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HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

Issue #61 October / November 1997

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Richard and Stephanie Dutton built their SoCal organic farm from hand-made adobe brick. Their innovative forming procedure cuts drying time and builds muscles.

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Access and Info

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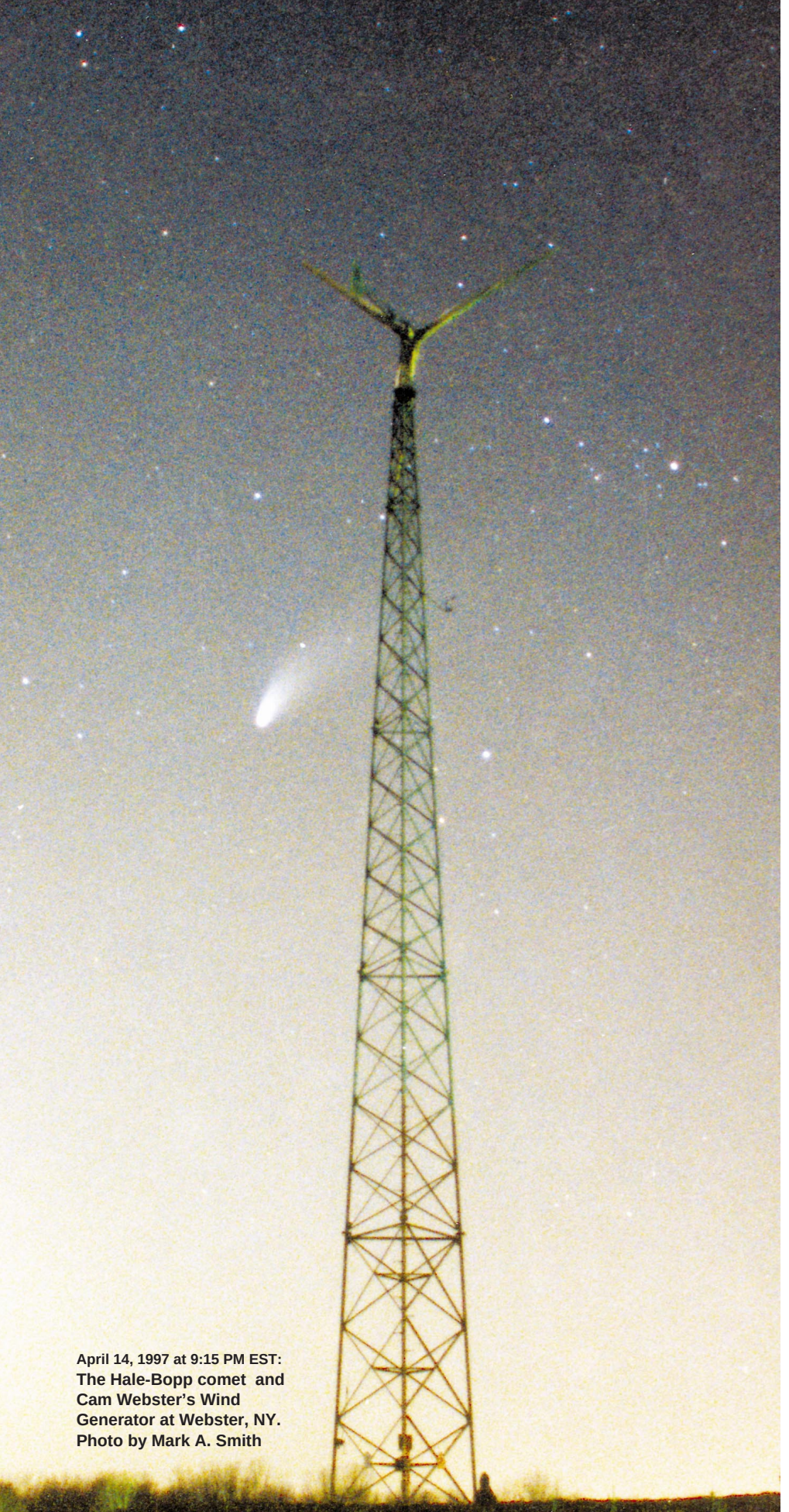

April 14, 1997 at 9:15 PM EST: The Hale-Bopp comet and Cam Webster's Wind Generator at Webster, NY. Photo by Mark A. Smith

People

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Mike Brown
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Windy Dankoff
Richard Dutton
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Benjamin Root
Katcha & Bill Sanderson
Bob-O Schultze
Mark A. Smith
Brent H. Van Arsdell
Michael Welch
John Wiles
Myna Wilson

" Think about it…"

In memory of Richard Dutton

"A man and what he loves and builds have but a day and then disappear; nature cares not—and renews the annual round untired. It is the old law, sad but not bitter. Only when man destroys the life and beauty of nature, there is the outrage."

George Macaulay Trevelyan
1876–1962

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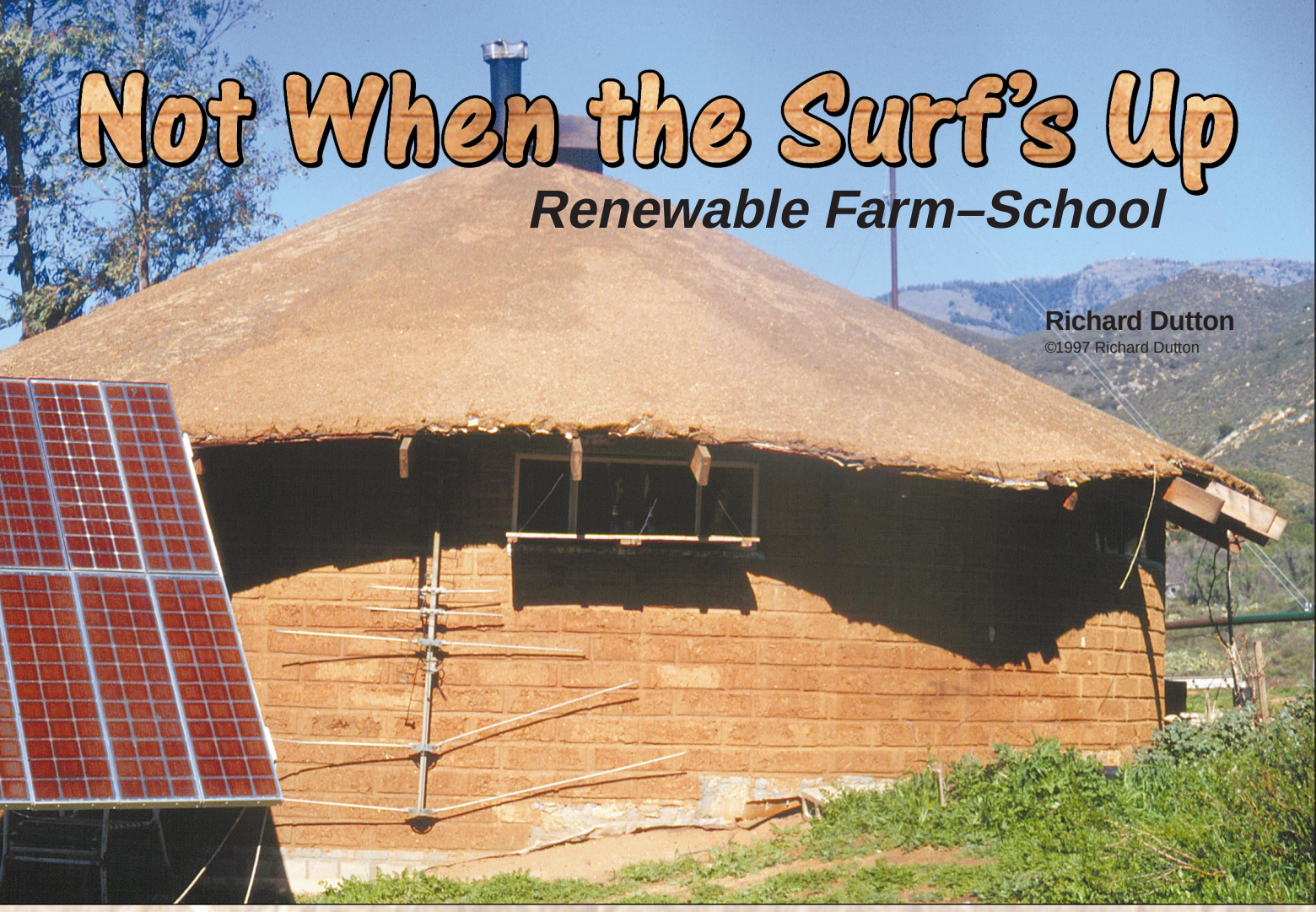
Not When the Surf's Up

