows. For the whopping price tag of 80 bucks each they were about 10-15% of what they would have cost new. Garden space is one of the major focuses of the structure so we opted to glaze about 90% of the south wall to gain maximum sunlight for plant growth. In a living space this would be excessive glazing area. (See the side bar on the basic elements of Passive Solar Design.) For a green house and bath house, with wider acceptable temperature fluctuations, we felt it appropriate. With properly designed overhangs, overheating can be eliminated. The noon sun on the summer solstice barely enters the garden bed. On the winter solstice, however, the lower noon sun reaches 16 feet to the base of the north wall. This means solar thermal gain when it's needed most. A draw-back to this much glazing is excessive heat loss at night. Even efficient windows with an R value of 3 or 4 are basically, from an insulative standpoint, huge holes in the wall. Eventually, operable window quilts will be installed to lessen nighttime heat loss.

Stone

A six inch deep floor of paving stones serves as the building's thermal mass. Flat stones gathered from the property are set loose in sand; this means no concrete and great drainage. High mass is needed to balance the daily thermal fluctuations created by the large glazing area. Local stones were also used for the south retaining wall. Set without mortar, except for the cap layer, they create a natural transition from the landscape to the building.

Straw

Now we are efficiently gathering solar energy through the glazing and storing it as heat in the building's mass. To keep the heat in during the cold season and nights

The Basic Elements of Passive Solar Design

Effectively heating a home or other space with solar energy is a balance of many variables. Even the simplest technique, direct gain, takes planning to avoid the possible pitfalls. Here are the five main elements to consider when designing a direct gain solar house.

1 Siting & Orientation
The building should be positioned where it will receive winter sun from 9:00 am until 3:00 pm (90% of the suns daily energy). Orient the building south (beware of magnetic declination for your site) to capture available radiation. Variations up to 25° east or west of true south will still provide 90% of the sun's energy throughout the day, so some positioning to maximize view is OK. Position rooms within the building to efficiently use the suns heat: living spaces on the south, garage and utility rooms on the north.

2 Glazing
Windows allow the sun's energy in to heat your house (direct gain). Larger windows should be positioned on the south wall to maximize efficiency. Window area of 0.19 to 0.38 square feet per square foot of floor area is recommended for cold climates. In contrast, the north wall should have very few, and small, windows to prevent heat loss. East and west windows may be of moderate size but low sun angles here can create over-bright conditions, and unwanted solar gain in the summer months.

3 Overhangs
Eves or awnings are important on south-facing windows to limit the amount of sunlight transmitted in summertime. Too much summer sun will cause overheating of the space. An overhang of 1/4 of the window height in southern latitudes (39°), up to 1/2 of the window height in northern latitudes (48°) will prevent excessive summer sun from entering. Lower winter sun will still be able to enter to warm the space. Overhangs are not as effective on east and west windows due to low sun angles.

4 Thermal Mass
Mass is often the most important yet misunderstood element in a successful solar home. Appropriate mass, (e.g. concrete floor, adobe walls, masonry stove, etc.) acts as a thermal battery, collecting the sun's energy which shines on it during the day. This heat then dissipates slowly back into the living space overnight or through cloudy periods. Too little mass and your house temperatures will fluctuate daily, and seasonally. Sufficient mass will level out a buildings temperatures like a warm rock in the sun during winter, and a cool rock in the shade during summer.

It is possible to have too much mass, causing your building to never reach a comfortable temperature during the hours of sun, but this is more often the exception.

5 Insulation
Insulation (or more appropriately "Outsulation") is the compliment to mass. By enclosing the outside of the structure with a barrier against heat transmission, heat is kept inside where it's needed. Insulation does not store heat but merely prevents it from escaping.

These elements need to be balanced for each specific application and within each element lies many variables, but the potential for free, comfortable, and non-polluting space-heating is worth doing the homework.

means insulation. Quick to build, strawbale walls seemed to be an obvious choice. The material has an R value of 40 to 50, more than twice the insulative value required for walls in most states. Straw is non-toxic, harvested annually, and is largely considered a waste product by agri-business. Much of this resource is burned in the field to make way for the next planting. The results are diminished nutrient levels in the soil and increased air pollution. No thanks, how about an inexpensive and efficient building material instead?

Our one hesitation in using strawbales was due to the activities that would take place inside the building; baths, showers, and garden watering. We knew we could eliminate potential outdoor moisture problems with proper drainage, good footings, and big roof overhangs. However, indoor humidity is guaranteed to be high creating a difficult environment for the bales. We will be installing a system to monitor temperature and humidity at several locations within the bale walls and throughout the building. Logging of the sensor's output data will enable us to analyze both strawbale and overall building performance.

Dirtbags

Many successful structures have been built using strawbale walls to support the roof. However, we decided on non-loadbearing strawbale walls. We wanted to minimize our use of concrete to hand-mixed only. Instead, bale wall footings were formed using donated plastic grain sacks. These bags were filled with dirt, tamped, and layed in a running bond up to four feet high, leveling the grade. This packed earth retaining/foundation wall seems stout and we were comfortable with having the weight of the bales bearing on this footing, but the idea of having the roof load added to this seemed a bit much. The bale walls, and their coating of earth stucco now stand almost independently from the other structural elements of the building. We are very impressed with this cheap and stable foundation technique, but look for some cautions in the upcoming article on the construction process.

Poles

A post and beam frame on concrete pier footings supports the weight of the roof structure. While we didn't harvest these 40-50 year old lodgepole pines ourselves from Home Power land, they are still a rather environmentally and economically efficient material. The trees are felled and run through a debarking machine, that's it. The peeled poles display all the structural characteristics of the original tree, except the roots. The six to eight inch in diameter poles were 25% of the cost of milled, 6x6 fir posts and contained about a third of the embodied energy. The guy at the yard made it real clear that he wasn't selling "peeler cores," the

Above: The tower from the North.
No access yet.

less-structural leftovers from plywood manufacturing. Trees are a renewable resource if the forest is treated with respect, and these relatively young round poles create little unused byproduct.

Mud

The mud at Agate Flat is deep, sticky, and everywhere. The high clay content makes it stick to everything: tires, boots, animals. After years of experience fighting the effects of the sticky goo Richard and Karen were convinced of its ability to bond into a tough construction quality material. They were also psyched about the karmic implications of making good use out of a previously frustrating element of their remote existence.

Using the mud as a natural, breathable, earth stucco on the strawbales was cheap, easy, and fun. While we are still experimenting with the variations in recipes, the outcome looks good so far. Thanks to Mix-Master Dave, Doug, Suzan, and AJ for their help with the dirty work.

Under Construction

With the appliances and materials defined, construction commenced. Often, manual labor was used to replace fossil fuels, or to access our low-energy materials. Hundreds of stones were brought from the other side of the creek by wheelbarrow. Footings and trenches were dug by hand. When power tools were used they were run on the Home Power RE system. A solar-powered cement mixer mixes our adobe stucco. It feels good to create a relatively luxurious structure while paying attention to the energy resources going into it.

Detours

Throughout this project, and surely still to come, were many changes of plan and, well, mistakes. The windows are a perfect example. Luckily, when Joe found the four huge windows that became our south wall the building was still on paper. The original plans had the bents on four foot centers; the windows were five by eight foot. Back to the drawing board to remove one bent and spread the others to five foot nine inches on center. When building with salvage, we suggest aquiring as many of your materials in advance as you can so that you can design your building around them. Architects don't work that way, but this is homebrew.

Other changes happened on the roof. We had wrestled 18 foot by six to eight inch diameter peeled poles into place as rafters. Only then did we realized that to use more of the same material as purlins would be structural overkill, not to mention difficult. Thousands of needless pounds of material were eliminated from the roof load by switching to dimensional lumber. Left over poles will become future projects.

The plans called for a vaulted ceiling. But when we started crunching numbers for cost we found that externally applied foam board cost three times as much as the equivalent R-value in fiberglass. We opted to create a cold attic space by adding a ceiling of salvage-pile, one by twelve rough-sawn pine, and fiberglass batt insulation. Unfortunately we didn't have time to explore other natural insulation alternatives. Suggestions from readers would be appreciated.

Below: large roof overhangs kept bare bales dry over the winter.

Above: Big Blue, the composting toilet, in the bottom of the Tower of Turd (surrounded by the usual construction clutter.) Vents above the tank allow warm air into the second floor, taking the chill out of winter duties.

The vent on the entire south edge of the ridge peak (and the gable end vents) was added to vent excess summertime heat from the new attic. But this innovative change of plan was actually inspired by a different need. The ridge vent also acts as a chase through which solar water heater plumbing can pass. No holes need to be punched through the roof as different solar hot water systems come and go. The vent is screened to discourage critters, and overlaps to discourage the weather

This new ceiling also needed the ability to vent to the attic. Simply, a row of four ceiling boards near the north wall is hinged. Flip them up and excess heat and moisture can escape to the attic and out.

Also with a ceiling added, the bathing deck needed to be lower to accommodate the shower height. No longer did we have ample below-deck clearance to crawl in and plumb comfortably. So we added the interior retaining wall of dirt bags. Now there is over three feet of headroom below the bathing deck, plumbing access is easy, and we saved ourselves many wheelbarrow loads of back filling.

Lucky for us, we are in charge of the project, with the time and freedom to make changes as we see fit. The balance of planning versus flexibility is up to you when you are doing the project for yourself.

On Schedule?

The project has been under way for over a year now, progressing mostly on weekends between Ben's magazine schedule and Joe's job at Electron Connection. Over that time we have learned a lot, and can finally see a light at the end of the tunnel. The floor is unfinished on the inside. Outside, final layers of stucco will have to wait until spring nights are above freezing. Plumbing and electrical systems are still in the planning stages. Even before the building is finished an addition is planned. On the east end a new power room and electronics workshop will be built...eventually.

A disclaimer. We were excited but aprehensive when it was decided that we would undertake this project using alternative building techniques. The prospect of using low energy, earth friendly, and inexpensive materials to create an efficient structure seemed to fit

Remote Possibilities

Agate Flat is 50 miles from town, over an often treacherous mountain pass, and up 9 miles of rough or muddy jeep road. A round trip drive takes over three hours (chores not included). Needless to say, building in an "out-there" location is a bit of a challenge.

The cost to deliver the strawbales we used for the bathhouse was more than the bales themselves. Dump truck and cement truck drivers will only bring half a load at a time due to the road, yet delivery still costs full price. We couldn't bring ourselves to pay so much for sifted dirt. For many months, before Joe bought a full-size pickup, parts of the project sat half-finished.

In one early project adventure, we drove a 24 foot rental truck 300 miles to Central Oregon, loaded it with forty 22 foot pine poles, and all the huge windows for the project (Logs and glass...together!), back to Agate Flat, off-loaded, then back to town. Slept in the back overnight, picked up metal roofing and a pallet and a half of concrete in the morning, back up to the Flat, off-loaded by hand, then back to town to drop off the truck by 4:00. The 48 hour rental was well worth the money to get that much material up the hill so quickly. They didn't even charge us for the blown tire and hole in the truck floor from picking up a rock while stuck in the creek bed. Whew!

It's also amazing how a single small missing part can grind a whole project to a halt. One screw, gas line fitting, water line fitting, bolt, bag of concrete, spade connector, drill bit, or other gizmatchi can put the kabash on a whole day's work.

We've come up with three methods to help combat the missing part blues:

1 **Plan as much as possible.** If you try to figure it all out in advance, you might have it mostly figured out once the work gets going.

2 **Buy extra.** Plan for dropping little parts from the top of the ladder. Plan for poor planning (see #1). Build yourself a stockpile of often used bits and pieces.

3 **Be patient.** Remember, it's usually better to wait for the proper part to get the job done right. Don't rush, bailing wire and duct tape are for experienced professionals only.

Above: Brown the dog at the west entrance.

Home Power's ideals perfectly. However, Joe was the only person with building experience on the crew, and his expertise lies in more traditional carpentry. This article and the one to follow describes the techniques we used, and our reasoning, in the building of the bathhouse. Many of the techniques are brand new to us, and in our eyes still experimental. Please use our experiences to generate ideas, but see the following list of references for more in-depth information on these building techniques. These are the resources that we used.

References

The Passive Solar Energy Book, by Edward Mazria Rodale Press, ISBN 0-87857-237-6

The Strawbale House, by Steen, Steen, and Bainbridge Chelsea Green Publishing Co., ISBN 0-930031-71-7

Build It With Bales, Version 2, by Matts Myhram and S.O. MacDonald, Out on Bale Publishing, ISBN 0-9462821-1-9

Access

Joe Schwartz & Ben Root c/o Home Power
PO Box 520 Ashland, OR 97520 • 541-488-4517
ben.root@homepower.org

Thanks to *Man or Astro-Man?* for aural stimulation throughout this project. www.astroman.com

TRACE ENGINEERING

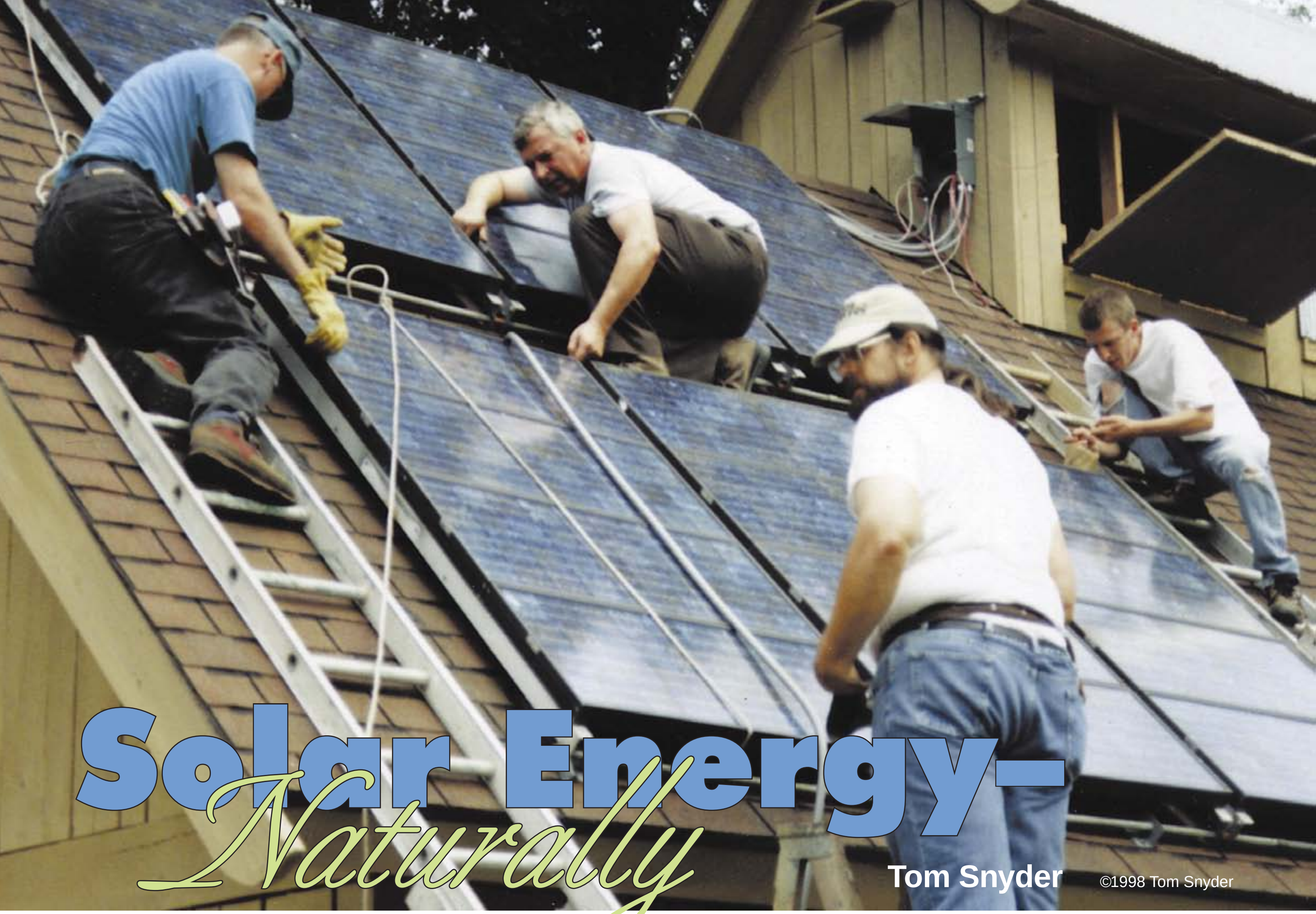
full page
four color on negatives

this is page 20

TROJAN BATTERY

four color
on film negatives

7.125 wide
4.5 high



Solar Energy– *Naturally*

Tom Snyder

Above: Students run wiring in 1/2 inch flexible metallic conduit to the PV junction (J) box.

The Indian Creek Nature Center (ICNC), Cedar Rapids, Iowa, is a beautiful example of how nature and people can interact and coexist. This nature center and director Rich Patterson have created an environment and energy example for the world to follow.

Where solar comes naturally

When the Iowa Renewable Energy Association became involved with the Nature Center in 1996, Rich Patterson had already replaced all lights with compact fluorescents, and all light switches with proximity switches. This cut his electric bill by 40%. The Sugar House, built in 1987, is a new building and extremely well insulated. About three years ago, the nature center was featured in a national magazine, *The Smithsonian*, for the natural wetlands project they developed. This nature center was a natural place for IRENEW's first PV installation class.

Surplus PVs go back to work

Two years ago, I heard that Brookhaven National Labs, Upton, New York, had a 5 kW PV array mothballed since the early 1980's. Over the next year, IRENEW managed to acquire this equipment with the expressed stipulation that the PV panels be used for education. Last fall we solicited places for these panels to be installed with the requirement that a class would also be held at the site. Originally this project at ICNC was to be taught by SEI from Colorado, but lack of time to get organized for a full week class did not work to our advantage. With more time to organize this

Right: Eight circuit Square D J-box on cupola, ready for PV wiring.

class over the spring and summer, and with the offer of help from Trace Engineering, the PV class was scheduled and held two weeks after our 6th Annual Energy Expo, on September 6 and 7, 1997. Another project IRENEW built with 24 of the Brookhaven PV Panels is a 1000 watt power trailer with an Exeltech 4000 watt Inverter, the subject of another article on my schedule for HP readers.

Above: IRENEW member Don Laughlin explains PV wiring to students before going on the roof.

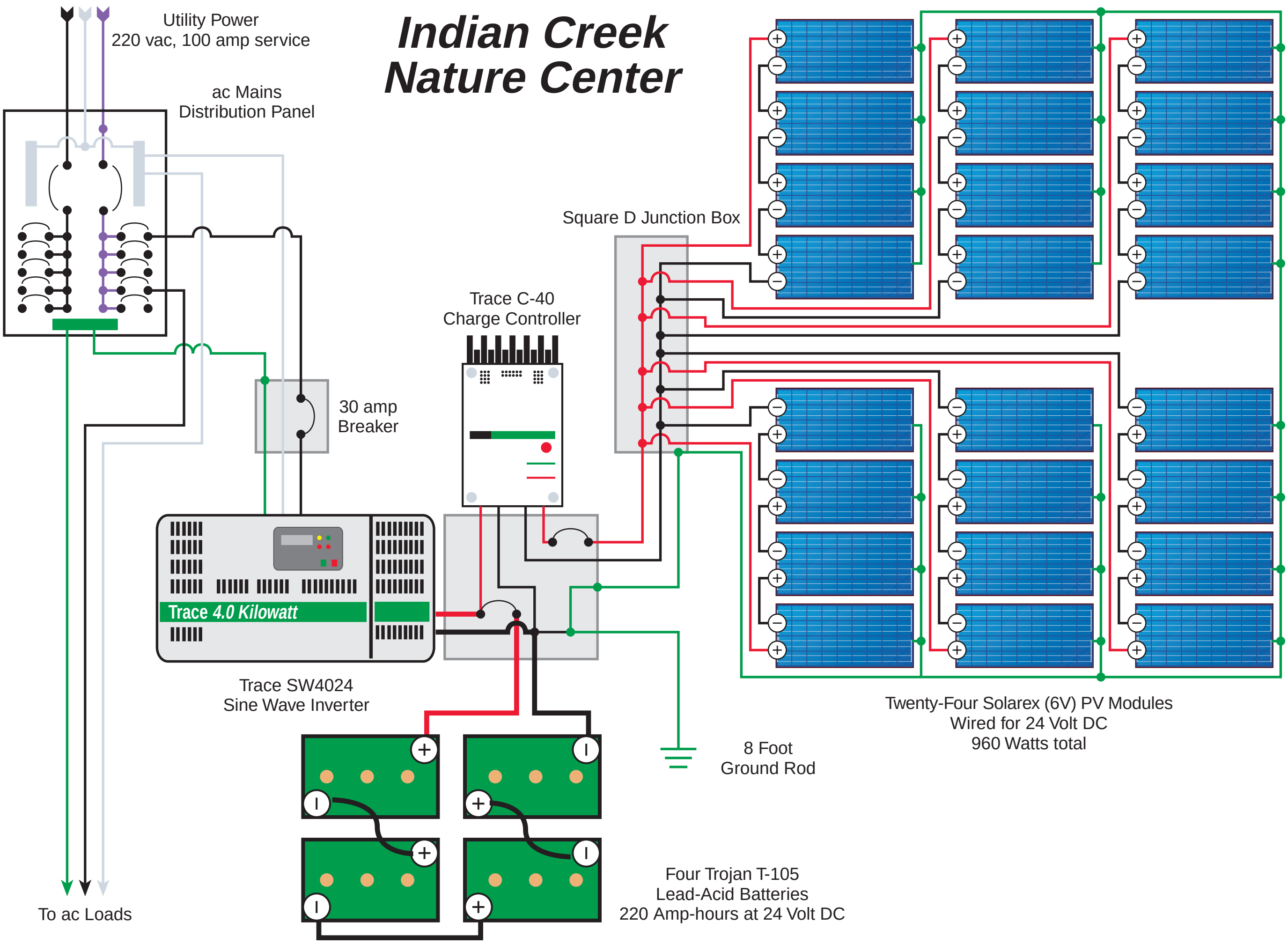
Getting official approval
I thought it would be a big challenge to organize a class of this type in Cedar Rapids, Iowa (PV panels, grid intertie, home of one of Iowa's three IOUs, and quite unionized). Rich Patterson had established himself as very dedicated and capable in projects such as this. This helped the project from the beginning. I thought that having an employee of IES (the local IOU) on the Nature Center Board would be an asset. As the project went along, an IES engineer spent a day reviewing the Trace inverter's manual. His comment about all modern inverters was, "They can do everything except mow the lawn! And quite efficient, besides!"

In the summer of 1997, I met with the City of Cedar Rapids' electrical inspector and showed him a schematic of the proposed system. He was very open about what he wanted and agreed with our proposal after looking in the NEC book. My advice is to do your homework, as this makes things easier than constant guessing. The City of Cedar Rapids electrical code is specific on requirements on systems of 24 Volts and above. The National Electrical Code specifically starts at 50 Volts, so the 24 Volt system we installed easily met all NEC code requirements. The city codes were a little tougher, because as the inspector stated, "We don't want to torch the building." Actually that statement can be seen as a compliment of how well PV should be respected.

Below: Mounting the 24 Volt sub-arrays.

Wiring it all up
All wire from the PV panels through the J-box to the inverter had to be in conduit (no rigid PVC allowed). A licensed electrical contractor or city inspector had to see and do the 110 volt work after the inverter. I personally would like to thank Tom Shea for his expertise and guidance in that part of the system. IRENEW and alternate energy have made a convert for future work. Tom Shea saw pictures of our power trailer which is the same size system as the Nature Center's. He invited IRENEW to display the power trailer at an electrical inspector conference next spring. Electricians need to see PV in operation.

Square D, located in Cedar Rapids, Iowa, was very helpful in supplying the major equipment. I knew there were reasons why I was nice, as his science teacher, to Square D engineer Curt McDermott! Square D is one of



the manufacturers of DC circuit breakers and boxes which can be used in PV electrical systems. They supplied the number 10 THHN cable and 1/2 inch flexible metallic conduit from the six 24 Volt PV arrays to the Square D J-box located on the cupola at the roof peak. The number 4 THHN cable and 1 inch NM Flexible conduit to the Trace Inverter was also supplied by Square D as well as various fuses. Some of Square D's equipment was exchanged with Trace's because it simplified installation—less conduit and fuses stuck in odd places.

Left: Don Laughlin designed sub-array mountings to pivot for wiring access.

The 1/2 inch conduit we used was Anaconda with copper inside the metal spiral. Even with the copper spiral in the conduit, we grounded all modules together with bare copper wire, along with the battery negative, to a buried ground rod. This is City of Cedar Rapids code as well as NEC requirement. We found there was no continuous ground in the system until we did this. For those readers who have followed the discussions with John Wiles on plastic (nonmetallic) and metallic flexible conduit, I now offer my unofficial scientific two cents on the subject: NM and metallic conduit may offer similar temperature ratings, but I feel much safer with the metallic. Some of the joints of the nonmetallic wanted to separate when they got warm.

Inverter to mains connections

Connecting the Trace SW4024 to the existing electrical system was straight forward as far as the wiring goes. From the Trace, we ran #10 THHN wire to a new load center that the local IOU (IES) required. I call it a redundant box because we entered the existing load center in the Sugar House with a 30 ampere circuit breaker anyway. This redundant load center will be available when the nature center wishes to become grid interactive. Now, extra electricity is being sent out to the grid with no major energy storage in batteries on site.

Do your homework first!

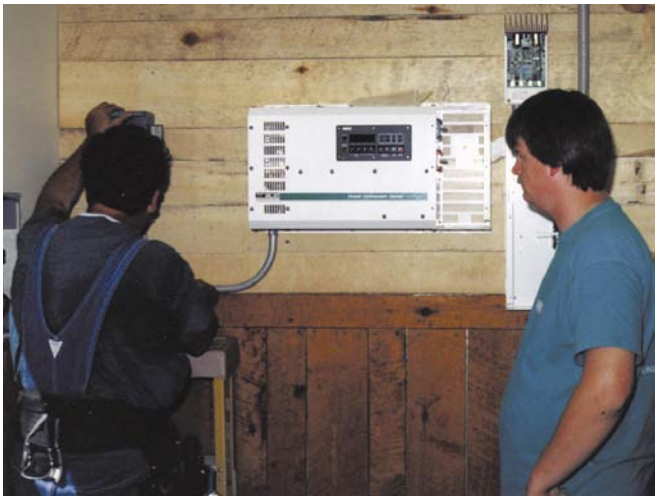
Be sure you know the code requirements and the law, both nationally and locally, before you begin a grid intertie system. In Iowa, we have a Utilities Board that “asks” the IOUs to follow their rule on “net metering” and allow the energy you produce to turn your electric meter backwards. Because this is not a law (only a ruling) in Iowa, MidAmerican Energy (the other IOU in Iowa) is not going to allow a small wind project to “net meter” without a court order! The Utilities Board may not get to this subject this year as it is not a priority! Also, do not let any IOU tell you they need another meter to measure your production and then ask you to buy your own electricity back from them at their retail rate. Educate the IOUs nicely, and the installation will go great.

The meter spins backwards!

This PV installation at Indian Creek Nature Center was finished in early September, 1997. Since then, according to unofficial results of infrequent meter watching, the 1 kW PV system has produced approximately 2.5 kWh per day. Considering October is the worst month for solar insolation in Iowa, this 2.5 kWh per day is quite good. I feel that this first of its kind PV installation class in the Midwest has proven to the people of Cedar Rapids, the electrical inspector, and to the 20 or so participants from Georgia, Missouri, Illinois, and Iowa that PV really does work—Big Time!

Rich Patterson called a few days after installation and was excited because his electric meter was running backwards. I think that this says it all….

Below: Dave Allegro, Trace, and Tom Shea, Cedar Rapids Electrical Inspector, check the redundant breaker between the inverter and the ac mains panel.



Above: With panels tilted up, series connections are easy to make.

Access

Author: Tom Snyder, President of IRENEW, 611 Second St. SE, Dyersville, IA 52040 • 319-875-8772
E-Mail: tsnyder@mwci.net

Dennis Potrazt, Go Solar, 718 Mechanic St., Decorah, IA 52101 • 319-382-3242

Don Laughlin, Prairie Technologies, 1881 Fox Avenue, West Branch, IA 52358 • 319-643-5650

Trace Engineering, Chris Frieatis, 5916 195th NE, Arlington, WA 98223 • 360-435-8826

Rich Patterson, Indian Creek Nature Center, 6665 Otis Road SE, Cedar Rapids, IA 52403 • 319-362-0664

Curt McDermott, Square D Co., 3700 6th St. SW, Cedar Rapids, IA • 319-365-4631

Iowa Renewable Energy Association, PO Box 2132, Iowa City, IA 52244 • 319-351-2338

SOLAR-ONE™ TECHNOLOGY AT WORK:
THE HIGH UTILIZATION POSITIVE PLATE

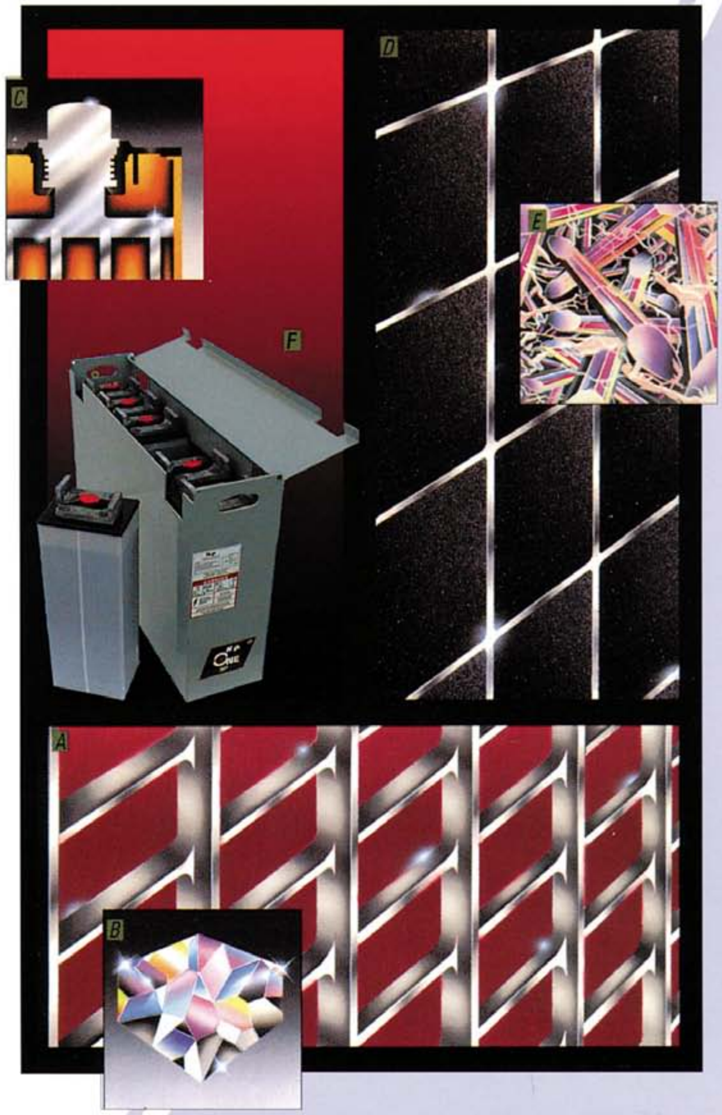
*Innovative technology is what separates **Solar-One**™ from the rest of the pack. Delivering full capacity for more total cycles than conventional batteries, **Solar-One** batteries are engineered for outstanding performance, from the inside out!*

A *Take a close look at the **Solar-One** unique high-utilization positive plate, and you will see that it is our positive grid that provides the foundation for **Solar-One** Positive Plate Technology. Incorporating the highest quality raw material available in the industry. The **Solar-One** grid uses our own metallurgical formulation and a computer-controlled grid casting system, another industry exclusive! The result:*

B *the **Solar-One** grid contains larger lead crystals, and larger crystals mean fewer points for corrosion to attack the battery.*

C *To accommodate grid corrosion and growth, many battery manufacturers are forced to use a "floating seal", a battery design which is far more subject to leakage than the **Solar-One**'s burned post-to-cover seal. Having controlled the growth of our positive grid, the **Solar-One** seal is stronger and less vulnerable to leakage.*

D *The key to **Solar-One**'s tradition of longer battery life at full capacity is our patented **H.U.P.** technology (US patent #4,135,829.). **H.U.P.** is a process which optimizes both the active material utilization and the longevity of the positive paste. A colloidal suspension of tetrafluoroethylene (Teflon®) is added, at precisely measured volume, temperature, and time, to the paste mix and causes the formation of a pervasive network of fibers throughout the active material.*



E *This process known as fibrillation, locks the active material into place and virtually eliminates flaking and shedding - the chief causes of battery failure.*

F *Tested at the National Battery Testing facility batteries with **H.U.P.** have been shown to increase working life by at least 20%, with absolutely no sacrifice of capacity! In fact, **H.U.P.** batteries deliver full capacity longer, have faster voltage recovery with lower internal resistance, and last longer than conventional batteries. For more power in your Renewable Energy System look for the **H.U.P. Solar-One™** label. High Utilization Positive plate technology only from:*

NORTHWEST ENERGY STORAGE

The First Name In R-E Batteries

P.O. BOX 137
Colburn, ID, 83865
800-718-8816
208-263-6142
Fax 208-265-3677
http://www.nwes.com

Dealer Inquiries Invited.

The HUP SOLAR-ONE has the BEST FACTORY WARRANTY for RENEWABLE ENERGY

Warranteed for 2100 cycles at 80% depth of discharge, 5 years free replacement & 5 years pro-rated. HUP Technology Patented in 1982, ISO 9000 Certified, now you can enjoy the benefits of the Proven Hup Technology in your R-E system with the Hup Solar-One.

Free Shipping for the HUP Solar-One in Canada and 48 States. Ten Year Factory Warranty.

SALE *4+ quantity*

Solarex	MSX60	$339	20 yr wty
Solarex	MSX77	$415	20 yr wty
Siemens	SP75	$415	25 yr wty
Siemens	SR90	$479	25 yr wty

We Offer Competitive Pricing, System Design, & Customer Tech Support

Your West-of-the-Mssissippi Surrette Battery Dealer

Surrette Solar 1, 400 Series, Type CH 375 - L16

$249 each
+ shipping

- 33.3% More Life Cycles
- Greater Reserve Capacity
- Expected Life of 10 Years
- Warranty 2 Years Unconditional
  3 Years Prorated
- Available Wet & Dry Charged
- Engineered under careful guidelines by Dave Surrette – Family owned since 1935

NORTHWEST ENERGY STORAGE 800-718-8816

Introducing:

THE GRAVITY SIPHON SOLAR WATER HEATER

John Whitehead ©1998 John Whitehead

The gravity siphon is a new way to do solar water heating, with several unique advantages. It began with a dream to create an effective system using only hardware store items, instead of specialized components. There are no pumps, and the water is kept hot in a fully-insulated indoor tank. Cold water doesn't enter the hot storage tank, which is unlike other systems. The best part is that you can build your own. Construction details will be described in an article in the next issue of Home Power.

Don't ask if it's active or passive, because it falls somewhere in between. The energy which drives collector flow comes from the cold water supply pressure. There are neither continuously-moving parts nor an extra energy source. Valves simply need to be opened and shut each morning and evening. Automatic valves and a controller may make it an active system. Consider it passive if you agree that flipping valves can be as easy as opening your mailbox or adjusting windows.

Figure 1 is a system diagram. Any flat-plate solar collector will work, including a used or homebuilt one. There's no hiding the fact that extra tanks are needed. This is the key to both pumpless operation and isolated hot storage. The rest of the system is just plumbing parts costing several dollars each, for the manual version.

How it Works

The cold water supply is connected to the upper tank. Solar heated water is stored in the lower tank. They are partly full as shown, and the remaining volume contains compressed air. This air can pass freely between the tops of the two tanks, through the air pipe shown in Figure 1. Therefore, cold water supply pressure keeps the air compressed, which in turn keeps the hot water pressurized. Each time hot water is used, the water level in the lower tank falls a little. It is replaced by air from the upper tank, which then receives fresh cold water.

The lower tank stores enough hot water for the evening and early morning. When the solar heated water is gone, the lower tank contains mostly air, and the upper tank is full of cold water. If there is extra demand, cold water overflows through the air pipe, and is delivered instead of hot water. As with any solar water heater, it makes sense to have a regular heater as a backup between the solar tank and the house.

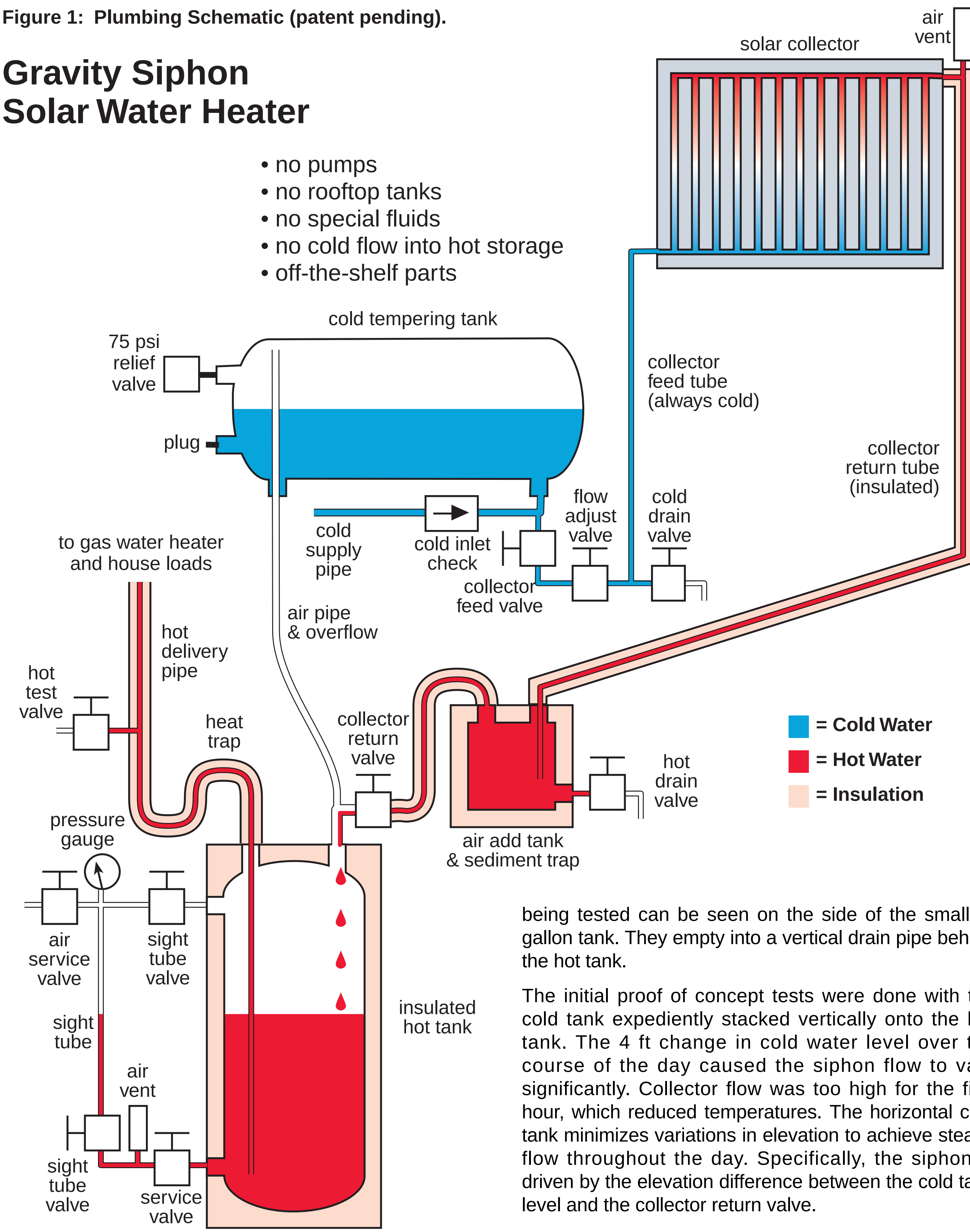
During the day the hot storage level gradually rises, as cold water is heated by the sun. The air is displaced back into the upper tank, as the cold level falls. Collector flow is sustained all day simply because the cold tank is above the hot tank. The real trick, conceived in 1993, is to run this gravity siphon inside a pressurized water system. Cold water pressure starts the siphon, and permits feeding a rooftop collector from the lowest floor with no pump. Note that a gravity siphon is just a regular siphon, as can be used to empty a fish tank, for example. The term is used here to avoid confusion with a solar thermosiphon, which is entirely different.

Afternoon shutdown does not require precise control as with systems that use pumps. The siphon flow through the collector stops passively at the end of the day, when the hot tank is full. Specifically, the water level in the hot tank rises into the air pipe to the bottom of the cold tank. When hot water is used, the level falls and collector flow can start again. To prevent collector flow at night, the collector feed valve needs to be shut anytime during the evening.

Prototype experience

The first prototype system was built and flow-tested throughout 1995, then connected to a collector in 1996. Figure 2 is a photograph of the indoor parts with refinements made in 1997. The main tanks are the cheapest 52-gallon electric water heaters purchased for $150 each. One of these was stripped down to the bare tank and painted. The plumbing is as depicted in Figure 1, except the cold tank ports are interchanged. The long copper tube in front of the hot tank is positioned to fill a bucket from the hot test valve. Automatic drain valves

Figure 1: Plumbing Schematic (patent pending).



being tested can be seen on the side of the small 2-gallon tank. They empty into a vertical drain pipe behind the hot tank.

The initial proof of concept tests were done with the cold tank expediently stacked vertically onto the hot tank. The 4 ft change in cold water level over the course of the day caused the siphon flow to vary significantly. Collector flow was too high for the first hour, which reduced temperatures. The horizontal cold tank minimizes variations in elevation to achieve steady flow throughout the day. Specifically, the siphon is driven by the elevation difference between the cold tank level and the collector return valve.

One surprise, obvious in retrospect, occurred with the earliest prototype. If the utility supply pressure is

Figure 2: The gravity siphon system.

interrupted for any reason, backflow into the cold water system could occur. After air was found escaping through faucets, the cold inlet check valve was added. A swing check valve was found to slam with the slightest pressure surges. Its replacement, a spring check valve, now operates quietly.

Another fact is that the air tends to dissolve in the water. At the tap, hot water can appear white due to microscopic bubbles, which is harmless of course. The problem was that the air in the tanks was gradually lost during the first half of 1995. A few tricks were devised to passively add air and maintain the correct amount of air in the system. This includes the 2-gallon air makeup tank, connected along the collector return tube.

Whenever the collector is drained, atmospheric air enters the makeup tank. This extra air is then compressed into the hot tank when the collector is filled with water the next morning. The small tank also can trap any sediment from the collector. The other passive air-management device is the vent valve at the lower end of the hot tank. Should the water level ever fall too low before cold overflow begins, the excess air is vented back to the atmosphere.

Transparent vinyl tubing has been extremely useful to monitor tank levels. Sight tubes were initially connected high along the air pipe, so maximum water levels could be viewed. However, flow through the air pipe created suction which sometimes invalidated the readings. The compromise settled upon (Figure 1) eliminates this problem and simplifies the plumbing.

Hot water production

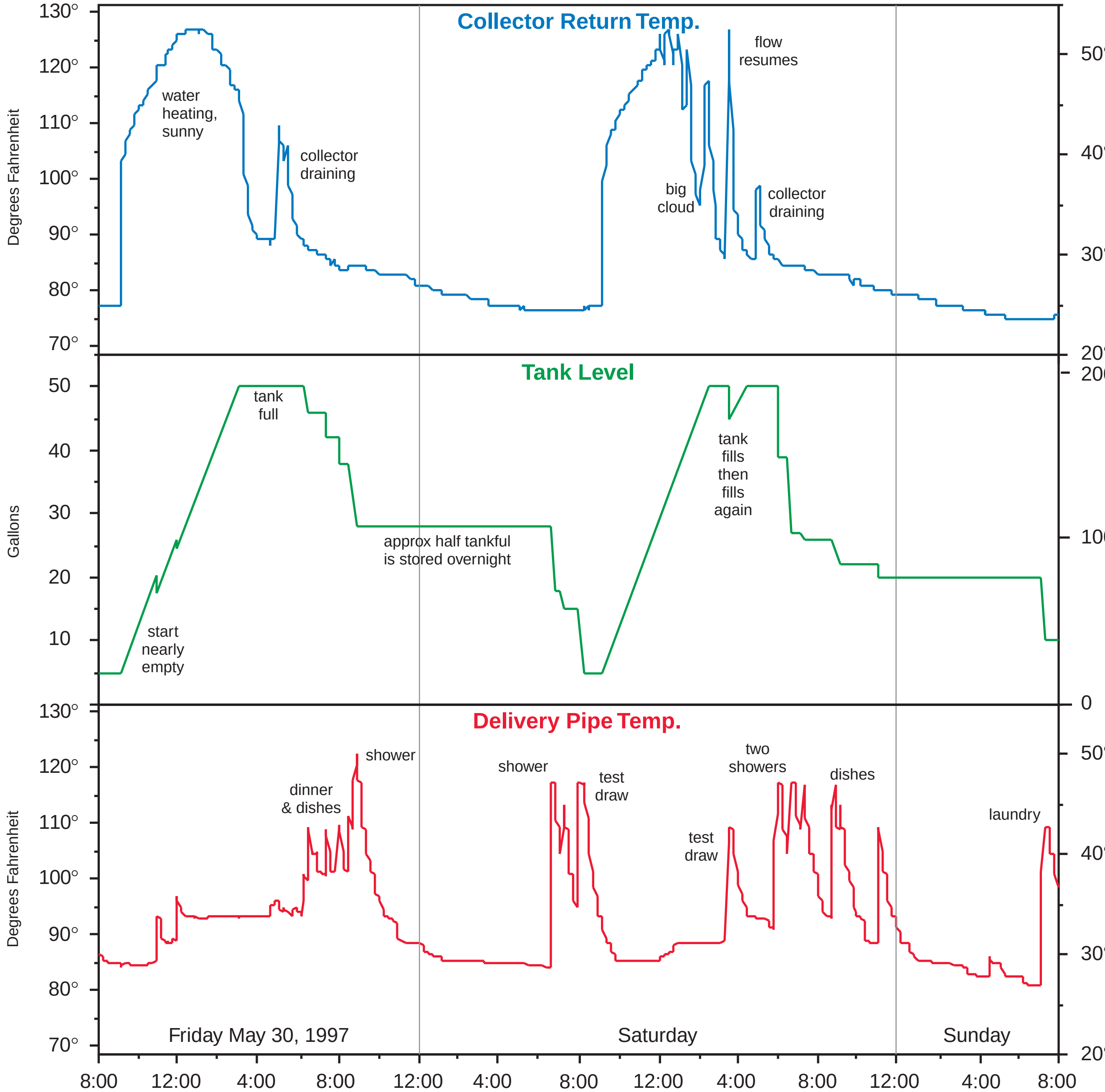
The debugged system has been found to work well, even with a single 4x8 foot homemade collector. Pictured in Figure 3, it was mounted at a 45 degree angle, which is steeper than optimum for spring and summer. A digital data logger records temperatures on both the collector return tube and the hot delivery pipe. Results for a clear spring day followed by a partly cloudy day are plotted in Figure 4. Tank level, hot water use, and clouds were carefully noted during this 48 hour period.

Over 45 gallons of hot water were collected each day, and delivered above 110°F. The data prove that solar heated water is available the next morning, with very little cooling. Actual temperatures obviously depend on the collector technology, so a professionally-manufactured collector would yield more impressive results.

The upper curve rises rapidly upon morning startup at 9 am on both days. As the sun angle improves, a midday peak is reached. On Friday, the collector return tube cooled rapidly after a full hot tank stopped flow at 3 pm.

Figure 3: The solar thermal water panel.

Figure 4. Hot water production and use data, late spring.



The blip at 5 pm resulted from evening valve switching. The gallon of warm water in the collector heated the temperature sensor on its way to the drain valve.

Solar hot water can be used anytime during the day. It just takes longer to fill the tank. The middle graph shows a pair of small draws at lunchtime on Friday. These appear as blips on a gradually rising tank level. Based on the extra time available (3–5 pm), 10–15 more gallons could have been drawn during the day. By 5 pm, a full tank would still have been stored for Friday evening.

The upper graph looks complicated on Saturday, but it is completely understandable. Several clouds passed overhead beginning at noon. A large thick cloud blocked the sun between 1:30 and 2 pm, reducing the temperature below 100°F. No hot water was used during the day on Saturday, so the tank filled earlier than on Friday. Over the next hour, the stagnant water in the collector continued to receive solar heat. At 3:30, 5 gallons were drawn through the hot test valve. The sharp collector return peak demonstrates that collector flow subsequently resumed. After 4 pm the tank was full again. The cloud-cooled collector draining blip appears on schedule at 5 o'clock.

The delivery temperature graph is tricky to interpret, since it is visually tempting to assign meaning to the area under the curve. Instead, the middle graph should be used to interpret volume information. Hot water use actually occurs over very short periods, after which it takes almost an hour for the pipe to cool down. If faucets are turned on briefly, the pipe sensor may not reach the actual water temperature. This explains numerous low temperature peaks on Friday.

Showers and washing machine operation have sufficient duration to show the actual water temperature on the lower graph. Starting late on Friday, the peaks indicate deliveries consistently above 115°F. Saturday morning deliveries were not affected by heat losses to cold water as occurs in conventional solar tanks. The clouds which rolled through Saturday afternoon reduced the Sunday morning delivery to just below 110°F.

Solar hot water was delivered all summer, but it was felt that a better test would come later in the season. Figure 5 shows similar data for two sunny days in October.

Collector flow gradually increases the tank level during the day, with temperatures exceeding 125°F in the upper graph. The return tube rapidly cools when the tank becomes full and stops collector flow. The subsequent spike each day results from stagnant water flowing past the sensor on its way to the drain valve.

The tank level falls in steps which correspond to actual hot water use. Each step lines up with its delivery temperature peak in the lower graph. For example, showers used approximately 10 gallons. On Sunday morning, the dishwasher used about 5 gallons to wash, then 4 gallons to rinse almost an hour later.

Early on Saturday morning, the tank was nearly full. The hot test valve was used to demonstrate that lots of solar heated water can indeed be delivered after overnight storage. This left the tank ready to receive freshly heated water. Saturday's production was over 45 gallons, including 5 gallons used for laundry during the day.

A greater total volume would have been heated if the tank had started completely empty. This was deliberately avoided because a tree shadow reached the collector just after 2 pm at this particular time of year. No hot water was used during the day on Sunday, so the tank filled a half hour earlier. Flow stopped while the collector was fully illuminated, which explains the precipitous drop in Sunday's collector return temperature.

Performance is good considering the time of year, although it should be noted that the 45 degree collector angle is nearly perfect for this date and latitude. Delivery temperatures were consistently above 115°F, and as high as 125°F on Saturday evening. Very efficient overnight storage was demonstrated on all three mornings in Figure 5. Outdoor ambient temperatures varied from the sixties to the seventies during the day. Cold water remained at 70°F during October.

The test data represent actual hot water use by two people. The temperatures shown represent deliveries to a backup gas heater. Additional heating was not specifically recorded, but the main burner was rarely heard. Summer gas bills and extra meter readings indicated that the vast majority of additional heat came from the pilot light alone.

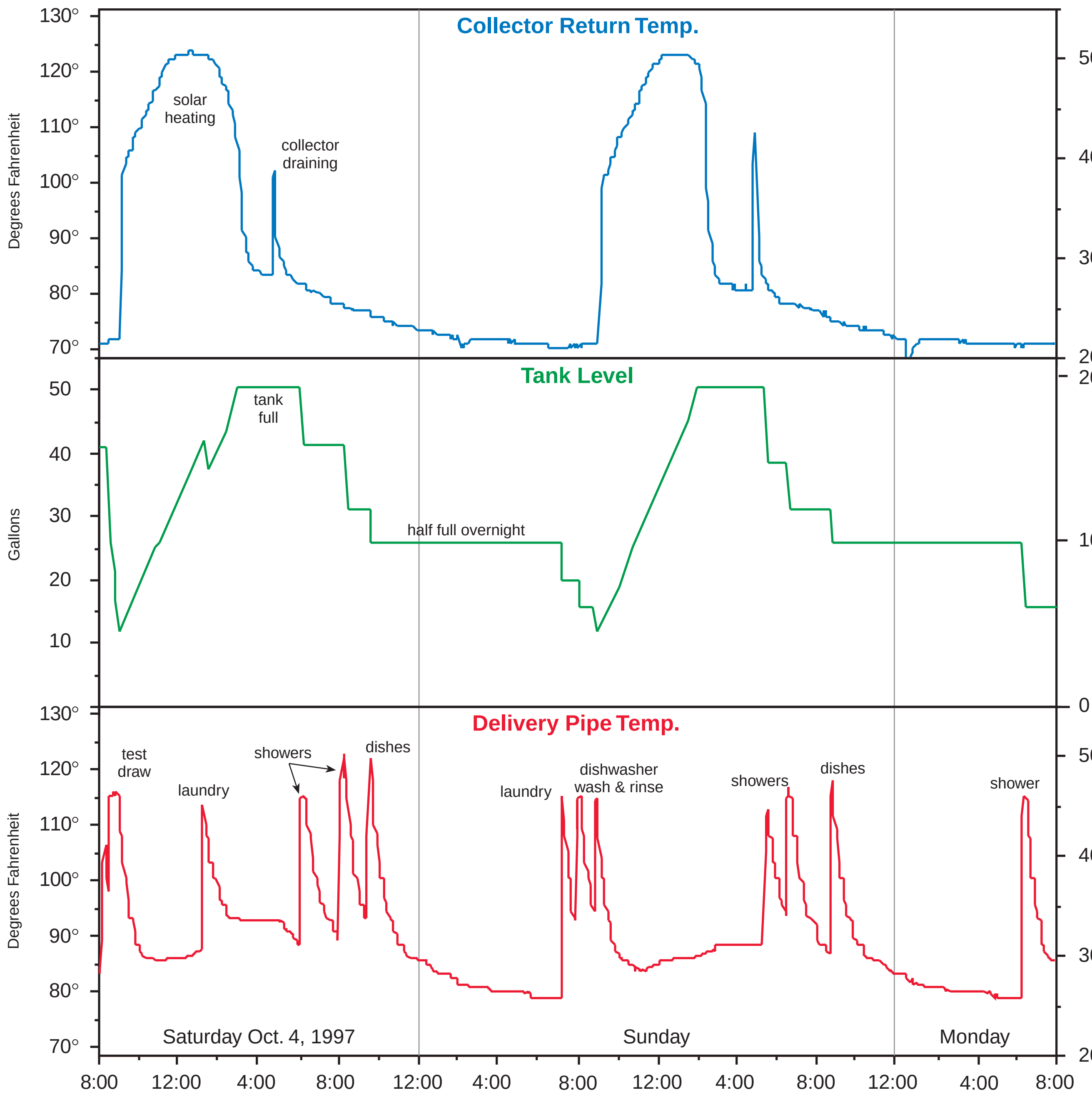
Perspective

The gravity siphon is a "once through" or "single pass" system, because heated water never returns to the collector. As another example, some heaters in developing nations have a vented hot storage tank on the roof. During the day, cold water is simply fed through a solar collector and into the unpressurized tank. In the engineering literature, these systems have been documented to be very effective. They are not well known in the United States, since high delivery pressure is considered essential here. The ideas in this article are offered as one solution. The gravity siphon system even provides a little pressurized water during supply outages.

Single pass heaters don't need insulation on the collector feed tube. The tube may even be routed through a hot attic for low temperature preheating. An air-to-water heat exchanger would maximize the effect. Similarly, a low cost solar collector can in turn feed a smaller high temperature collector. The latter would finally maximize the water's temperature after it receives most of its energy in the low tech unit. These cost-effective schemes don't work with repeated circulation, because hot water would lose heat in the attic or in the low-cost collector.

Flow rate in pumped circulating systems has been a subject of debate and detailed study. The older standard of rapid circulation increases collector efficiency early in the day, by evenly adding heat to the entire tank at low temperatures. Temperatures can be maximized because all the water receives a final pass through the collector in the afternoon. Unfortunately, this mixes the tank and destroys thermal stratification. Water used before noon is lukewarm. Draws during the afternoon introduce fresh cold water, which is then mixed in.

Figure 5. Hot water production and use data, early fall.



In recent years, it has been recognized that circulating systems should use low flow. This reduces pump power, and preserves tank stratification. Hot water floats above cold, with little mixing. Some research papers have recommended a flow of one tankful per day. Single pass systems inherently achieve this, while eliminating pumps and cold dilution entirely.

Even with perfect stratification, conventional solar tanks lose heat to cold water during the night. After evening use, there may be a half tank of hot water, floating on top of cold. The ideal situation is no liquid movement. Still, heat is conducted through the water itself and within the metal tank walls. The resulting impact on early morning solar showers is rarely considered. By coincidence with the normal workday, standardized tests only draw hot water during sunny hours.

Expensive collectors compensate for feeding cold water into the hot tank. Extreme temperatures yield acceptably hot water after mixing and conduction losses. However, temperatures above 140°F increase mineral precipitation, which can be a problem. If the house remains unoccupied, daily reheating in conventional systems produces even higher temperatures. Tank life is reduced, and mixing valves are needed to avoid scalding. Single pass operation is entirely different. Water is heated only once, to a reasonable temperature in an affordable collector. Tank overheating during vacations is impossible.

With regard to freeze protection, the gravity siphon can be classified as a drain down system. However, it differs from classic drain down systems which use pumps. In particular, automatic valves for the gravity siphon can be smaller than a conventional draindown valve. Electrical power is needed only for a small valve assembly, instead of a large valve and a pump.

Of course the gravity siphon is not the only pumpless solar water heater. Some systems use fluid boiling action for circulation through a highly specialized collector. In more common batch heaters, the sun shines directly on the tank walls. These passive ICS (integral collector storage) heaters deliver pressurized hot water. Their plumbing is extremely simple and they require no extra indoor space for tanks. Although water flows through only once, ICS units are entirely different and classed separately from single pass systems.

Storing hot water outdoors at night obviously impairs performance of ICS heaters. The side of the tank(s) exposed to the sun cannot be insulated in the usual sense. Double glazing, high tech coatings, and even glass vacuum vessels are used to mitigate heat loss to the night sky. Homemade batch heaters without these features would be much less effective. The inherent lack of freeze protection makes ICS solar water heaters impractical in very cold climates.

A collector and tank can be manufactured into one assembly, with thermosiphon circulation. These can be recognized by the large bulge at the top of a flat plate collector. They are as passive as batch heaters, but the tanks are well insulated. Unfortunately, a horizontal tank orientation puts all the hot water in a wide shallow layer, in close proximity to incoming cold water. Even a homemade thermosiphon heater could be more effective if a vertical tank is used (see HP issue #58, p. 30). This option for pumpless circulation requires the tank to be higher than the collector, which can be inconvenient.

Conclusion

Like clotheslines, water heating is one of the most cost effective ways to use solar energy. For under $1000, a gravity siphon system can deliver 50 gallons daily at a 50°F temperature rise. This represents over 20,000 BTU, or 6 kilowatt-hours of heat energy. The same daily electrical energy consumption would require a $10,000 PV system.

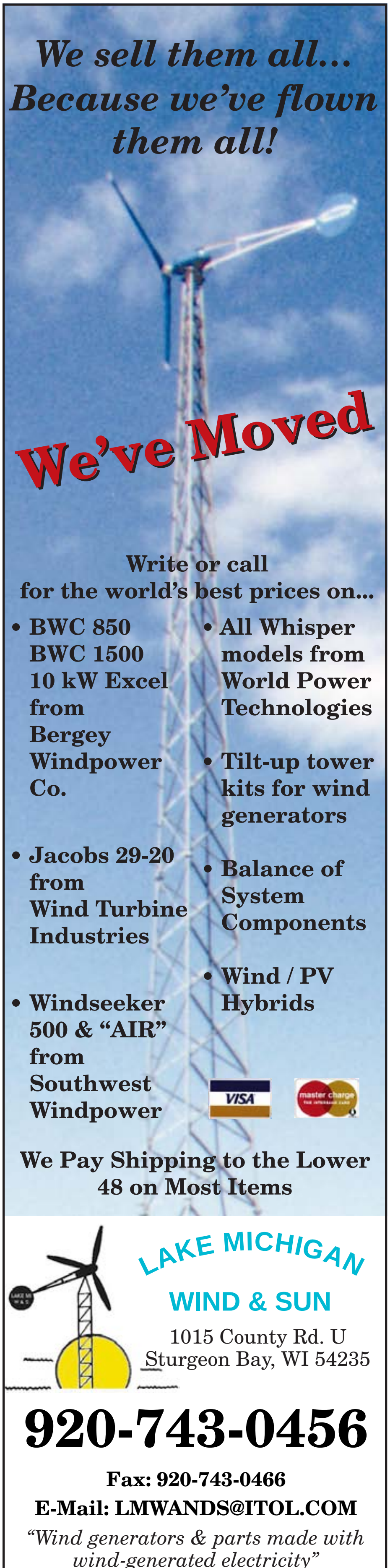
Above: Author John Whitehead.

Many types of solar water heaters exist, with a wide range of advantages and disadvantages. The choice depends on factors such as budget, climate, the desirability of overnight storage, and the availability of space for tanks. The gravity siphon is a new option which is likely to be favorable in many situations. Hot water is stored in complete isolation, the system can be home built, and the collector can be high above the tanks without needing pumps. The sight tube takes the mystery out of solar water heating, by showing exactly how much hot water is produced, stored, and used.

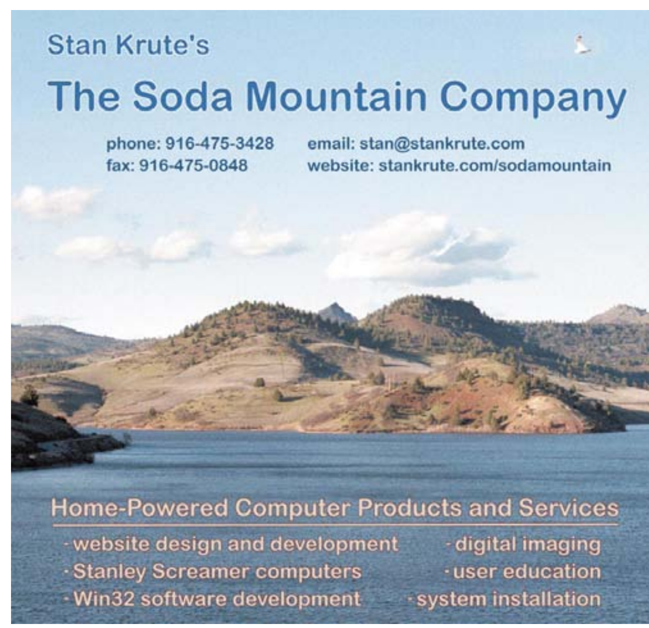
An article coming up in the next issue, *HP64*, will explain site evaluation, tank selection, plumbing details, and operation of the gravity siphon solar water heater.

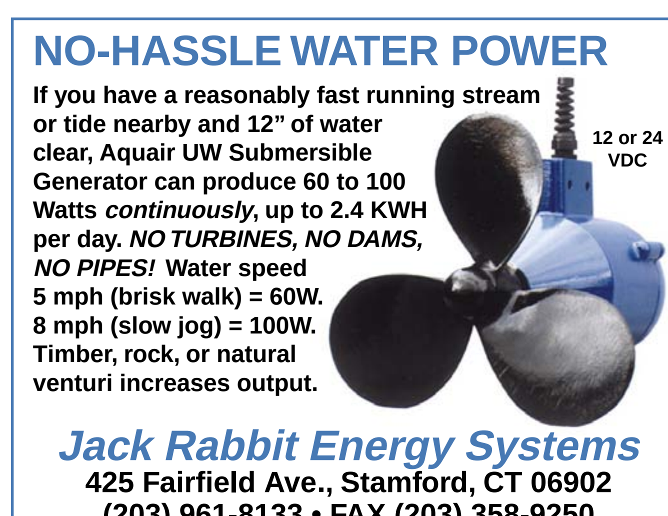
Access

Author: John Whitehead, PO Box 73343, Davis, CA 95617 • 530-758-8115 (Thursday evening through Sunday evening).


We sell them all...
Because we've flown
them all!
We've Moved
Write or call
for the world's best prices on...
• BWC 850
BWC 1500
10 kW Excel
from
Bergey
Windpower
Co.
• Jacobs 29-20
from
Wind Turbine
Industries
• Windseeker
500 & "AIR"
from
Southwest
Windpower
• All Whisper
models from
World Power
Technologies
• Tilt-up tower
kits for wind
generators
• Balance of
System
Components
• Wind / PV
Hybrids
VISA
master charge
We Pay Shipping to the Lower
48 on Most Items
LAKE MICHIGAN
WIND & SUN
1015 County Rd. U
Sturgeon Bay, WI 54235
920-743-0456
Fax: 920-743-0466
E-Mail: LMWANDS@ITOL.COM
"Wind generators & parts made with
wind-generated electricity"


Track Rack™
Passive Solar Tracker for
Photovoltaic Modules
Dependable as gravity. Reliable as sunshine.
Proven in climates around the world.
• Captures 98% of available solar energy
• Improves energy performance by up to 40%
• Nearly 8000 installed since 1980 with 99% still in operation
• Ten-year Warranty
Call Today!
1-800-279-6342
ZOMEWORKS
Passive Solar Energy Products
CORPORATION
Since 1969
© Zomeworks Corporation


Stan Krute's
The Soda Mountain Company
phone: 916-475-3428
fax: 916-475-0848
email: stan@stankrute.com
website: stankrute.com/sodamountain
Home-Powered Computer Products and Services
·website design and development
·Stanley Screamer computers
·Win32 software development
·digital imaging
·user education
·system installation


NO-HASSLE WATER POWER
If you have a reasonably fast running stream or tide nearby and 12" of water clear, Aquair UW Submersible Generator can produce 60 to 100 Watts continuously, up to 2.4 KWH per day. NO TURBINES, NO DAMS, NO PIPES! Water speed
5 mph (brisk walk) = 60W.
8 mph (slow jog) = 100W.
Timber, rock, or natural venturi increases output.
12 or 24 VDC
Jack Rabbit Energy Systems
425 Fairfield Ave., Stamford, CT 06902
(203) 961-8133 • FAX (203) 358-9250

Solar Charge Controller

for Medium Power Applications


Homebrew

G. Forrest Cook

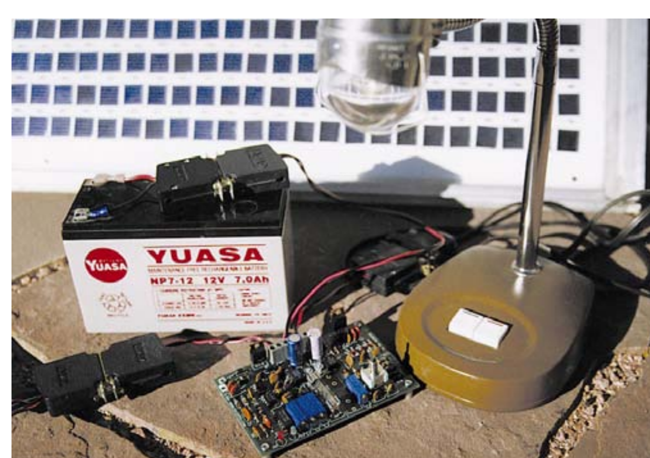
This article is the companion for the low voltage disconnect circuit in *HP* #60. This circuit regulates the charging of the battery in a solar system by monitoring battery voltage and switching the solar or other power source off when the battery reaches a preset voltage. A charge controller circuit can increase battery life by preventing over-charging which can cause loss of electrolyte. The absence of a relay and its associated coil current makes this circuit efficient for small systems as well as for systems using larger current components.

This charge controller was designed for high efficiency, use of common parts, and operation with common ground circuitry. Some ideas used were inspired by an article in *QST* magazine, but this is a much simplified circuit. A circuit board is available with both the charge controller and low voltage disconnect circuits on one board. The charge controller circuit has been used with solar power input. It also functions well as a battery charger when used with any current limited DC power supply such as small "wall wart" transformers or a high current supply with a series resistor.

Specifications
Night time current drain: 0.6 mA
Operational current drain: 19 mA (less without LEDs)
Maximum solar panel current: 3-10 Amps (see text)
Voltage drop during charging: 0.5 Volts at 1 Amp

Theory
During charging, current flows from the solar panel through diode D1, MOSFET transistor Q1, fuse F1, and into the battery. Power MOSFET transistor Q1 is the main switching device in the charge controller circuit. It connects the solar panel to the battery when it is in need of charging and power is available from the solar panel. As with the LVD circuit, Q1 is set up in a "high side" switch arrangement which allows for a common ground circuit. This is helpful in automotive and other applications. Switching efficiency is very high due to the low "on" resistance of modern power MOSFETS, usually under 0.1Ω. Diode D1 is a Schottky device preventing back currents from flowing from the battery to the solar panel. A regular silicon diode may be used but a Schottky will have a lower forward voltage drop and resulting higher efficiency. Fuse F1 provides a safety limit on the current available from the battery in the event of a short.

Comparator U2 is used to control power to the rest of the charge controller circuit. When the solar panel voltage is lower than the battery voltage, the rest of the circuitry is disabled, reducing night time idle current to the few milliamps consumed by U2 and its associated input circuitry. When the solar panel voltage rises above the battery voltage, the output of U2 goes negative, switching on transistor Q2 which provides power to the rest of the circuit. Resistor networks R1/R13 and R2/R4 scale the battery and solar panel voltages to a range that is useful to U2. Capacitor C23 prevents oscillation in the comparator at start up. Voltage regulator U4 is used as a reference for the battery set points, the reference points are adjusted via resistor network R11, R12, and R3. Comparators U1A and U1B monitor the battery voltage and switch states when the battery is fully charged (U1B) or has dropped to a voltage where charging should resume (U1A). The comparators drive



Above: Charge controller circuit board in action.

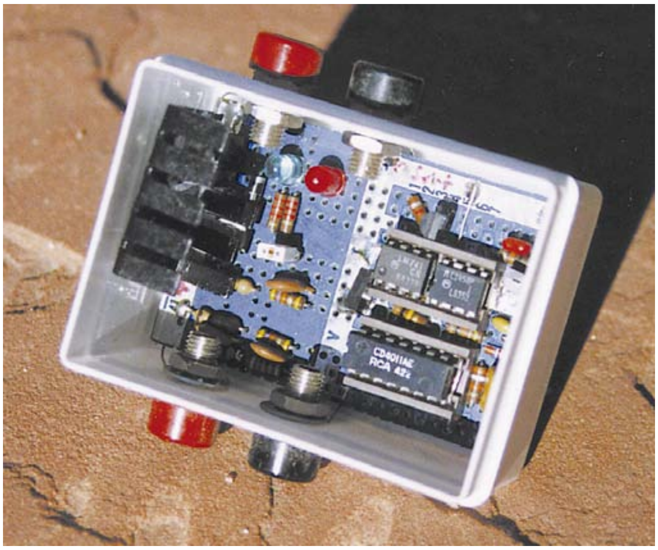
a set-reset flip-flop circuit consisting of U3A and U3D. The comparator outputs are inverted logic, on is low and off is high. The output of the flip-flop is used to turn the oscillator consisting of U3B and U3C on and off. The flip-flop also drives the two LEDs used to indicate charging or battery full states. The oscillator generates a 10 kHz square wave that is stepped up to around 25 Volts DC by the voltage doubler circuit of D5, D6, D7, and C7, C8, C21. The gate voltage is higher than the battery's 13 Volts, and is used to turn Q1 on fully. Ferrite bead L2 is used to prevent oscillation in Q1. Resistor R9 discharges the voltage doubler when the oscillator is shut off. The technically picky may note that all of the ICs comparators are really common op-amps, not special purpose comparators. The op-amps are wired in a comparator configuration. The circuit is fairly dependent on the use of 741 and 1458 op-amp parts. Other op-amps may require changing the values of R1 and R2. An equalize switch is included to allow for occasional over-charging of the battery by raising the threshold of the high voltage sensing comparator, forcing the charge current on. Equalizing helps bring lower voltage cells in the battery up to a full charge.

Alignment

Alignment equipment consists of a multi-meter, a charged 12 Volt lead acid battery, and a 0-16 Volts DC variable voltage power supply with a 10Ω 25 watt resistor in series with the positive lead to limit the current. A word of caution is in order when dealing with circuits involving potentially high battery currents: the circuit should be placed on an insulating surface for testing and all wiring should be insulated to lessen the chance of creating a short circuit. Be sure not to reverse the polarity of the battery wires, doing so may damage the circuit. The voltages in this circuit present no shock hazard but the currents present a potential burn hazard.

The first step of the alignment is to set the charge controller turn-on voltage with R13. Start by turning R12 fully clockwise (toward positive) and turn R11 and R13 fully counter-clockwise (towards ground). Connect the charged 12 Volt battery to the battery terminals and connect the current limited variable power supply to the solar panel input on the charge controller. Connect the volt meter across the Schottky Diode D1 with the negative volt meter lead on the cathode (bar end) of the diode. Adjust the variable supply from zero up to around 13 Volts until the meter reads about 0.3 Volts across the diode. Slowly turn R13 clockwise until the red LED just turns off, now turn R13 counter-clockwise again until the red LED just turns on.

The second and third alignment steps involve setting the low and high points that the battery will alternate

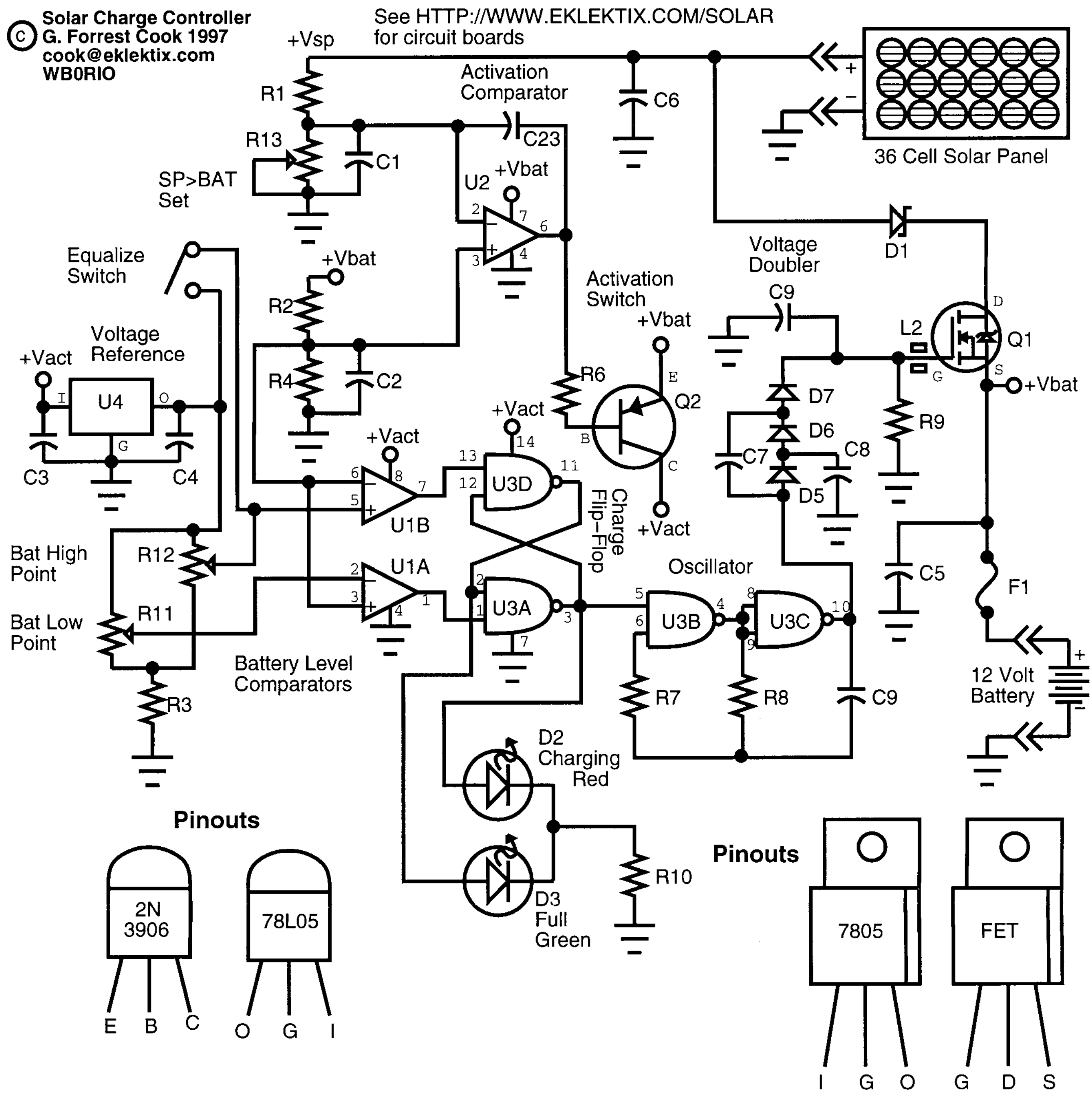


Above: Prototype charge controller on perf board.

between when it is fully charged. Connect the volt meter across the battery for this step. Turn the variable voltage supply to 15 Volts. Adjust R12 counter-clockwise until the green LED turns on. Adjust R11 clockwise until the red LED turns on. At this point, the charge controller should be functioning and the LEDs should alternate. Adjust R12 until the battery voltage peaks at the desired high charge point. Richard Perez recommends setting the high charge point to 13.8 Volts for sealed gel-cells and to 14.5 Volts for flooded cell (wet) lead-acid batteries. Richard also notes that these values are for solar applications where the sun only shines for part of the day, the values should be lower for applications with continuous power sources. The battery low set point should be set to 0.5 to 1 Volts lower than the high set point, adjust R11 until the battery drops to the desired voltage before the charging cycle begins again. In a properly adjusted circuit, the two LEDs should alternate several times per minute. This varies with battery and solar panel capacities. If the battery voltage drops too slowly during the test, it may be helpful to connect a small 12 Volt lamp across the battery, this will cause the battery to discharge faster. It may also help to adjust the voltage of the variable supply, this will vary the charging current and duty cycle of the flip-flop.