Renewable Farm–School

Richard Dutton



Above: Richard Dutton's round adobe brick studio with mud roof, and the QuadLams that power it.

Greetings from sunny Southern California. But many of us in San Diego County say we actually live south of Southern California. Not When the Surf's Up Renewable Farm-School (NOWSURFS) is located at the southern foot of Mt. Palomar, home of the famous astronomical observatory and about an hour from the beach.

"Not When..." is a market garden, selling at five farmer's markets a week which we service via a propane powered '66 Ford pick-up. Almost all our seed, that we don't save ourselves, comes from non-profit Native Seeds SEARCH in Tucson, Arizona. Our energy for irrigation (from 1 to 3 acres depending on the season) and household/office needs comes from five Arco quad-lams feeding eight Trojan 105s and a Trace 612 inverter, and an AIR 303 wind machine. We have a Honda 6500 back-up generator, a Todd 75a charger and a Lincoln welder back-up generator. Our main loads are an Amiga A2000, 060/50 with a 1 gig hard disk computer which we are converting to DC power and a Maytag ringer washer using a Bosch 12 Volt Volkswagen generator as a motor (see HP #40 pg 40).

As part of the National Tour of Solar Homes this year, we have attracted interest in Latin America among farmers who would like us to help them with closed loop energy/agriculture. If you are inputting exotic energy, then your "organic" farm is not sustainable.

We have accumulated a lot of experience in solar water pumping for a small agriculture, very dry environment (14 inches yearly average rainfall). We use two "slow" type pumps, one 24 V and the other a 120 VDC pump (using 12 Volts converted to 95 Volts via a Vicor custom DC/DC converter, see HP #40 pg 70) and a PV powered (24 Volt) "stock" Jensen Jack pump. We pump all our irrigation water direct to field (the most efficient way) with a Doughboy 7500 gal. pool as a back-up, gravity-feed tank for emergency watering, household use, and fire safety. The tank is filled periodically by our generator-driven back-up pump, a Grundflos 12 GPM ac centrifugal.

The goals of NOWSURF are to move toward no irrigation input, primarily indigenous crops, to achieve and demonstrate subsistence, to teach closed loop ag/energy, to provide a venue for workshops in alternative architectures, and to promote respect for our Native American neighbors. We live in a 24 foot Pacific Yurt and two adobes; one 400 sq ft octagonal (the kitchen) and one round (the studio). We have assorted trailers for guests and visitors.

Adobe Adored

We lived in a 30 ft., 50's vintage aluminum trailer for 3 years while we studied literature on adobe construction. Adobe appealed to us for several reasons:

1 It's been traditional in Southern California for 400 years.

Below: From the earth, by our hands, function is beauty.

Above: Richard, Amelia, Pash, and Beemer.

2 It's an indigenous material on site requiring no fossil fuels to transport.

3 It has great thermal mass: cool in summer and warm in winter, acting as a thermal battery. Heat stored in the walls during the day is paid back slowly at night. This is an advantage over straw bale and other methods which are primarily insulating.

4 The necessarily thick walls provide soundproofing.

5 Each winter we have the mother of all Santa Ana winds, 100 plus mph this year. It's nice to be ensconced in these thick walls during high winds.

6 Bricks can be all made at once and stored for later use, an advantage over cob construction.

7 Large forms made of wood or metal are not required, an advantage over rammed earth.

6 Adobe bricks are clean, neat, and very attractive.

Now that we are becoming a non-profit and providing a location for workshops, we plan on giving these other interesting methods a shot, but that's not what this story is about!

Background

As our research progressed, I was working part time in the darkroom of our local two-bit weekly. When they wanted to do a story on the new library going up on the Pauma Indian Reservation nearby, I offered to do the photography. There we met Pat Friend, the librarian. She and Richard provided the know-how behind their own large-scale brick production. Our interest in these techniques really took off. This was the first time we had seen a standard size brick 18 by 14 by 4 inches, the largest size a man can reasonably be expected to lift up a ladder, and the molds used in their manufacture. Pat and Richard lent us two forms to try out; one full size

Above: Standard brick,
18 x 14 x 4 inches.

and the other yielding two half-size bricks. Later we met a member of the Pala band of mission Indians who had designed his own device for mass producing a smaller size brick. But things were to take a different turn for us due to the results of our own efforts at brick production.

Slave Labor

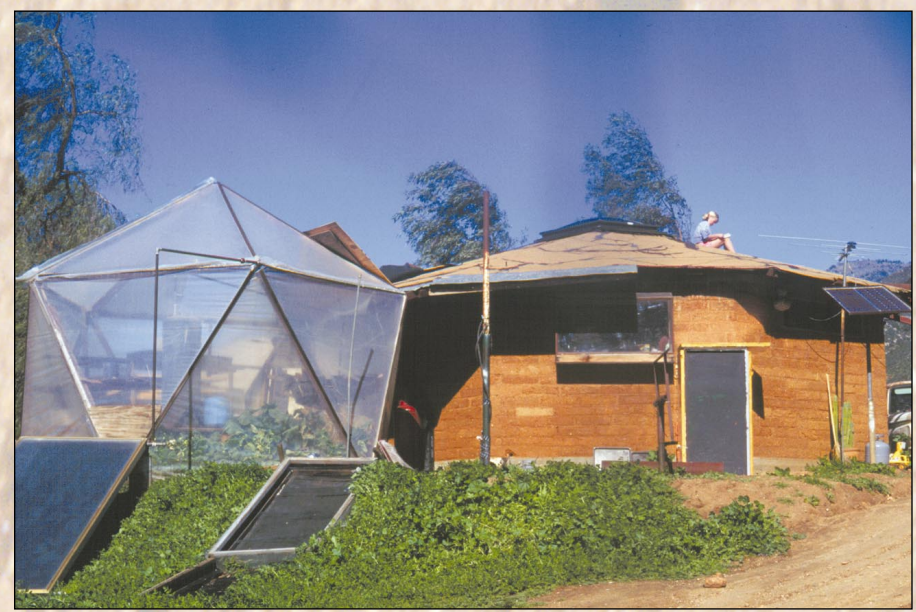
It has been said that almost any site in the world will yield some type of material suitable for adobe brick-making. One third of earth's population lives in structures made of mud. Publications from VITA and other third world development agencies in the US and Canada describe how to do the old "shake it in a jar of water" test, and what the "ideal ratio" is.

In our case we knew adobe would work because our neighbors on the reservation had been using the technology ever since the Spanish padres introduced it in their slave labor camps. The elders had been born in these structures and we had their structures as examples, as well as their good advice. As they have been doing for 400 years, the Indians are still helping us.