Current Capacity

The current handling capacity of this circuit is determined by the MOSFET transistor Q1, diode D1, fuse F1, and the current carrying wires in the path between the solar panel and the battery. An IRFZ34 MOSFET is rated at 30 Amps max and should easily handle 10 Amp charging currents. A heat sink should be used on the MOSFET and diode D1 if you are running



currents higher than 2 or 3 Amps through the circuit. The peak current may be determined from the solar panel specs. Diode D1 can be an IR 80SQ045 when the max current is less than 8 Amps. higher current diodes such as the GI MBR1045GI rated at 10 Amps may also be used with a heat sink. For efficiency, it is important to use a Schottky barrier diode since it has a voltage drop of around 0.4 Volts under load while a regular silicon diode has a voltage drop of around 0.8 Volts under load. At 5 Amps, the silicon diode would waste 4 Watts while the Schottky diode wastes only 2 Watts. The circuit board version of this circuit can handle about 8 Amps maximum if the proper semiconductors are used. The fuse should be rated the same as the maximum current of the FET or diode D1, whichever is lower.

Construction

I built the prototype circuit on perforated circuit board using point to point wiring. Teflon insulation over tinned bare wire works well and does not melt under a soldering iron. Be careful not to overheat any of the

Parts List

U1	1458 dual op-amp
U2	741 op-amp
U3	4011 CMOS quad nand gate IC
U4	78L05 or 7805 voltage regulator IC
Q1	IRFZ34 power MOSFET, see text
Q2	2N3906 PNP silicon transistor
D1	80SQ045, or MBR1045GI Schottky diode, see text
D2	Red LED
D3	Green LED
D5-D7	1N4148 silicon switching diode
C1-C8,C21,C23	0.1µF ceramic disc capacitor
C9	0.001µF ceramic disc capacitor
C20	100µF 16V electrolytic capacitor
R1-R3,R7	100KΩ 1/4w resistor
R4	39KΩ 1/4w resistor
R6,R10	2.2KΩ 1/4w resistor
R8	47KΩ 1/4w resistor
R9	1MΩ 1/4w resistor
R11-R13	100KΩ 10 or 15 turn trimmer potentiometer
F1	DC fast blow fuse, see text
L2	ferrite bead or 3 turns #24 wire on a 22 Ω 1/4w resistor
Heat Sink	TO-220 finned heat sink on Q1 for greater than 3A capacity (don't ground the Q1 tab, it's hot)
Battery	12 Volt lead acid flooded or gel cell battery
Solar Panel	36 cell photovoltaic panel, see text about maximum current

semiconductors, especially the LEDs. IC sockets may save a lot of time and grief in circuit debugging. Wires between the solar panel, D1, Q1, F1, and the battery should be heavy gauge to handle the charging current. Be sure to use thick wires for the current carrying part of the circuit. In the prototype I built the circuit into a small plastic box and used banana plugs as connectors for the input and output terminals.

Use

Connect the solar panel to the solar panel terminals and the battery to the battery terminals and watch the battery charge up. When the LEDs alternately blink, the battery is charged. A load may be connected between ground and the fused C5-Q1 source junction if the load current is lower than the fuse rating. The circuit board has the companion LVD circuit connected in at this point. Be sure to use battery cables that can handle the load current. If the circuit is to be connected to a high current source such as an automobile cigarette plug or a high current capable power supply instead of a solar panel, it will be necessary to use a high wattage series resistor between the positive power source and the charge controller solar panel input. A 10Ω, 25 watt resistor would be a good value to start with.

Access

Author: G. Forrest Cook • WB0RIO • 2910 Carnegie Dr., Boulder, CO 80303 • E-Mail: cook@eklektix.com • Web: www.eklektix.com/gfc/elect/solar

Circuit Board: A blank 3 by 4.5 inch circuit board with this charge controller and the low voltage disconnect circuit shown in HP #60 is available from Eklektix, Inc. for $20. An 8 Amp circuit board and parts kit is available for $45. An 8 Amp assembled and tested circuit board is available for $60. US Postage is included, we are not set up to do foreign orders yet. Assembly instructions are included with bare boards and kits. Make a postal money order or check out to Eklektix, Inc.

Parts

Digi-Key • 1-800-DIGIKEY
Newark Electronics • 1-800-4NEWARK
Mouser Electronics • 1-800-346-6873

Article

The FET Charge Controller, by Michael Bryce • WB8VGE, *QST*, January 1992

Surrette

BATTERY COMPANY LIMITED

THE POSITIVE CHOICE FOR LIFE.

ADVANCED ENGINEERING designed in combination with new improved materials makes available better batteries with **LONGER POTENTIAL LIFE.**

Surrette started manufacturing batteries over 50 years ago with a desire not to be the largest but the best.

The heart of a solar battery is the positive plate. Surrette pioneered the **REZISTOX GRID** design which has rugged vertical and horizontal main members with the main cross members reinforced by filleting. Surrette batteries require the rezistox design due to the utilization of dense active material which exerts higher than normal pressure on the positive grid.

High density active material, like Surrette uses, retards active material shedding thus prolonging the useful life of the battery. In cycling service, deep discharge and recharging, causes the active material to loosen and shed from the positive plates. Low density active material is less expensive and gives good performance when the battery is new but is susceptible to shedding, thus a shorter battery life.

THE SURRETTE DIFFERENCE

POSITIVE ACTIVE MATERIAL is manufactured from a dense coarse oxide which is specially formulated for maximum life and performance. Surrette manufactures all its own oxide from pure lead. Most manufacturers purchase their oxide which is usually designed for automotive batteries. Not so with Surrette.

RUGGED OVERSIZE REINFORCED POSITIVE GRIDS. This is necessary as Surrette uses dense active material which exerts high pressure on the positive grid. This would exceed the limitations of most grids used by our competitors. All Surrette grids and other lead components are manufactured from a highly refined lead alloy.

2 Volt Cells

Two Volt Surrette Solar Cells are available from 100 AH to 1500 AH for contractors wishing to design their own system with the least number of batteries and with the lowest cost per life cycle in the industry. Surrette Solar Batteries are designed specifically for solar use and are not adaptations from the golf cart or floor machine industries.

Remember, the bitterness of poor performance and short life far outlasts the sweetness of the lowest price.

Surrette Solar 1, 400 Series, Type CH 375 - L16

- 33.3% More Life Cycles
- Greater Reserve Capacity
- Expected Life of 10 Years
- Warranty 2 Years Unconditional, 3 Years Prorated
- Available Wet & Dry Charged
- Engineered under careful guidelines by Dave Surrette - Family owned since 1935

RAE Storage Battery Company

Since 1943... Quality & Service

If you need Competitive Pricing & Prompt Delivery call:

860-828-6007

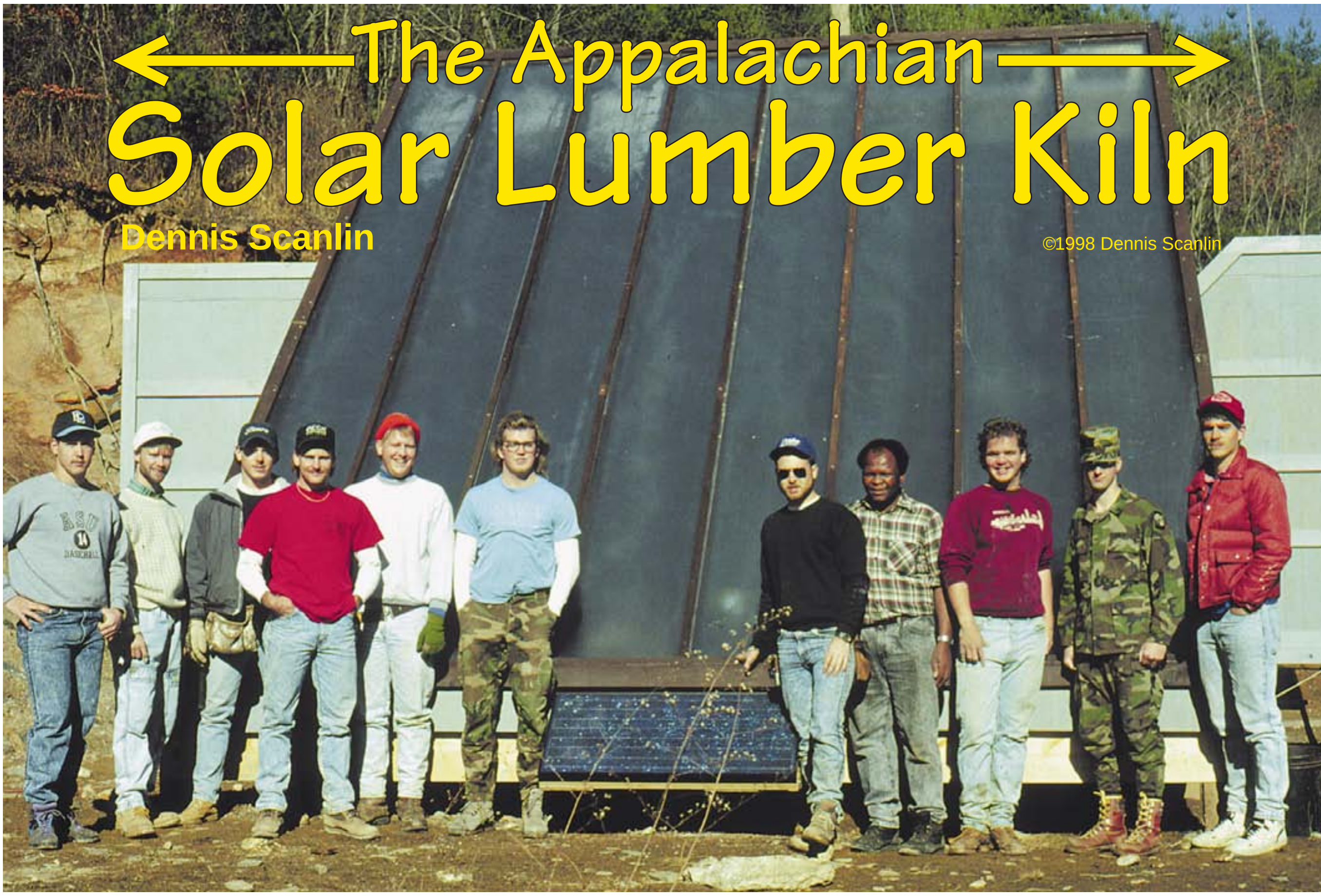
Fax 860-828-4540

51 Deming Rd., POB 8005, Berlin, CT 06037

Northwest Energy Storage is now wholesaling all Surrette Batteries West of the Mississippi. Call 1-800-718-8816

The Appalachian Solar Lumber Kiln

Dennis Scanlin



Above: Students from Appalachian State University with the Solar lumber kiln.

The drying of lumber is essential before it can reliably be used indoors. Drying consumes an enormous amount of energy. Each year (in the United States) lumber drying consumes 10 trillion BTUs, the equivalent of 1.7 million barrels of oil (*Fine Woodworking*, 1986). Two-thirds of all the energy used in producing lumber is for drying, adding 40 to 75% to lumber's value. Green 4 by 4 FAS cherry currently costs $1.27 per bd. ft. and kiln dried is $2.20, a 73% increase. Edwin Culbreth, the former owner of General Hardwood Products in Deep Gap, North Carolina, for whom the 3000 bd. ft. capacity kiln described in this article was constructed, spent as much as $0.08 per bd. ft. drying lumber in a dehumidification kiln. The initial cost of a kiln is also significant. An all electric 2,000 bd. ft. kiln with a small electric boiler can cost over $30,000.

Solar Drying

Lumber drying can be successfully accomplished with solar energy. The temperatures desired for lumber drying are between 100 and 180° F (the same as for food drying) and these can be obtained with a low temperature solar thermal collector. A solar kiln can operate all year long and during good solar periods can dry lumber in virtually the same amount of time as could a fossil fuel powered kiln. The quality of solar dried lumber is also as good or better than lumber dried in conventional kilns. Solar kilns can be constructed for much less than the cost of conventional kilns. The kiln described in this article was designed and constructed by students and faculty at Appalachian State University in the Department of Technology's Appropriate Technology Program. It has been in continual operation for 6 years. The inspiration for the design came from the "Oxford Kiln," a lightweight, portable, inexpensive, but not very durable kiln designed at Oxford University in England (*Fine Woodworking*, 1986). The 3,000 bd. ft., PV controlled, solar kiln described in this article was constructed for $3800. I have also constructed a smaller 600 to 1000 bd. ft. kiln in West Virginia for about $1000.

Wood Drying
Wood absorbs water, and swells and shrinks with changes in moisture content. This characteristic can make wood difficult to predictably use. The goal of wood drying is to remove moisture until it reaches the level present in the environment where the wood will ultimately be used. This keeps the swelling and shrinking to a minimum. Wood will release or absorb moisture until it is in equilibrium with the surrounding air. This state is called the equilibrium moisture content (EMC). If the wood will be used outside, then wood could be stacked outside and will eventually reach equilibrium with the environment. No kiln is necessary. The speed of drying will be affected by the thickness and density of the wood and the relative humidity of the surrounding air. Thin, low density wood placed in a low humidity environment will dry most quickly. If the lumber is for furniture to be used in a lower humidity environment inside a house, then the wood should be dried until it has the same moisture content (MC) of that environment. Usually 6 to 8%. This involves removing water from inside the cell walls (bound water), as well as the “free” water in between the cells.

The bound water is more difficult to remove. It could be removed by stacking the lumber inside the space where it will eventually be used. However this could take a year or more and most of us are not interested in living with stacks of lumber. Indoor drying can also proceed too quickly, because of the low humidity indoors, and cause surface checking. More commonly, lumber for furniture is dried in a kiln. The wood is exposed to 100° to 180° F air until it reaches the moisture content comparable to the relative humidity of the end use environment. In general the higher the temperature and air flow and the lower the humidity, the faster the drying. The goal is to speed up the drying process but keep it

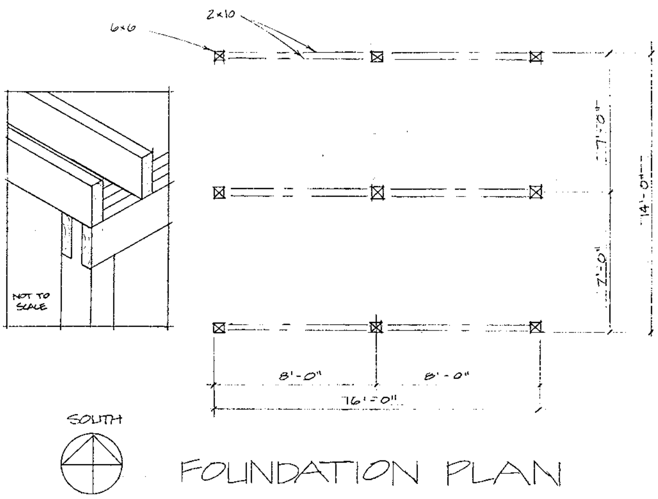
Above: Installing exhaust vents.

Above: Installing the dark aluminum screen used for solar absorption.

slow enough by controlling the humidity and temperature to prevent uneven shrinkage and the resulting defects. Most conventional kilns operate with air velocities of between 200 and 500 CFM through the lumber pile. The humidity is normally kept high during the early phases of drying and lowered as the drying proceeds.

Components of a Solar Kiln
A solar kiln is basically a low temperature solar thermal collector, usually an air heating collector, connected to an insulated and tightly constructed building. A stickered lumber pile is placed inside. A solar kiln has the same basic components as most solar thermal technologies: south facing glazing to admit solar energy; an absorbing material, often metal, to absorb solar energy and convert it to heat; insulation and tight construction to reduce unwanted heat loss; an air intake, flow path and exhaust area; and an area for lumber pile. A reflector could be added to increase performance.

Glazing Options
Glazing is the material that allows solar energy to enter the solar collector. It can be glass or plastic. An ideal glazing would have a high solar transmittance, over 90% and a low terrestrial infra-red (IR) or heat transmittance. It would let a lot of solar energy in but not much heat radiate out. Glass is an ideal material having as high as 91% solar transmittance and as low as 1% IR transmittance. But it is heavy, breakable, and is not normally available in long lengths. Sun-Lite HP plastic or Kalwall is also a good material with properties similar to glass (86% and 4% transmittances), with the added advantage of coming in rolls which can be cut any length desired (manufacturer recommends no longer than 16 feet). This eliminates horizontal seams



which can be problematic. It is also light weight and non-breakable. If properly maintained it can last a long time, maybe 25 years. Maintenance involves coating every 10 years with “Kalwall weatherable surface,” a 2 part resin. The Sun-Lite HP glazing for the solar kiln described here is 0.040 inches thick by 49 1/2 inches wide. The cost is $1.85 per sq. ft.

Thinner plastic glazing can also be used. Many have very high solar transmittances over 95%, but also have high IR transmittances, over 50%. They are not as durable as glass or Sun-Lite. But some resist UV degradation and can be good options for a second inner glazing. There are a variety of products on the market. The kiln depicted has an inner, second layer of glazing separated from the Sun-Lite by a 3/4 inch air space. The inner glazing is Teflon FEP film. Wengert and Oliveira (1987) have indicated that collector performance can be improved by 35% or so when a second layer is used.

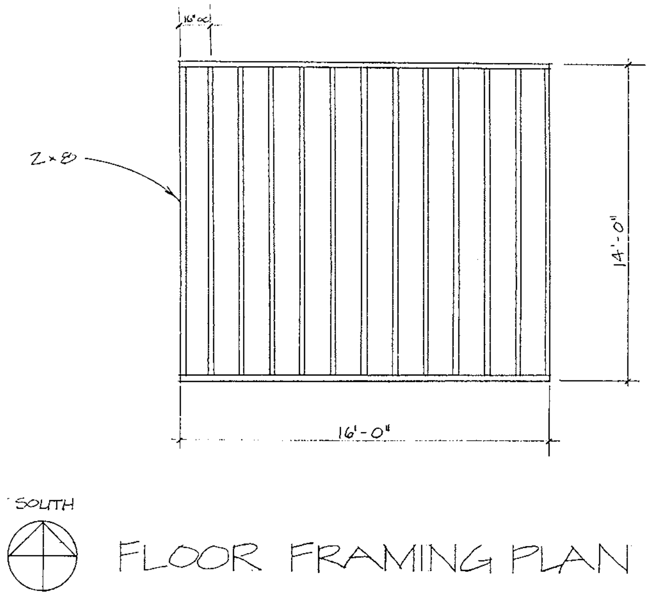
Other Glazing Issues

Other glazing decisions include: what angle should the glazing be above a horizontal plane or the ground (altitude) and what direction should the glazing face (azimuth)? Assuming the kiln would be used all year round, the glazing angle should be the same as one’s latitude. This would provide the greatest number of BTUs over a year. Latitude plus 10 to 15° would result in slightly better performance during the shorter days of winter while still providing good summer performance and more usable interior space. This is the strategy we pursued. The Appalachian kiln is located at 36° N LAT and has a glazing angle of 45°.

Above: Laying out foundation and floor.

The azimuth angle for the kiln’s collector should be due south for best performance in northern latitudes, although slight variations won’t significantly affect the performance. Make sure the sun can strike the collector all day long or at least from 9 to 3 solar time.

A final consideration is what size the glazing needs to be. Wengert and Oliveira (1987) recommend 1 sq. ft. of glazing for each 10 bd. ft. of dryer capacity. All successful designs surveyed have this much or more glazing. The Appalachian kiln has a 3,000 bd. ft. capacity (1,000 cubic feet) and 320 sq. ft. of glazing, a little more than 1 sq. ft. per 10 bd. ft. (0.32 sq. ft. per

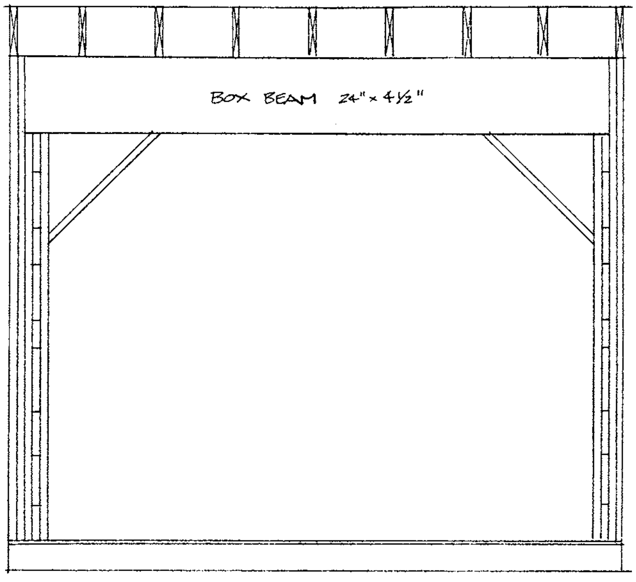


Above: Bracing the north wall.

cubic ft.). This ratio performs well, although two recently published kiln designs have higher ratios of around 1 to 3 sq. ft. per cubic foot and are capable of producing higher temperatures and faster drying (Kashihara, 1989; Kavvouras, M. and Skarvells, M.A., 1996). They also cost considerably more to build.

Absorbers

A good absorber will be a dark color, thin, and have good conductivity. Most absorbers are made of black metal. Copper and aluminum are often used because of their excellent conductivity. The Appalachian dryer uses 6 layers of dark gray aluminum window screening. 5 to 7 layers has been suggested in articles and books on solar air heating. We have not explored the difference in performance with different numbers of layers. Others have used metal or wire lathe painted black instead of window screening. When we compared the lathe to the screening in small test collectors we found no significant difference in performance. The screening cost less, \$0.22 vs. \$0.28 per sq. ft., and did not have to be painted. The screen is diagonally positioned in the air flow channel. This through-pass mesh type absorber has been proven to be a superior configuration in our tests. Other published reports have come to the same conclusion. The air must pass through the warm metal mesh, resulting in good heat transfer.



NORTH WALL FRAMING PLAN

Insulation and Tight Construction

The floor of the dryer is insulated with 8 inch unfaced fiberglass insulation (R25). The east, west, and north walls are insulated between the studs with 3 1/2 inch faced fiberglass insulation (R11) and are sheathed with 1/2 inch Tuff-R polyisocyanurate insulation board (R3.5). The exterior surface is 3/8 inch T111 sheeting and the interior was sheathed with 3/8 inch plywood. A layer of polyethylene was caulked and stapled to the interior surface of the studs before the 1/2 inch plywood was installed. Caulking and weather stripping made the structure as tight as possible.

Air Intake, Flow Path, and Exhaust

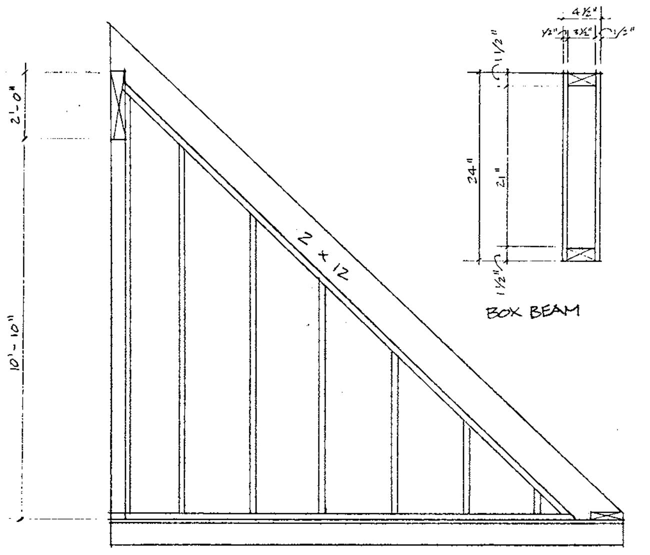
The air flow path through the collector was created using the south facing framing members. They are 2 by 12's on 24 inch centers. On the bottom of the 2 by 12's, 1/2 inch plywood was glued and screwed in place. Then 3/4 inch by 3/4 inch absorber mesh support strips were positioned diagonally up the air flow channel on the faces of the 2 by 12's and screwed in place. The inside of the air flow channel (the 2 by 12's, absorber mesh support strips, and the top or south side of the plywood) was painted a dark brown (black was not available at the time). Then the 6 layers of dark gray aluminum screening were stapled in place and the glazing layers fastened to the top, south facing surface.

The depth of the air flow channel, determined by the 2 by 12's, was selected by computing 1/20 of the length of the collector which was approximately 20 feet or 240 inches (1/20 or 0.05 x 240 = 12 inches). The 11.25 inch depth of a 2 by 12 was as close as we could get using stock lumber.

Above: Setting up 2 by 12 south wall rafters.

of the south facing 2 by 12's. The air is pulled down through the absorbing mesh and into the air plenum. The fans then blow the air into the lumber pile. A row of eight exhaust vents was placed below the intake vents just above the doors. Covers hinged at the top of the vents permit regulation of air intake, exhaust, temperature, and humidity inside the kiln. These can be controlled by ropes and pulleys operated from the ground. Another set of eight vents was constructed inside the kiln at the top of the north side. These can be opened when the other two sets are fully or partially closed to permit the recirculation of the kiln air for further heating. This permits greater control of temperature and humidity.

Air is drawn into the kiln by three 1000 CFM, 12 VDC, 1.1 Amp fans, powered by a single MSX-60 Solarex PV module. The fans are 16 inches in diameter, with a three wing aluminum blade. An air plenum for the fans was constructed in the bottom south corner of the drying chamber. The PV module is connected directly to the fans, which are connected in parallel. No controls, regulators, or batteries are used. When the sun is shining the fans are turning. They have done so now for 6 years with no maintenance. The fans draw air into eight 8 inch by 16 inch soffit vents placed in the top of the north wall. These vents were placed between each



EAST/WEST FRAMING PLAN

Area for the Lumber

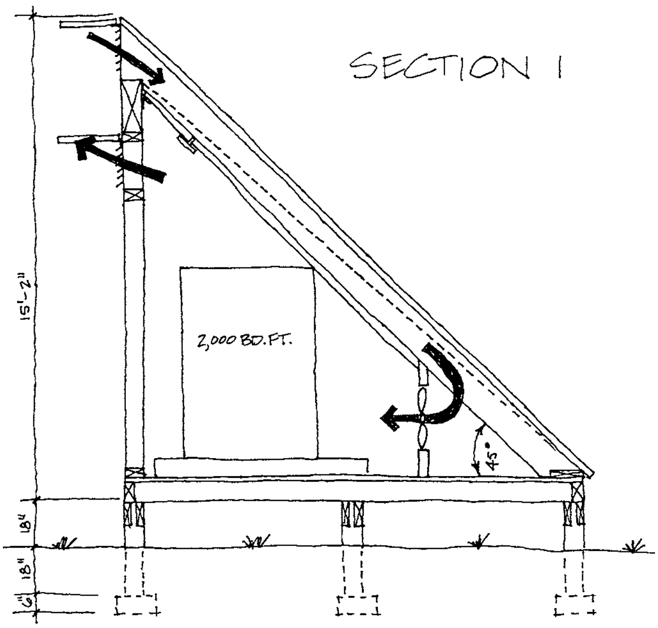
The kiln will accommodate up to 3,000 bd. ft. of lumber, up to 14 feet long. It has two large doors on the north side to facilitate loading with a fork lift. Baffles were installed inside the kiln on the east and west interior walls to force the warm air through the lumber. They are 1/4 inch plywood panels hinged to the sides and controlled with string and cleats.

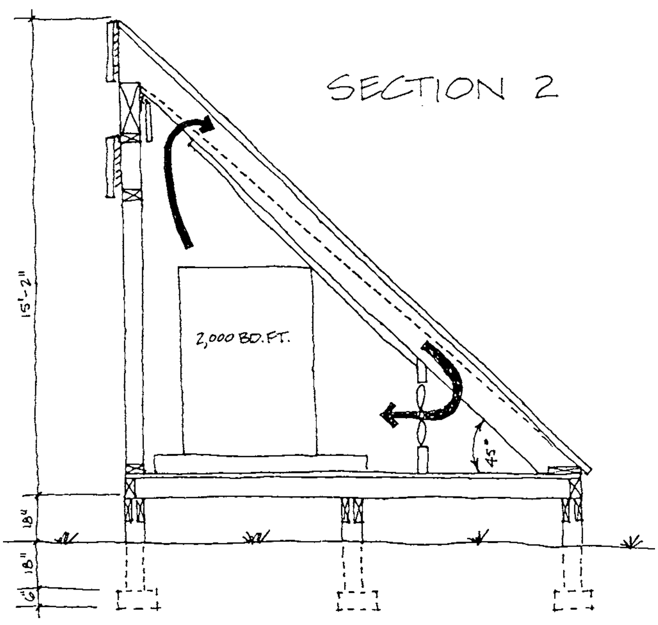
Other Construction Details

Except for the glazing, the kiln was constructed of common building materials. The kiln is 16 feet long east to west, 14 feet wide north to south, and approximately 15 feet tall. The drawings provide most of the construction details. The foundation is nine 6 by 6 locust posts positioned in three rows. Three posts are 8 feet apart in each row and the rows are 7 feet apart. Two 2 by 10's are bolted to each of the rows to form three 16 feet long girders. The floor is 2 by 8 joists, 16 inches o.c., with 1 by 8 boards nailed diagonally to the joists. A 1/4 inch plywood air barrier was fastened to the underside of the joists after the insulation was installed.

After the floor, the north wall was constructed. This required a 24 inch by 4 1/2 inch by 15 1/2 foot box beam, constructed of a 2 by 4 frame with 1/2 inch plywood glued and screwed to each side. The beam permitted the large opening for loading with a forklift. The beam and north wall were constructed, plumbed, and braced in place.

Next came the 2 by 12's for the south framing, the east and west framing, and collector construction. Insulation, vent detailing, door construction and installation, painting, and all the other details followed.





Kiln Operation

As soon as possible after cutting the lumber, the ends should be sealed with aluminum paint, paraffin, glue, latex paint, or urethane varnish to reduce rapid drying at ends. This helps avoid cracking. The lumber should also be stacked and stickered as soon as possible after cutting. Shelter furniture grade lumber from direct sun and aim the end of the stack into the prevailing wind. This also helps avoid overly rapid drying and cracking. Build the pile about 1 foot off the ground and place stickers (1 inch by 1 inch) at the ends and every 18 to 24 inches. Cover the top of pile with scrap boards or plywood and put some rocks or cinder blocks on top. Lumber can be air dried outside to about 20%. To compute moisture content, use an electronic moisture meter or use an oven and 1 inch cubes from a board about 2 feet from the end. Weigh a cube and put it in the oven at about 220° F until it no longer loses weight. Subtract the oven dry weight from the sample's wet weight, divide by the oven dry weight, and multiply by 100.

$$\frac{W - D}{D} \times 100 = MC$$

where

W = Sample wet weight
D = Sample oven dry weight
MC = Moisture content in percent

The air dried lumber can then be kiln dried down to 6 to 8%. Green lumber can also be placed into the kiln. The normal operation of a dry kiln is to maintain low to moderate temperatures (120° F) until the wood drops to about 30% MC then increase the temperatures to 160 to 180° F in several steps. Most solar kilns do not permit as much adjustability as in a conventional powered kiln. However, it is possible to adjust the temperature and humidity by controlling the air vent covers. The temperature will drop at night. This temperature drop allows the lumber MC and temperature to equalize. Some (Wengert and Oliveira, 1987) have suggested that this reduces cracking and bending.

In the initial phases of drying green lumber keep the inner vent cover open and the outer vent covers closed to keep the humidity high. The temperature will automatically be depressed by the mass of all the

Below: A Solarex MSX-60 powers three 1000CFM fans.

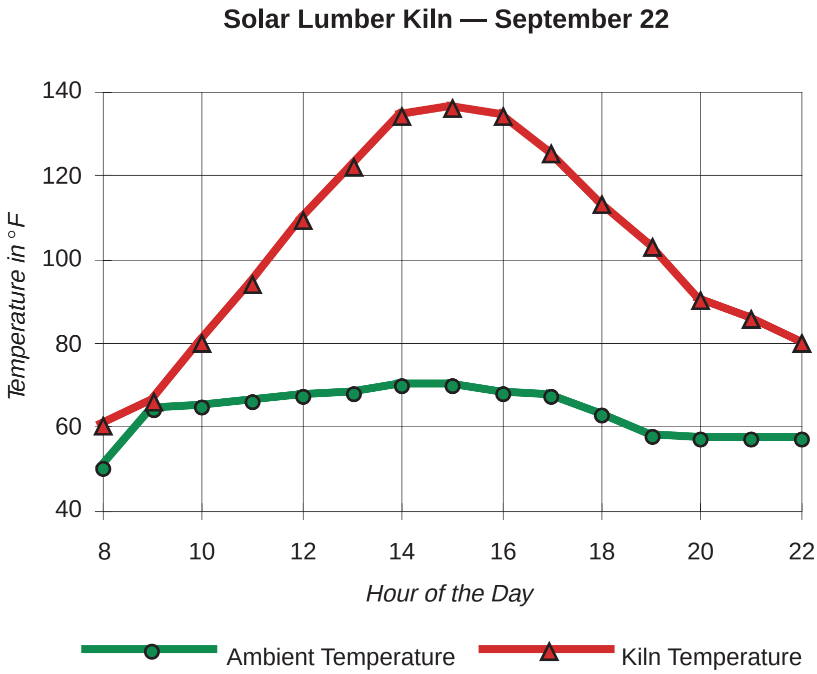
Above: Setting up vent control lines.

moisture. Some moist air will still escape and after the moisture content drops to around 30% or the temperature rises over 130° F, the outer vent covers should be opened a little and the inner vent cover closed. Adjust the exterior vent covers to regulate the temperature. They normally won't need to be opened very much. Gradually close them to increase the temperature as much as possible at the end of the drying cycle for maximum drying. Keep taking MC measurements and closing vent covers until wood gets down to about 6% MC. The operators of the Appalachian kiln found that it dried well by keeping the interior vent covers open and the exterior vent covers almost closed. A reflector would probably improve the kiln's performance but add to the cost and complexity. We have not experimented with one on this kiln, but a reflector added to solar food dryers has increased temperatures by about 20° F and reduced drying time.

After drying to below 6 to 8% remove lumber from kiln if you have a dry place to store it. Lumber will reabsorb moisture after being dried if left in an environment having a higher moisture content. Stack the lumber tightly without stickers.

Kiln Performance

The kiln has been in continual use for 6 years and has successfully dried many loads of lumber down to 6 to 8% MC. The maximum temperature observed in this kiln is about 150° F. The graph shows the kilns typical performance on a sunny day in September midway through a drying cycle. It dries more quickly in the spring, summer, and fall than in winter. The first load of lumber placed in the kiln was about 2150 bd. ft. of 4 by 4 basswood. It was put in on December 13 and was down to 38% by December 28, 28% by January 12, 15% by February 5, and 7% by March 13. There were a lot of cold, cloudy days throughout the period. During most of the year, air dried lumber with a moisture content of about 25% placed in the kiln takes 2 to 4 weeks to reach 6 to 8% MC. During one summer, 4 by 4 cherry dried from 39% to 15% in 2 weeks. After 4 more weeks the wood had an average MC of 8%. Ash, oak, cherry, poplar, and cedar have all been successfully dried. The largest load dried at one time was 3,880 bd. ft.



Solar Kiln Costs

Basic framing, sheathing and foundation	$1,800
Insulation	$279
Absorber mesh	$480
Glazing (FRP)	$635
Air distribution system (PV module, 3 fans)	$665
Total	$3,859

Access

Author: Dennis Scanlin, Appalachian State University, Department of Technology, Boone, NC 28608
704-297-5084 • E-Mail: Scanlindm@appstate.edu

Fans and module: Alternative Energy Engineering, PO Box 339, Redway, CA 95560
800-707-6609.

Sun-Lite HP: Solar Components Corporation, 121 Valley Street, Manchester, NH 03103 • 603-668-8186.

Teflon FEP film: DuPont Company, Electronics Department, High Performance Films Division, Wilmington DE 19898 • 800-441-9494.

References

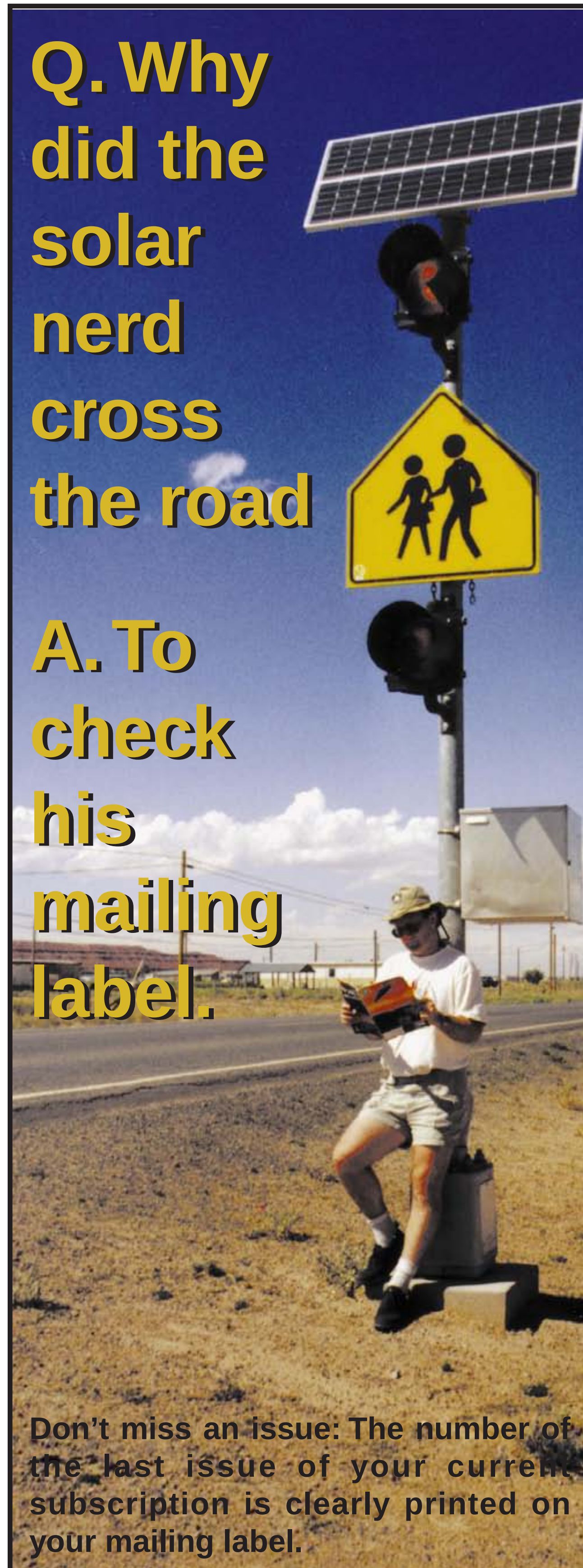
Bertorelli, P. (Ed) (1986). *Fine Woodworking*, on "Wood and How to Dry it." Connecticut: The Tauton Press

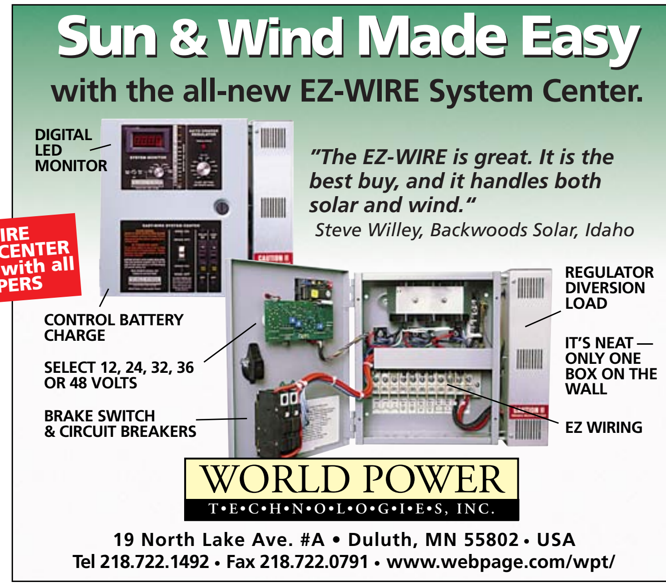
Kashihara, S. (1989). Lumber drying in a solar lumber kiln. Business Japan. Sept. 01 (34) #9. page 68.

Kavvouras, P. K. and Skarvells, M. A. (1996). Performance of a solar-heated, forced-air, fully automatic lumber dryer. Holz als Roh- und Werkstoff. Jan 01, 1996. (54) #1.

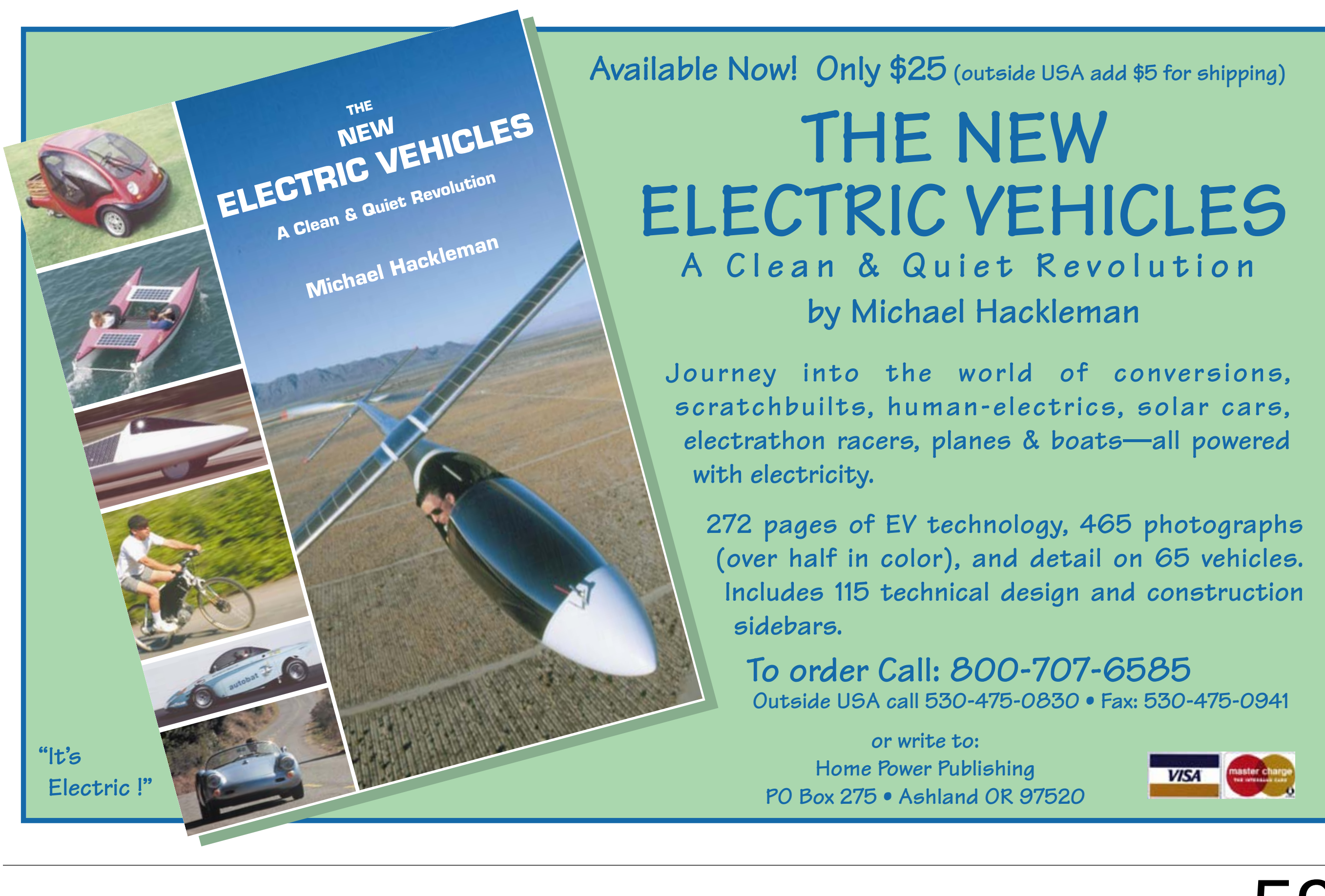
Rasmussen, E. F. (1961). *Dry kiln: Operator's manual*. Agriculture Handbook # 188. Madison, Wisconsin: Forest Products Laboratory, Forest Department, U.S. Department of Agriculture.

Wengert, E. M. and Oliveira, L. C. (1987). *Solar heated lumber dry kiln designs: A discussion and compilation of existing solar heated lumber dry kiln designs*. Blacksburg, VA: Department of Forest Products, Virginia Polytechnic Institute and State University

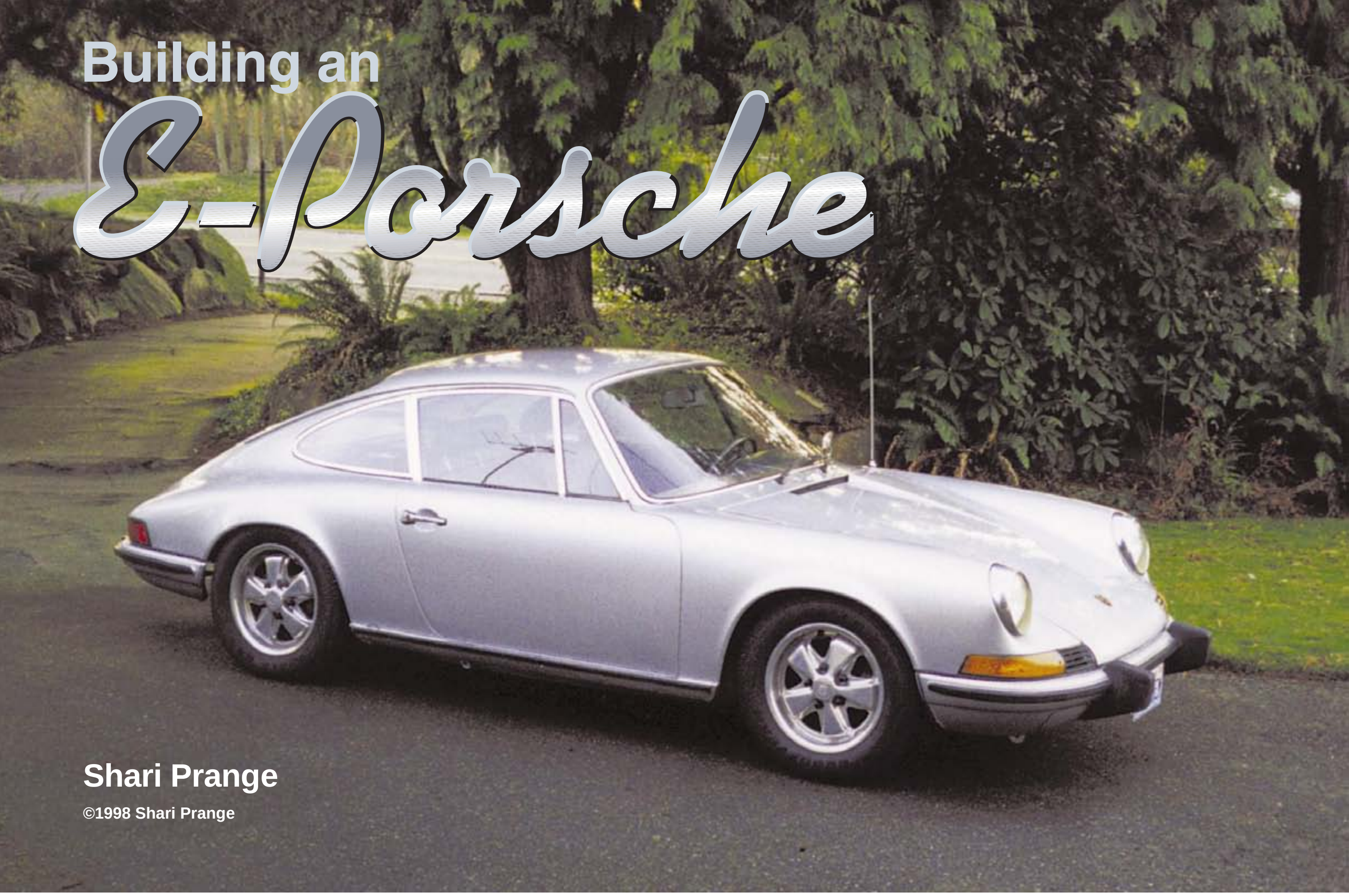




SOLAR ELECTRIC INC
camera ready, b/w
3.5 wide
1.6 high



Building an E-Porsche



Shari Prange

Everyone comes to an electric car conversion by his own path. Some are looking for environmental friendliness, some for economy and low maintenance, and some for the cachet of something different.

Dave Brockman was looking for a project, “something with some meat on it”. He had a history of putting things together in ways other than their original configuration. He once mated a “mini” computer with a TV and a teletype to produce a “personal computer” in the days before that concept existed.

So when he retired his Porsche 911T from service because it couldn’t pass smog tests, it was no surprise that he started thinking about making it electric. He had bought the car new in 1973, and knew it intimately. He was an adventurous, hands-on kind of guy, so why not?

Getting There Is Half The Fun

He started seriously researching conversions, and located Electro Automotive through Kit Car Illustrated magazine. Not a hasty man, he spent a year familiarizing himself with the issues of a conversion and the parts he would need. Finally, he took the plunge.

Dave kept a diary throughout the project, and his detailed notes can be found on his web site at http://www.oz.net/~daveb/porsche.htm. The diary reflects the way many conversions happen: an hour or so a day for a few days, a flurry of activity over a long weekend, then a few weeks when life intervenes and nothing happens on the car.

In addition, Dave was in no hurry. He had other transportation, and for him, the process itself was part of the thrill. He examined each piece of the car as he disassembled it, scouring away rust, fabricating replacement pieces where necessary, priming, painting, and undercoating. He replaced rubber seals, re-painted, re-plated, and re-upholstered to make the finished product look good. In essence, he was doing a partial restoration along with the conversion.

Part of the fun for Dave was also an excuse to buy new tools. By the time it was over, he had spent over $5,000 on tools, including an industrial metal strapping device and a MIG welder. Of course, he didn’t HAVE to buy most of this stuff to do the conversion, and Dave admitted it would have been cheaper to hire things like welding done, but hey, he wanted a welder anyway.

Dave had had two quarters of welding in college, and spent some time practicing before working on the car. In the end, he did send out pieces he felt were critical. “I just couldn't match the guy in the shop," he said. "His welds were always smaller and more even than mine. Welding is half an art."

Some Disassembly Required

The first several weeks of his project involved the disassembly, assessment, cleaning, and touch-ups on the original parts. His diary recounts this process in terse yet detailed lists of each item removed, interspersed with occasional dry humor. One entry reads, "Lowered engine on jack, whence it promptly fell off." Another says, "Removed starter motor. Examined mysterious rivet."

Once all of the internal combustion components were removed, he steam cleaned the chassis and transmission, and sold the old engine for $300.

Above: Rear batteries in the engine compartment with a glimpse of the Advanced DC motor beneath.

Heart Transplant

The actual transformation to electric began with the installation of the Advanced D.C. nine inch electric motor and its adaptor on the transmission. This combination weighed in at 309 pounds total. Dave built a special wooden holder to fit on the transmission jack and help him move the assembly into place.

Before he stripped the car, he had used a stick to measure and mark the position of the transmission against the chassis. Now he moved the transmission back to this same position to begin designing his motor mount. First he built a crude mock-up from wood and masonite to get his basic dimensions. From this, he made a precise design drawing. Then he fabricated a more precise dummy from poster board and fitted it in place. The dummy showed him where he needed to make a few modifications. He adjusted the drawing and dummy to suit.

Below: Battery box behind the seats.

When he was satisfied, he took them to a welding shop. The welder suggested a few more modifications for strength. With these ideas incorporated into the design, the mount was built.

Support Your Local Battery

Next he started on the battery rack design. He had settled on using the U.S. Battery model #1450, twelve volt, deep cycle unit because he was so limited for battery space. Both the front and rear of the body drop off sharply and are curvy, limiting useful battery space. In addition, there was no hatchback for easy access to the back.

He started with a wooden frame to test the measurements for his front battery rack. When the design had been tweaked to fit, he welded up the basic rack. Then he located and welded on mounting "ears" to support the rack in place.

There were a few places he needed to cut the chassis a little to make room, but he tried to avoid any cuts or even hole drilling if possible. "I wasn't really sure what was behind things, and I didn't want to compromise the structure any more than necessary," he said. And any place he did cut was thoroughly smoothed, sanded, primed, painted, and undercoated for protection.

Above: The cockpit with guages fitted into original dash.

Boxed In

The battery boxes were built from 5/8 inch plywood, except on the two ends of the front box, which were only 1/2 inches thick due to space constraints. The front box held four batteries, with four more in a box in the back seat area. “If I had it to do over, I would do the boxes in plastic for acid resistance,” Dave said. “In fact, I just may do that some day.”

There were small details that could not be ignored. For example, the bottom edges of the box had to be chamfered to clear the radius of the weld inside the rack. The box was secured to the rack with carriage head bolts from the inside, below the batteries. Inside the box, wooden blocks were secured to the bottom of the lid at strategic points to keep the batteries held down.

Altogether, the front battery box, rack, and hold downs weighed 46 pounds.

Dave tried to squeeze five batteries into the rear box, but they just wouldn’t fit, so he settled for four. The rear rack, box, and hold downs weighed in at 66 pounds. Since there was no easy access to the back seat area, Dave designed and built a “battery loader”. This consisted of a steel and wood device that fits in place of the front seats temporarily when loading batteries. The batteries are loaded into their box first, then slid into place across the battery loader.

Once the wooden boxes were finished and painted, Dave reinforced them with bands of steel strapping tape around the outside. Small, angled, corner protectors kept the bands from biting into the wood on the corners.

In The Belly Of The Beast

In the engine compartment, Dave fabricated two aluminum plates to fill the space on either side of the motor, and had them anodized black. On one of these, he mounted a finned heatsink below in the air stream, and the Curtis/PMC 1221 controller and its potbox on top.

The original throttle linkage was a problem. A cable ran from the pedal to a bell crank on the transmission, which connected to a rod. The problem was that there was no way to mount the potbox so that its lever’s natural motion would correspond to the motion of the rod. Dave solved this by substituting a sheathed throttle cable from a Dodge, cut to fit, for the rod. The flexibility of the cable allowed him to loop it around and achieve the proper direction of motion. A couple of convenient threaded holes in the chassis provided anchors.

The car’s original accessory battery would no longer fit, so Dave replaced it with a smaller motorcycle battery in the same place. The main pack charger and DC/DC converter to charge the accessory battery were mounted on an accessory plate in the front battery area. The charging receptacle was fitted into the old gas fill tube, an almost de rigueur electric vehicle touch.

Something Old, Something New

Dave wanted to modify the original chassis as little as possible. For this reason, he built plates to fill the larger

Below: More batteries, charger, and DC/DC converter in the nose.

Above: Fuel in! Plastic cover thwarts dust and water.

holes from old gauges on the dash, and mounted the smaller electric vehicle gauges into those.

He also made a challenge out of reusing as much of the original wiring as possible. Having invested over $300 in the six-volume Porsche factory manual set, he was able to identify all the original wires by color code, and apply many of them to new uses. In some places, the original wiring loom terminated with all the wires in a single plastic plug, and he was able to graft his own wiring into the plug and re-use it.

Dave's personal touch of engineering was an optical drive for the car's tachometer. It used a thin plate on the shaft of the motor to interrupt a light beam, and this was calibrated to display the motor rpm.

He also added an onboard data acquisition system of his own design. This tracks various voltage and current readings during driving and charging for later analysis on a computer.

Test Flight
When the car finally rolled under its own power, Dave drove it to the state patrol office to have it certified as an electric. The converted car weighed 2,740 pounds compared to the original 2,425, still well under the gross vehicle weight of 3,086. The axle weight ratios stayed close to original and also well within maximum specs.

With some driving experience, Dave learned the subtle differences of an electric, such as the need to down shift earlier on hills to keep revs up. He also found that he really wanted a little more power, so he decided to add two more batteries in the engine compartment, bringing the system to 120 volts. This also required a little redesign on his front accessory plate to accommodate a charger booster. The final version topped out at 2,955 pounds

"A lot of other vehicles would be more practical conversions," Dave said, "but I wasn't really looking for practical." The EPorsche will do 50 mph even on a slight upgrade. Because of the car's weight, and the lower capacity 12 volt batteries instead of 6 volt units, range is not its strong suit, but most of Dave's driving is less than fifteen miles round trip, so it suits him fine. He also has a Dodge Ram when he needs it, but he only puts about 1,600 miles a year on it.

Dave didn't put any distinguishing graphics on the car. "I'm basically kind of shy," he said. He did fill in the original exhaust pipe hole, but nobody seems to notice that. When he went to the dentist with it, or doctor, or accountant—the whole staff had to troop outside and get the tour, but outside of that he keeps a pretty low profile, just a happy, quiet phantom sliding through the Seattle traffic and disappearing into the fog on little cat feet.

Access
Author: Shari Prange, Electro Automotive, POB 1113-HP, Felton, CA 95018, phone (408) 429-1989,
E-mail: electro@cruzio.com

Dave Brockman aka Big Dave • E-mail: daveb@oz.net
Web: http://www.oz.net/~daveb

EV TechTalk

Mike Brown

We started this column to talk about Electric Car technical problems. In the past months we have covered tires, battery checking, battery care, and step-by-step check-out of a dead EV. We have taken a look at extreme duty and low performance EVs, and what kind of car to make into an EV. This time we are going to look at another kind of EV problem, the "perception" problem.

Perception Problem #1: Range
The common statement goes like this: "I'd really like to drive a EV, but a range of less than 100 miles is too limiting." This usually comes from a person who, when questioned closely, admits that his usual daily trip mileage is 25 to 30 miles, often less. (Ninety percent of the cars in the U.S. go 25 miles or less in a day, usually with only one person in them.) But he insists he needs to be able to go to Lake Tahoe (enter your area's getaway spot here) even though he hasn't been there in years.

As I have said before, an EV is a mission-oriented vehicle. Determine what the EV's daily mission is in miles traveled, and measure that against the EV's range (a baseline 96 volt EV should be able to get 60 to 80 miles range). If your daily trip is with in that range, an EV is worth considering. If you want to build in some reserve for extreme duty, such as lots of traffic or hills on your route or long periods of cold weather, check and see how half the range fits with your mission.

As for occasional long trips, take your gas car. The average number of cars per household in the U.S. is 2.5. If you are a one-car person or family, consider renting a gas car for the occasional long trip and save the money that would be spent on maintenance, insurance, taxes, and depreciation on a car that is only used occasionally.

To sum up the range issue, examine your lifestyle and needs and measure them against the EV's capabilities, and if they match, an EV might be a good choice for your next car. If they don't match, keep an eye on EV developments.

Much progress has been made in the past few years and either small incremental gains or a large breakthrough might bring the EV's capabilities into a match with your needs.

Perception problem #2: Speed.
The only contact a lot of people have had with EVs is a golf cart, which by design is a slow vehicle. When you add to this contact the statement made by an auto executive that, "Electric cars are nothing but gussied-up golf carts," the perception that EVs are all low-speed vehicles is a logical conclusion.

In the early days of the hobbyist conversion movement, when the only available motors were surplus aircraft generators, the control systems were either series-parallel switching contactors or primitive transistorized "choppers," and the battery pack voltage was limited by the motors and control system, speed was a problem.

Years of development fueled by increasing interest has brought us motors and controllers fed by higher voltage battery packs. The modern motor/controller/battery pack systems now in use provide us with freeway-capable EVs with good acceleration which also have ranges that are useful in the real world. As with every thing, there are trade-offs. Building an EV capable of tire-smoking, hot rod performance will leave you with less range and cost about one third more than a more modest performing commuter. Again, what is the mission of the EV? Look at what you want the EV to do and what your resources are, then build to suit.

There is another advantage to EVs: where else do you get to build or have built a car that suits your needs?

Perception Problem #3: Safety
Since my experience is in conversion EVs, I am going to address the safety issues as they pertain to conversions.

The safety issue that is raised most frequently is, "What happens to the batteries in a crash? Are they going to break open and spill that nasty battery acid all over?"

In a properly designed EV, battery placement and containment are the first things the designer/builder looks at. Are the batteries that share space with the driver and passengers secured and contained in such a way that even if there is a roll over they stay put and that none of the acid spills out of the battery box? Are the batteries placed in the car in such a way that the front-to-rear weight distribution is not heavily biased toward one end of the car? Likewise, are the batteries placed as low as possible to keep the car's center of gravity close to the road, to help prevent rollovers? Proper attention to those details is essential to safe construction of an EV.

Another part of the EV package needing attention for both safety as well as performance reasons is the car's suspension system. The additional weight of the batteries must be compensated for by changing the springs or torsion bars and installing heavy duty shock absorbers. These changes restore the car's ride height and handling.

The cars brakes should be examined to determine their ability to handle the additional weight and modified if necessary. If the brakes are determined to be adequate they should be given a complete overhaul to put them in like-new condition.

Another safety question that is raised frequently concerns electrical hazard. "With the high voltage from the battery pack running through the car, am I in danger of being shocked during operation or in case of a crash? What about fire from short circuits?"

The issue of shocks from the traction battery pack during operation is covered by isolating the high voltage system from the car's chassis. This isolation is required by the speed controller and the battery charger for proper operation and serves as the first line of protection for the passengers. In case of an accident or a short in the high voltage system, fuses in each of the battery boxes will open and prevent shocks or fires.

The remaining perceived safety issue associated with EVs is the danger of fire or explosion from the hydrogen given off by the batteries during charging and discharging. Hydrogen is given off during the last few minutes of the charge cycle and in such small amounts that a properly designed battery box ventilation system makes the accumulation of enough hydrogen for an explosion and fire unlikely. Likewise, for the even smaller amount of hydrogen given off during discharge.

Since we have moved from discussing only EV technical problems to discuss non-technical EV issues I think I would like to throw open this column to any questions the readership of *Home Power* might have concerning EVs. So let's hear from you. Maybe some of the questions explored and answered might help somebody decide it's time to Go EV.

Access

Author: Mike Brown's TechTalk, Electro Automotive, POB 1113-HP, Felton, CA 95018, phone (408) 429-1989 • fax (408) 429-1907 • email electro@cruzio.com

Solar Sprint Performance

Don Kulha

The performance of our solar sprint racers depend to a large degree on how much energy they capture from the sun and how much power they deliver to the drive wheels. This time we'll discuss how reflectors can enhance energy collection and how to do some simple motor tests.

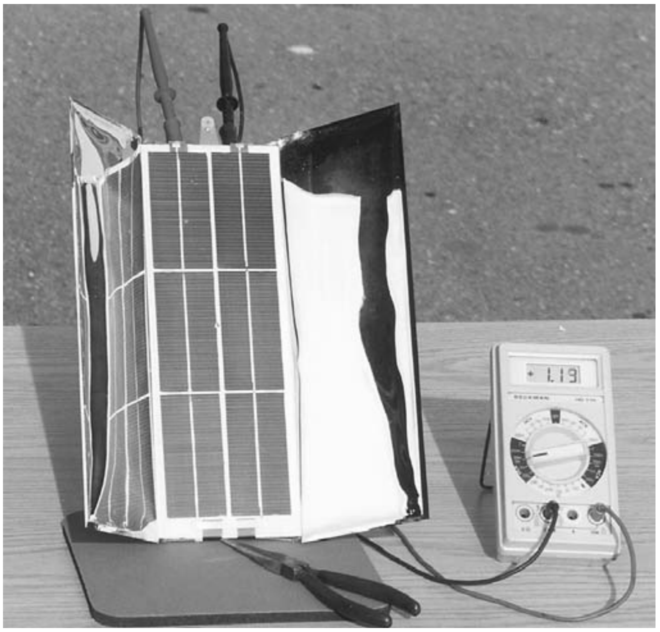
The official rules for solar sprint racing state, "Any energy enhancing devices, like mirrors, must be attached to the vehicle." Tests on my vehicle indicated that using reflectors increased panel voltage from 3.2 Volts to 3.3 Volts and amperage from 1.5 Amps to 2.79 Amps. This lowered test run times by over half a second (and potentially more after future gearing tests). This is a 3% increase in voltage which yields higher motor rpm (revolutions per minute) and an 86% amperage gain greatly increasing motor torque. When reflectors were added, the first thing I noticed was that my racer accelerated much harder off the starting line and run times dropped slightly. Changing to a higher (lower numerical) gear ratio made the racer pull much harder at the mid-run and shaved 0.57 seconds off the run time. This is a substantial improvement.

Reflect On This

Reflectors must be sturdy, highly reflective, as light as possible, and must not exceed dimensions stated in the rules. This means that your vehicle, with reflectors mounted, must not be taller or wider than 12 inches. I used 2 mil aluminized mylar, aluminized side up, epoxied to 0.039 inch stiff wire measuring 4.5 inches tall and 13 inches long. These fit into sockets attached to front and rear edges of my solar panel so they could be removed for transport or quickly replaced if damaged.

Reflector Angle Performance

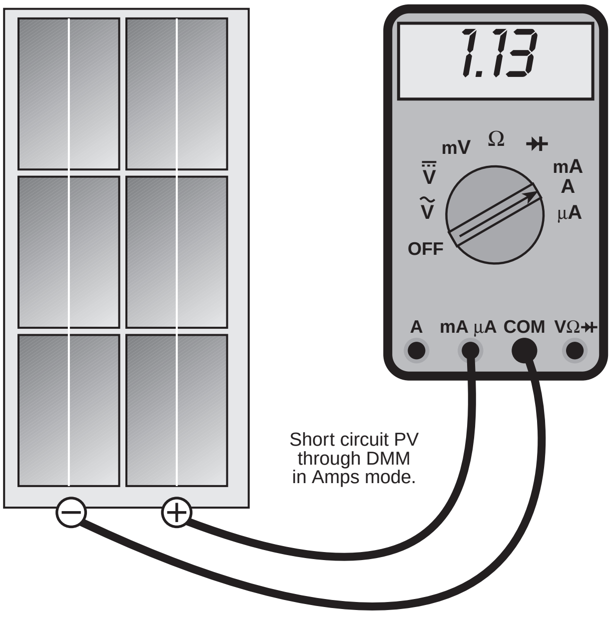
Degrees From Vertical	*PV Amps*	*% Change*
No Reflector	1.55	0.0%
38	1.56	0.6%
35	1.95	20.5%
32	2.38	34.9%
29	2.65	41.5%
28	2.79	44.4%



Above: All it takes to determine optimum reflector angle.

The table shows my panel's performance at various reflector angles as measured with an ammeter across the panel output leads. Depending on your reflector design different angles may be required. I'll share one of my "speed secrets" with you here: at 38 degrees from vertical, collection advantage on a clear day was basically zero. However, energy collected from scattered light on an overcast day improved substantially.

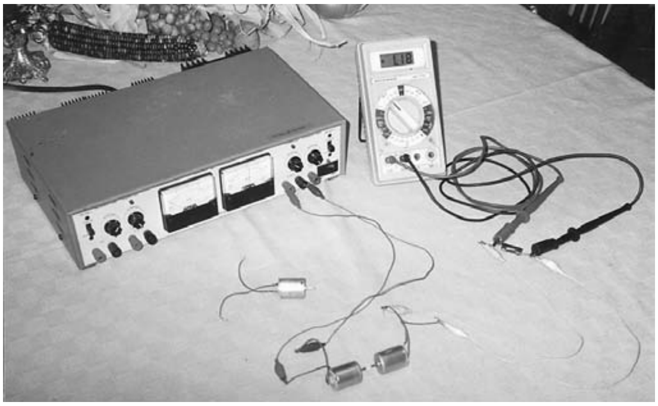
PV Test Schematic



Reflectors do have their down side. They increase aero drag at speed, add weight, and increase the effect of side winds on vehicle stability. Given all that, it still seems worthwhile. I recommend that if you use reflectors be prepared to remove them and change drive gearing and run without them if race day is too windy. Adding a rear line guide can reduce wind effects to some extent. Testing in different conditions is suggested in any case.

Motor Testing

Motor performance is worth testing if you're serious about winning. The standard solar sprint motor is a Mabuchi 280. Generally, performance between motors is within 2%; quite close for an item produced by the millions. Still, 2% can be a margin of victory and occasionally one will perform worse than average. One motor I tested from a batch of 14 was about 8% worse than average. It's worth a little effort to quantify your motor's performance to make sure on race day it gives you its best.

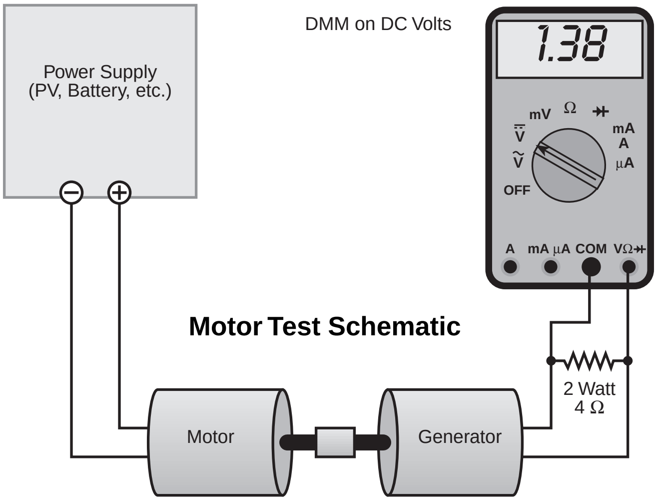


Above: Simple motor test rig. Batteries can be used instead of a power supply.

A simple motor testing setup consists of a power supply, the test motor, a second motor driven by the test motor, a resistor, and a voltmeter. We're looking for a relative measurement of how much power a test motor can transfer to a driven motor acting as a generator. I use a 2 watt, 4 Ω resistor across the leads of the driven motor as a load and measure the voltage generated. Higher is better. The motors can be coupled with a plastic sleeve or gear, shrink tubing, or electrical tape. The power supply could be your PV panel, 2 D-cell batteries in series, or any other consistent power source of an appropriate voltage. I use a triple-regulated lab power supply for the simple reason that I have one. You could use a different value resistor or even none, though some load allows a better estimation of real world performance. The important thing is consistency in testing and elimination of as many variables as possible.

Motor Performance

Motor #	*Volts Generated*
1	1.38
2	1.35
3	1.37
4	1.27
5	1.41



Motor Test Schematic

The table shows results of tests on a sample lot of five motors. All were "broken in" by running them for a half hour to seat the brushes to the motor commutator and wear-in the bearings. My tests indicate that doing so yields a 3 to 5% power increase over an unused new motor. Motor #4 is the "underachiever" mentioned above and #5 is the motor from my Senior Solar Sprint car that won the race at MREF last year. As you can see this simple prony brake dynamometer can yield valuable information.

Many thanks to friend Tim Porritt for help developing and performing test procedures.

Access

Author: Don Kulha, PO Box 7518, Santa Rosa, CA 95407 • dkulha@vom.com

NREL Education Office, Event host technical assistance
1-800-NEW-ENGY
Web: www.nrel.gov/business/education/SprintWeb

Solar Sprint kits: Pitsco • 1-800-835-0686
Web: www.pitsco.com

Code Writing Processes and Series Diodes

John Wiles

Sponsored By The Photovoltaic Systems Assistance Center Sandia National Laboratories

Some readers that have written to *Home Power Magazine* and to me have expressed concerns about the contents of the National Electrical Code® (NEC®). They have also asked for reasons for some requirements and also how proposed changes related to PV systems for the code come about. A brief review of how recent 1999 code changes were developed will answer most of these questions and will give some background on "Article 690 - Solar Photovoltaic Systems." The Code Corner articles that I have been writing have been an important effort to extend the PV industry activities related to the NEC to *Home Power* readers.

Article 690 - Solar Photovoltaic Systems

Article 690 first appeared in the 1984 issue of the NEC, several years after the first terrestrial PV systems were installed to power homes or to tie them to the utility grid. The Code Corner column actually started with issue #13 of *Home Power Magazine* (in Oct./Nov. 1989) and has appeared in nearly every issue since then. Thanks to a successful *Home Power Magazine*, and in response to years of Code Corner articles, I get more than a half dozen calls a month from *Home Power* readers with questions about the code requirements. One call recently came from the Falkland Islands while others have come from as far away as England and South Africa. No one can doubt the scope of the *Home Power Magazine* international audience.

I have discussed the manner in which the NEC is developed in a number of Code Corner Columns. Readers of issues 51, 52, 53, and 54 were given the name of a person to contact for anyone that desired to participate with a Task Group in the process of formulating proposals for the 1999 NEC. The National Fire Protection Association (NFPA) appointed this nine person Task Group named "CMP#3 Task Group, Article 690 - Photovoltaic Solar Systems" to review and propose changes to bring the Article up to the state-of-the-art for PV systems. In *HP* #55, PV industry representation for the group of volunteers that served on the Task Group was identified. That Task Group helped to formulate and approve for submittal some of the proposals for Article 690 for the 1999 NEC. Proposals were also submitted by individuals outside the Task Group.

The formation of the Task Group was at the request of the CMP#3 Chairperson. I was elected the Secretary of that Task Group, therefore my name is used as submitter of all the Task Group proposals and comments. More important than the Task Group in this process was the PV industry support provided by a team of experienced people belonging to the Solar Energy Industries Association Technical Review Committee (TRC) on Standards and Codes. They prioritized issues and then proceeded to formulate code language to address those issues. The TRC consisted of more than 60 volunteers representing the entire spectrum of the PV industry. The group included customers, dealers, installers, systems houses, electrical contractors, utilities, university researchers, and module, inverter, and charge controller manufacturers plus two from the national laboratories. This group met two to three times each year during 1995, 1996, and 1997 to work on the 1999 NEC proposals.

Each Task Group proposal submitted to the NFPA for the 1999 NEC contained the following statement: "This proposal is the result of work by NFPA Ad Hock Task Group to CMP-3; Task Group-Article 690-Solar Photovoltaic Systems and supported by the Solar Energy Industries Association (SEIA) Technical Review Committee on Standards and Codes." Each proposal was balloted within the TRC and the Task Group before submittal.

The proposals for the 1999 NEC were submitted to the NFPA in November 1996, nearly two years before the publishing date of the NEC. They have also gone through an extensive NFPA technical and public review process. The process and suspense dates for the 1999 NEC, for those who read the NEC in detail, are printed in the back of each copy of the 1996 NEC. Everyone is invited to participate by the NFPA and the NFPA proposal form is printed in the NEC. All it takes to propose changes are some good, well substantiated requirements, needs, or solutions. Put them on the form, drop them in an envelop with a 32 cent stamp and mail them to the NFPA before the NFPA established deadline. Once in the system, code making panels must pass proposals by a 2/3 majority before they can become code.

Series Diodes — Old Technology with New Applications

Blocking diodes have been used for years to prevent batteries from feeding current back into PV arrays at night. Only in recent times have they been eliminated from low voltage PV systems. In *HP* #59 it was mentioned that diodes were one possible way to protect PV modules from reverse currents caused by module or wiring faults. Overcurrent protection is required on all modules and the requirement is marked on the back of all listed modules. Fuses are currently required, but these are seldom used to provide this required protection. There are cost and performance considerations involved in the selection of any device used to provide this protection for the PV module.

Although the use of diodes in this manner does not currently meet UL or code requirements for module protection, future consideration might be given to changing the UL Standards to allow such use. As Dave Katz pointed out, there are some performance impacts of using diodes. These impacts are nothing new and have always been associated with the use of diodes, especially in low voltage PV systems (12 to 24 volt).