The Cure

The standard lore gives a time of six months to one year curing time, depending on temperature, humidity, soil factors, brick thickness, etc. for bricks made with the approved ratio of sand silt and clay. A wet mix is used, and time must be allowed for the moisture to migrate out from the center of the brick. If your material doesn't come out of the ground in the proper ratio you add the missing constituent(s) from your other location(s). All material is carefully sifted to eliminate untoward rocks, and re-blended, usually in a mixer.

Above: The octagonal adobe kitchen, greenhouse, solar hot water panels, and solar hot air food dryer.



Above: Hinged form
and pounding mallet.

Water is added along with a stabilizer such as asphalt emulsion to yield a consistency like (have you guessed?) mud pies. This material is poured into a mold often looking like a ladder to make multiple bricks. Human hands pitter-pat and fist the mix into all the corners. Handles at each end allow the easy removal of the form if bricks are first allowed to dry just enough. However, this isn't what we did.

Dry Method

First, make a test brick. You must test before making a bunch of bricks (don't worry, this is the fun part). Maybe you can be next to rock the adobe world! Our material is pretty high in clay. We tried making a brick with a dryer mix and the rest, as they say, is history. We found that a much dryer mix could make a brick that finished curing in days instead of months. How dry? For us, it worked to form it with our hands at the consistency that it just barely wouldn't crumble. The labor intensiveness of our process increased since each brick must be pounded with a custom designed mallet into a form. The form can then be opened up away from the finished brick. Increased pressure, as in many geological processes, can make up for diminished time. Immediately the form is re-secured, and on to the next brick. After one to three days the finished bricks must

Above: Home-made concrete lintels save wood.

be stacked on-end into windrows to finish curing another two days. If you pour your footings before you make bricks the footing (if larger by at least 5 inches than the bricks) can make an ideal “endless highway” on which to make them. By the time the last ones are ready to stack, you can start again at the beginning.

Two Being Team

A two person team is ideal: one to dig out new, pre-wetted material, sometimes re-wetting as she goes and occasionally tossing in a handful of straw; and one to make bricks. Every so often the helper does double duty helping to load the form with a shovel. We found that one person working hard can make between 50 and 70 bricks in a long summer day if sufficient material was pre-wetted overnight. This process, if the material is sound, makes a very hard, dense brick with a minimum of moisture, hence the very rapid curing.

No Mixing

We eliminated the step of mixing our adobe by mining it. It may happen that you encounter a strata of material that is just right for your bricks, while material above and below it or even to one side or the other is not. A five foot high road-cut location is ideal for this. In this case you can “mine” the material by pre-wetting it over night (with a length of drip-tape) removing the overburden, usually good topsoil, and then removing the adobe clay stratum by scraping it off the “face” with a hand trowel or Pulaski blade onto the ground where you toss a little straw on top. With practice you can “follow the right moisture” as you go and save another step of continually adding water.

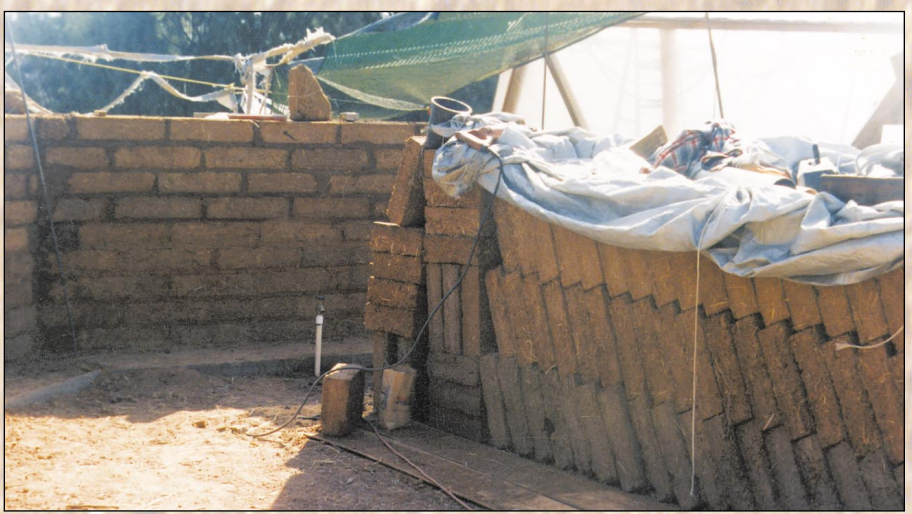
Mud Roofs Rule!

You can make your roof out of mud in a low rainfall environment. You should probably add a stabilizer. Use stucco paper (with chicken wire) for your last layer of roofing paper. You can put the mud on in a layer 3 inches or thicker, using the consistency of concrete. Since you’ll be troweling this on it needs to be wetter than your brick mix. You will need to go back over it in a week to fill subsequent cracks. We also brushed on a final coat of very wet emulsion-mud mix.

You May Have the Floor

An adobe floor is a wonder. An oiled adobe floor will eventually turn to “rock.” Make, as dry as you can, one huge adobe brick from wall to wall. Use a five foot long 4 by 6 as a huge mallet. Earth compactors won’t work as they push out to the sides too, and you’re constantly working against yourself. Drill a hole through the six inch width near one end. Stand on the other end and pick up and slam down the end with a rope passed through the hole and held in your hands. You may wish to use ear-plugs, or work to loud music. Make a “fan-shaped” pattern on the floor as you go. Then work back

Below: Wall building in progress and bricks stacked for drying.



Left: Ready for the roof: The kitchen under construction.

Below: The recording studio inside the round adobe stucture. Eighteen inch earthen walls are perfect sound proofing.

from another center point towards the one you just did, etc. This is the only way we know to get the floor really flat. The length of the 4 by 6 makes this method self leveling if done properly. Once in a while add more material to low spots. After a week go back and hand trowel into the cracks, if any, as dry as you can. The aforementioned technique (not the pounding part) works well for walls, as well. Last, treat your floor after a month or so with boiled linseed oil mixed 50/50 with turpentine or thinner. Depending on your soil you may go all the way up to pure linseed oil. (In Mexico they use used motor oil – not recommended.)

I'm writing this in a partially earth sheltered adobe yurt. Walls below grade (3 1/2 feet on the upgrade side) to 6 inches above are of mortared native stone painted on the outside with asphalt emulsion and sheathed in plastic. The bricks are laid end-wise making the walls 18 inches thick. This structure has been standing more than a year and there is no sign of appreciable cracking. Remember, adobe is heavy, so to prevent settling you must have a substantial footing. Atop our walls goes an eight inch concrete bond beam with four courses of 1/2 inch re-bar. In addition, some codes require vertical ties between footing and bond beam every four feet. The floor and roof finish of this studio are also of mud. Only the roof has stabilizer added to forestall rain damage. Although some codes require their use, we find the use of stabilizer an unnecessary expense and morally reprehensible. If the roof is in such poor repair that eaves allow the walls to melt, no one should be living here. The structure will simply melt back into the earth from whence it came. Over on the "Rez" the old-folks' home-places are doing just that. Maybe someday someone will decide it's a good spot for a house. I hope when they do its an adobe.

Pray for Surf

Fifteen years ago I thought it would be nice to have a solar powered recording studio, so be careful what you want because you may get it even if you've forgotten what it was!

As someone surrounded by Indians, one last thing: if presented with the attractive idea, "one world," please ask yourself, "According to whose pattern? Whose permission? Who profits?"