In utility interconnected systems that employ peak power trackers in the inverters, power lost in the diodes is due to the PV current through the diode and the voltage drop across the diode. Since most utility interactive systems operate at 48 volts and above, the diode losses, while measurable, are not significant. For example, a 2,000 watt PV system operating at 200 volts and 10 amps might have 14 watts of loss in the diodes — only 0.7%.

Low voltage, stand alone PV systems using crystalline silicon PV modules that charge batteries may have the available battery charging current reduced when series protection diodes are used. These reductions in available charging current are primarily a function of the system voltage (12 or 24), battery charging voltages (ranging from low states of charge to equalizing voltages), the PV module characteristics, and the module operating temperature.

The use of a diode in series with each string of PV modules in 12 or 24 volt systems causes the module(s) to shift the module operating point to a higher voltage. The shift in operating point is a function of the battery (charging) voltage and the module operating temperature. The resulting shift in available PV module current is an inverse function of the battery voltage and module operating temperature. The shift (with the diode and with the operating voltage higher than the maximum power point voltage) lowers the available PV current that can flow to the battery. The table below was generated using a generic 49 watt PV module that at standard test conditions of 25° C cell temperature and 1000 watts per square meter of irradiance, has the following parameters: Isc=3.18 amps, Voc=21 volts, Vmax=16.6 volts, Imax=2.95 amps, and Pmax=49.

As an example, a PV module simulation and performance program was used to obtain the numbers shown. Battery temperatures were assumed to be constant and were not considered in this analysis. I ran the simulation at module temperatures of 45° C (113° F), 55° C (131° F), and 65° C (149° F) to represent the range of temperatures that modules operate at when ambient temperatures are 25° C (77° F) to 40° C (104° F). In windy conditions, or conditions with lower or higher ambient temperatures, the modules may operate at temperatures higher or lower than the 45 to 65° C range.

I used battery voltages of 12, 13.4, 14.8, and 15.5 volts (twice those values for 24 volt systems) to simulate a battery at various states of charge. The 15.5 volt (31 volts on 24 volt systems) operation represents an equalizing voltage of a flooded lead acid battery.

Percentage of Current Reduction when Diode is Added to Circuit

	12 Volt System		*24 Volt System*	
° Module Temp.	*Battery Voltage*	*Current Reduction*	*Battery Voltage*	*Current Reduction*
45	12.0	0.6%	24.0	0.3%
45	13.4	1.6%	26.8	0.6%
45	14.8	4.2%	29.6	1.6%
45	15.5	7.1%	31.0	3.0%
55	12.0	0.6%	24.0	0.3%
55	13.4	2.5%	26.8	1.0%
55	14.8	7.4%	29.6	3.4%
55	15.5	11.8%	31.0	5.4%
65	12.0	1.6%	24.0	0.6%
65	13.4	4.5%	26.8	2.3%
65	14.8	12.3%	29.6	5.4%
65	15.5	19.4%	31.0	8.9%

When the battery voltages are low (low states of charge) and the module temperatures are moderate (cool ambient temperatures), the reduction in the available current is very small. On the other hand, when the batteries are at a higher voltage (mid to high states of charge or being equalized) and the PV modules are at high temperatures (in hot climates) the reduction in available charging currents can approach 20% on a 12 volt system. For a 24 volt system, the reductions in current due to the use of a diode are less than half the reductions in a 12 volt system.

All voltage drops in a PV system shift the operating point of the PV module. Once the operating voltage of the PV array is higher than the maximum power point voltage, then each additional voltage drop (including the drop caused by the use of a diode) enhances the decrease in available current from the PV modules. All PV systems, especially low voltage systems, should be designed for low voltage drops, code compliant wiring, and tight connections.

Dave Katz was on the money, so to speak. If you live in the hot sunny southwest and your PV system is sized such that your batteries operate in a high state of charge (high voltages) for much of the day, measurable reductions in available charging current (if a diode is inserted in the system) are likely. On the other hand, the reduction of charging current may not be critical since the charge regulation process will also result in average current reductions as the battery becomes fully charged. When low voltage systems operate in cooler climates, the reductions are less.

Miscellaneous Material

Drake Chamberlin, in his letter in *Home Power* #62, made some interesting points about code practice. Drake is a practicing electrician who installs PV systems. I would urge caution, however, when using 90° C wiring on Square D circuit breakers and fused safety switches. All of those devices that I can find require 60° C or 75° C conductors and some require 75° C conductors without allowing 60° C conductors. The reason that 60° C conductors are not allowed on some circuit breakers is that these devices normally operate at high temperatures that would damage conductors with 60° C rated insulation. Even where the devices are rated for 60° C/75° C or 60° C conductors, 90° C conductors may be used if operated at currents that keep the conductor cooler than the 60° C or 75° C. This can be easily accomplished by using the 60° C or 75° C ampacity columns from NEC Table 310-16 and 310-17 when using 90° C conductors. Such temperature limitations may also apply to terminals used for splices and even terminals used on switches.

Drake also pointed out that he thought there wasn't much reason to use 90° C conductors on PV modules. However, with a very few exceptions, most listed PV modules are marked on the back that 90° C conductors must be used. UL and the PV industry are considering a 90° C marking for all listed modules. In some installations, the J-box temperature exceeds 65 to 70° C where conductors rated at only 75° C lose most, if not all, of their current carrying rating.

Questions or Comments?

If you have questions about the NEC or the implementation of PV systems following the requirements of the NEC, feel free to call, fax, email, or write me. Sandia National Laboratories sponsors my activities in this area as a support function to the PV industry. This work was supported by the United States Department of Energy under Contract DE-AC04-94AL8500. Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy.

Access

Author: John C. Wiles, Southwest Technology Development Institute, New Mexico State University, Box 30,001 / MSC 3 SOLAR, Las Cruces, NM 88003
505-646-6105 • Fax: 505-646-3841
E-Mail: jwiles@nmsu.edu

Sandia National Laboratories Sponsor: Ward Bower, Sandia National Laboratories, Division 6218 MS 0753, Albuquerque, NM 87185 • 505-844-5206
E-Mail: wibower@sandia.gov

National Electrical Code® and NEC® are registered trademarks of the National Fire Protection Association. The 1996 NEC and the NEC Handbook are available from the NFPA, 1 Batterymarch Park, Quincy, MA 02269-9101 • 800-344-3555 • 617-770-3000

Join The "OHM" Team To Make Solar Homes Affordable

Off-grid home mortgage **(OHM)** loans make a solar powered home affordable with the low interest rates and long financing terms of conventional home loans. ***Home Power Magazine*** is teaming up with the Solar Energy Industries Association, Utility Photovoltaic Group, Renewable Energy Development Institute and the Switzer Environmental Fund to identify lenders currently involved with or interested in financing off-grid homes.

You Can Help!

If you or anyone you know has financed an off-grid home you can enter the lender into a nationwide database by contacting the toll-free number below and leaving the name of the lender, location and contact information. By doing so you will make it easier for the next off-grid homeowner to find financing. Who knows, it could even be you!

Phone/Fax 1-888-646-7334
E-Mail redi@saber.net
REDI 383 South Main Street #234
Willits, CA 95490

WINDSTREAM®

WIND GENERATORS

FOR DC, AC BATTERY CHARGING, WATER PUMPING, AERATION

FOR COTTAGE, RESIDENTIAL, MARINE, RV, TELECOM AND WIND – SOLAR APPLICATIONS

BUILT TO LAST!

WIND TURBINES FOR ALL USES

SOLD WORLDWIDE

CONSTRUCTION PLANS, KITS AND ALL PARTS AVAILABLE

HAND AND PEDAL GENERATORS

MICROHYDRO SYSTEMS

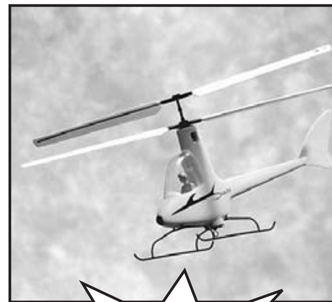
PERMANENT MAGNET GENERATORS AND ALTERNATORS

WINDSTREAM POWER SYSTEMS INC.

ONE MILL STREET
POST OFFICE BOX 1604–HP
BURLINGTON, VT 05402–1604

TEL 802 658 0075
E-MAIL windstrm@ix.netcom.com
FAX 802 658 1098

MANUFACTURING WIND AND WATER POWER SYSTEMS SINCE 1976



World's First!

RUBBER BAND HELICOPTER

Counter Rotating Blades

only **$14.50** + $4.50 S+H

Check or Money Order
Visa/Mastercard
HI, AK, Foreign/Canada add $10.00 for Shipping

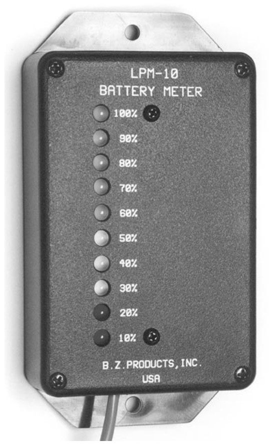
Ready to Fly!
Vertical & Horizontal Flight
Adjustable Stabilizers
Fun!
Educational!
Exciting!

R&D Toys
9438 US Hwy 19 N
Embassy Plaza, #218HP
Port Richey, FL 34668

LPM-10

State of Charge meter displays battery charge with 10 easy to read and understand LED lights. Great for use in RV's, Homes, and Farms. Available in low cost 12 and 24 Volt models.

Call your local IPP today.



B. Z. Products, Inc.
7614 Marion Ct., St. Louis, MO 63143, USA
tel: 314-644-2490, fax 314-644-6121
e-mail: frank9966@inlink.com

NATURAL ENERGY SYSTEMS

b/w

3.5 wide
3.3 high

on film

Harris Hydroelectric

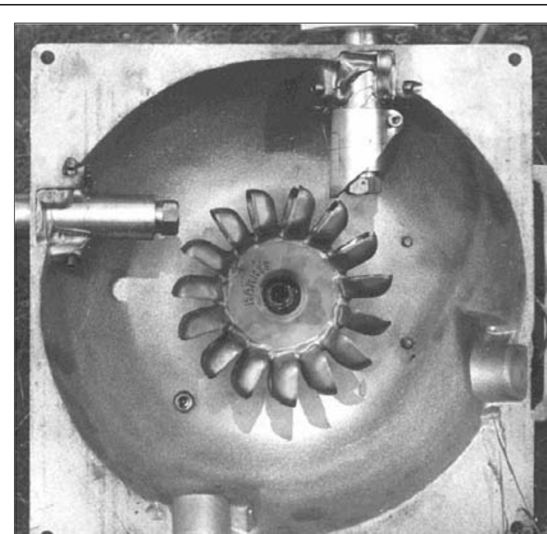
Hydro-Power for Home Use

Works with heads as low as 10 feet • Price starts at $750

New Features:
17 bucket reshaped Pelton wheel
Powder coated castings
More efficient stator in high output models

632 Swanton Road
Davenport, CA 95017
408-425-7652

"The best Alternator-based MicroHydro generator I've ever seen."
Bob-O Schultze, Hydroelectric Editor, Home Power Magazine



Don Loweburg

Maine Update—Readers of the last two issues' of IPP will recall that Central Maine Power had refused to connect two households on a net metering basis even though the state has a net metering law. CMP's position was that under restructuring they were no longer required to sign power contracts. Thanks to the hard work of many people some resolution is in sight. The issue went before a PUC examiner and the decision was that the two residences (and others) were eligible for net metering, but only until February 28, 2000. This is the date when the state's restructuring law is fully implemented. The question of net metering after this date is being considered by a Maine PUC Rulemaking Proceeding. Tom Starrs, a Washington state attorney specializing in interconnection issues and renewable distributed generation writes, "I'm working on comments for the Maine Rulemaking as we speak. Things look pretty good—the Maine PUC's initial Proposed Rule calls for continued availability of net metering after the effective date of competition. But there are a bunch of details to be worked out which is why I'm submitting comments. We'll see what the PUC ultimately decides to do. But I'm pretty optimistic."

California Incentive Plan

The California Incentive Plan discussed last issue continues to be put in place and should be available to California grid connected customers early in 1998. The California Energy Commission and PVUSA (a PV test facility managed by the CEC) have created a web page that will handle the actual rebate calculations (see Access). A few simple entries, including module manufacturer, module wattage, inverter manufacturer, and array mounting method will yield a value of the rebate. By having vendors and customers access the same information regarding rebate calculations, misunderstandings should be minimized. Also recall that the rebate amounts are calculated on the basis of the PVUSA Test Conditions (PTC) rating rather than the STC. The PTC more closely represents the system ac output. As an approximation, the PTC rating will be about 75% of STC output. The California Energy Commission maintains a web page where the forms for this program are available for downloading (see Access).

Small Wind Too

The California Incentive Plan also provides incentives for small wind systems. Small wind system (< 10kw) rebates will be available for grid connected customer sited systems. Again the ac output wattage will be used to calculate the rebate amount and the rate will be the same dollars per watt as PV. There are four technologies eligible as "emerging," PV, Small Wind, Solar Thermal Electric, and Fuel Cell (fuel must be renewable). If you access the web page for the reservation forms, note that each technology has its own form.

Nightmare In Washington State

The following example is yet another illustration of the need for uniform interconnection standards for small residential systems and the need for third party (non-utility) inspection and jurisdiction. Technically the system in question is code compliant and uses listed components. The homeowner, wanting to do everything on the up and up, contacted his local utility (located in Washington state not far from Trace's factory) and discussed his project. A meeting appointment on site was set. At that meeting was a local installer, a Trace representative, the homeowner, and several utility personnel. Things went well at the site meeting. The utility personnel seemed to understand the protection features built into the Trace SW4048 inverter and the meeting ended on a positive note on all issues. However, later when the utility contacted the homeowner, he was told he was required to install a 400 amp transfer switch at the service entrance. A price check at an industrial supply house on the cost of an automatic transfer switch of this capacity was over $4,000! This unreasonable and expensive requirement is not acceptable. The customer is challenging this requirement and is being supported both by Trace Engineering and Washington State SEIA. This situation is yet another example of the wildly divergent and capricious requirements the utilities impose when allowed to do so. Readers interested in knowing what a sensible grid connected system might be should read “Grid Intertie and Code” Home Power #62.

Times a Million?

Reflect for a moment on what the scene described above means for the future of the PV industry as thousands of new systems are installed under the Million Solar Roofs and the California Incentive Plan. From the perspective of an installer and businessman, I can not afford the time and expense of this kind of hassle, nor can my customers. In this respect, our industry is being held hostage by the utilities. If President Clinton is serious about a million solar roofs, there better be some relief from this situation soon. For my part I’m seeing a more radical approach as necessary. Install systems according to NEC 690 using approved and listed equipment and be sure to have the system permitted and inspected by the local building authorities. Do not ask for utility permission. If threatened with loss of service, take it to court. As an industry we must stop trying to make nice to the utilities. They are our competitors. They know this and act toward us accordingly. Why does the PV industry not get the picture and continue to be chumped by the utilities?

The Voice of Reason

I shared this thinking with Tom Starrs who offered this reasoned response. “It would be pretty interesting to make an argument that systems that are installed on the customer’s side of the meter, in accordance with proper codes, is presumptively OK and doesn’t need the utility’s approval. But I don’t think the regulators are ready for that. They’re still hung up on the traditional idea of the utilities as ‘protectors’ of the grid. They need to get over that—the way to ensure power quality and reliability is through independent equipment performance standards. As you’ve heard me say countless times, think of the RJ-11 jack that is now the standard wiring interface for most telecommunications devices (phones, fax machines, modems): At the time, AT&T fought the development of a standard interface tooth and nail. Now we totally take it for granted. The same will happen with PV systems, but we’ve got to scratch and claw our way to that point. I don’t have a big problem with the ‘stealth’ approach you suggest, but it doesn’t help us win the big fight. As hard as it is on your end-use customers, I have a lot of respect for the ones who are willing to fight the good fight even though they pay a price.”

Massachusetts Restructuring

Thanks to reader J. Mell who sent some news clippings detailing the recently passed restructuring law in that state. The formula is very similar to the California plan. The key elements are; recovery of utility “stranded assets” (about $10 billion), retail competition, and a mandated 10% rate reduction. This approach seems to be the standard package going down. This should be no surprise since utility lobbyists are acting in a very concerted fashion in all states. Massachusetts State Treasurer Joe Malone stated, “I think this bill is a turkey.” and “It doesn’t pass the smell test.” State Representative Eric Turkington states, “It has the aura of the S&L bailout around it. I’ve seen utility lobbyists smiling all week.” It’s clear why. Ratepayers are paying for the bailout and in the process recapitalizing the utilities so they can become competitive.

Ditto California

The San Francisco Chronicle (certainly not a radical publication) in a front page lead article of December 15, 1997, by staff writer Kenneth Howe lays out the full scope of restructuring in this State. Among some of the gems covered: Concerning the 10% rate reduction, “The bad news is that customers will foot the bill for their own 10% rate rollback. That’s because the short-term rate cut, it lasts only four years, is being paid for by a $7.4 billion bond sale. And it is consumers who will pay off the bonds through a special charge on their electric bills.” And about “stranded costs,” “But the biggest stumbling block to the panacea of low electricity rates is that PG&E and the other investor-owned utilities can’t compete without help. They are saddled with debts called ‘stranded costs,’ from ill-fated investments in nuclear power plants and long term power contracts.” The author continues, “In California the total amount of what the utilities call ‘stranded costs’ is estimated to be about $28 billion. The utilities could have written off the debts, which would have severely hurt their stock price. But the big three contended that ratepayers, not shareholders, should pay off these debts. The California Legislature let the burden fall entirely on ratepayers.”

"From the beginning of the debate, there was this non-rebuttable presumption that the utilities should be able to recover all their costs," said Steve Linsey, of the PUC's Office of Ratepayer Advocates. "We argued against it, but we weren't listened to." This dark side of deregulation has prompted many consumer groups to brand it as a hoax, at least in the short run. "This game is so rigged that consumers aren't going to get much out of it at all," said Nettie Hoge, executive director of The Utility Reform Network, a San Francisco consumer watch dog group. "TURN and several other consumer advocates, including Harvey Rosenfield, the author of Proposition 103, the insurance reform initiative, have filed a ballot initiative to force electric utility bills down by 20 percent, instead of 10 percent." The complete article is available on the web at <www.sfgate.com>.

Distributed Generation Wake up Call

DG has been a discussion item in these pages for several years. IPP is a supporter and cosigner of the California Public Utility Commission's Office of Ratepayer Advocates (ORA) policy paper that recommends against regulated utility ownership of Distributed Generation and Resources. Joining IPP in support of this position is the "party of ten" representing energy producers and marketers. For a copy contact IPP. To reiterate past discussions: One, DG is a competitive technology (there is no natural monopoly franchise here). Two, Allowing regulated monopolies to do DG has profound anti-competitive consequences. Three, The espoused purpose behind restructuring is competition. Four, DG as new generation will be a major growth industry as the old generation model (large baseload plants) will give way to a new decentralized paradigm. Five, Renewables represent a prime form of DG. They will capture a larger and larger portions of the market as the externalities of other energy sources must be accounted for in the marketplace.

The Vandals Stole the Handle

For the most part, none of these issues have been dealt with in any restructuring legislation. What is really scary, is that this is very much on (under?) the table, but no one is talking about it. By leaving DG undiscussed, and therefore, unrestricted, the regulated utilities plan to employ it as a distribution "asset." In fact, this is one reason the utilities prefer the term Distribution Resource rather than using terminology that includes the word "generation." The claim is that it's not generation! This is consistent with utility propaganda that they are getting out of generation. There is very good evidence that strong attempts are being made to remove any discussion of DG from public view and access. For example, in California a group (CADER) has been meeting for over a year to identify issues relating to DG and restructuring. The group was hosted by the California Energy Commission. The ORA letter co-signed by the "party of ten" was addressed to that body. The group was structured as a consensus-collaborative. In this case, consensus did not occur and the CADER group has ended. In its place are proposals to form a new group to deal with DG. The new group will be based on a voting-majority rule model. Furthermore stiff membership dues of $5,000 will be required. Public agencies and nonprofits would be admitted, but on a nonvoting basis only. IPP sees this clearly as an attempt to limit participation. Interested parties (we all should be) must take action to make this conversation public. We already missed the bus in Massachusetts. A colleague writes, "Massachusetts' new restructuring law not only permits distribution companies to own DG 'to avoid transmission or distribution constraints or the installation of new transmission or distribution facilities,' it also permits them to use public benefits funds on renewables for those purposes." All this while they are simultaneously bailed out of bad nuclear investments at ratepayer and taxpayer expense.

Corporate Marketing

Good things are happening. Change is in the air. I was startled several weeks ago to see an ad on TV showing wind turbines and the voice-over discussing "clean renewable power being available for your home." My first take on this is that corporate marketing of renewables can help the independent power provider too. Reading the pages of *Home Power*, one cannot miss the ads of some of our larger corporate partners offering complete systems, power panels, system design, and installation assistance. IPP companies offer the same products, but clearly we market differently. At first I was disconcerted at the "corporate" intrusion into this business. Upon reflection, though, I see little threat. First, IPP members can sell packaged systems if that is what the customer wants. Second, hardware is only part of what we offer. IPP companies can be classed as Energy Service Companies. IPP companies have long offered load analysis, energy efficient appliances, and passive design in addition to selling and installing renewable energy systems. Our companies must emphasize and market our strengths: service, knowledge, and hands-on expertise. We must be on guard for what I like to call the "dumbing up of the industry." This term relates to remarks made by a corporate colleague at a recent PV Alliance meeting. The general topic at hand was about how to reduce installed system cost. The gist of his presentation was that with "cookie cutter" systems, roofers could slap these systems together in a few hours and labor costs would be eliminated. (I don't think he ever got it that he was talking about taking work away from people like me.) Corporate, especially the marketing, types have no respect for expertise and craft. They want to eliminate intelligence and know-how from the delivery end of the product. Sort of like "Plug n Play," and we all know how great that works. Another corporate partner markets a power panel product. The ads read, "just add PV and batteries." Simple! The purchaser of one of these systems called me explaining that his inverter had fried a bunch of household appliances and he needed a trouble shooter. Within a couple of minutes on the phone, the problem was clear to me. He had purchased a power panel consisting of stacked inverters but somewhere in the process the fact that it was a stand-alone application was dropped out. In short he was operating his inverters without a stacking cable ($37 item). The purchase had been made from a discounter with very obvious consequences. I'm sure the $1,000 plus loss of appliances and an expensive service call more than offset any discounts. IPP companies come from a position of strength. We know customers. We have the expertise and experience. We must continue to strongly market these facts about ourselves. I know that if corporate marketers push product alone, they will quickly loose any market they might have had and IPPers will make money fixing their mistakes. Look for the IPP logo. Use the IPP logo. Join IPP.

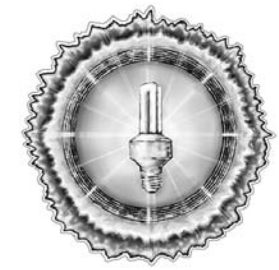
Access

Author: Don Loweburg, IPP, Box 321, North Fork, CA 93643 • 209-877-7080 • E-Mail: i2p@aol.com

PVUSA PTC rating worksheet:
Web: www.endecon.com/pvusa/rebate.html

California Rebate forms: Web: www.energy/renewables

Home Power's
Business



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

Display Advertising

Advertising Rates per Consecutive Insertion

	Single Insertion	*Three Insertions*	*Six Insertions*	*Ad Area sq. in.*
Full Page	$1,200	$1,080	$1,020	64.13
Half Page	$672	$605	$571	32.06
Third Page	$480	$432	$408	21.38
Quarter Page	$377	$339	$320	16.03
Sixth Page	$267	$240	$227	10.69
Eighth Page	$214	$193	$182	8.02
Twelfth Page	$150	$135	$128	5.34

Four process color (CMYK) in any sized advertisement for a flat rate $185 per insertion. For inserts, and current subscriber/circulation demographics, please call us.

Home Power is published bi-monthly. Ad deadline for the April / May 1998 issue (*HP* #64) is 20 Feb 1998. Call 530-475-3179 for further details.

International *Home Power* Subscriptions

Due to the high cost of international mailing, we charge more for *Home Power* international subscriptions.

1 YEAR — 6 ISSUE INTERNATIONAL RATES:

All payments in U.S. currency ONLY!

Canada:	Air — $36	Surface — $30
Mexico:	Air — $38	Surface — $30
Western Hemisphere:	Air — $40	Surface — $30
Europe:	Air — $53	Surface — $30
Asia and Africa:	Air — $64	Surface — $30
Pacific Rim:	Air — $64	Surface — $30

Surface shipment may take up to three months to get to you. All international issues shipped in mailing envelopes. International subs are best paid for by either VISA, MasterCard, or funds from a U.S. bank.

International orders call: 530-475-0830
or FAX: 530-475-0941

MicroAds

MicroAd rates are 10¢ per character. Characters are letters, numbers, spaces, and punctuation marks. $15 minimum per MicroAd insertion. Send check with your ad. We do not bill MicroAds.

Home Power Magazine for Resale

Quantities of *Home Power Magazine* are available for resale by distributors, newsstands, bookstores, energy businesses, and others. Please call or write for rates and shipment specifics.

Back Issues of *Home Power Magazine*

Back issues through #20 are $3.25 each ($4.25 each outside USA) while they last. Sorry no more issues #1–#10, #12, #14, #15, #16, #35, #36, #38, #41, or #60. Back issues of #21 through #45 are $4.75 each ($6 each outside USA). Back issues #46 to the present issue are $5.75 each ($7.25 outside USA). Back issues are shipped First Class mail in an envelope or box. See the ad index for current *Home Power* back issue specials. Issues #1–#42 on CD-ROM for $29 (US$32 outside USA) Win/Mac/Unix.

First Class *Home Power* Subscription

Home Power Magazine (6 issues) via First Class U.S. Domestic Mail for $36. Many of you have asked for faster delivery of your issues. So here it is: First Class *Home Power*. All First Class issues shipped in an envelope. We start your subscription immediately with the current issue.

Second Class *Home Power* Subscription

Home Power (6 issues) via Second Class U.S. Domestic Mail for $22.50. Second Class is forwardable for one issue (2 months), so let us know immediately if you move! We start your sub with the next scheduled issue, so please allow ten weeks for your first copy to arrive.

ACCESS ➠ *Home Power*, PO Box 520, Ashland, OR 97520 USA
800-707-6585 or 530–475–0830 Subscriptions and Back Issues
530–475–3179 Advertising and Editorial. Web: www.homepower.com

Bob-O Schultze, a Wrench

A thousand thanks to all the Wrenches who have written, faxed, and E-mailed in their support and feedback for Wrench Realities. You have proved what I believed all along. Many, many Wrenches from all across the country are tired of being talked down to by Code Corner and are very concerned about the proposed changes to the NEC. Time and again, Mr. Wiles has asked us, “Don’t shoot the messenger.” In this case, however, the messenger is also one of the main formulators of the message. He is also the strictest interpreter of the wording of the NEC regardless of the situation or intent of the policy.

FNC Debate Goes On

I see in this month’s Code Corner that Mr. Wiles makes no mention of flexible nonmetallic conduit (FNC). This is regrettable because it leaves many installers in the lurch as to whether its use is OK or not. Perhaps he is saving himself for a detailed response in a future article. Perhaps he feels that his earlier response was sufficient and folks can just decide whether to believe him or some lowly Wrench. Happily, this Wrench’s opinions are shared and echoed by other Wrenches.

One of the most thought provoking opinions on the subject of FNC comes to us from Mr. Robert Allen, a retired engineer from Idaho. He writes:

I have been following your debate...on NEC regulations for solar PV systems with interest, I must say that you both make good points on various issues. My tentative position may be closer to Schultze than Wiles, but the spirit vs. the letter of the NEC is really what is at issue here. Everyone wants a safe system, but where does reality set in?

The one issue that I have not seen you both address relative to 60°C vs 90°C insulation and flexible nonmetallic conduit is the time factor. Wiles states the NEC position that a twenty year life is the goal of the heat rating system relative to insulation, etc. I agree with that, but since no PV system will ever be operated 24 hours a day for 20 years at anything close to the magic 60 or 90°C rating, is there not some time of exposure relevance involved? From what I understand about the NEC and UL testing, a [listed] insulation will withstand twenty years of exposure to the maximum temperature rating and still remain safe. Wire and conduit for a motor in a factory operated 24 hours per day may see those conditions; PV systems will not.

My intuition tells me that even if a 60°C rated insulation or conduit were exposed to a higher temperature than rated for say...ten percent of its life, any degradation would be compensated for by the ninety percent of the time it would be operating well under its rating. Insulation does not fail immediately with some overstressing and I see no reason to believe that understressing is not beneficial to its life.

I realize that the NEC ratings do not take time (other than a twenty year life) into account, but maybe they should. PV systems are already very expensive. It is unnecessary to make them more so by requiring unconventional or very limited source products to satisfy an exceptionally small safety concern, based upon a letter strict interpretation of the NEC.

Darn good point, Robert, and thanks for your input. It illustrates the NEC’s failure to specifically speak to a new set of circumstances caused by an emerging technology. This is not necessarily due to any shortcoming of the NEC. Documentation must always follow the actual events. When we try to reverse this process, that writing is called science fiction. One cannot codify what is happening, only that which has happened long enough for good historical data. This is why the intent of the Code MUST take precedence over the letter in new situations. It's also why strict interpretation of the letter of the Code is not only wrong, but it serves no one well.

Christmas Past

It wouldn't be the first time Mr. Wiles' interpretations were refuted by *Home Power* readers. It also wouldn't be the first time he used silence as a response to legitimize criticism of his opinions. Long time readers will remember his advice to use overcurrent protection (of different current ratings) on either side of an LCB used in a PV direct pumping application (*HP*#26, refuted in *HP*#26, pg. 83). How many of you remember his absolute insistence on using grounding wire the same size as inverter cables (or the largest conductor in the system)? How many systems went in with that unnecessary added expense? The rule was changed in the 1993 Code so the point became moot, but prior to that time he was adamant that anything less was unsafe (The Shocking Story of Grounding, *HP*#18).

When the Code changed, Mr. Wiles changed his recommendations, but nowhere did he ever explain the differences in his interpretations and at no time did he ever suggest that perhaps the NEC needed a bit of fixing on that subject or any other. Blind allegiance to the letter of the NEC may score big points at the National Fire Protection Association, but it causes a huge credibility gap with a most important audience, the PV Wrenches. The feedback was there, but Mr. Wiles either apparently discounted it or outright ignored it. He certainly didn't encourage it. As a result of this attitude, many Wrenches, including myself, give only a cursory and biased glance at Code Corner. This is a pity. Dispersed among all the opinions expressed, there are some things that were important reading. I'm sorry to have missed them, but it is easy to see why.

No Taxation Without Representation

I have no doubts that the make-up of the CMP#3 Task Group is all of what John Wiles says it is; people representing NFPA, UL, an electrical inspectors' association, an electricians' union, academies, manufacturers, etc. No working RE Wrenches. Not one. Mr. Wiles is quick to point out that the group collaborated heavily with the Solar Energies Industries Association (SEIA). That sounds good until one realizes that SEIA was, is, and continues to be, overwhelmingly populated by members of the elder solar thermal industry, not the solar electric industry. Certainly there are a few SEIA members that are strictly electric companies and others do both thermal and electric to one degree or another, but it isn't their main push. In fact, the Independent Power Providers (IPP) was formed as a direct result of CALSEIA (the California chapter of SEIA) members dissatisfied with the way CALSEIA was representing its member PV Wrenches. I was one of those disenchanted CALSEIA members who helped to form IPP. John surely knew about IPP, yet he chose to ignore them and any other Wrenches for inclusion into either the CMP#3 Group or its advisers.

It gets worse. About a year ago, the CMP Group issued a draft of its proposed Section 690 changes to the 1999 NEC. This draft was sent out to various PV and Balance of System (BOS) manufacturers and others both within and out of the Group and its SEIA advisory panel. It was a great idea. Get as much feedback and consensus on these new ideas as possible. Who better than the Wrenches who advertise and write in *Home Power* to help with the process? Yet, to the best of my knowledge, not one Wrench got a copy of that proposal. Why not?

Mr. Wiles did provide a phone number information for Mr. Ward Bower in the Access section of a few Code Corner articles, stating the he was the person to call for participation in the SEIA advisory group. Mr. Bower, as Mr. Wiles points out, is Wiles' "sponsor" for the Code Corner articles. Two people of apparently similar, if not identical opinions. You would think that something as important as input changes to the PV section of the NEC would rate rather more column inches than an "oh, by the way..." in the usual Access information that most readers just skip over in an ongoing column. Why not?

You'd also think that Code Corner would give access info to the web site containing all the proposed changes to the NEC. The NFPA was wisely looking to get as much feedback as possible by providing the site, but nary a whisper of it in Code Corner. .

Who is Responsible

We Wrenches must shoulder some of the blame for not informing ourselves of this process earlier. It may now be too late to effect the 1999 Code. Perhaps we can be forgiven somewhat for being occupied in actual system design and installations, rather than spending our time proposing "ungrounded" opinions. In this Wrench's opinion, Mr. Wiles and company should have been actively, deliberately, even desperately seeking feedback from the Wrenches. Anything less does the PV industry and the furtherance of photovoltaics a terrible disservice. The question is, was the NFPA aware of this? I doubt it sincerely. How about a letter writing campaign to the NFPA? We could perhaps suggest that all CMP#3 proposals be put on hold until what is clearly the politics of exclusion can be turned into the wisdom of inclusion. Will it work? I don't know, but let's find out.

Letter, Letters, Letters
A physicist from Berkeley, CA writes:

I read your excellent "Wrench Realities" article. John Wiles must [be ill-advised] to propose the NEC interpretations he does without taking measurements in actual installations... Seems like another case of the legal and regulatory system being used to exclude the little guy.

From a Wrench via email:

... no way would someone stuff something in the ends of a short piece of FNC put it in the sun with some temp. probes and call it a test no matter how informal....Good luck trying to convince the NEC to ignore 'Them that worry much and do little' (with our tax dollars providing most of their pay most often).

In the interest of fairness, here is a letter supporting Mr. Wiles:

I am writing in response to the "Wrench Realities" article. I was honored with the privilege of being a member of the Technical Review Committee (TRC) for the Code Making Panel for section 690 of the N.E.C. for 1999. I am employed by Vanner Inc. as an engineer. I graduated from Jordan College Energy Institute (R.I.P.) with a BS in Applied Environmental Technology (i.e. renewable energy). I have been reading Home Power since #24.

With the background out of the way I will inform you that Mr. Wiles was also a member of the TRC as were representatives from Trace, Omnion, A.E.S., Solarex, Sandia, U.L.,and more that I cannot remember. The group numbered twenty or so people. Mr. Wiles was gracious enough to undertake the massive task of translating the proposed changes that the TRC agreed on to the proper submittal forms and then submitting them to the N.E.C. It is this kind of dedication that is propelling the industry forward to mainstream acceptance. We owe much to people like Mr. Wiles, the people who spent time away from home and families to attend the committee meetings, and the corporations that cared enough to send people and paying for transportation, hotel, and meals. Regards, David Saxby, Jr., Hilliard, <Ohio • dsaxby@ix.netcom.com>.

With all due respect to Mr. Saxby and his opinions, it proves my point that whether by design or omission, there were few or no actual working Wrenches included in that committee. In fact, given that ALL the members seem to be either funded in one way or the other by the government or representatives of manufacturers which sell products into the PV industry, it makes me wonder if the foxes are writing the rules of conduct for the hen house?

Another Wrench on Diodes
This was submitted by Christopher LaForge, of Great Northern Solar in Wisconsin.

On the multiple diode issue for protection of PVs, I feel that Mr.Wiles does not consider the real effects of his suggestions. We want the amps to get to the load/storage—not be burnt up in redundant protective devices. Here in Wisconsin we have been using fuses in DC collection centers with proper array engineering to provide for safety without power loss. We use type KLK fuses on the positive leg of each string of PVs in a DC collection center at the array. Correct fusing of the positive leg in the collection center accomplishes fire safety and protects panels from improper wiring without the losses of introducing diodes into the circuits.

Another feature of fusing strings of PVs at collection centers is that this provides for easy troubleshooting of arrays down the road in the event of power loss or other malfunction. Having individual strings to test speeds up troubleshooting and provides for convenient repair.

This does not apply to small arrays, of course, where fusing is present at the disconnects between the charge controller and batteries. There is a good argument as well that this fusing is severe overkill as we already have fused disconnects between the PV/Charge Controller/ Battery. While we in the Midwest are known for our polite conservatism, I hate to be putting resistance generating devices in the way of my precious PV amps. We use weather tight (NEMA-3) J-boxes for the DC collection centers, water tight connectors on conductors, and the best quality fuse blocks and power distribution blocks we can find. This makes the issue of corrosion on connection points as small an issue as we can make it and allows us easy work if corrosion occurs and we need to remove it.

Mr. LaForge's approach of fusing subarrays is a good one and important to use when the total current output of the array exceeds the current carrying ability of the interconnects of the subarrays. A similar diagram illustrating this technique can be found in *HP*#44, pg 11. His report from the frozen reaches of Wisconsin also makes another good point. Seasonally hot weather is found nearly everywhere. Multiple diode insertion loss during those times is not only unnecessary, but downright wasteful.

Calling all Wrenches
A "Wrench" is someone that is actually involved in the installation of RE systems. In other words, them what's doin' as opposed to them what's talkin'. IPP members, folks that have installed their own systems to Code, and many others are mostly Wrenches. If the shoe fits...tell us about it!

It boils down to this. The main depository of the information and data needed to realistically and efficiently modify the National Electric Code is in the memory banks and records of Wrenches who have been doing the actual work for years. Sandia doesn't have it, SEIA doesn't have it, John Wiles doesn't have it, the Wrenches have it. You have only to look through the pages of this magazine to realize who is making renewable electricity happen. I'm of the opinion that if we make the NFPA understand that, some actual reality checks will happen. You want to see more of the same in the 2002 Code or do you want the NEC to get real?

Access

Editor and Author of Wrench Realities: Bob-O Schultze, Electron Connection, PO Box 203, Hornbrook, CA 96044 • 530-475-3402 • Fax: 530-475-3401
E-mail: econnect@snowcrest.net

National Fire Protection Association, PO Box 9101,Quincy, MA 02263-9904
Web: http://roproc.nfpa.org/nec/

–January, 1998

An Open Letter To Future Generations

Jim Bell

I hope this letter finds you in good health and spirits. If you are, it probably means that my generation acted soon enough to keep this planet you now enjoy healthy and productive.