Access

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Box 1148 • Valley Center, CA 92082 • 619-749-7376
Web: www.users.cts.com/sd/r/rdutton

Seeds: Native Seeds Search
2509 N Campbell Ave. #325 • Tucson, AZ 85719

Understanding Adobe (and other useful "third world" info.) VITA, 1815 N Lynn St. Suite 200 • Arlington, VA 22209

DC–DC Converters: Vicor, 23 Frontage Rd.
Andover, MA 01810

It is with regret that we announce the recent death of Richard D. Dutton. Richard was dedicated to pioneering and advocacy of low impact, climate specific, organic farming. His building techniques, too, were based on appropriate, site available materials. His electricity came from the sun. Richard's ideals, and respect for the earth and its peoples, were shown through his actions. He will be missed by his wife Stephanie, daughters Amelia and Pash, friends, relatives, and the renewable energy community.

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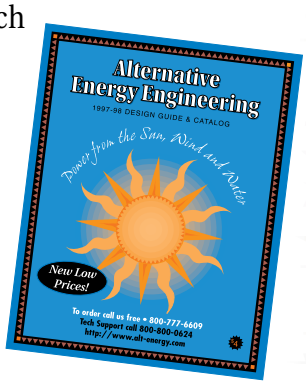

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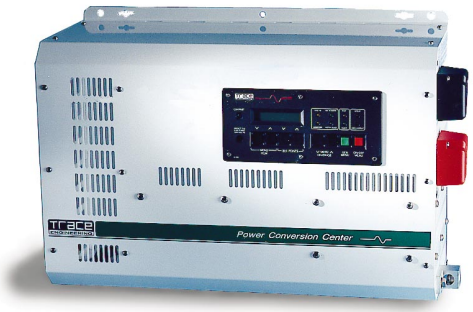

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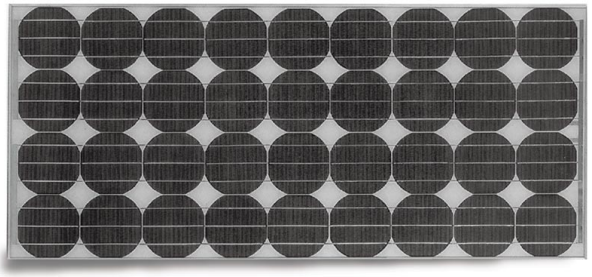

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ADOBE BACKACRES

Katcha and Bill Sanderson

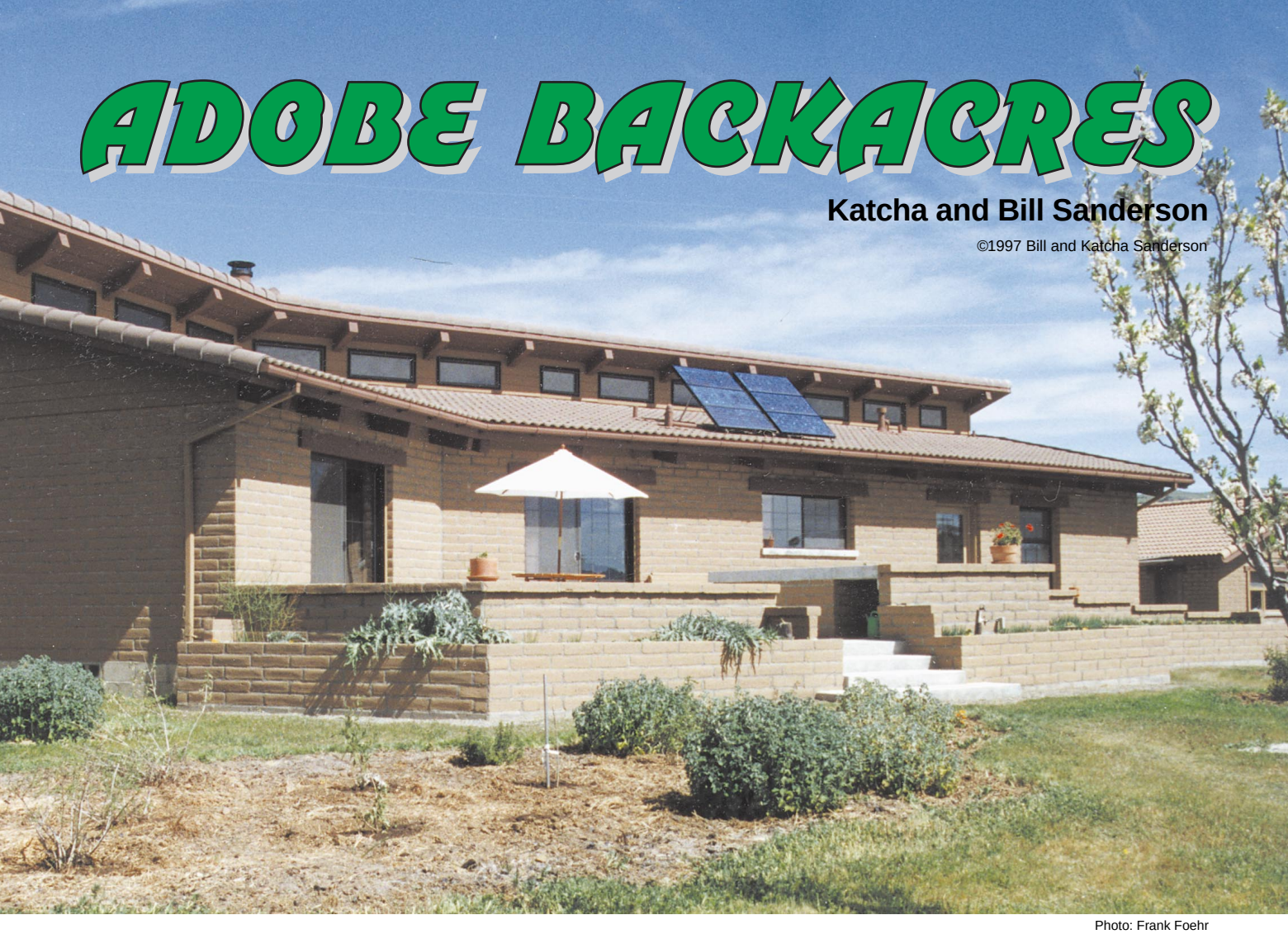


Photo: Frank Foehr

In the late 1970's the written resources for what we wanted to achieve at our site were less numerous and informative than now available. Combing bookstores, we located three, "The Owner Built Home" (Ken Kern), "Living the Good Life" (Helen & Scott Nearing) and "Wind and Wind Spinners" (Michael Hackleman). Added to those volumes was a collection of The Mother Earth News and we were off on a learning curve which at times rode like a wild mouse.

Kern's book helped us to decide on building with adobe, "Use native materials whenever possible.... Rock, earth, concrete, timber, and all such materials have excellent structural and heat-regulating qualities when properly used." Nearing's book gave us insight into lifestyle choices and the means to live them. From Hackleman's book we began a site study of wind energy.

It was the early 1980's and tax credits for solar energy use were sweeping the market. Our wind study showed our site to be marginal at best, so we turned our attention to the then emerging photovoltaic panels. Katcha, being more mechanically oriented, still favored wind machines. Bill, with his knowledge and comfort of electronics, saw photovoltaics as the way to go. In 1981 we purchased our first 35 Watt panel and later used it to power the adobe garage we built.