I shudder to think of what your world is like, if we who live today didn't soon get our act together. Why? Because, in our present, our economy is rapidly using up your ecological future.

As I'm writing this I cannot see into the future in any specific sense, but I do see two general directions it can take.

On the positive side, what I work for and hope for, I see the strengthening of democracy, and the protection and expansion of the basic human right to be free. Free to do anything we want as long as it doesn't hurt any one else or restrict their freedom.

I see the creation of a strong vibrant, completely sustainable economy, rich in meaningful business and employment opportunities. An economy rich in goods and services at affordable prices. An economy that doesn't deplete our planet's ecological capital; doesn't deplete the fertility of our soils, contaminate our air, water, or land, and that treats everyone fairly and kindly.

I see the percentage of CO2, methane, and other Green Houses gases in our atmosphere being the same as they were at the turn of the 20th Century. I see our planet's ozone layer being completely restored and weather phenomena like tornados and hurricanes, on average, being less severe.

I see a renaissance in all sciences. I see a rapid increase in space exploration and commerce including a space debris defense system to detect large space objects on a collision course with earth and to deflect these objects or bring them into earth or moon orbit for mining.

I see people living increasingly longer, healthier, more meaningful lives through a combination of preventive measures such as good nutrition and training doctors to utilize and build on the best of all the medical knowledge available world wide.

I see a renaissance of consciousness and the blossoming of fairer and kinder ways of enjoying and benefiting from each other's gifts, and the bounty which our planet's life support system can sustainably provide us. I see ourselves, as individuals and as a species, ever increasing our understanding of existence and our place in it, and our capacity to use this knowledge wisely. Or...

On the negative side, I see disaster and even the potential extinction of the human species.

Short of extinction, I see our species declining rapidly both in population, cultural sophistication, and knowledge in a descending spiral of social, political, and ecological chaos and a world filled with pain, suffering, sadness and regret.

As I said in the beginning, I hope this letter finds you in good health and spirits. If this is not the case, at least you will know that some of us, in our time, devoted our working lives to creating a future in which you would flourish. For your sake and ours, I hope we succeed.

Peace and love, Jim Bell

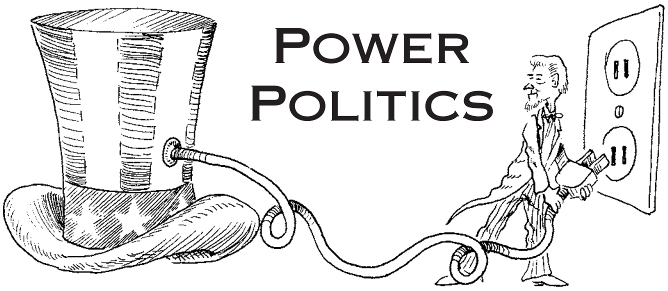
P.S. I invite you to read my book, *Achieving Economic Security on Spaceship Earth*, subtitled, Using Free-Market-Forces To Save Our Life Support System. Quite simply the book is about how to gracefully make non-sustainable economies sustainable in ways that are a win win for everyone. You can down load this book from the web at www.jimbell.com, free of charge, or you can order a paperback copy by calling (619) 281-1447.

If you think the book makes sense, let's work together to create a future, our descendants will thank us for.

Access

Author: Jim Bell, Ecological Life Systems Institute, Inc.,
2923 East Spruce, San Diego, CA 92104
619-281-1447

Jim Bell is a internationally recognized expert on how to gracefully transform non-sustainable economies into economies that are completely ecologically sustainable. His radio show, "Jim Bell & Common Sense," airs weekly on KFMB, 760 on the AM radio dial, Sunday evenings from 10 to 11 PM, California time. The show's signal reaches listeners as far north as Sacramento, as far east as Phoenix, and deep into Mexico. The show can also be heard world wide, by logging into KFMB's web page via www.jimbell.com. Jim is also available for lectures, workshops, and design and consultation services.



We Buy Wind Energy!

Michael Welch

Well, we did it. Early in December, Redwood Alliance signed up with one of California's new electricity providers.

As you are probably aware, California is the first state to offer electricity consumers a choice in power providers. Previously, each region only had one choice, a mega-utility that was granted a monopoly in their area. In our region it was Pacific Gas & Electric Co., the largest investor owned utility (IOU) in the world.

Not very many people liked PG&E's business practices. They were infamous throughout the nation for the amount of power they wielded over our state's legislatures, governors, and rate payers. But now we have a choice, or at least a partial choice.

California's IOUs will continue to be in charge of the distribution systems in their regions. That means we are still under the thumb of PG&E. For awhile we'll be receiving two electricity bills, one from our electricity provider for the electricity we consume, and another from PG&E that pays them for us using their distribution system.

Green Energy Providers

Redwood Alliance is looking forward to making specific recommendations for choosing the "best" green energy provider. But, we did not think it appropriate to spell out the recommendations at this writing because we want an opportunity to observe how they operate and whether or not it looks like they can each meet their promise of renewable energy. At this point in time, we recommend that Californians stay with their current provider, which is the regional IOU. By the beginning of March we should have a good handle on which is the best, so call or write Redwood Alliance at that time for our recommendations.

In the meantime, we felt it important that Redwood Alliance make a public statement in favor of using renewable grid power. We chose a company called Green Mountain Energy Resources of South Burlington, Vermont because, of the companies that we'd heard of, they were the most straightforward in their publicity. They had several programs to choose from, and I think that strategy will be typical of most new energy providers.

The program that Redwood Alliance signed up for is called "Wind for the Future." This is their most expensive (per kWh) program, but guarantees an investment in the construction of new wind turbines. For every 3,000 customer signups, the company will build one new wind turbine. As the turbines begin to come on line, they will produce about 10% of the energy that "Wind for the Future" customers consume. The rest of the customers' electricity will come from Green Mountain's "75% Renewable Power" program which includes 75% renewables and the remainder being large-scale hydro and system power. Their other program is called "Water Power," and relies on a mix of large- and small-scale hydro power, with up to 10% system power.

System Power

You can pretty much count on any energy provider giving you some "system power." This is power that is produced and sold into a "pool" and is likely to provide close to the cheapest rates available for resellers. It includes heavily subsidized nuclear, fossil fuel, and some small amount of renewables. In other words, the same dirty mix of power we were getting prior to the arrival of choice. The pool is relied upon to make up any deficits that green energy providers may have. These deficits can occur when, for example, the provider's green generation source is down for repairs. It can occur at night when the sun doesn't shine on solar panels or when the wind doesn't blow on wind turbines.

System power also comes in real handy as a buffer for adding new green energy customers. It would be prohibitively expensive if a green energy provider had to keep extra generation resources on line and ready to go for every potential new customer. There is no accurate way to predict exactly how successful the green energy marketing programs will be in influencing customers to choose them. So, using system power as a buffer allows the provider to add customers then increase the renewable energy resource to meet their needs. Green Mountain promises that none of their programs will include more than 10% system power. They also claim that they expect it to be significantly below 10%, but they use the 10% figure to err on the conservative side. They don't want to promise customers 5% and then have to apologize for the mistake if unforeseen circumstances force them to use a little more. First appearance make this company look they will be good at disclosure.

The April/May (*HP*#64) issue will go a little further into the costs and programs associated with other green energy providers, and also will contain Redwood Alliance's recommendations. But, once again, until then, RA is recommending that you stay with your current provider.

One of the things we are concerned about is any confusion or mistakes that are made during signups and switch-overs, but this is exactly the kind of thing that should shake down in the next couple of months. Switching now will work, but what if something better comes up? Having to switch and sign-up a second time compounds the potential for problems, confusion, and mistakes. Energy providers are still working out the bugs in their sign-up programs, as I can tell you from first hand experience. We called Green Mountain and got someone that was very inexperienced at customer service. It was weird, I think what he did was get on their web site and add me to the sign-up forms they have on line instead of putting me directly into their database. I subsequently had to deal with calls from two other sales representatives to finally get it straightened out.

Nuclear Waste Policy Act of 1997

Dang, won't they ever let up? I'd love to be able to concentrate my activism on promotion and education for renewable energy. But jiminy, the nuclear industry never takes a break! They make energy activists spend way too much time putting fingers in the holes they drill in the dikes. Fortunately, most of us have ten fingers each.

In my last column I let readers know that Congress was about to vote on Mobile Chernobyl, or the Nuclear Waste Policy Act of 1997. Well, it happened, and each house of Congress passed its version of the act. Now it goes to a conference committee made up of members of both the House of Representatives and the Senate. Then the bill must be passed again by both houses.

President Clinton has promised to veto this bill, then Congress will try to overturn the veto, which takes a 2/3 majority in both Houses. It's a bit scary, as the original bills were passed with a solid margin in favor. As it stands, the Senate's original vote was only two short of being able to override a Presidential veto, but the House would need 26 more votes to sustain the veto.

Check It Out... It sucks!

An awful lot rides on this bill. It would transfer title and responsibility for the nuclear waste to the government (that's us, remember?) removing the responsibility from the nuke companies that made millions of dollars while creating a huge problem, and it would do this before there is an acceptable method for dealing with and storing nuclear waste. It would begin the movement of thousands of truckloads of high level nuclear waste through our communities. It would preempt local and state laws and authority over environmental standards.

It would establish a repository standard that allows public exposure to radioactivity four times greater than current regulations do, or one cancer death for every 286 exposed individuals. It would order that construction begin without NRC approval. It would bail out the nuclear industry by capping fees they pay into the Nuclear Waste Fund, shifting the costs of storage to the taxpayer.

Nevada is Not a Wasteland

To top it all off, the state where the dump will be sited is Nevada, which doesn't even have one nuclear reactor, and the state strongly opposes putting it there. Additionally, it looks like the Nevada site may not be a good one for long term storage since Yucca Mt. is a seismological active area and its characteristics don't fit the need. That would mean there is a potential for having to move all the high level nuclear waste a second time to a better place.

The decision to use Nevada was a political one, not a scientific one. Congress chose the state that they felt would generate the least opposition. This whole deal really exposes the hypocrisy of Congressional conservatives. For a long time, they have espoused the concept of "returning power to state and local government," or states' rights. The only way they can place a dump in Nevada is over the objections of Nevada's citizens, state government, and its entire Congressional delegation. But this is exactly what we have come to expect from the same people that put corporate welfare, for their big bucks supporters, ahead of what the public wants.

Spanks or Thanks

We must be able to uphold the President's promised veto of this bill. Every citizen that cares about this issue should write their state's Congressional representatives and either thank them for voting against it or expressing displeasure with their support of this nuclear industry bailout. The list of who voted which way can be found at the NIRS web site or by calling them (see access). There are 314 Representatives and 65 Senators to be spanked, and 120 and 65, respectively, to be thanked.

A simple, hand written letter is best. And please involve your group of friends or organizations. This is critical, we must be able to uphold the veto. Congress has not heard very much about this from citizens, so every letter will count a huge amount against nuclear industry efforts. That industry has spent a lot of money and time lobbying Congress, and it shows. While energy activists cannot possibly match those kind of resources, we can do a better job than we have of getting citizens motivated to let their representatives know how important this really is.

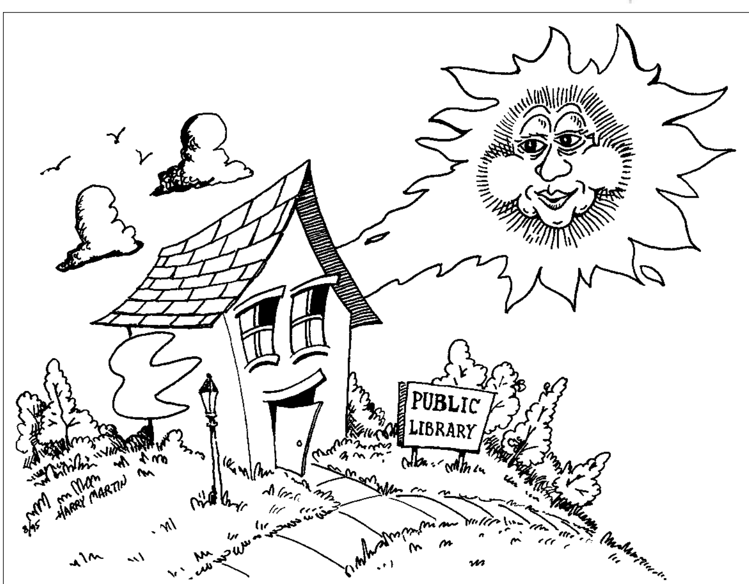
According to NIRS director Michael Mariotte, "That such a large majority of the House could vote for this signals something desperately wrong. It represents either a complete misunderstanding of the issues or a deliberate disregard for the American people in favor of the most despicable industry ever to sully our shores. And it cannot go unchallenged."

Access

Author: Michael Welch, c/o Redwood Alliance, PO Box 293 Arcata, CA 95518 • 707-822-7884
E-Mail: michael.welch@homepower.org
Web: www.igc.org/redwood

Green Mountain Energy Resources, 55 Green Mountain Dr., PO Box 2206, South Burlington, VT 05407 • 888-246-6730 • Fax: 802-846-6102
Web: www.choosewisely.com

Nuclear Information & Resource Service (NIRS), 1424 16th St. NW Suite 404, Washington, DC 20036 • 202-328-0002 • Fax: 202-462-2183 • Web: www.nirs.org



Home & Heart

Kathleen Jarschke-Schultze

Since our 24V Sun Frost F-10 freezer is in the basement I don't hear it running. The basement is always cool, as in the summer, or even downright cold, as in the winter. I have not been able to get power use measurements yet. The problem is getting a chance to use Bob-O's Fluke 87 meter when he's not using it.

F-10 Performs

For the actual use part of the test, everything works. I blanched and froze broccoli and cauliflower from our garden. We bought a quarter of an organically raised beef. At Thanksgiving we got a couple of turkeys while they were on sale. If Bob-O and I end up in town on the same day, but in different vehicles we sometimes both buy whatever food we can remember we are out of. So we end up with four loaves of bread. No problem, two loaves go in the freezer.

On the Road

We drove out to Arcata to the Sun Frost facility itself to pick up our freezer. There by saving the crating and shipping charges. We drove my 1987 Subaru station wagon. I had measured the cargo area in the Subaru and compared them with the freezer's measurements in the product literature. I told Bob-O that it would fit with two inches to spare. Then Bob-O took the measurements and compared them. He declared me correct. The freezer did fit with mere inches (two) to spare.

We cleaned out a corner in the basement and placed the freezer on a pedestal made of 2"x4"s to raise it up off the floor. Now that space underneath is used for storage. My conclusion on the Sun Frost is that it works and I don't have to worry about it.

Eating Scraps

At the same time we picked up the freezer we also picked up one of Sun Frost's solar composters, the Scrap Eater. It rode home strapped to the roof of the car. Bob-O thought we had a certain "Grapes of Wrath" look about us after that.

The Scrap Eater consists of a redwood barrel with an interior container of hardware cloth and insulative material rimmed with a hard plastic collar. A smooth clear plastic dome rests on the growing medium, outside of the collar. Along with the composter comes an aerating tool. It is a length of metal pipe with two short pieces of rod welded to one end so that end is shaped like an arrow head. You plunge the pointed end down into the working compost turn it halfway and lift it up. This effectively gets air throughout the material.

Location is Everything

By mixing your household compost with some dry matter, adding a little water and stirring you get compost. The really swell thing about this composter is the solar element. The clear plastic dome works like a solar cooker by intensifying the heat in the composter while sealing in the moisture.

The placement of the composter is important. It should not be right out of the back door. It needs to be sheltered from the rain. and finally it needs to get as much sun as possible during the day. I found the perfect place for winter. On the southwest side of the house under the eaves. In the winter months this area gets sun for most of our short days. In the summer it is shaded by the apple tree and a honey locust, so the Scrap Eater will have to be moved.

In Da Mix

For household compost I use a regular sized plastic mop bucket. I found an enameled pot lid that just fits the top. The bucket gets emptied about every week or when it gets full. Of course in the spring, summer and fall it gets full faster.

As with any compost bin or heap you have to layer wet or green matter with dry material. At first I tried to use some peat moss I had for the dry matter. This did not work out very well. I spoke to Larry at Sun Frost and he thought that because the peat moss had already been through the composting process (in Nature) it was in effect dead. So I began mixing shredded straw as my dry matter and it really began cooking. It would work faster if I would chop my household scraps into smaller pieces, but I don't have the time. All the dry skins from my garlic harvest went into the Scrap Eater.

The volume of matter in the composter raises when I add material and lowers when it cooks down. I have been adding scraps since the end of September. It was pretty full. The other day I emptied the whole center section into plastic buckets. At the bottom I removed about five gallons of really fine black compost. I reshuffled the half composted material, added some dry matter and the bucket of scraps from the house. When I walk by the Scrap Eater the plastic dome has condensation on the inside, showing me that my compost is cooking again.

Looking Good

Besides being a superb composter, the Scrap Eater is quite attractive. With the four inch wide circle of growing medium around the composting chamber a variety of plants may be grown. Plants that hang or drape over the sides are recommended and look the best. Sun Frost's display Scrap Eater has miniature ice plant that cascades down the sides . It looks tremendous. Since it's winter I haven't planted anything yet. I am considering strawberries though. The Scrap Eater is so much handier than hauling the bucket down to the garden compost heap. Especially in the winter when I don't frequent the garden often. Plus, it is much easier to aerate. I like it a lot. I'll be using my finished compost for seed starting in the spring.

Outside Tub

The work progresses on our hot tub project. The deck roof is framed and will soon be shingled. Then Bob-O will begin the assembly of the plumbing and all its myriad acoutremont. Of course if that doesn't happen I could always make in into a gigantic Scrap Eater. Ha. Just kidding. We are really anticipating soaking in the hot tub before the weather warms up again.

Access

Kathleen Jarschke-Schultze is reading all the new seed catalogs arriving at her home in Northernmost California, c/o Home Power Magazine, PO Box 520, Ashland, OR 97520 • 530-475-0830
Email: kathleen.jarschke-schultze@homepower.org kjs@snowcrest.net

Sun Frost, PO Box 1101, Arcata, CA 95518-1101
PH 707•822-9095 • FAX 707•822-6213
Web: www.Sun Frost.com

HAPPENINGS

ARGENTINA
XII World Hydrogen Energy Conference, June 21-26, 1998, Buenos Aires, Argentina. For more information contact: Secretaria General: Congresos Internacionales S.A., Moreno 584-Piso 9-(1091) Buenos Aires, Argentina; Tel: 54-1-342-3216/3283/3408; Fax 54-1-331-0223/334-3811; e-mail: congine@mbox.servicenet.com.ar

AUSTRALIA
The World Solar Challenge is now a biennial event and will run October 18–27, 1998. It is the premier solar car race in the world and contributes vital research and development towards the quest for sustainable future transportation. New: Entry Competition open to school and tertiary entrants. Free entry to the first school and tertiary teams to register. Contact: Ray Wieland, Event Manager, level 7 178 N Terrace, Adelaide 5000, South Australia • +61 8 8303 2021 • E-mail: wsc@saugov.sa.gov.au • Web: www.wsc.org.au

CHINA
Renewable Energy & Energy Efficiency Asia-Pacific '98 (REAP'98) Conference and Exhibition, Shanghai, China, October 14–16, 1998. For information contact: Alternative Development Asia Limited, 1406 Leader Commercial Building, 54-56 Hillwood Road, TST, Kowloon, Hong Kong; Tel. +852-2574-9133; Fax +852-2574-1997; e-mail: office@adal.com; www.adal.com

THE NETHERLANDS
The first European conference of Renewable Energy on roofs and facades, March 8-9, 1998, Leeuwenhorst Congress Centre, Nordwijkerhout, The Netherlands For more information: European Media Marketing Ltd., PO Box 259, Bromley, BR1 1ZR, UK Tel: +44-181-289-8989, Fax +44-181-289-8484; web-site:
http://www.emml.com/changing_roof

UNITED ARAB EMIRATES
Sharjah the neighboring Emirate to Dubai is hosting the "3rd International Conference on Solar Electricity" to be held at the Holiday Inn Resort, Sharjah United Arab Emirates March 21–25 1998. There are 2 contact persons at NREL USA. For commercial Robert McConnel e-mail bmcconne@nrel.nrel.gov For Academic Dr. Faud Abdulfotuh e-mail abulfotf@tcplink.nrel.gov They are both based at NREL, 1617 Cole Boulevard. Golden, Colorado, 80401, Tel 303-384-6601, Fax 303-384-6604. They also have a web site for conference: www.icse.org. For UAE contact Dr. Abdalla A. Alnajjar, Physics Dept, UAE University, Al Ain. UAE, Tel 9713-5063333, Fax 9713-671291

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

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

Electric Vehicle Society of Canada, Toronto Chapter—whose purpose is to promote EVs in order to reduce the terrible environmental impacts of conventional automobiles (and have some fun at the same time!) are a group of enthusiasts, inventors, Sunday mechanics and environmentalists from every walk of life who share the belief that EVs are a viable alternative. Meetings on the 3rd Thursday of each month, September through June. New Members welcome! Contact: Howard Hutt, 21 Barritt Rd, Scarborough, Ontario, M1R 3S5 Canada • Phone/Fax: 416-755-4324

Renewable Energy Technologies in Cold Climates '98, May 4-6, incorporating the 24th Annual Conference of the Solar Energy Society of Canada Inc. A forum for the exchange of information, research and development for renewable energies in areas with cold or extreme climates. For more information contact: RETCCC'98, c/o Solar Energy Society of Canada Inc., 116 Lisgar St Ste 702, Ottawa, Ontario, Canada K2P 0C2 • 613-234-7004 • Fax: 613-234-2988 • E-Mail: RETCCC.98@simpatico.ca

NATIONAL
National Summary Reports on State Financial and Regulatory Incentives for Renewable Energy. These two reports provide the most current info on state and federal tax, grant and loan programs that target renewable energy. Also, check out the online Database of State Incentives for Renewable Energy at their web site. To order reports: North Carolina Solar Center, Box 7401 NCSU, Raleigh, NC 27695 • 919-515-3480 • Fax: 919-515-5778 • Web: www.ncsc.ncsu.edu/dsire.htm

Sandia's new WWW address is www.sandia.gov/pv and they have added new material and organized it to make material easier to find. It includes "Stand-Alone Photovoltaic Systems: A Handbook of Recommended Design Practices," "Working Safely with PV," and balance-of-system technical briefs which provide information about battery and inverter testing.

Solar Energy & Systems, a college credit course by Mojave Community College. Covers fundamentals of RE for the home owner or small village. Taught on the Internet using the latest technology. Weekly assignments for students to review various text books, videos, WWW pages, a weekly chat room, and email questions and answers from students. Tuition $100 plus $10 registration. Contact Don Timpson • 800-678-3992

DOE Online Energy Info Resources—Information on energy efficiency or renewable energy technologies. The Energy Efficiency and Renewable Energy Clearinghouse (EREC) BBS Online Service offers users free access to text files, share and freeware programs and utilities, and a free publication ordering system. Accessible via the Web: erecbbs.nciinc.com • Modem: 800-273-2955. The Energy Efficiency and Renewable Energy Network (EREN) is accessible on the Web at www.eren.doe.gov and provides links to hundreds of government and private internet sites. EREN also offers an "Ask an Energy Expert" online form that allows users to E-mail their questions directly to specialists at EREC. For more information: 800-363-3732.

American Hydrogen Association, national headquarters, 216 South Clark Dr. #103, Tempe, AZ 85281 • 602-921-0433 • Fax: 602-967-6601 • E-Mail: aha@getnet.com • "Prosperity Without Pollution" Web: www.getnet.com/charity/aha

Energy Efficiency and Renewable Energy Clearinghouse (EREC) offers free info: 1998 Fuel Economy Guide (SD404), Insulation Basics (FS142), Small Wind Energy Systems for the Homeowner (FS135) Reviews system requirements, site determination, and costs of residential wind turbines. Also; The New Earth-Sheltered Houses (FS120), Photovoltaics: Basic Design Principles and Components (FS231), Cooling Your Home Naturally (FS186), Automatic and Programmable Thermostats (FS215). Contact EREC: PO Box 3048, Merrifield, VA 22116 • 800-363-3732 • E-Mail:

energyinfo@delphi.com • TDD: 800-273-2957 • Modem: 800-273-2955 • Web: www.eren.doe.gov

American Wind Energy Association World Wide Web: www.igc.apc.org/awea. Obtain information about the US wind energy industry, AWEA membership, small turbine use, and much more.

The Federal Trade Commission is offering free pamphlets on: Buying An Energy-Smart Appliance, the EnergyGuide to Major Home Appliances, and the EnergyGuide to Home Heating and Cooling. Write to: EnergyGuide, The Federal Trade Commission, Room 130, 6th St and Pennsylvania Ave NW, Washington, DC 20580 • 202-326-2222 • TTY: 202-9326-2502. The full text of these and more than 160 other consumer and business publication are available • Web: www.ftc.gov

The Surface Solar Energy data set, derived from satellite observations and produced by the Atmospheric Sciences Division of NASA Langley Research Center is now available. The data set contains site specific insolation values with monthly fluctuations, three hourly cloud fraction, and additional useful data. Text files, color plots and contour plots on a global scale are also available. Web: eosweb.larc.nasa.gov/DATDOCS/Surface_Solar_Energy.html

The Interstate Renewable Energy Council (IREC), in cooperation with the SEIA and Sandia National Lab has a handbook to guide state and local government procurement officials and other users in the specification and purchase of renewable energy technologies. Information on biomass, photovoltaics, solar domestic water and pool heating, and small wind systems. Technology specs about equipment, photographs and vendor contact info. Contains information on simple methods for estimating the pollution benefits of RE systems. Send $15 ppd USA to Interstate Renewable Energy Council Distribution Center, c/o ASES, 2400 Central Ave Ste G-1, Boulder, CO 80301 (make checks to ASES).

SOLAR 98: Renewable Energy for the Americas, June 13-18, 1998, Albuquerque, New Mexico. The conference includes all renewable energy technologies and professions. For more information contact: American Solar Energy Society, 2400 Central Ave. G-1, Boulder, CO 80301: phone: 303-443-3130, Fax 303-443-3212; e-mail: ases@ases.org; web-site: http://www/ases.org/solar

NORTHEAST US

Tour de Sol, the US electric vehicle championship, May 7-15, 1998, NY, NJ, DE, MD, and DC. Contact: Northeast Sustainable Energy Association, 50 Miles St. Greenfield, MA 01301 • 413-774-6051 • Fax: 413-774-6053 • Web: www.nesea.org

SOUTHEAST US

The Self-reliance Institute of Northeast Alabama is seeking others in the southeast interested in alternative energy, earth sheltered construction, and other self-reliant topics. Contact SINA, Route 2 Box 185A1, Centre, AL 35960 • E-Mail: cevans@peop.tdsnet.com.

ARIZONA

Power to the Parks, Phoenix, AZ, Feb. 2-7, 1998. A special workshop focusing on RE to meet park service needs. $500, Contact SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • FAX: 970-963-8866 • E-mail: sei@solarenergy.org

Women's PV Design & Installation Workshop, March 2-7, 1998, Tucson, AZ. Help power the Cooper Environmental Science Camp cabins. $500. Contact SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • FAX: 970-963-8866 • E-mail: sei@solarenergy.org

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

CALIFORNIA

Windpower '98, April 27 to May 1, 1998, Bakersfield, CA. Contact: AWEA, 122 C St. NW, 4th Floor, Washington, DC 20001 • 202-383-2500 • Web: www.igc.apc.org/awea

Lead Acid Battery Workshop, Feb. 20-21, 1998, Los Angeles, CA. Limit: 20 persons. Contact SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • FAX: 970-963-8866 • E-mail: sei@solarenergy.org

Siemens Solar Industries offers two levels of PV training: Basic PV Technology Self-Study Course (continuously available), and the Comprehensive Photovoltaic System Design Seminar (call for seminar dates). Instructor Mark Mrohs, Manager of Training for Siemens Solar. The Self Study program includes our 500-page Training Manual and 9 hours of video lessons and applications, with exercises and examples throughout. The System Design Seminar is a 5-day intensive mixture of lecture, hands-on assembly, labs, and team system design problem solving. Completion of the Self Study program ($500 plus shipping and tax) is a prerequisite for the System Design Seminar ($1000). Contact: Siemens Solar Training Department, 805-388-6568 • Fax: 805-388-6395 • E-Mail: cvernon@solarpv.com • Web: www.solarpv.com

Rising Sun Energy Center presents ongoing Solar Energy Classes including electricity, water heating, cooking, and a kids' day. Contact for schedule and info: PO Box 2874, Santa Cruz, CA 95063 • 408-423-8749 • E-Mail: sunrise@cruzio.com • Web: www.cruzio.com/~solar

Institute for Solar Living offers ongoing workshops on a variety of subjects. Call Real Goods, 800-762-7325.

COLORADO

Solar Energy International (SEI) offers hands-on workshops on the practical use of solar, wind, and water power. The Renewable Energy Education Program (REEP) features one and two week sessions, PV Design & Installation, Advanced PV, Wind Power, Micro-hydro, Solar Cooking, Solar Home Design, Cob & Natural Building, Straw-Bale Construction and Adobe/Rammed Earth. Experienced instructors and industry representatives. Learn in classroom, laboratory and through field work. For owner-builders, industry technicians, business owners, career seekers, and international development workers. The workshops may be taken individually or as a comprehensive program. $450 per week. SEI is a non-profit educational organization dedicated to furthering the practical use of RE technology. Contact: SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • Fax: 970-963-8866 • E-Mail: sei@solarenergy.org

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

FLORIDA

SOLTECH, IREC, AND UPVG annual meeting, April 25-30, 1998, Coronado Springs Hotel, Orlando FL. Contact: Sharon Wilson, SEIA • 202-383-2620

IOWA

Iowa Renewable Energy Association board meetings are held the second Saturday of every month at 9:00 am, at Cooper's Mill Restaurant (Village Inn Motel) in Cedar Rapids. Everyone is welcome. Time and place of meeting may change so call I-Renew for updated information. Contact: I-Renew, PO Box 2132, Iowa City, IA 52244 • 319-338-3200 • Fax: 319-351-2338 • E-Mail: irenew@igc.apc.org

MAINE

An energy conference that will make a real difference,will be held at Camp Chewonki, Wiscasset, Maine, March 20-22, 1998. The Katahdin Center, Chewonki Foundation, Maine Solar Energy Association, and the Maine Association of Conservation Commissions are co-sponsoring "A Peoples' Energy Quilt for the 21st Century." Householders, community leaders, and small-business owners are invited to explore options for using energy more effectively and responsibly. Emphasis will be on energy conservation. We will also stress the wise use of renewable energy and the development of sustainable communities on personal, local and regional bases, avoiding the well-known basics. We will discuss strategies which can be put to work immediately with technology already available and affordable. This information will be disseminated directly via public access TV and other media, so that people can get started. We will conference in the informal atmosphere of Camp Chewonki, where a number of energy-conservation projects are up and running. Transportation will be available for tours of solar homes in the area. Information on resources and products will be available, (participants will receive a copy of The Maine Solar Primer in the registration package) but there will be no commercial vendors' booths. The keynote speaker is John Perlin, author of The Golden Thread. Please join with us in creating a practical and comfortable patchwork quilt for Maine from renewable resources and a myriad of conservation measures now available. Leave your name, address, and phone number at (207) 737-2488, for registration materials, or guarantee your space at the conference by sending a check (returnable if you cancel by March 1st) for $25 to the Katahdin Center, 20 Peary Drive, Brunswick, ME 04011. The basic cost for facilities, food (7 meals plus snacks) and van transportation is $80. Accommodations are available on site in yurts for $10 or at group rates of $20-$30 in local motels. Donations to Katahdin Center in support of this effort will be gratefully received.

MASSACHUSETTS
NESEA is converting its headquarters into a showcase of environmentally responsive building. Members are converting a historic railroad hub into a working demonstration of a healthy, daylit, office building flanked by a park which celebrates transportation history while demonstrating principles of urban ecology. Opportunities for involvement: Saturdays at NESEA: A volunteer program through which construction novices learn green building tricks of the trades working with professionals. Major transformations of the building and park will be undertaken as "barn-raisings." Contact: NESEA, 50 Miles St, Greenfield, MA 01301 • 413-774-6051 • Fax: 413-774-6053

NEW MEXICO
Solar 98: Renewable Energy for the Americas, June 13-18, 1998, Albuquerque, NM. Featuring the ASES, ASME, and AIA conferences for RE. Contact: ASES, 2400 Central Ave., #G-1, Boulder, CO 80301 • 303-443-3130 • Fax: 303-443-3212 • E-Mail: ases@ases.org • Web: www.ases.org/solar

OREGON
APROVECHO RESEARCH CENTER is a non-profit educational institute on forty acres nestled in the forest of Oregon. Internship programs March 1, June 1, and September 1. Also, a six week winter internship in Baja, Mexico which focuses on studying and researching appropriate technology applications, learning Spanish, teaching in a grade school, and working in fruit orchards and gardens. Contact: Internship Coordinator, Aprovecho Research Center, 80574 Hazelton Rd., Cottage Grove, OR 97424 • 541-942-8198.

Eco Design Arts Conference, April 17-19, 1998, explore the collaborative process in ecological design, community development, and the arts. Contact: Hannah Wear, HOPES: School of Architecture and Allied Arts, University of Oregon • 541-346-0719 • E-Mail: hopes@laz.uoregon.edu

TEXAS
SEASUN, El Paso Solar Energy Association has a new web site: www.epsea.org

VERMONT
Free PV Workshops for beginners wanting to see working systems and for experienced off-grid people looking to share information and to see new, or different ways of solving problems. Hosted by David Palumbo of Independent Power & Light, 9 am to 3 pm the first Saturday of most months. Participant interest will determine the topics discussed and demonstrated (as practical): site selection, PV modules, batteries, charge controllers, inverters, lighting (ac & DC), balance of system components, system monitoring and maintenance, water topics, snow topics, ponds, living in cold climates, living with our woods, heating with wood, and root cellars. Visit a beautiful part of Vermont and meet other people who are either living with renewable power or considering it. David Palumbo has taught workshops in the past with the fine people of Solar Energy International and at the Solar Living Institute. David Palumbo, RR1 Box 3054, Hyde Park, VT 05655 • Voice/Fax: 802-888-7194 • E-Mail: indeppower@aol.com This is a freebie so bring your own lunch and coffee.

WASHINGTON
GreenFire Institute is offering workshops and information on straw bale construction. Contact: GreenFire, 1509 Queen Anne Ave #606, Seattle, WA 98109 • 206-284-7470 • Fax: 206-284-2816 • Web: www.balewolf.com • E-Mail: wilbur@balewolf.com

WASHINGTON, DC
Utility PV Experience, Conference and Exhibition will share experience of energy service providers engaged in introducing solar electricity to customers. Contact: Erin O'Donnell, Utility Photovoltaic Group, 1800 M Street, NW, Suite 300, Washington, DC 20036 • 202-857-0898 • Fax: 202-223-5537 • E-Mail: eodonnell@ttcorp.com

WISCONSIN

Midwest Renewable Energy Association Workshops. Call MREA for cost, locations, instructors and further workshop descriptions. See our ad in this issue. Membership and participation in the MREA are open and welcome to all. Significant others may attend for 1/2 price. Contact: MREA, PO Box 249, Amherst, WI 54406 • 715-824-5166 • Fax: 715-824-5399

The Affordable Comfort Conference will be held in Madison, May 3-8, 1998. Renewable energy systems are expensive but can become a more viable option when installed on efficient buildings. The Conference addresses concerns from how to evaluate the energy efficiency of a home to the most cost effective way to improve its efficiency. There are also sessions on sustainable housing and communities, health and safety, multifamily buildings, utility involvement, marketing, and more. The workshops include both classroom presentations and practical, hands-on sessions in the field. For more information contact Affordable Comfort, Inc., at 894 Beaver Grade Rd., Coraopolis, PA 15108, (412)299-1136, e-mail: JudeRut@aol.com

the Wizard speaks...

Time Travel

The possibility of time travel has intrigued many people for a long time. Modern theories of physics do not rule out this possibility, but there is as yet no proof of its actuality. However, if time travel is possible, there are a few things that can be said about it. These are based on theoretical considerations.

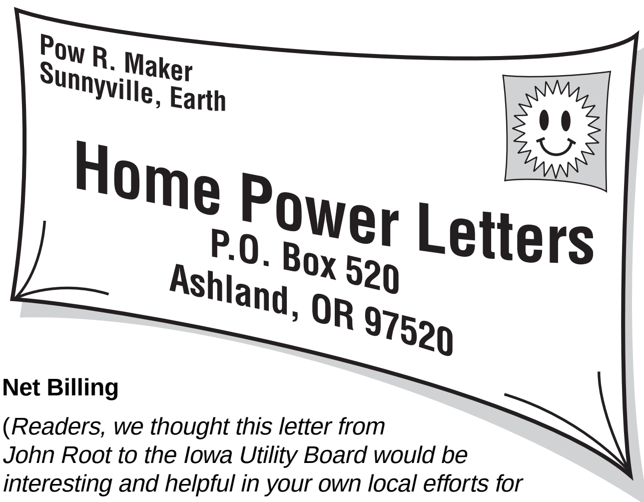
First, for maximum flexibility and minimum complication, the temporal continuum should have three time components. This means that the spacial continuum of three dimensions moves through a temporal continuum of three dimensions. Local elapsed time is measured along the path of the spacial continuum. This path is traced out by the movement of three dimensional space through three dimensional time.

Secondly, in order to avoid temporal paradoxes and discontinuities, time needs a branching structure. For every time travel event, the path of space through time splits. This happens twice for each event. The first branching occurs when leaving the original temporal path, while the second occurs when reentering the temporal flow. Upon reentry, the time traveller exists on the new temporal branch created by that reentry.

A third element is the mode of time travel. There are potentially two. These are linear branch travel and cross branch travel. In linear branch travel, only those temporal branch paths that are in a direct line forward or backward in time are accessible. In the cross branch mode all paths in the temporal continuum are accessible. One, or both, of these modes may be the allowable form of time travel.

The fourth consideration is the relationship of branch paths to the original path from which they branch. This relationship can be one of divergence, convergence, or parallelism. if the paths are divergent, the resulting realities will be totally different. Parallel paths produce realities which are similar, but differ in certain respects. Convergent paths will eventually merge into a single reality. Branches created by leaving the original path will usually be convergent or parallel, while those created by reentry will usually be parallel or divergent.

Finally, it is suggested by some that the mathematical structure of time may be describable by a form of quantum relativistic chaos theory. The branching structure may be reduced to a fractal pattern, controlled by various modes of chaos attractors.