Lean System

Bill hooked up that single panel to a 10 Amp controller and a 360 Amp-hour mining cart battery. That simple system provided electricity for lighting, a radio, a CB radio, and a 13 inch black and white ac/DC TV in our "construction hut"/garage. The standing rule was "count to 3" – for when the 4th item was turned on, OFF went the entire system! Bill and I adapted quickly, but whenever we had visitors, someone would be in the bathroom (2.1 Amp light), while we talked around the table (7 Amp lights) and when the next person opened the refrigerator (propane, 1.3 Amp light) for a cold drink, we all ended up in the dark. Most visitors associated

switch turning and darkness to equate "This solar electric doesn't work!" But Bill and I knew it wasn't the system's fault and lived comfortably within its limits.

In 1984 we bought two 40 Watt panels and added a 200 watt Tripplite square wave inverter to the growing system. With ac available a VCR and computer joined our appliance list. The inverter gulped Amps the instant it was on so we learned to do the "Trippe Trot" and turn it on just before we used it and off as soon as we were done. Our training continued to be "efficient" to say the least – in winter if the batteries were low, we ran a generator (1500 watt Honda) which also added 15 Amps DC to the batteries while we used our ac items.

Photo: Frank Foehr

Above: Natural light and an open floorplan keep the adobe interior bright.

Our Home

By 1985 we were heavily into planning for our house. We had discovered *PV Network News* then written by Joel Davidson. Bill obtained and read *Practical Photovoltaics* by Richard J. Komp and we decided to go DC with the house's main circuitry but with a couple of separate circuits for inverter uses (computer, VCR, and ignitors for gas appliances) and one circuit for generator items (washing machine, iron, and vacuum). Inverters continued to be very expensive and not really efficient or quiet! Katcha had obtained a 12 VDC washing machine out of a recreational vehicle catalog so could eliminate a whole day in town (ugh, laundromats!) and do some of the household chores in between loads. That machine used 5 Amps but it only washed and rinsed, so wringing and drying remained manual labor.

We completed our building plans for a house that would be passively heated in winter and cooled in summer. Our home would be patterned after the early California ranch adobes – exposed brick inside and out. Indoor rooms were to be adjacent to outdoor areas so that they could flow together and enhance the use of both. 16 inch thick adobe walls would create a heat sink for thermal mass and an effective means by which to temper indoor vs. outdoor temperatures. With a bank of PV panels on the roof we knew our energy needs would be met. Building started in the spring of 1986 and took the entire first year to lay the exterior adobe walls. Bill calculated we moved about 400 tons in that process! We also installed conduit and electrical boxes as we laid the bricks so that we could put in the wiring later.

In 1987 we switched over to carpentry doing floors, interior frame walls, and an open beam ceiling/roof. Our work was slow but precise – a mistake in cutting a 22 foot 6 by 8 inch beam is too costly to hurry! We hadn't started the plumbing and electrical installation yet since the windows and doors were needed to completely weather-proof the "shell" before we started the interior finishing. About November 1987, we received our first *Home Power* magazine (#1) and we were never before so glad to be on a mailing list. We now felt enriched with a great resource for items that we had only dreamed about a year or two before.

Energy Fairs

June 1988 we went to RETSIE in Santa Clara, California, mainly to meet the *Home Power* crew as well as to see if there was anything new which we wanted to know about and incorporate into our evolving home. It was such a joy to meet Karen, Richard, and Bob-O. *Home Power* was the most practical and sane booth in the entire show and we strongly seconded their suggestion to have a more earth/human oriented meeting outdoors the next time such an event took place. It was August of 1990 before the first Solar

Photo: Katcha Sanderson

Above: In the solar tradition, the North wall has few windows.

Energy Expo and Rally (SEER) could be organized in Willits, California. For us it was the crowning event of our RE experiences to date. We met and interacted with so many of the people who were out there DOING just about every aspect of RE imaginable. Meeting Steve Baer and his wife Holly was marvelous. Holly inspired Katcha to "go ahead and use 'weeds'" to establish a native landscaping for our house. There were just too many other notables to list and we gathered more information and personal energizing than could have been foreseen.

We attended the next (all too) few SEERs, and were sad to see them dwindle to a halt by 1994. But then again, the greatest percentage of RE dealers and producers were as "lean and mean" budgeted as we were. The facts of business are understood by us, since by then we too had developed an RE related business. One of the amp gulpers which we had set aside for generator use had been vacuuming. Rediscovering the 3 and 4 amp Kirby vacuums of yesteryear allowed us to not only switch its use to our Trace 612, it also created a business of supplying other RE households with an efficient and quality appliance. A big bonus was that this business let us work at home while we continued to complete our house. AND, it fit within our energy system!

Back on the home front, our grunt and sweat equity produced an occupiable home by June of 1990. Although it would be some time before all the little details and finish work gave us our completed house, we were overjoyed to live the independent lifestyle we got from RE power.

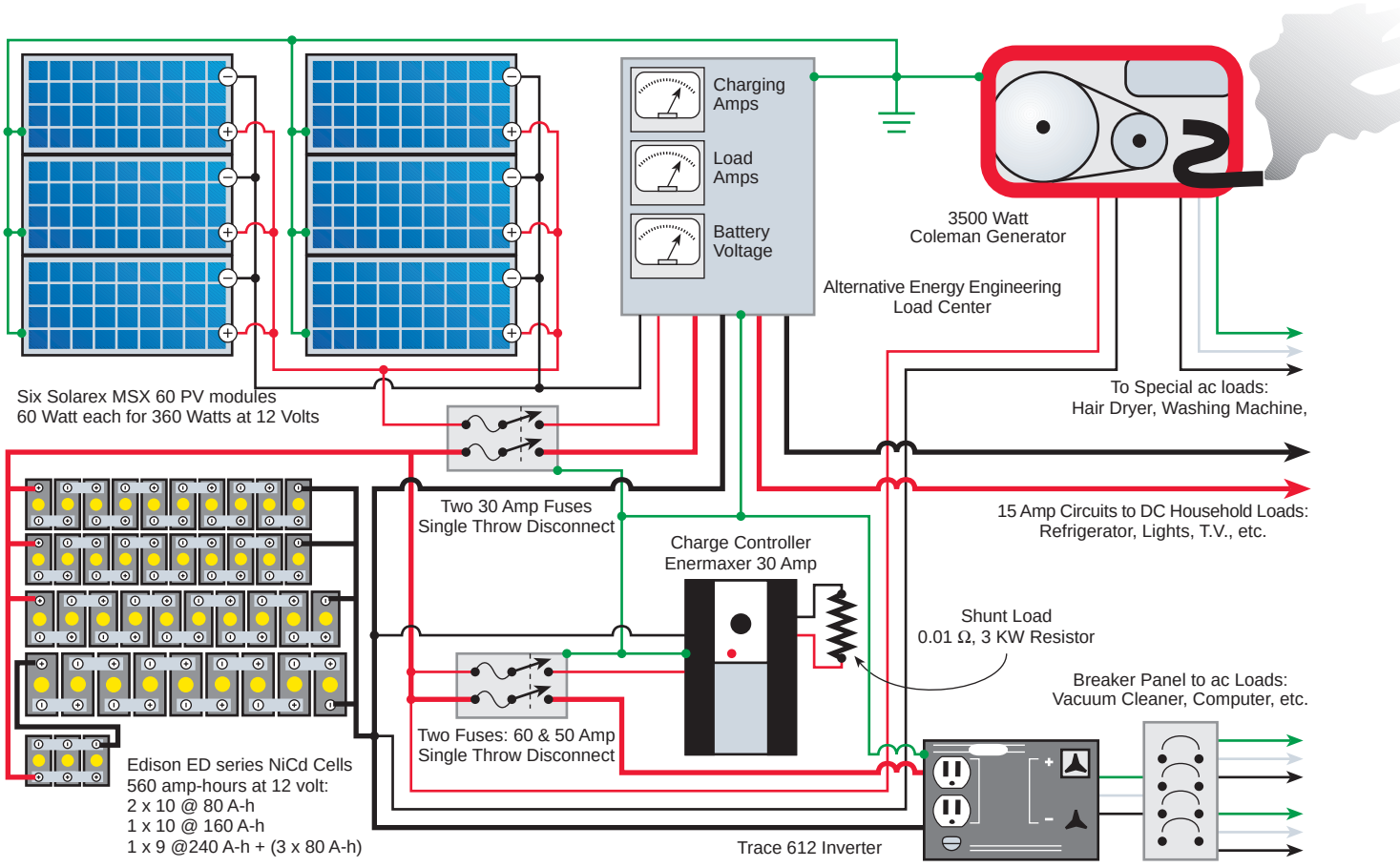
The System

Having side tracked with a bit of a history, we want to give some insight into how and why we choose to have what most others would classify as an extremely small and efficient RE system for our 2,226 sq. ft. house.