Net Billing

(*Readers, we thought this letter from John Root to the Iowa Utility Board would be interesting and helpful in your own local efforts for Net Billing. The Crew.)*

Dear Members of the Iowa Utility Board (IUB):

Attached you will find my 1983 written comments to the Iowa Commerce Commission defending the Alternative Energy Production (AEP) law and Net Billing. I am appalled that after 14 years the Investor Owned Utilities (IOUs) are still opposing Net Billing. The amount of money involved in this controversy cannot possibly justify the effort that has been expended on both sides.

This is an ethical question rather than a monetary question. Do we support the greatest good for the greatest number of people by having Net Billing? Do we encourage the people of Iowa to determine their own energy destiny and security by creating a friendly environment for decentralized power generation? Or do we support the greatest good for the shareholders of the IOUs, many of whom do not live in Iowa and could not care less about the well being of our state's inhabitants or our economy.

Clearly the IOUs lobbying for the elimination of Net Billing is an act of corporate greed and selfishness. Once again Iowa's Independent Power Producers (IPPs) are under attack from the IOUs. All the citizens of Iowa will be the losers if the IUB allows this to continue.

Fourteen years ago when I first defended the AEP law we had a fledgling wind industry in Iowa. At that time electricity produced by wind turbines cost 30 cents per kWh. Today the electricity produced by Iowa's wind turbines costs between 3.5 and 4 cents per kWh. How did that happen? Was it from the support of Iowa IOUs? NO! It was from the persistence of Iowa's IPPs.

The citizens of Iowa want their electricity to be produced by renewables and to prove my point I refer you to two reports, one performed by the University of Dubuque (UD) and the second by the University of Northern Iowa (UNI). Please note that in the UD report section IV question #7, 80.1% of the people surveyed favored legislation promoting alternative sources of energy and in question #10, 67% of the people surveyed were willing to pay between 0 and $5,000 on the purchase of an alternative energy system. In the UNI report Table 2a, 89.8% of the people surveyed supported solar and 87.3% supported wind. Again in Table 5, 58.4% of the people surveyed were willing to pay $10 per month more for electricity generated via wind turbines. The UD report was performed by a group of MBA students for the Root Cellar in 1983; The UNI report was performed for Cedar Falls Utilities in 1997. Please note the similarities despite the passage of time.

I propose to the IUB that these surveys represent a mandate by the citizens of Iowa for the promotion of renewable sources of energy. And by disallowing Net Billing the IUB is violating this mandate.

Why should the IOUs care about Net Billing? Not that many people are taking advantage of it anyway. I suspect the IOUs fear the advancement of Photovoltaic (PV) technology, which is approximately at the same stage of development as wind turbines were 14 years ago. It is my opinion that the IOUs do not want to have PV infiltrate their markets the way wind turbines have. Also, PV is a technology which is not as site specific as wind, therefore the whole state is fertile ground for PV. The most import point is that there are no moving parts with PV. This makes it the perfect renewable generator to use in urban applications.

Finally, I find it highly inappropriate for the IUB to allow the IOUs to purchase the IPPs co-generated GREEN POWER at 1.2 cents per kWh and then resell it on the open market at 10 to 20 cents per kWh, which will be the case when restructuring reaches Iowa. At the very least, I suggest that the IUB make a ruling that IPPs be compensated for their co-generated electricity at 5 or 10% below the price the IOUs resell this co-generated electricity for on the open market. Better yet would be a ruling that allows IPPs to sell their GREEN POWER to the highest bidder. After all, if we are going to allow Iowa's citizens to purchase electricity from whomever they choose, shouldn't they be able to sell their GREEN POWER to whomever they choose?

Environmentally yours, John R. Root, President, The Root Cellar, Cedar Falls, IA • E-Mail: PVperson@aol.com

We'd like to thank John and all the other renewable energy supporters that we've been hearing from. You are all over the nation and doing a great job. Keep it up! The Crew.

A Reader Responds

Hi, Don Loweburg. I saw your mention in the October *Home Power* about the New York Net Metering bill. I have to say that I disagree that this is even half a loaf. Here is my reasoning: 1) People who really need PV live too far from the power lines to hook up (obviously?). 2) People who are able to hook up to power lines but choose to go with PV are doing it for environmental (fine with me) or hobbyist reasons rather than economic ones, but 3) can anyone who is relying on PV afford enough to make net metering matter? The folks I know who rely on PV generally have less than 1 KW arrays, and usually much less. When I visit them, the "one room, one light" rule is always very evident. And generators are always present and often running, especially during the winter doldrums. In my area of upstate NY (20 miles SW of Albany), we have fabulous wind potential, and some of my neighbors already sport 3 or 10 KW windmills which keep them in abundant power year round. Ditto micro hydro. These are the folks that should be connecting to the mains to make renewable energy more than just lip service. But, without net metering, basically why bother with the rules and administrative overhead? So all in all, I think the Pataki net metering bill is just a smoke screen to appear environmentally benign, but give up nothing (and keep the utility money flowing). As for me, I'm saving up for a 3 KW Whisper, which will fit merrily into my 15 MPH average (79 MPH gusts for 12 hours last week!) wind location, and probably power my very electric, solar-heated house forever. In any event, keep up the good work but please don't rubber stamp the BS we are getting from our state government. Regards, Jeff Klein, Albany, New York

Don Loweburg Replies

Jeff, thanks for the thoughts. I agree with you that PV is cost effective at this time only for offgrid. It's also clear that wind and hydro are being excluded from net metering in most states. This was clearly the case here in California. Our initially proposed net metering law contained hydro and wind. Due to intense utility lobbying, those renewables were removed and we were left with a PV only net metering law in California. Since PV is the most expensive renewable, the utilities probably feel it's safe to give a little here. So, if PV is not cost effective on grid, why go to the trouble of working for net metering laws, especially when the most cost effective renewables are systematically excluded from eligibility? For me the answer is that it's a small step in the right direction. Net metering improves the economics of grid connected renewable energy systems. We need the visibility of the early adopters. (Isn't the term hobbyist a little perjuritive?) Net metering coupled with purchase incentives and the customer's commitment to bear some additional cost for a good cause (green pricing) can stimulate the market for PV. I might add that offgridders have been paying green pricing for many years. The hoped-for result will be a reduction in the cost of PV. Another somewhat strategic aspect of net metering is that it grants residential customers the right to access the grid as producers of energy. In other words, the grid becomes bi-directional at the point of use. This is significant in the context of distributed generation since DG benefits are maximized when applied at the point of load. Finally, I see eventually that net metering (or open grid access) will be the rule for all renewable energy sources. But we will have to fight the fight.! Don Loweburg

Find True South

Dear Mr. Perez, There are many methods that can be used to determine a true north-south line for the orientation of solar arrays. I am going to suggest that the following is the easiest for the user.

I am a designer of large sundials (usually about 12 feet across) where the person seeking the time, stands on the centerline of the sundial and the shadow of his/her head will indicate the time. These large sundials need to be aligned, exactly, with the local North/South Meridian.

If the user of this information will drop me a line and include the following information, I will send them the complete information that will be accurate within several seconds of arc for the following 30 - 45 days.

1 The name of the nearest town, village, or city.

2 The name of the state wherein lies the site.

3 The zip code and name of the nearest US post office.

4 Their personal mailing address, so that I can reply.

The equipment required, by the user (at the site), is:

1 Eight or ten feet of clothesline rope.

2 A weight (rock, old tire, log) to be tied to the clothesline.

3 A place to hang the clothesline so it dangles, with the weight at the bottom.

4 Sunshine shining on the clothesline at the time period around noon.

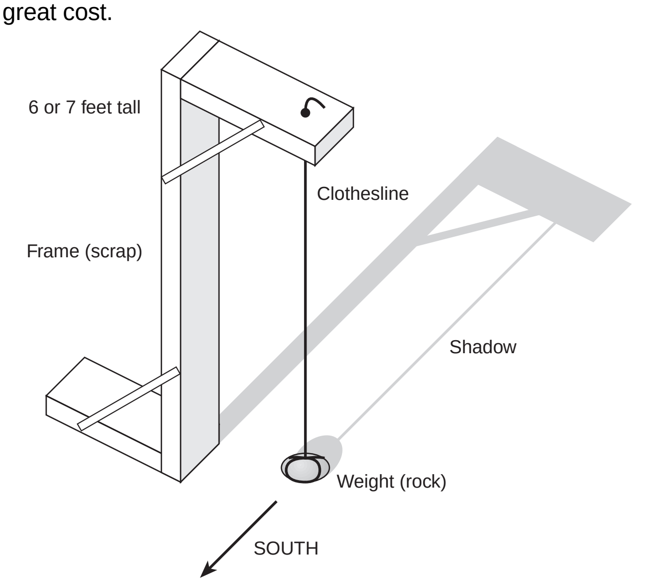
5 A couple of wooden sticks, about one foot long.

I will even thrown in the stamp and the envelope to mail the reply to them.

Very truly yours, William C. Farrell, 1 Kennedy Ct., New Milford, CT 06776 • Tel/Fax: 860-355-8731 • E-Mail: u11216@snet.net

Thanks a million, William. I'm sure readers will want to take advantage. For those that would like to do it themselves, below are excerpts paraphrased from a second letter William sent us that showed us how to find true north-south for Ashland, Oregon, near the Home Power *location.*

The little sketch is of the very complicated apparatus necessary at the site of the solar array and an example of its great cost.



Each degree east or west of the Time Zone Meridian (120° for Pacific Standard Time) equals 4 minutes on the clock. Therefore, Ashland, OR is 10 minutes and 39 seconds different than the Standard Meridian (120° W). This means that "local noon" at the solar array site will occur 10 minutes and 39 seconds later than Pacific Standard time.

There is an additional problem. The sun runs early or late on a regular schedule throughout the year and there has to be a correction for this as well as the longitude error. There are all sorts of tabular renditions of this error (see Old Farmer's Almanac) but I will include a tabulated error for the 30 day period following the sending of the response to a reader's inquiry.

The procedure to establish the true north-south line is as follows:

1 Start out on this adventure before noon.

2 Set your watch to Standard Time. Use a radio signal from any AM/FM station as they use time set by the US Atomic Clock at the Naval Bureau of Standards, which is accurate to millionths of a second.

3 Try to get the seconds accurate, too.

4 Locate your array site, or wherever you want the true north-south line.

5 Erect the scientific apparatus and its stone plumb line.

6 Smooth out a space where the shadow of the clothesline appears so that you can see the shadow clearly.

7 Note the Longitude Correction (10 minutes and 39 seconds for Ashland, OR).

8 Look up the date in the table for the correction of the Equation of Time. For example, for December 12, 1997, the correction is (pos.) 6 minutes and 36 seconds.

9 Subtract this correction from the Longitude Correction time. This means a total of 4 minutes and 3 seconds as a correction.

10 This means the sun will be dead south at 12:04:36 pm in Ashland, OR.

11 At that precise time, your clothesline shadow will be a true north-south line, within minutes of a degree and one heck of a lot better than a magnetic compass.

12 To preserve this monumental discovery, drive a couple of sharp sticks in the ground in line with the shadow.

13 Wear it in good health.

Safe Water

Would you, please, recommend both a UV purification system and a demineralizer-filter system suitable for our off-grid system?

Water has always been a problem here in the Champlain Valley of Vermont. The wells traditionally drilled tap into water that is hard and sulphurous.

There is public water supply piped through the county pumped from the lake and treated at the pump stations. It smells strongly of chlorine. There may also be dioxin in it from the Ticonderoga paper mill ten miles south and it would be very expensive to bring the pipes to our remote site. Also, we resist bringing services to our site because we don't want to encourage the common development of this beautiful area. Right now, the absence of water and power is a significant barrier to the rapid development plaguing areas of Vermont similar to ours.

We dug a shallow well when we first started building. That water is very hard, making a reddish or white mess of the shower stall, sinks, glassware, etc. State testing also found coliform and above allowable limit amounts of arsenic and lead in that water. The state thinks that when lead arsenate was banned for use on orchards in 1960 a farmer dumped his remaining store on the bit of unfarmable land I bought. We use this water for washing dishes, watering the garden, and for showers.

Our drinking water is filtered rain water, batch chlorinated (which dissipates in a few days), and stored in a 500 gallon stainless tank. We pump it from the tank with a pitcher pump.

The water from our shallow well makes my head itch. Though that's a minor complaint, we are wondering about the long term effects of having lead and arsenic washed frequently over our bodies and would like to treat the water to remove the lead, arsenic, and at least some of the stain-causing minerals. We also would like to replace the batch chlorination of our drinking water with a UV purification system that is compatible with our off grid system (not a power hog).

Thanks as always for helping with our project. Paul Kenyon, Bridport, VT • paulkenyon@juno.com

Thanks for writing, Paul. We don't know a lot about water purification here, having been blessed with a wonderfully pure well. We have heard of 12 VDC ultra-violet systems that should take care of the coliform problem, but will have to rely on our readers to help you out with where to find them and the other equipment you should consider for demineralizing and filtering. Many communities have local experts in this sort of thing. Our yellow pages show lots of entries under the heading "Water Filtration & Purification Equipment." The Crew

Damn the Torpedoes

Now that the end of the year rush is subsiding, I have had some time to reflect on some issues which have been gnawing away at me for some time.

In the last issue I noticed the first set of commentary and rebuttals to the Code Corner by John Wiles and while I personally see a need for code reference and explanation and believe in following the NEC wherever possible, I have found at least one or two points in every issue with which I take exception.

The use of flexible conduit as noted by Bob-O Schultze was one issue from the last go-round, but there is something in the writings of Mr. Wiles which I found to be quite distasteful and downright UN-AMERICAN in attitude and demeanor. It is apparent that he has become (in his opinion) the official source of all information for government and municipal PV and RE installations. This sort of demagoguery is just generally the antithesis of *Home Power* in that he, as do many electrical and code inspectors, appear to wish to control the actions of the many who would attempt to create and sustain their own energy and existence by their own hands. In bringing about ever more complicated and new regulations which ostensibly are meant to create a safe environment, the cost of purchasing and installing these systems goes ever higher when in fact it could be lower if driven by the market which this industry serves.

The bureaucracy which decrees and enforces these codes is generally much less enlightened than the end user and inevitably, conflict and confusion will arise. In many cases, just as the IRS "used to" make promotions and compensation based on collection of money, so the code enforcement machines reward their employees by the number of infractions noted and in many cases are not permitted to explain to the end user how to meet the particular code. I have personally seen this over and over again in 11 states and in many, many jobs.

This type of situation can and will develop when code people forget who actually employs them and become little dictators. The reason for this is very simple. Most code people know only the code… they do not know electrical theory, DC and ac circuits, or anything that they would not ordinarily come in contact with in the average home. When asked to perform out of their comfort zone, they revert to quoting chapter and verse and cannot be reasoned with or accept logical exceptions. In many cases, they are there to enforce who works on what rather than safety. In general, it is not the fault of the person but of the enforcement bureaucracy for which they work in not providing proper training and an environment of cooperation and information.

So, how does Mr. Wiles fit into this scenario? Very simply, he seems to think that every system should be installed by an electrician, and that his is the only way… definitely not the case.

For most people, the $8,000 to $15,000 for the equipment is plenty of cost, but adding another $2,000 to $5,000 for an electrician to learn on the job is definitely not in the budget. I have always tried to educate people to do-it-yourself as much as possible. In this way, they are more knowledgeable about their system and can inspect and maintain it.

I will freely admit that, though I generally work with an electrician to install, I have no problem with installing myself or helping the owner install either behind the scenes or long after the code people have left. Possibly because of my background in industrial power, or because I am very careful, I have generally very good success and very safe systems without Mr. Wiles input, and have done so for years. With any luck I will continue to do so.

For all the do-it-yourselfers out there I say … Damn the torpedoes—full speed ahead. Wm. von Brethorst, Jackson WY

Degrees of Conduit

Hi Richard, Thanks for printing my article and letter. There was one mistake in the letter, for which I apologize. John Wiles sent me an e-mail and pointed out the error. Fortunately it is one which did not affect the point that I was trying to make.

Square D breakers are rated at 75° C, not 90 as I had written. In my example, instead of 60° C wiring being run to a 90° terminal, it is run to a 75° C terminal. The case is still one in which the temperature ratings of the equipment and wiring are different. So long as none of the equipment or wiring is exceeded in its maximum operating temperature, the requirements are met.

The breakers that I use currently have the 75° rating. In this situation, the 90° wiring that is run to the terminals has a higher temperature rating than the terminals.

The major benefit that I generally derive from using high temperature wire, is that it allows more “current carrying conductors” to be run through a conduit, without having to reduce the ampacity. I probably wouldn’t fill a conduit to the point where the wiring’s maximum allowable temperature could be reached, if the wiring would often operate at maximum ampacity. This would waste energy, lower the voltage, and be potentially alarming to the customer.

In some cases, feeding ac loads, it can really reduce the scope of a project if only one pipe needs to be run.

If the load distribution is such that all of the wiring will seldom be run at maximum ampacity simultaneously, then it seems a good situation to fill a pipe with the maximum allowable number of current carrying conductors. If all the wiring were run at maximum capacity, it would neither do any damage nor violate the code.

In this situation, different parts of a system are being run at different temperatures. The portion of a wire running through a 90° conduit can be run hotter than another portion of the same wire that is attached to a 75° terminal.

Even if high temperatures are encountered in PV junction boxes, and this situation does logically require a 90° rating for wiring in the boxes, does that necessarily mean that the flexible conduit will be that hot? The conduit is not bonded to the module the way the box is.

John’s tests on flexible conduits indicate to me that there could possibly be problems with the flexible conduits currently available for outdoor use, with the electrical industry in general. Liquidtight flexible metal conduit is commonly used to connect commercial refrigeration and air conditioning equipment. These installations are usually outdoors and often in direct sunlight. They are commonly installed on tarred roofs. It would appear that the temperature ratings of these conduits must routinely go above the rated wet temperatures.

My guess, however, is that evaporative cooling effects would keep a conduit from reaching high temperatures when water is present. I would think that the wet temperature rating of these conduits would only be reached in steam tunnels and similar environments. I haven’t noticed liquidtight conduits showing signs of deterioration when used outdoors in direct sunlight.

I believe that both metal and nonmetallic liquidtight flexible conduits, that are listed for outdoor use and are sunlight resistant, should be allowed for solar array wiring. The temperature ratings of both are same. I believe that one standard should be used for both PV and standard electrical installations.

If a 60° wet rating is good enough to connect a liquidtight conduit to a commercial compressor in full sunlight, then it is good enough to connect to solar modules, where the conduit will at least be in partial shade. Sincerely, Drake Chamberlin • solar@eagle-access.net

Keep ‘Em

I think that you certainly should allow the advertisers to decide whether or not they want to include prices in the ads that they’re paying for. The whole purpose of advertising is to get the information to those who need it and *Home Power Magazine*, like many other publications, deals with a very specific type of consumer. To not allow pricing to be included in the ads would be a disservice to the RE community — both sellers & buyers. Most people know that when a manufacturer publishes a price, it’s the list or suggested price and that the price set by individual dealers may vary. I think we all have purchased something at one time or another and the decision was based on an advertised price — it’s the basis of free enterprise.

In my opinion you should (and to date, have) restrict your ads to those applicable to RE and/or its associated lifestyle. Besides great content, the format of your magazine is the best

I've seen anywhere and I look forward to every issue. Best Regards, Ron Ropers • onerope@dcache.net

Still More Keep 'Em

Hi, Richard and Karen, OF COURSE *Home Power* should not stop advertising prices. Excuse me, but ALL competition is basically cutthroat in nature—none of it is nice and friendly. When it is, it is called price-fixing. When competition is thwarted by the suppression of information of any kind (prices, quality comparisons, etc.) it fosters the growth of mega-companies and their monopolistic powers, all to the detriment of the consumer, and I have been a *Home Power* subscriber long enough to know that this is not what you want, nor do your subscribers.

The argument that publishing prices harms the industry is completely bogus. What publishing prices does is to foster innovation on the part of businesses to keep up with the times with regard to fair profit and quality goods. The only ones harmed by price lists are those with their prices higher than need be, who have a sweet deal and don't want newcomers in the industry. This "bad for the industry" argument sounds exactly like the flip side of the old line that "What's good for General Motors is good for the country." I don't respect that argument nor the motives of businesses who would have us think like that. I say, let them move their advertising to the Sharper Image catalog and bill your subscribers for the shortfall. We'll all be better off.

Thanks for the good works of *Home Power* and it's staff. Don't change philosophies now!! Michael Tandy • clayton158@aol.com

Keep 'Em Again

Hey y'all, Hope this note finds you well and dealing with your weather with the proper attitude.

As a small retail and repair electronics shop, many of my business acquaintances talk to me about the "unfair" pricing policies of K-mart, Wal-mart, etc. (or the large repair shop). While I will admit that I cannot compete with their prices, they cannot teach you how to setup that bargain TV or program that cheap VCR. I guess what I'm trying to say is that you have to sell what people are willing to pay for and not spend so much time worrying about what business others are "stealing" from you with "unfair" pricing.

The majority of people who search for the lowest price are either skilled enough to not need technical assistance or (how to put this politely?) haven't yet realized that they need that help and they're going to have to pay for it, sooner or later. Sometime they will realize it's cheaper to pay a higher price for a product with decent technical support then to buy the less expensive warehouse cash and carry item with the "HUH, Wha??" type of after sale service. So, I like advertisers putting their prices in their ads and telling us what after sale services they offer. I often sell used equipment cheaper, If I don't have to support it for the full 90 day warranty. Trying to stay afloat in FL, A.J. Jerig • ajerig@email.msn.com

More Keep 'Em

Another great issue, as usual. You ask if you should allow prices to be included in your ads. It might be OK to REQUIRE prices in the ads…but totally absurd to not allow them! You said it plainly — no prices only slows down the flow of commerce, causing needless work, communication and expense for both buyers and sellers. I'm sure only the big-buck, glossy-catalog, large margin retailers don't want prices published...since their prices are so high. Not allowing prices is the worst kind of prior restraint! Please continue to foster free and open commerce, as you always have! Love your magazine! Rik Beeson" <rikbeeson@hotmail.com

Well, Home Power readers have spoken on the subject of allowing prices to be printed in advertising. We received dozens of letters on this subject and not one said not to allow prices in ads. I suggest that advertisers in Home Power who object to printing prices should consider that their potential customers have spoken. A business which ignores the wishes and needs of its customers will not long prosper. Richard Perez

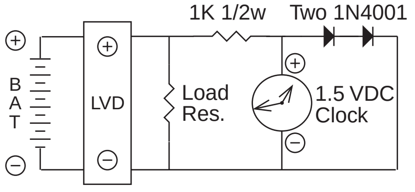
Missing Skiz

In issue #60, the Homebrew LVD circuit from Forrest Cook, there is no way this circuit could prevent overcharging of the battery (this is not a combination of charge controller / LVD). In addition, what happened to figure 2?

Home Power Schematics are much better than they used to be, but as a circuit designer, I always like to puzzle them out for errors.

Keep up the good work, Solar Toby, Tucson, Arizona

Thanks for pointing out the missing skiz, Toby. Here it is for those others that also missed it. As for the circuit preventing overcharging, it was never claimed to do so, it's a Low Voltage Disconnect (LVD). Note that this issue has Forrest's Homebrew charge controller. Michael Welch



NiCd Electrolyte Mixing

I love the magazine! As I read the articles about mixing electrolyte for NiCd batteries, and then mixing up a batch, I find that the references for the quantities of KOH per gallon were in pounds. I believe the units should be in kilograms (i.e. 1 kg per gallon instead of 1 lb. per gallon). I started mixing 100 lbs of KOH into 45 gallons of water. My room temperature specific gravity is about 1.184 by two different hydrometers! The specific gravity of representative electrolyte is about 1.21! Timothy Hiebert, Temple, Texas

Thanks for setting the record straight, Timothy. You are right the correct amount of KOH is over two pounds per gallon of distilled water. Since the bottom line when mixing alkaline electrolyte is specific gravity (you are correct about 1.2 is just right), I have never paid much attention to the weights and volumes involved. Just mix it up until the specific gravity is right. Richard Perez

Dr. Acrobat

Home Power Staff: Hi Guys! I subscribed to *Home Power* a few weeks ago. I bought the Solar2 CD and all of the back issues from #43 to present. I have already read through a large number of them.

I have a few comments about an ongoing debate in *Home Power*. I have a 17 inch monitor on my computer and I still find it hard to read an electronic publication. Adobe Acrobat is a wonderful program but it is just not the same as the paper version. The Acrobat versions should be used as a supplement, not as a replacement for the paper version of *Home Power*. As to pricing, I think that you should definitely attach a fee to the downloading of the electronic version. Particularly if it is a current version.

I am very impressed with the Solar2 CD. I highly recommend it to others. It is a very nice product and ran flawlessly on my Pentium computer. Having the index on the CD makes doing searches much easier. Plus, as some of the other readers have mentioned, it is much easier to put in the CD than to search through 30+ back issues. As a matter of fact, I will be buying Solar3 as soon as you release it.

I think that you have a very impressive publication. The articles are very informative and appear to be very well written. Keep up the good work.

I have one other comment that I have debated about including, but, here goes. As you may have noticed from my signature, I am a Doctor. I worked extremely hard for over 6 years and spent a very large amount of money to earn the right to use that title. I find it somewhat offensive when other people use that title but have not officially earned the right to use it.

I realize that your “Dr. Doug” has probably devoted many years to learning the field of RE. However, that alone does not give him the right to call himself a Dr. Being a Dr. is a professional designation that is bestowed upon you and I feel that the title is almost like a badge of honor. I am quite proud of my accomplishments and I deserve the distinction of using that title. It cheapens it for me and for others when people use the title Dr. without having earned it.

From what I have gathered “Dr. Doug” is probably a fictional character. If so, then I apologize for going on this little rampage. However, I just thought that I would share my feelings on this matter with you. Thanks, Mark A. Lane, PhD • drlane@BGNet.bgsu.edu

Mark, thanks for your feedback on the Solar2 CD and using Acrobat. We agree that at this time Acrobat is not a full substitute for the paper version but that it can be a good complement. We continue to experiment with the electronic edition and how or if to charge for the current EE issue.

As for “Dr. Doug,” he is a real person, but not connected with Home Power in any way. You are referring to a column, written by Doug, in Real Goods’ catalogues. But, I too have a beef about the title Doctor. Many (not necessarily you) people that are entitled to use the title are no more competent than the rest of us which could lead to a false sense of expertise. Someone with a Doctorate in Electrical Engineering may not even be capable of wiring two PV modules in parallel. But I can, even with a BA in Business Administration.

To avoid confusion, I think the title should only be used in public by medical doctorates that have successfully completed their internships. It could also be used for non-medical doctorates within academic circles, but leave it behind when stepping out of the hallowed halls. Michael Welch

Pension and Church PV

Is it possible to use our pension plans (IRA, etc.) for the financing of renewable energy as a home improvement for our existing homes or vacation homes? It appears that the tax laws allow the use of these funds for this purpose. This method would be extremely effective economically in states or areas that also provide for tax credits for the installation and use of renewable energy.

Thus, by using our own pension money, it is equivalent to buying the renewable equipment at a reduced price, because the money put into the pension fund reduces our income taxes at the federal and state level. Also, in areas that have net metering and much potential renewable energy, the pay back period and money saved would amount to quite a lot.

I am not extremely knowledgeable on the current tax laws, and I do not live in a state that promotes renewable energy, such as California.

Another interesting possibility is use of church donations for renewable energy for church property. When I donate money to various religious organizations, I specify that the money be used for the purchase of organic food for the soup kitchens or the food banks. Thus, the money donated meets my religious requirements, but the money does not go to the purchase destructive products or to corporations that are ravishing the environment. Are there any organizations that will accept and use money for the purpose of renewable energy on church (temple) property? Good luck with your publication, John Commons

Great question, John. How about it, readers? Does anyone out there have the expertise to detail the pension PV home improvement possibilities? We, the Home Power *Crew, are low budget types. Our financial expertise is limited to getting out of the supermarket without having to put stuff back because we haven’t enough cash at the register. Richard Perez*

Dear Home Power:

Greetings from Jamaica. My name is Eric Leversen, and I’m a Peace Corps volunteer working in the sunny southern hills of this lovely island. I do most of my work at a Munro College, a boarding school for boy’s 12 to 18 which uses the English form system. My responsibilities center around the environmental club, environmental concerns on campus, and managing the school’s computer lab. And a surprise which you’ll read about below.

A year ago, I asked for a subscription for our school library which you graciously donated. Thank you again. The other day, however, the latest issue came and as I checked my label, I noticed time was up. Time to renew. So I decided that to justify the issues you’ve given us, I’d write a report on what the school has done with all that great information.

Turbine—First, let me tell you about what RE was here already. On December 5, 1996, a 225 kW Vestas V-27 wind turbine was set in motion as an income generating project for the school. And yours truly has been managing it since January of last year. If you had told me before I came here that I’d be in charge of a wind turbine I would have said “What’s a wind turbine?” But, I love it. What a great insight it’s given me into energy and renewables. (Check it out at www.toj.com/~munrot/turbine.htm)

To date we've produced about 900 MWh in just under two years, made some money for school improvements, and, by my calculations, we've displaced 500 barrels of imported oil. Jamaica last year spent US$450 million for a population of two million on oil for electricity generation. Solar and wind hold such promise for this nation, but the powers that be don't seem to have the political will to encourage their use. (Sound familiar?) To put Jamaica in perspective, Barbados, a country with 1/10th the population, gave a tax credit for solar water heaters a few years ago. Today, they have ten times more solar waters heaters than Jamaica. I'd love to know what amount of the all important foreign currency was saved by this forward thinking move.

Windmill Pump—One nice thing about Munro College is that, in its 150 year history, it has always been an innovator and leader. That is true of the wind turbine today and the windmill used to pump water from the 30's to 60's. Unfortunately it was replaced with an electric pump when the grid was extended to our part of the island and it was called progress. Well, that progress today has left burned-out pumps attached to a poor electricity supply. We would love to restart such a project, but today there is a 60 foot building in back (as the wind blows) of the catchment tank we want to pump from. The wind is mainly from one direction, but not always. Is there any hope?

Another alternative is to pump from a different catchment tank (we have five with a total capacity of 600,000+ gallons for the 900 people on campus daily and 300 night boarders). This tank is unobstructed except for a one story building 40 feet to the east. In fact, there are three tanks each with a side within 10 feet of the other two. What options are there for pumping from more than one tank? Where can I go for more information? Or how about the using a solar pump for the above job?

Solar Heating—And speaking of solar, our environmental club is going to use the diagrams found in HP to preheat the water for our kitchen. We are just stuck on what to use for a storage tank. Since it will be placed on top of a building, the usual concrete is going to be too heavy, I think.

Solar UPS—Our thirty-two unit computer lab obviously needs clean, stable power and a quality UPS system. Unfortunately we have neither at the moment. We are, however, researching a system with an inverter and batteries which would allow us to use the grid to charge the batteries, thereby giving us a UPS and nice clean power. Gradually we'll install solar panels to phase out the grid altogether. In a year or two (or three...) we'll be independent from oil, although we'll remain hooked up in case of low sun periods.

Let me close by echoing the thoughts of other readers. Thank you a million times for the information you provide. I certainly respect and appreciate your philosophy of teaching and giving others RE information to make our Earth a cleaner and greener place. Peace and Renewable Energy, Eric Leversen and the entire Munro College Environmental Club., US Peace Corps/Jamaica, Munro College, St. Elizabeth, Jamaica • munroeric@toj.com • Web: www.toj.com/~munrot

Living with Solar Electricity is Like Owning a Car.
Dear Richard, Karen and Crew too! Selling an energy independent house is one learning experience after another. It has become apparent that we needed a quick and easily understandable means to present 'solar' electricity without getting into a debate about either economics or ecological practices. If you think it has merit and use for *Home Power*, share it with the rest of those who might benefit from a bit of a "prepared" thought. Oh yeah - a BIG HUG and many thanks for our subscription. We really appreciate it and USE it too!

If you have a car, you can just as easily live with a solar electric system. While a car serves to transport, electricity provides power to run equipment like appliances, tools, and entertainment items. A car is fueled by gas while electricity is mainly fueled by indirect solar sources (hydro, fossil fuel, and wind) and now with photovoltaic panels by direct solar (sunlight), too. In a car the gas gauge lets the driver know the fuel status. Solar electric systems have meters to show fuel (electricity) storage and availability. Car general maintenance consists of periodic checking of the fluids (radiator, battery, brake, wiper, etc.) and cleaning of wind shield. A solar electric system's maintenance also requires periodic checking of battery water levels and cleaning of the glass on the PV panels.The initial price of a car can best be broken down into 3 subcategories: economy ($9000 to $14,000), standard ($15,000 to $24,000) and luxury ($25,000 and up). Likewise can the initial cost of solar systems be classified: economy ($1,000 to $4,000), standard ($5,000 to $14,000) and deluxe ($15,000 and up). The performance life expectancy of a car is around 150,000 to 300,000 miles depending on use and maintenance—about 15 years. Solar electric panels now come with 20 year warranties. The actual life expectancy of PV panels is not established since there are many with already over 20 years of use and still going strong. No moving parts plus the stability of silicon crystals make for a solid and long term functioning item.

But while most people are willing to pay for transportation "up front," buying a personal source of power (electricity) has not been the norm. And while a car has additional costs of tires, license, insurance, and repair (wear to moving parts), a solar system has none of these added on costs and in fact pays back its initial investment by freeing the user from an electrical service bill each month. Yet people do buy cars but don't 'buy' their electrical supply. Why?

Electricity is available to most people for a pay-as-you-go monthly bill, but so are rental cars. Why buy one and not the other? Because people have become comfortable with owning and managing a car, but don't have experience with handling electricity beyond plugging a cord into a socket. Cars have also come to represent convenience, independence, and prestige. Then why not take advantage of a bus which frees a person from operation and maintenance responsibilities? Riding in a vehicle that costs $150,000 or more sounds prestigious too. But what about convenience? Only a personal car can be available on demand whereas a bus is tied to a route and schedule. But isn't electricity always available so why have the hassles of its management? Independence is a main factor, convenience is realistic, too, with outages quickly managed on site. And prestige comes a bit later when you can afford to buy the next car because you aren't paying and paying for electricity rental. Sincerely, Katcha and Bill Sanderson • sandbill@garlic.com

Hey, Katcha and Bill, your analogy is right on! Here are some other thoughts on this analogy. Just about anyone can waltz *into their bank and get a loan for a new car. A new car which will probably be becoming junk just about the time the loan is paid off. A new car which pollutes our planet, and costs its owner with every visit to the gas station. And yet your bank is happy to lend you money for this scenario. Instead try asking for a loan to purchase a solar electric system. A PV system which frees you from monthly electric power bills. A system which does not pollute this planet. A system that is so long lived that you will deed it to your children. A system with virtually no operating cost. The bank will mostly likely say no. So solar systems are self-financed by most folks (read that , "We bought the PVs one or two at a time as we could afford it."). This is more financially sound than borrowing the money and paying the interest! Richard Perez*

Fuel Cell Technology and Independent Testing of "TtW!"

I would like an article on the developing fuel cell industry that auto makers are starting to invest in. For example, Daimler Benz bought 25% of the Vancouver, Canada Ballard Power and will also have fuel cell buses in Chicago in 1998.

Also, I like your column, Things that Work! but feel you could improve it by receiving items for testing through a third party so the manufacture doesn't know it will be tested. In my own independent testing of two Sunfrost RF19 refrigerators, I've found they don't come close to the specs claimed, but I still own one. N. Markovitz, Lewisburg, WV

Most of the products we test for "Things that Work!" are purchased on the open market. We have had "ringers" shipped to us by manufacturers in the past. We try to be as objective and fair as possible in this testing process. On the Sun Frost RF-19, we purchased ours directly from the factory and have been using it for over five years now. For over four years we have had a data logger recording its energy consumption. Our RF-19 consumes an average of 980 Watt-hours per day. This is right on Sun Frost's specifications. I'll see if we can come up with an article about the fuel cells used in EVs. Richard Perez

Hydro Pipes

I enjoy the magazine. I especially like the hands-on projects and I have built several.

After reading about the trip to MREF in the RV, I have decided to keep the old 1971 VW camper awhile longer. What ever happened to SEER here on the west coast?

Here are a couple of suggestions on hydro power. Be sure to have the pipe full of water before the flood comes, otherwise the pipe floats up out of the ground. After we reburied the pipe we had a second flood which washed gunk into the intake which closed it off. Water continued to flow out the bottom end which caused a vacuum that in turn caused the pipe to be crushed. We replaced part of the pipe but there is still a break deep under ground and we no longer have a backhoe.

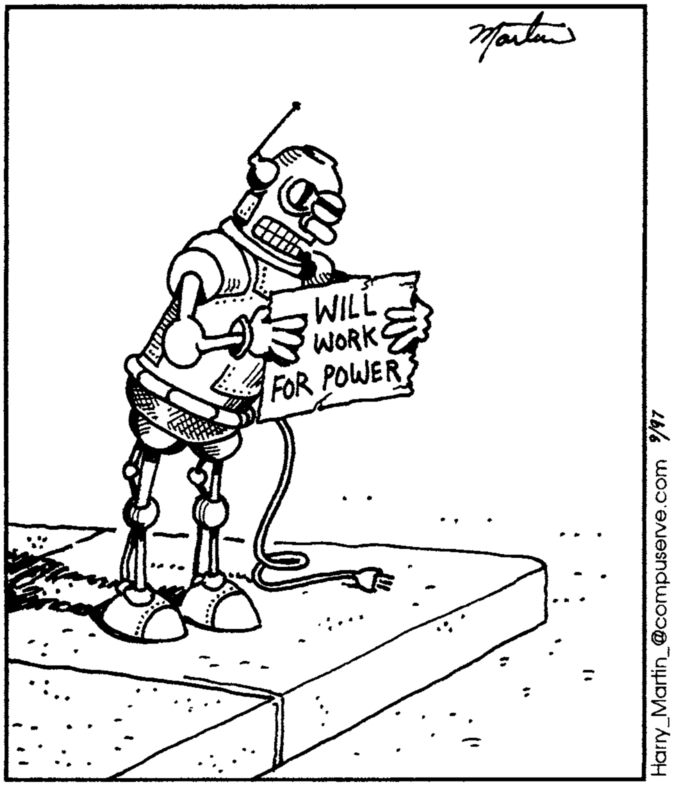
I belive this problem could have been avoided if we had placed a "T" just below the intake with a pipe extending above the high-water line in the reservoir so that the pipe could have sucked air when the inlet became clogged. David Marsh, Eagle Point, Oregon.