Our present household system consists six 60 Watt panels, 560 Ampere-hour NiCd storage, a 30 Ampere EnerMaxer regulator, a Trace 612 inverter, and an Alternative Energy Engineering load center with three analog meters showing charging current, battery voltage, and load current. Hardly state-of-art by today's standards, but it works fine for us. System disconnects are standard breaker boxes with manual lever arms to shut down the connections. Circuit loads are mainly 12 VDC with 15 Amperes per circuit maximum. We put in two sub-panels wired from the main panel with a "bus" of

Below: Even rooms on the North side of the house receive natural lighting from clerestory windows which run the length of the house.

Photo: Frank Foehr



000 wire for the main run, sized down to #6 for the connection to the panel boxes. The household circuit wires were #10 up to #6, depending on amperage and distance requirements. We used several 3-way switches for the convenience of walk-thru light switching, so our wire sizes grew due to the extra length needed to complete such circuits.

Our lighting is entirely 12 VDC planned around task and background demands, but with as efficient wattages as possible. We created our own fixtures for most lights incorporating the use of down-spot halogen (MR-16s) and fluorescents for as many 12 VDC ballasts as we could afford. Regular lamps ended up with incandescent bulbs but were kept in the 15 to 25 Watt range. Adobe is not a highly reflective material, so our night lighting takes on a lower and softer level in the living room when that area is used for talking or watching TV. Reading is always bright enough with MR-16 halogens, even in the 20 Watt size. Our kitchen and our master bath use 35 Watt fluorescents and are very well lit, the kitchen especially so with its majority of light-reflective cabinets and walls.

The old propane refrigerator has been replaced by a Sun Frost RF-16 which we keep fully stuffed with supplies and ice cream (when there is room!). Its greatest claim to fame with us is that it basically is paying for itself. The old Servel ran great, but didn't keep ice cream hard and after 10 years of use we put enough money into it in propane to have paid for the Sun Frost! Of course, Sun Frosts didn't exist when we first (gladly!) bought the Servel. It was a while later before we could put together the finances to switch over

Photo: Katcha Sanderson

Above: Two disconnects (PV/battery & controller/inverter), The AEE DC load panel with metering, Enermaxer controller, and Trace inverter.

Bill and Katcha's Electrical Appliances

12 VDC Appliances

Battery charger (AAA, AA, C, D & 9V)	2 watt max
Computer (monochrome laptop)	60 watt max
Computer Printer	108 watt
Lights	16 @ 15 watt incandescent
Lights	6 @ 25 watt incandescent
Lights	1 @ 75 watt incandescent
Lights	8 @ 20 watt halogen incandescent
Lights	1 @ 13 watt fluorescent
Lights	3 @ 14 watt fluorescent
Lights	3 @ 35 watt fluorescent
Radio (Auto built into cabinet)	12 watt
Television Set	77 watt max
TV antenna rotor	10 watt
Video Cassette Recorder	22 watt

117 vac Appliances (Trace 612 powered)

Blender	300 watt
Computer (color laptop)	140 watt max
Computer Printer	700 watt
Iron	500 watt
Kirby Vacuum Cleaner	470 watt
Mixer (counter top)	120 watt

Photo: Katcha Sanderson

Above: The power corner including Edison NiCd batteries on the lower shelf.

Photo: Rudy Heckmann

Above: Bill and Katcha built their home brick by brick...literally.

to the Sun Frost. Not an unfamiliar story for most of us who have been living with the "as-you-go" system development plan.

Off-System Appliances

We want to note those appliances for which we have found non-system electric alternatives: alarm clock/calculator (3 VDC battery), clocks (AA batteries), clothes line, hair curler (butane), iron (butane), match/lighter (butane), smoke detector (9 VDC battery), and of course several flashlights (AA and D batteries). I even have a "button" battery charger with a mini PV for charging small watch and calculator batteries. We're sure that several readers have noticed that we don't have a clothes dryer, dishwasher, or microwave. They are items we don't use, but the house has been wired and plumbed for a dishwasher to be installed if one is wanted later. Katcha prefers to hang dry laundry outdoors in the sun and air, and in winter we have a line up in our garage. The obviousness of NOT wanting lights on in the house by day does need mentioning. We assured that by having clerestory windows at our roof peak, and careful window sizing and placement.

Additional RE stand-alone systems power our garage (one 40 Watt panel and an old 360 A-h lead acid battery) and our water system (two 40 Watt panels to a Solar Jack pump). Water pressure is by gravity from our 2500 gallon main tank and 1800 gallon overflow tank on a hill behind our house.

System Costs

Since our system has grown and changed over several years, figuring an overall cost is very difficult and maybe even not comparable in light of today's newer items and prices. A rough calculation reveals under

$5000 spent for panels, batteries, controllers, distribution boxes, and water pump. We made our own mounting racks for the PV panels on the house and garage. We also had great luck and timing to get our NiCds from a salvage source when they weren't as highly sought. We didn't include the Sun Frost in that total since it's an appliance, not a system component.

Would we have the same system if we installed it today? Probably not. Newer inverters make it possible for a "power shed" away from the house and for easier use with off-the-shelf appliances. They are also very reliable and work well with generators for charging and as a backup source in case of a system component failure.

Other people living in this same house would likely have an altogether different system. But then, that's the beauty of RE, it is ALTERNATIVE based; the more the choices, the better the system can fit the user. Plus, these systems are flexible and can be added to if and when requirements increase. Continuing to use DC is comfortable to us because it is in line with our preference to do things in as direct a means as possible and keep to the simplest means as well. One thing we know for sure, our system meets all our needs and doesn't send us a bill at the end of each month!

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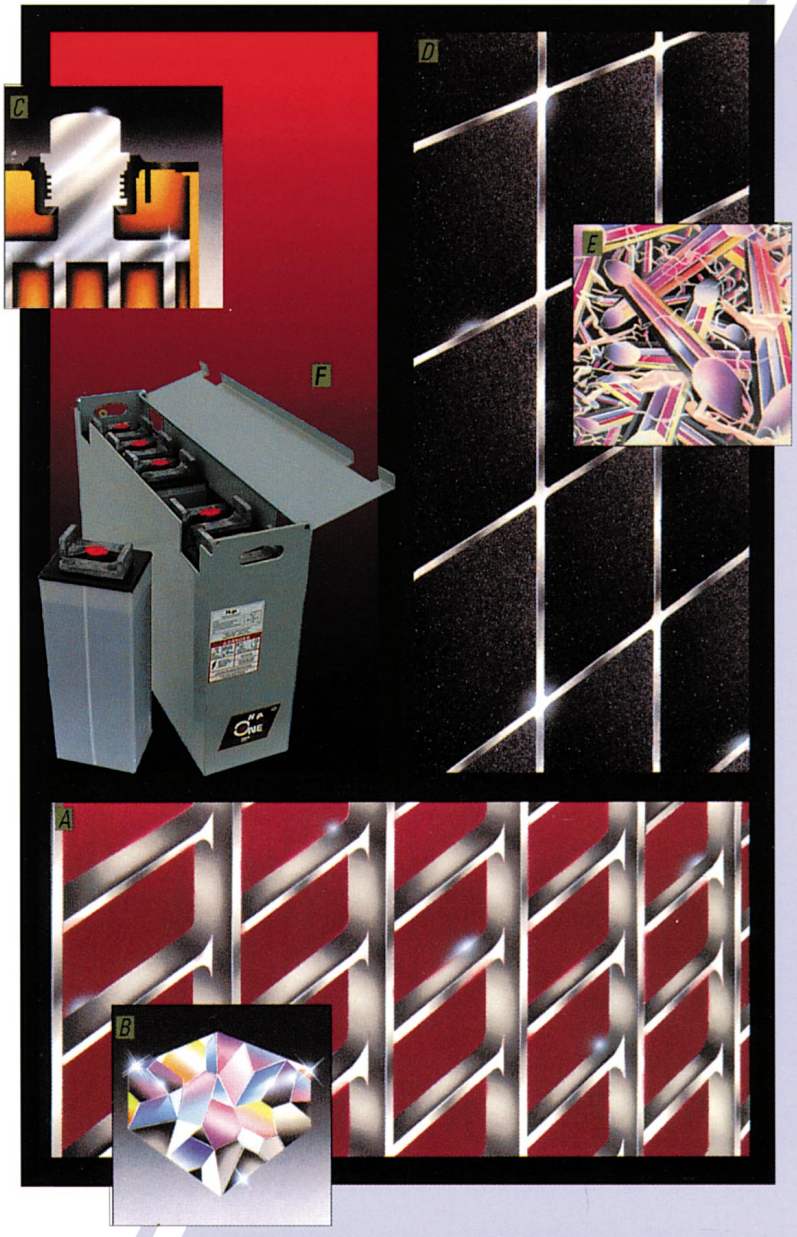

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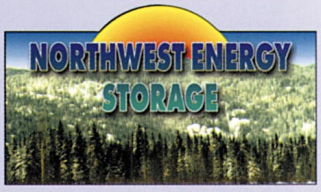

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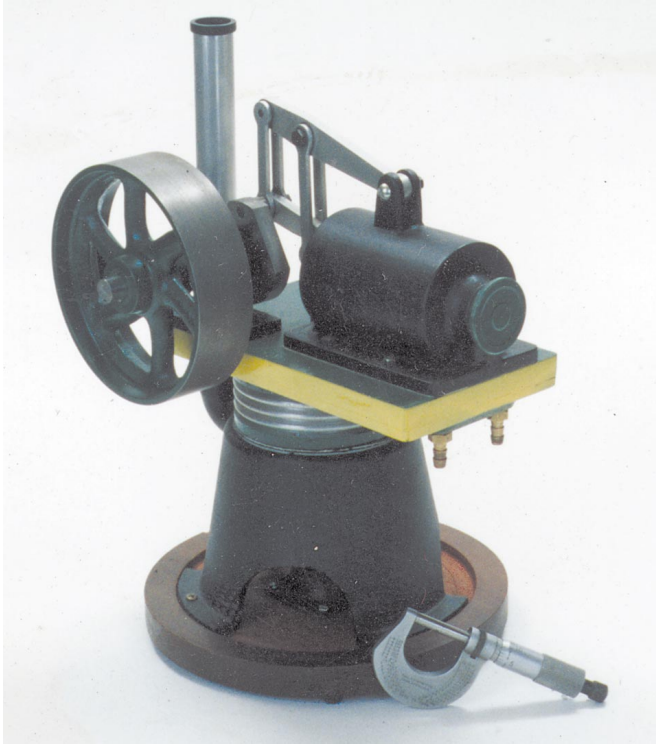
STIRLING ENGINES For Home Power

Brent H. Van Arsdell

Solar power is great, but there are other environmentally friendly ways besides PV systems to pump water, run a fan, or charge your batteries. Besides, if you live in a cloudy part of the world and you want to get off grid, you'll need a way to top off your batteries on days when the sun doesn't shine. If you're looking for a good way to supplement your home power system you should consider a Stirling engine.



Above: A Robinson type engine for low power uses.

Above: A Civil War era Rider-Ericsson Stirling cycle engine restored by Charles Mac Arthur.

A Stirling engine shares some traits with the engine in your car. Stirling engines use heat supplied from the outside rather than from burning fuel inside the engine itself. The air inside the cylinders is alternately heated and cooled to make the force that powers the pistons. Stirlings can be made to run on solar power, wood chips, cow chips, or just about any heat source you can imagine. The illustrations shows the basic principles. One end of the engine is kept hot and the other side is kept cold. In the middle of the engine is a mechanism to move the air from the cold side to the hot side.

One difficulty with understanding Stirling engines is that there are literally hundreds of different mechanical configurations. But all that really matters is that the hot side stays hot, the cold side stays cold, and the air moves back and forth between sides. When the air moves to the hot side it expands and pushes on the piston. When it return to the cold side it contracts and pulls on the piston. *An Introduction to Stirling Engines,* available from American Stirling, is probably the best introductory guide book available.

To get a feel for what you can do with a Stirling engine today you need to know a short history. Stirling engines were invented in 1816 by the Reverend Robert Stirling

who was a minister of the Church of Scotland. The steam engines of the day tended to explode, often killing people nearby. Stirling engines wouldn't explode.

The trouble was that in a Stirling engine, the hot side of the engine heats up to the average temperature of the flame and stays hot. Cast iron was the only material readily available when Stirling engines were first made, but when cast iron is heated to almost red hot, it oxidizes fairly quickly and the engines would break. In spite of the trouble with cast iron, tens of thousands of Stirling engines were built up until about 1914 as pumping engines, general purpose engines, or to run fans.

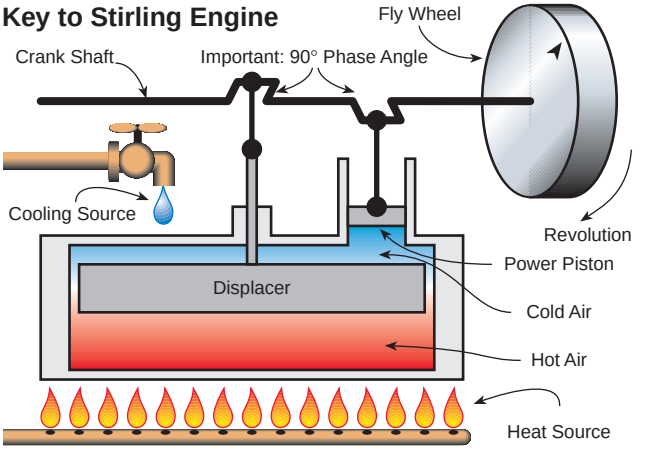
Above: Free Breeze fan runs on top of wood stove.

It just so happens that the Stirling engine cycle is the most efficient engine cycle. That doesn't mean that any given Stirling engine is very efficient, but they can be. Some research engines have reached an incredibly high efficiency of 40%. For comparison, a good car engine is about 25% efficient. Stirling engines like to run at one power setting, so applications like pumping water, running a fan, or charging batteries are a particularly good use.