Hi David. Great suggestions on hydro piping. Vacuums, and their opposite which are water hammers, can easily ruin the pipe. Not only are vents good, but also close any valves very slowly so as not to induce water hammers (hydraulic pressure surges). With regards to SEER, the core group was disorganized, factional, and financially silly. It is a mystery to me why the area with the most independent PV systems cannot sustain an Energy Fair. All of the SEER Fairs were well attended by over ten thousand people. Everyone had a great time and got swell deals on RE hardware. But somehow, the group was unable to keep it together. See you at next years MREF which is as reliable as a PV panel. Richard Perez

Contribute to Home Power

It is my hope to be a contributing writer for your magazine. Several articles could be taken from my web page that would be good things to know. If you want to use the article about "High Wind Conditions" and supporting diagrams. People would learn how wind turbines survive gale type winds. One of my working diagrams shows a side view of the Jacobs machine. Doug Johnson, Green Bay, Wisconsin • Web: www.baywinds.com

Doug, we'd love to receive articles from you and other readers in your areas of knowledge and experience. That is what Home Power *is all about—we are a hands-on users' journal. But, we do have a policy of not publishing articles that have been published elsewhere. We feel that printing only new and original info best uses our limited resources. For further information, see "Writing for* Home Power*" on page 104. The Crew.*



Writing for *Home Power* Magazine

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

Informational Content
Please include all the details! Be specific! We are more interested in specific information than in general information. Write from your direct experience—*Home Power* is hands-on! Articles must be detailed enough so that our readers can actually use the information.

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

Written Release
If you are writing about someone else's system or project, we require a written release from the owner or other principal before we can consider printing the article. This will help us respect the privacy rights of individuals. Please call us for a form for this purpose.

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

Photographs
We can work from any photographic print, slide, or negative. We prefer 4 inch by 6 inch color prints which have no fingerprints or scratches. Do not write on the back of your photographs. Please provide a caption and photo credit for each photo.

Line Art
We can work from your camera-ready art. We can scan your art into our computers.

We can redraw your art in our computer. We usually redraw art from the author's rough sketches. If you wish to submit a computer file of a schematic or other line art, please call or E-Mail us first.

Got a Computer?
Send us your article's text on 3.5 inch computer floppy diskette, either Mac or IBM format. We can also read ZIP disks (either Mac or IBM), and Magneto-Optical disks (128 MB, 230 MB, 1.2 GB and 1.3 GB all Mac only). This not only saves time, but also reduces typos. Please also send a hard copy printout of your article. Save all word processor files in "TEXT" or "ASCII TEXT" format. This means removing all word processor formatting and graphics. Use your "Save As Text" option from within your word processor. Please don't just rename the file as "text" because it will still include unreadable (at least to us) word processor formatting.

You can send your article via modem either to the *Home Power* BBS at 707-822-8640 or via Internet, as an enclosed ASCII TEXT file. On our BBS, address the message with the enclosed file to: Richard Perez. The E-Mail address is: richard.perez@homepower.org .

It is wise to telephone or E-Mail ahead of electronic file submission. This is particularly true concerning graphics files. There are many, many, many ducks and they all need to be in a row....

Got any questions?
Give us a call and ask. This saves everyone's time.

Access
Richard Perez, c/o *Home Power* Magazine,
PO Box 520, Ashland, OR 97520 USA
Voice Telephone: 916-475-3179 (during West Coast USA business hours, otherwise you will get an answering machine)
FAX: 916-475-0836 (24 hours a day)
Internet E-Mail: richard.perez@homepower.org

Ozonal Notes

Richard Perez

Hot Showers at Funky Mountain Institute (FMI)!

After 27 years of bucket baths, spit baths, jumping in Skookum Creek, and Mickey Mouse solar showers hung in trees, the Funky Mountain Institute now has hot running water and a dynamite shower. See the article by Joe and Ben on page 12 of this issue. It's been worth the wait. Right now the hot water system is strictly powered by propane, but solar hot water is coming up quickly. We have space on the roof (28 feet wide, 9 feet high and facing South at 45°) for two and possibly three solar hot water collectors. I'm thinking of starting out with the high tech Thermomax collector because it is a known performer in our neighborhood. It gets cold here. As I write this on 29 December 1997, temperatures at night have been falling to 5°F. The other slots are open and I'd like to hear from you, our readers, what you think we should put up and test.

We've designed the bath house as a test bed for solar hot water systems. The concept is that the current "king of the hill" goes into slot 1 and other "challengers" can occupy slots 2 & 3 while trying to best the "king." We are planning for each collector to have its own, identical, 80 gallon tank with heat exchanger. We are planning on installing computerized A/D temperature recording on each tank. Then we will be ready to do solar hot water collector shoot-outs and, as a side benefit, get lots of solar hot showers for the Crew.

Joe, Ben, and I are planning on writing many more articles about this building and the operation of the systems and devices within it. Here's just a quick look as it is now.

Dealing with Low Water Pressure

We have been terribly afraid that the water pressure from our above ground storage would not be sufficient to drive the various appliances in the bath house. Right now only the shower and clothes washer are operational, but a huge and ancient cast iron bath tub is coming up. Ben and Joe installed a water pressure gauge on the incoming, one inch diameter, water line and the pressure is eight (8) pounds per square inch (PSI). Most town and city water systems deliver about 40 PSI to homes. We were worried that the new Sun Frost Low Power Shower and Staber System 2000 clothes washer would not work well with water pressure that low. In fact, the Low Power Shower did have trouble dealing with the low pressure. Instead of showering, it drooled. A quick meeting among the budding hydraulic experts (after all, we had at least a week on the job), we decided that the whole shower's plumbing was of insufficient diameter. Joe attacked the low flow shower head with a 5/16 inch drill bit and bored out its 1/8 inch apature. (It may been low flow at 40 PSI, but at our 8 PSI it was virtually no flow.) And like magick, we had a shower which was powerful enough to get the soap out of your hair. We are planning on replacing all the small gauge (1/2 inch diameter) shower plumbing with 3/4 or 1 inch diameter pipe. Low pressure plumbing is a lot like low voltage wiring—big conductors. We haven't fired up the Staber washer yet, but a call to Staber revealed that their specified minimum operating pressure is 3 PSI. Now, these are my kind of folks, they understand how to use energy wisely. Consider that most clothes washers won't operate below 30 PSI. Consider that we would have had to buy and install some $1,200 worth of water pressurizing equipment to raise our 8 PSI (provided reliably and for free by gravity) to a higher pressure. With the modifications to the shower, we won't need to pressurize the incoming water. We can use the inherent energy of gravity instead.

I want to thank all the HP readers who responded to my requests for info on hot water plumbing. Thanks to you sharing your experiences, we managed to avoid many novice plumber's mistakes. We used CPVC pipe to plumb the hot water system and it worked great. Ben and Joe did the assembly and they said it was way easier than soldering copper pipe. There were no leaks in the CPVC plumbing, but we had several to take care of in the mechanical, screw-in, fittings.

Solar Space Heating

On the solar space heating side, the building seems to be working well. We installed a minimum/maximum, recording thermometer. The building never gets below 34°F, even when the outside temperatures drop to 5°F at night and there is no sun for three or four consecutive days. Inside day time temperatures are in the 65° to 70°F range with outside temperature around 35°F. Joe and Ben are still working on the building's envelope which is now far from tight. We still have much air infiltration which needs to be sealed. The insulation below the rock bedded in sand floor is yet to be installed. We are looking for ideas on window quilts to reduce night time thermal losses through the windows. When this bath/green house is finished it's going to be toasty warm with solar energy alone. I'll keep you posted on the developments and conclusions.

I can only imagine soaking in the hot bath tub, surrounded by all of Karen's plant friends, and looking at 14,161 foot tall Mt. Shasta sixty miles away through the huge south-facing windows. It's a really nice space, and it is turning out to be worth the 27 years it took us to get it together (with more than a little help for our friends...).

No More Mr. Nice Guy!
We started Home Power on a dream in April of 1987. Our first issue hit the streets in November of 1987. The Energy Establishment [here read: the solar industries, utilities, governments (local, state, and federal), government agencies (small business administration, energy extensions, and national laboratories), and banks], and most of our friends, told us we were crazy. No one was interested in small scale renewable energy.

Now, just over ten years later, we inhabit a new world. The world of a "million solar roofs", deregulation of utilities which yields green energy options for consumers, and a radically heightened public awareness of energy's relation to our environment and personal freedom.

In the beginning, all the folks who told us we were crazy, advised a conciliatory attitude to the Energy Establishment. They told us that governments fostered solar energy research, and that the utilities were on the leading edge of solar energy development. They asked us to make nice with the Energy Establishment claiming that this Energy Establishment was our best bet for solar energy and environmental change. I am ashamed to admit that we believed them.

In the last ten years, I have seen government repeatedly subsidize planet-killing technologies such as nuclear power. I have seen the American government fight a war to ensure its oil needs. I have seen our government support the utilities strangle hold on energy over the individual's right to energy almost every time. I have seen utility scale, mega PV projects designed, from their very conception, for failure. I have seen utilities fighting, with all their wealth and power, to hold on to their polluting monopolies. I have seen our, home-made, renewable energy refused by utilities due to greed and technicalities. I've had it. A wise man knows who his friends are….

I am feeling much as I did in 1969. Governments can be our enemies—they can enslave us. The military/industrial complexes favor profit over life every time. The Energy Establishment is dedicated to control, profit, and pollution. After years of making nice, I am finally realizing who my friends are….

If I were the only one feeling these feelings, I'd admit to being paranoid and maybe seek a shrink to get my head straight. But I'm not the only one who feels that making nice with the Energy Establishment is kissing our enemies while they stab us, and our planet, in the back. See the IPP column in this issue on page 76. Don Loweburg, the author, is a reasonable and peaceful human. He took on the tough job of interfacing with Energy Establishment. He is our master of politics and diplomacy. Read his article and understand radical realizations. Read the editorial by Jim Bell on page 86 of this issue. Read the Letters from HP readers printed in this issue. Many people realize that the Energy Establishment is THE major barrier to renewable energy.

So what do I do now? Well, I will keep putting up PV modules and get going on the new, bigger, wind generator. These are radical and revolutionary acts we can all perform. If I had the grid here, then I'd be in court suing my utility to buy my surplus energy at a fair price and without unreasonable technical requirements. Every PV module, wind genny, and microhydro are small, but powerful, battles which affirm our free access to renewable energy sources and our belief that this planet must survive. Need help? Well, don't look to the Energy Establishment, look to your friends and to the friends of this planet. We, at Home Power, will continue to publish this magazine informing all who will listen about renewable energy. While I realize that this is a small and partial solution to a very big and complex problem, it is what we can do. And we will keep doing it!

Access
Author: Richard Perez, c/o Home Power, PO Box 520, Ashland, OR 97520 • 530-475-3179 • FAX: 530-475-0836 • E-mail: richard.perez@homepower.org
Web: www.homepower.com
Hams: N7BCR 146.400 MHz FM Simplex

**The time is now.
The time is right.
Use the Sun for
Light at night.**

**If you don't do it
No one will.
And you'll be feeding
Your utility bill.**

Q&A

M53 PV Diminished Output
Greetings, we're *Home Power* fans and would really appreciate your advice. Our Arco M53s have a diminished output after eleven years. In spite of the 24V configuration, we experience a considerable voltage drop over the 400 feet between the solar panels and the house. We hope to augment the carrying capacity by adding a #4 wire alongside the original #1.

To do this should we simply connect the supplementary cable to the original cable at both ends, or should I bond the two here and there along the run?

Further, in the interest of saving a few bucks, why should the negative cable be as large as the positive? Is it not just returning the overflow, or as it were, most of the force already spent charging the batteries — limping back up the negative feed or trickling into the ground? Sincerely, Harry Clarke, Calistoga, CA

Hello Harry. Without knowing the amount of current you are transferring, I cannot say how badly your PV cables are undersized, but they are obviously undersized. I normally specify PV cables for no more than 2% voltage loss. The length of your run is 800 feet (round trip). At 24 VDC you can only move about 5 Amperes of current before having 2% voltage loss in your #1 AWG cables (assuming that they are copper and not aluminum). You need bigger cables. Paralleling a single #4 cable as you suggested will have little effect on the voltage loss in this circuit. Consider adding two (both positive and negative) cables of at least #1 AWG or larger depending on how much current your array develops. Bond the paralleled cables at the array J-box and again at the fused disconnect before entering the charge controller.

There is exactly the same amount of current flowing in both the positive and negative cable. The negative cable is just as important as the positive. You have a series electrical circuit and Kirchoff's Law tells us that the same amount of current flows in each conductor. Making the negative cable smaller than the positive will only add resistance to the circuit. The total resistance of the cable is the sum of the positive cable's resistance and the negative cable's resistance. Voltage loss can and will occur in each cable, so keep them both equally large in gauge. Richard Perez

More M53 Problems
I power my home with Arco M53 modules which have gradually changed from blue to brown, with some loss of power. I assume that this is the result of intense summer heat here in Tucson. I'm planning on buying more PV modules soon. Has anyone done research on which type of modules survive best in desert conditions? i.e. single crystal (Siemens, etc.) vs. multi crystal (Solarex), what to avoid, etc. My modules have good circulation around them, so that's not the problem. Eric Mellen, Tucson, AZ

Hello Eric. The browning of your PV modules is due to outgassing by the pottant ethyl vinyl acetate (EVA) used in the module. The pottant outgasses acetic acid (vinegar) and this acid attacks the anti-reflective coating and the metallic conductors on the cell's face. This problem is worst in hot areas and really bad if the modules have been used under concentrators (mirrors). EVA is falling out of favor as a module potting material for this very reason. Check with the maker of your proposed new modules and make sure they are made with something other than EVA.

In terms of high temperature performance, the single crystal cells (such as BP and Siemens) show less voltage droop and power loss when hot (>50°C) than do the multicrystal cells (Solarex and Kyocera). The king of high temperature performance is the new triple junction, thin film PV made by UniSolar. These modules actually slightly increase power when they get hot. All this data is from our direct testing of these PV technologies on our democracy rack. Richard Perez

Measuring PV Power
I need to see a way to measure Watts off an individual solar panel. If it says 64 Watts at the high point of a sunny day, there should be an easy, inexpensive way to tell if this is true or higher or lower. If so, what, where, how much money? Donald Brown, Volcano, CA

Well, Donald, it's pretty easy to measure the power output of a PV module. You will need a digital multimeter (DMM) to make the two required measurements—voltage and current. You can spend between $100 and $350 for a good DMM. Both measurements are made with the module under load, i.e. charging the battery. See my article on DMMs in HP*#60, page 42, which details how to use a DMM to measure short circuit current and open circuit voltage of a PV module. Since you want to measure actual power output, the test procedure is slightly different. Both of these measurements must be done with the PV module wired into both an array (if there is more than one module in the array) and with the module actually charging the system's battery. Make sure that any charge controller in the system is not regulating when you make both measurements. Measure the voltage of the module at its plus and minus terminals. Next* *measure the current that the module is producing by inserting the DMM in series with either the positive or negative wire connecting the module to the rest of the array and thereby to the battery. Multiply voltage times current and you will get wattage, or the power being produced by the module.*

Be advised that there are several factors which can effect the accuracy of this test. First is the series resistance of the wires between the module (or array) and the battery. See the first Q&A in this column for an example of too small cables (and high resistance). The resistance of the wiring connecting the PV(s) to the battery can limit the amount of current the module or the array produces. So, wire size, wire length, and any funky mechanical connections can all affect the amount of current the PV(s) produces. It is more likely that there will be problems with the wiring than that the PV module is failing to deliver its rated current. The second factor affecting module power production is temperature. PVs are rated at 25°C while in fact they routinely operate at 50°C or more. As the temperature goes up, the power goes down. See the second Q&A in this column. The third factor is solar insolation. Without a device such as a pyranometer it is difficult to know just how much sunshine is reaching the module. It is best to do the testing on a totally cloud free and haze free day. The forth factor is module orientation. Make sure the module is perpendicular to the sun when testing its output power, otherwise the measurement will indicate low power. Remember sunlight is the fuel that drives PVs. If the module is not directly facing the sun, then you will not get full output. The fifth and last factor affecting this measurement is battery voltage. Since PVs are essentially constant current sources, their voltage will be that of the battery less cable and charge controller voltage losses (and there are always some). The PVs will seem to make the most power when battery voltage is high. If you are really serious about testing a module, then the best way is to run an IV curve (current vs. voltage for various voltage levels) on the module. See HP*#23, page 20 for complete instructions on how to do accurate IV curves. It's easy and uses the same DMM you will need for in circuit tests. Richard Perez*

RE: the question on graywater systems in Q & A in the Dec./Jan. issue in which you referred the questioning reader to Art Ludwig. I have an operating graywater "oasis" that I set up after reading Art's book. The only problem has been finding a place that sells the household cleaners made of plant nutrients that Art formulated. Health food stores in southern California commonly used to carry them. In recent years I have been unable to find the Oasis line of products. Your reader's question prompted me to investigate further into relocating a source for them. I called the phone number you listed for Art—a new number, different from the one in his book—and got his associate Laurie. Art is out of the country briefly. Laurie told me that he sold the plant nutrient cleansers to Bio Pac. Their phone is 800-225-2855 and they sell the cleansers by the case. You can also get these cleansers in single quart or gallon bottles from Real Goods at 800-762-7325. Remember, graywater containing regular detergents and cleansers is harmful to plants—Oasis cleansers nourish plants. Penny Harper, Hinkley, California • E-mail: lizardha@sprynet.com

Home Power MicroAds

Rates: 10¢ per CHARACTER, include spaces & punctuation. $15 minimum per insertion. Please send check with ad. Your cancelled check is your receipt.

Help us prevent fraud! Home Power MicroAds from individuals must supply serial number(s) for equipment being sold. Businesses must supply a published phone number(s) and a physical address. If at all possible, please pay for your ad via personal or business check or credit card.

While Home Power is doing everything we can to prevent fraud, we can assume no responsibility for items being sold.

USED WIND GENERATORS, Towers, Inverters. Many systems in stock, including several 12.5 to 20 KW Jacobs with utility intertie inverters & 100' free standing towers. We repair & make replacement parts & blades for many older wind systems, including pre-REA Jacobs & Winchargers. All rebuilt equipment comes with our one year warranty & technical support. For the do-it-your-selfer we also have "as is" equipment available. Call or write to Lake Michigan Wind & Sun, 1015 County Rd U, Sturgeon Bay, WI 54235, 920-743-0456, (Fax: -0466), LMWANDS@itol.com

PURE CASTILE & VEGETARIAN SOAPS. Handmade in an AE environment. We also have hard to find natural bath & body care products. FREE catalog: SIMMONS HANDCRAFTS 42295 AE, Hwy 36, Bridgeville, CA 95526

HYDROELECTRIC SYSTEMS: Pelton and Crossflow designs, either complete turbines or complete systems. Assistance in site evaluation and equipment selection. Sizes from 100 watts to 5 megawatts. Manufacturing home and commercial size turbines since 1976. Send for a free brochure. Canyon Industries Inc., P.O. Box 574 HP, Deming, WA 98244, 360-592-5552.

XXXXXXXXXX USED SOLAR MODULES XXXXXXXXX XXXXXXXXXXXX ARCO M-51 — $185 XXXXXXXXXXX XXXXXXXX 100 WATT QUADLAMS $359 XXXXXXXXX 900+ Ah Batteries, $60. EX 2000-12, 2 KW Inverter with 110 amp charger, transfer switch, 2 year warr. $950. New & used Equipment, Trace, Refrigerator, Meter's,.NiCds,will try to match anyone's prices. For free flyer call or write, Craig Eversole, 10192 Choiceana, Hesperia CA 92345, 760-949-0505. Trade-in,. M/C VISA Discover

AVAILABLE NOW FROM THE MIDWEST RENEWABLE ENERGY ASSOCIATION: Renewable Energy/Efficiency Directory. A great networking tool listing users, providers, networkers, educators and "do-it-yourselfers" in the RE fields. Send $5.00 (includes postage and handling) to: MREA, POB 249, Amherst, WI 54406.

START YOUR OWN TECHNICAL VENTURE! Don Lancaster's newly updated INCREDIBLE SECRET MONEY MACHINE II tells how. We now have autographed copies of the Guru's underground classic for $18.50, Synergetics Press, Box 809-HP, Thatcher, AZ 85552. (520) 428-4073, VISA/MC.

VERMONT SOLAR ENGINEERING — Over 16 years electronics & solar experience—Expert design & consultation, professional installation, sales & support, repair & upgrades — PV, Hydro, Wind & Domestic Hot Water. Do-It-Yourselfers welcome—price list available (no catalog at this time). Custom systems, kits & components at most attractive prices. Call Kirk toll-free, 1-800-286-1252, 802-863-1202(local), 863-7908(fax). PO Box 697, Burlington, VT 05402. Check Out Our Website for Attractive Trace & Siemens Pricing—www.vtsolar.com-Visa/Mastercard accepted.

CEILING FANS:The largest selection of DC Powered (12 & 24VDC) ceiling fans anywhere in the U.S. From traditional to modern, classical to custom design. For brochure and list of dealers send SASE to R.C.H., 2173 Rocky Crk Rd, Colville, WA 99114. Dealer inquiries welcome FAX 509-685-0535

INTERESTED IN INTENTIONAL COMMUNITY? Communities magazine offers complete, updated listings of intentional communities not found in the Communities Directory. Practical information about forming/joining community — alternative buildings & structures; getting off the grid, legal, financial & land options. Plus Eco-villages, Cohousing, decision-making, conflict resolution, successful communities, children in community, research findings on community living. Quarterly. $18/yr, $5/sample. 138-HP Twin Oaks Rd, Louisa, VA 23093. (540) 894-5798.

WIND/SOLAR/HYDRO ELECTRIC SYSTEMS. Propane refrigerators, ranges, lights & heaters. Diesel battery charger, Best buys on Inverters & Sun Frost refrigerators. DC Compact Lights, Pumps, Low cost DC motors, Grain mills, Tankless water heaters, Composting & Low flush toilets, Fence chargers, Solar cookers, Books, Shortwave radios & much more in $4 Catalog. Windmill Water & Hand pump Catalog $5. Food Catalog $3. KANSAS WIND POWER, Dept. HP98, 13569 214th Road, Holton, KS 66436"Since 1975" 785-364-4407 Discount Prices!

EARTH-SHELTERED HOMES This definitive manual by noted authority Loren Impson features detailed building instructions for the amazingly affordable and practical Ferro-Cement Dome Home. Only $15 from Sun Life HC 63 box 309, Mount Ida AR 71957

NEW SURVIVAL COMMUNICATIONS Book How to build communications systems. Covers all needs — shortwave radio, amateur radio, citizens band, scanners, federal weather, alternate news, satellite radio, equipment sources. How to build and use alternate emergency power sources, solar, generators, backup batteries. 200 pages. $24.00 Fast Delivery Priority Mail. MC or Visa. Call Universal Electronics 800-241-8171.

BUILD AN INDOOR OUTDOOR wood fired hot water heater/shower unit from a discarded gas water heater for around 100.00. For a 14 page detailed instruction manual, send $5.00 to CKB 2011 Colemans Canyon, Wimberley, TX 78676

STOP POISONING YOUR FAMILY, pets, livestock, home and our fragile environment with the Harsh Chemical laden products you are using!!! YOU Now have the POWER to DO something about it! Start using these Natural, Earth Friendly, Biodegradable and Totally NonToxic products Today! We have an Exciting assortment of Personal care products with pure Tea Tree Oil, a natural antiseptic, pain reliever and healing agent. Skin care products to protect your skin naturally. Health & Nutrition products that provide You with the right nutritional tools for Your body. Concentrated Home Care products to take care of Your everyday cleaning tasks + more! These products really work! The products and their ingredients are Never tested on Earth's Precious Animals. We really enjoy these products and so will You! If we all do a little, together, we can do Alot! Help us make a Big difference for our Fragile Planet! A portion of our Families profits as Independent Associates goes toward Renewable Energy Education! "Keep the Dream!!!" Distributors always welcome. Free catalogue & Distributor Info. The Silver & Bonnie Niewiadomski Family Homestead Farm, 102 River Drive, Plover, WI 54467, 715-344-0924

YOUR ALASKAN SOLAR EXPERTS! Complete source for Alaskan alternative power. ABS Alaskan, 2130 Van Horn Road. Fairbanks, AK 99701 907/452-2002, AK 800/478-7145

USED, SURPLUS AND DEMO Solar Equipment for sale at reduced prices. Inverters, Generators, Solar panels, Battery chargers and more. Discount prices on new equipment as well. Call or write us today for a free list of products, technical assistance or a free product or installation quote. 1-800-364-9941 Suntrek, 10629 138th Ave SE, Rainer, WA 98576

ELECTRIC POWER YOUR BICYCLE. Henthorn Regenerative Electric Auto. Simple Homemade Hydrogen. Plans catalog $1. DWFrench, POB 2010(AEHP), Sparks, NV 89432

JACOB'S 12.5 WIND TURBINES for utility interconnect on 80' towers. Guaranteed working but sold in "as is" condition. Complete with turbine, tower, inverter, tower wire & our technical assistance. Located in NM, MA & MI. $9500 each, plus freight. Price negotiable if you remove! Lake Michigan Wind & Sun, 1015 County Rd U, Sturgeon Bay, WI 54235, 920-743-0456, (Fax: -0466), LMWANDS@itol.com

FOR SALE: Photocopied reprints of Home Power issues 1–10 available. All proceeds will be donated to IRENEW. Call 815-469-5334 or e-mail Jeff_Green@msn.com. Sold only in sets of 1 thru 10 for $30 which includes shipping in most cases.

NEMO SUBMERSIBLE WELL Pumps feature Flojet pumps enclosed in rubber gasketed all metal cases. Complete Units low as $155. Case Kits just $50. Free Info Packet— Call 508-627-1319

I AM A SOLAR WHOLESALER looking for retailers to carry my solar electronic and hobby goods. Phone # (916) 486-4373. Please leave message.

VERMONT PV DEALER. David Palumbo/Independent Power & Light has been installing off-grid systems, and helping do-it-yourselfers (who buy their equipment from him) with free professional design advise for over 10 yrs. David offers free educational workshops (see Happenings). Trojan and Surrette batteries. FREE with battery purchase IP&L deep cycle battery instructions. Trace, Solarex, Siemens, and BP at fair prices. Large supply of wire and cable. Beware of "fast buck artist", slick talking, "lowest price anywhere" mail order company's who don't take the time to find out what you really need and can't spend the time on personal support and service. Buy from an honest dealer who knows the products and cares about your success in using them. David's installations are innovative, simple to live with, and successful. And our long following of do-it-yourself customers always come back for more because they can rely on getting straight talk, no BS, and the best service possible. "David is one of the original RE pioneers... he knows how to really squeeze all the energy out of a KWH!" Richard Perez hp#60). I P & L, 462 Solar Way Drive, Hyde Park, Vermont 05655 Call David Palumbo 802-888-7194. E-mail: indeppower@aol.com. Web site: INDEPENDENT-POWER.COM. No catalog requests please. Please call for appointment before visiting.

POWER VENT— BATTERY BOX Ventilator & Back Draft Damper. Positively vent battery gases to the outside and keep batteries warmer by stopping cold back drafts. Uses 2 watts, only when batteries are charging. Requires a voltage sensitive switch for control, standard in Trace SW inverters. Specify 12 or 24 volt. $74.95 + $6 S & H. For more details, contact Cone Construction, POB 52, Salida, CO 81201. 719-530-0718

ECOMALL http://www.ecomall.com: renewable energy resources, daily eco news & articles, eco companies/products, vegetarian restaurants, activism & links, eco chat, business to business, national solar database. To advertise or for more info, please call 212-535-1876 e-mail: ecomall@ecomall.com

COGENERATION CENTRAL Air conditioner for independent power homes. Do it yourself installation parts, plans, send $10.00 for info packet to: Petit Electronics, P.O. Box 996, Luling, LA 70070

DIRECT TO YOU SALE!!!! (no pickups on these items) Dometic(Servel) 7.7 cu. ft. propane fridge $1,019; Trojan L-16, $149; T-105, $65; all items freight extra. VT Solar 1-800-286-1252

CHINA IMPERIAL DIESEL Generator Sets. 6–40 KW. Free Brochures. County Line Engine-H, 1063 St Rt 545, Ashland, Ohio 44805

THERE BACK!! New modules 40 watt, 36, 4" single crystal cells with glass and alum. frames 17" X 38" X 1 1/2" $150 ea. New 70 watt modules 36, 6" single crystal cells with glass and alum. frames 21" X 47 3/8" X 1 1/2". U-Fixem's used 50 and 100 watt modules, 36 or 72 4" cells tedlar alum. backed $125 (13" X 52") and $250 ea. (26" X 52") 805-373-9433

SELLING WATER PUMPING Windmills. Send 5.00 for catalog. Muller Industries Inc. 1102 W21 Yankton, S.D. 57078 605-665-1924

OWN EQUAL SHARES of our cooperative herb farm in exchange for work on our energy projects. You can also use our shop and tools to start your own private energy business. 518-835-3211 E-mail:herb@klink.net

LIKE NEW 6Volt 9 AHR Gell Cell Batteries w/fuse + plug $14 each while supply lasts, 12v 20 watt Halogen Puck Lights $15 each, shipped UPS free, Replacement wind blades, new and used Wind Mills & Parts, New Jacobs 20KW w/100' tower $18,500 + freight Service, Installation and Consulting Anywhere Since 1982 Catalog $4, Bannertown Power & Light PO Box 92 Mayfield, NY 12117 phone/fax (518) 661-5445,
E-Mail: windsmth@computech-net.net,
Web Page: computech-net.net/altenrgy

LOW REVVING Generator info (http://www.onekw.co.nz), Email: al.forbes@onekw.co.nz Rotor Magnet Kit, Sugar Wine & Wine Vinegar Receipt—know exactly what you're drinking—make your own crystal clear wine for less than 50¢ a quart. Ph: +64-9-818-8967, Fax +64-9-818-8890/ M/C Visa AmEx.

USED TRACE U2624 (2600 Watt, 24 volt) inverter with Stand By battery charger and Digital Volt Meter options. Four years old, excellent condition $975 (was $1,750 new). Trace M1512 Marine Inverter, brand new, overstocked item need to move for $795 ($1,000 list price). Call David Palumbo at Independent Power & Light 802-888-7194.

WINCHARGERS, 24 to 36 volts, 800 to 1,500 watts, complete rebuilds or do-it-yourself projects starting at $100. Mountain Pass Wind, estb. 1981 in Montana (406) 222-1707

EV FOR SALE 1980 VW P/U truck. 144 volt Trojan 8-v pack w/pulse, Auburn Kodiak, ADC 9" motor, E-meter, tach., etc. 8000 elec. mi.. $7000. 714/744-4708. eesolar@oc-net.com.

WIND GENERATOR, Wincharger 3227 1500 watt @ 32 volt, very good condition, complete with original controller $875 Lynden, Wash (360) 354-5687.

IBM 510CS THINKPAD 486/50MHZ laptop (12V) computer RAM: 20MB, 200MG hard drive, passive matrix screen, one PCMCIA slot, with Backpack 4X external CD-ROM. $850. Call Steve @ (603) 284-7303

12 ISSUES OF FRUGAL Newsletters have about 500 ideas and cost up to $19.95 My 300 ideas are only $4.95 and you'll receive them all in one mailing! Send check to: Frugality Dept. HP P.O. Box 7 Athol, Idaho 83801-007, Idaho residents add 5% tax, read about the author on the internet, www.frugality.com

MAINE—Looking for house 2 acres or more, oil heat, woodstove, solar hot water, IF possible well, septic tank, low taxes call 1-413-739-7406 Leave message

RENEWABLE ENERGY BUSINESS 4 Sale in Costa Rica. Estb. 5 yrs., '97 gross $191k. Duty-free import. & manuf. license, vehicle, tools, inventory. $150k. Tel 011-506-289-4071 Fax 011-506-228-2295 email eneseesa@sol.racsa.co.cr

1992 GEO METRO Electric Conversion for sale. Complete system $10,500 Call 715-824-2069 7-9 pm

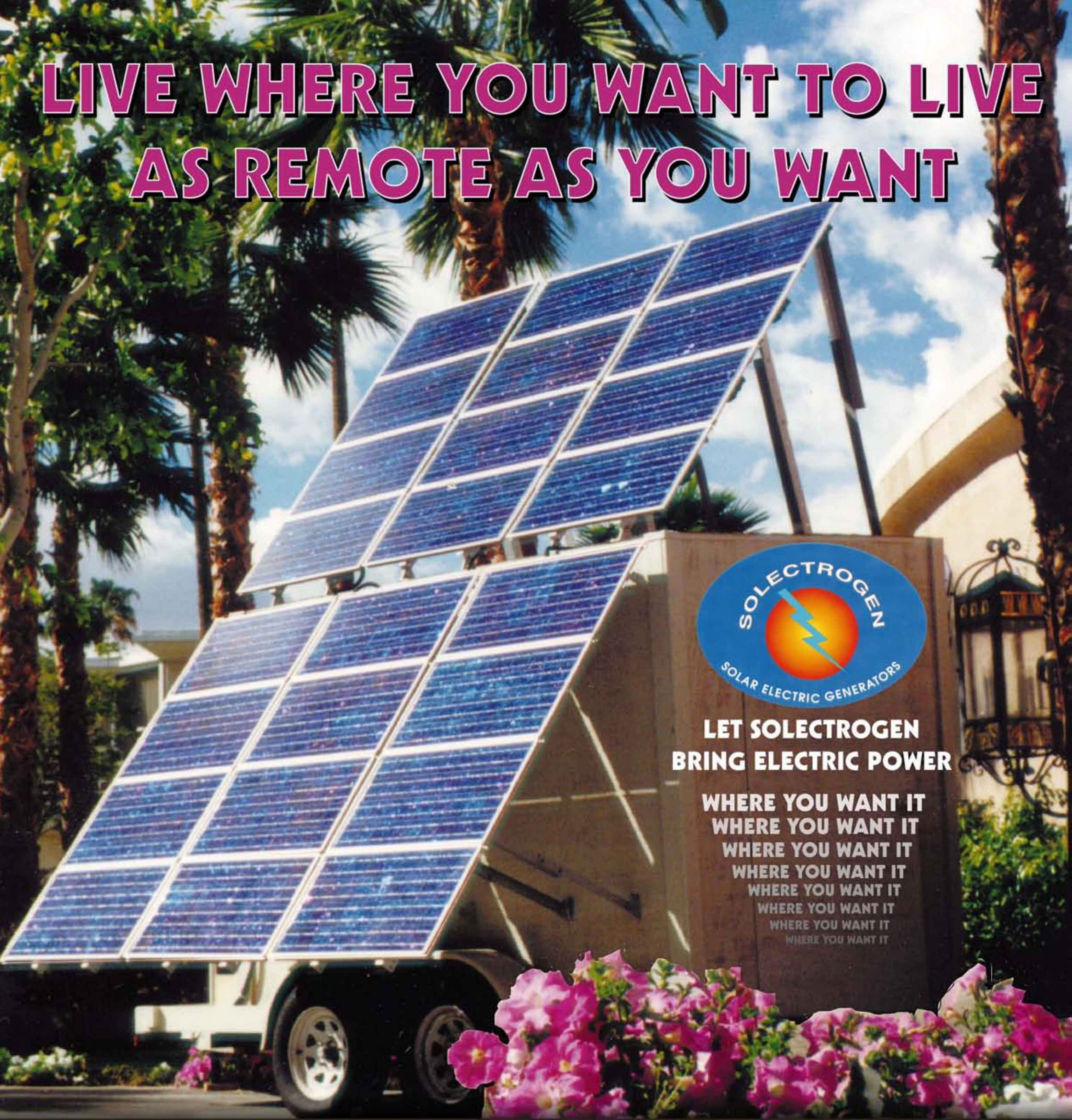
FOR SALE: Orig. Wind Stuff 32V. motors, 6 & 32 V chargers, comp. & parts, some new, manuals 1.5 KW Wincharger new in crate. Winpowers 1800 Jacobs SASE only W. Brawner, 6420 Sloan, KC, Kansas 913-334-4486

PROPERTY CARETAKERS/House Sitters enjoy rent free living. 500+ opportunities! The Caretaker Gazette, 1845 Deane-P, Pullman, WA 99163 (509) 332-0806, ONLY $24/year.

HOT H2O-2.5 gal 140Deg F per Min-Boiler-Direct Vent-has 100 lbs Copper Heat Exchanger, 4 gal hot reserve-can heat 2000ft home (125 K Btu) complete with: pump, expansion tank, exhaust pipe, and controls. $2000.00 17.5 KW Jacobs Totally-Absolutely Remanufactured with 120 ft galv tower, Master MInd rebuilt with 6 mo. warr+choke-salt water protected. Includes hinges. +31ft Carbon Fiber blades, del NoChg within 250 miles of Moscow, ID $16,575.00. 20KW Jacobs gen same rebuild as above $19,375.00 20 KW rebuilt Master MInd and Choke (shipping crate included) $2500.00 17.5 KW rebuilt Master MInd and Choke (shipping crate included) $2100.00. Used Master MInd Mother Board 3 mo. Warranty $350.00. Used on-demand Hot Water heater Junkers (Bosch) 117,000 Btu Nat/Gas $250.00. New, Round Elec. Meter 240V 3W Type J5S 30TA 7.2 Kh Sangamo $22.00. Set of 3 Jacobs 26 ft Wood Blades (half restored) (crate included) $1600.00 As-is Set of 3 Jacobs 29 ft Wood Blades (crate included) $1200.00 As-is Jacobs 10 kw stub tower (gear head j-box and Fiedelty alt) $2500.00. 120 ft Galv Advance Angle iron tower checked for flaws and new nuts and bolts, hinges, and unique "Big Shoe" ground foundation $6375.00. 80 ft galv Advance Angle iron tower (reworked same as above) $5500.00 Call 1-208-883-3676 10am to 20pm Pacific Standard Time

WANTED—Lightweight EV chassis. Prefer 3-wheel with regenerative braking. Solar boost a plus. Jerry Hapka, POB 984, Warroad, MN 56763. 218-386-2574.

Index to Advertisers


LIVE WHERE YOU WANT TO LIVE
AS REMOTE AS YOU WANT
SOLECTROGEN
SOLAR ELECTRIC GENERATORS
LET SOLECTROGEN
BRING ELECTRIC POWER
WHERE YOU WANT IT
WHERE YOU WANT IT
WHERE YOU WANT IT
WHERE YOU WANT IT
WHERE YOU WANT IT
WHERE YOU WANT IT
WHERE YOU WANT IT
WHERE YOU WANT IT