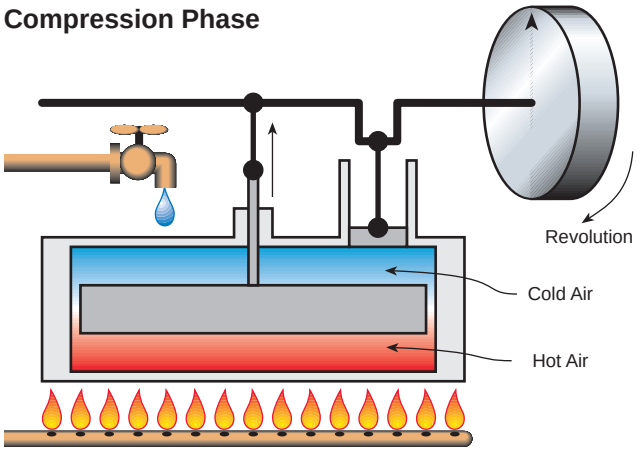
Above: Ryder-Ericsson with pump,
500 gallons per hour to 50 feet.

There has been a lot of very good modern research on Stirling engines, and companies are developing them for combined heat and power applications. Two companies may bring products to the market within two years or so. South Power, a company in New Zealand, has a promising design that is optimized for heating and remote power applications along with producing auxiliary power on yachts. In Denmark, Sigma Elektroteknisk A.S. seems likely to market a Stirling engine specifically intended for home power use, but it won't be available until at least next year.

A good Stirling engine design that is available now is the ST05 G Stirling engine designed by German engineer Dieter Viebach. Herr Viebach has designed a 300 to 500 watt Stirling engine that is intended to be powered by burning wood chips, propane, or your favorite renewable energy source. Casting kits are available for under $1,000 and complete engines without burners, alternators, or cooling systems are



Compression Phase

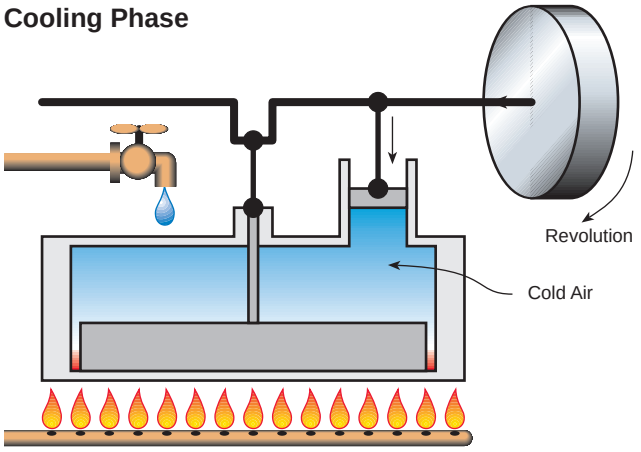


available for under $5,000. If you speak German or can get a German translator on the line, give him a call. Herr Viebach sells the casting kits or will put you in touch with a machinist friend who can build you a complete engine.

You may be able to find a Stirling engine solution to your home power needs a lot closer to home. Why not use an antique Stirling engine? Stirling engines (then called hot air engines) were very popular at the turn of the century for several reasons: they were reliable, safe, and could be made to run on just about any fuel. If you don't need huge amounts of power, an antique or perhaps a reproduction may solve your problem.

A down side to heating a home with a wood stove is that it can get too hot right next to the stove while the rest of the room stays cold. The Mealtime Stove company in Ontario, Canada builds a Stirling powered fan that you simply place on the hot surface of your wood stove. It will put out a nice gentle breeze that circulates the warm air through the entire room. The fan is available in the United States from the American Stirling Company.

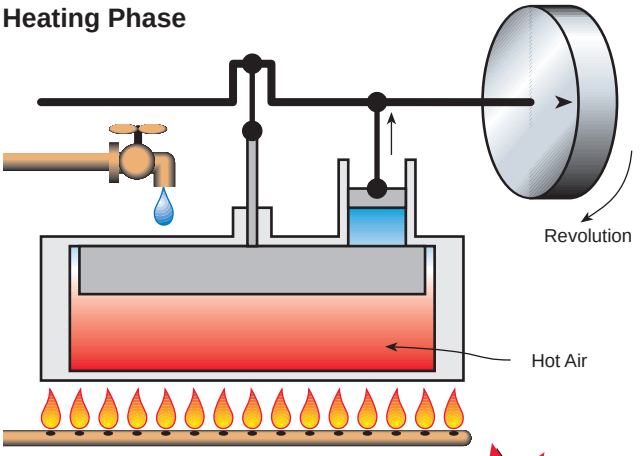
Cooling Phase



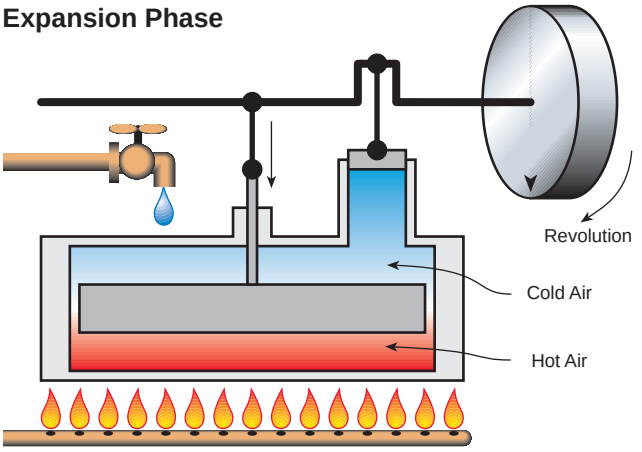
Do you need a fan to keep cool in the summertime? Kenneth Rhodes can build you a replica of an alcohol-fired 1906 Lake Breeze fan. If you want an engine to keep a small battery system topped off, Ken can build you a scale model of a Robinson type Stirling engine that comes complete with a propane burner. He can build full size engines too.

The simplest choice for some applications may be to buy an antique Stirling engine and get it running. These engines were built

Heating Phase



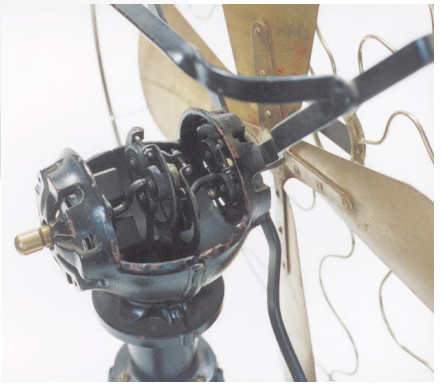
Expansion Phase



around the turn of the century for pumping water, running fans, and various light industrial uses Because these engines are made of cast iron, and often weighed hundreds of pounds, a lot are still around.

The price you'll have to pay will vary from salvage prices to the price of a museum quality restoration. Look for an unrestored "Hot Air" engine in local farm newspapers, antique machinery classifieds, or any

Above: The 1906 Lake Breeze fan runs on alcohol.



Right: Detail of Sterling mechanism in Lake Breeze.

Above: MM-1 demonstration Stirling engine shown running on a glass of hot water.

place where old machinery is likely to be sold. You definitely want to find an engine close to home because, with the exception of fans, these engines are very heavy.

How do you get one running? It's the same way you fix a Model T: you find what's broken and fix it. First repair the obvious things like greasing bearings and removing rust. But there is one specific part that is likely to be broken in an antique Hot Air engine. The cast iron hot head is likely to be burned through. Any machine shop should be able to build you one. Consider having your new hot head made out of stainless steel which is very resistant to oxidation giving you years of good service.

It's possible that high tech Stirling engines may heat and power millions of homes in the future, but why wait for high tech, when a simple, reliable and low tech Stirling engine might solve your home power needs today.

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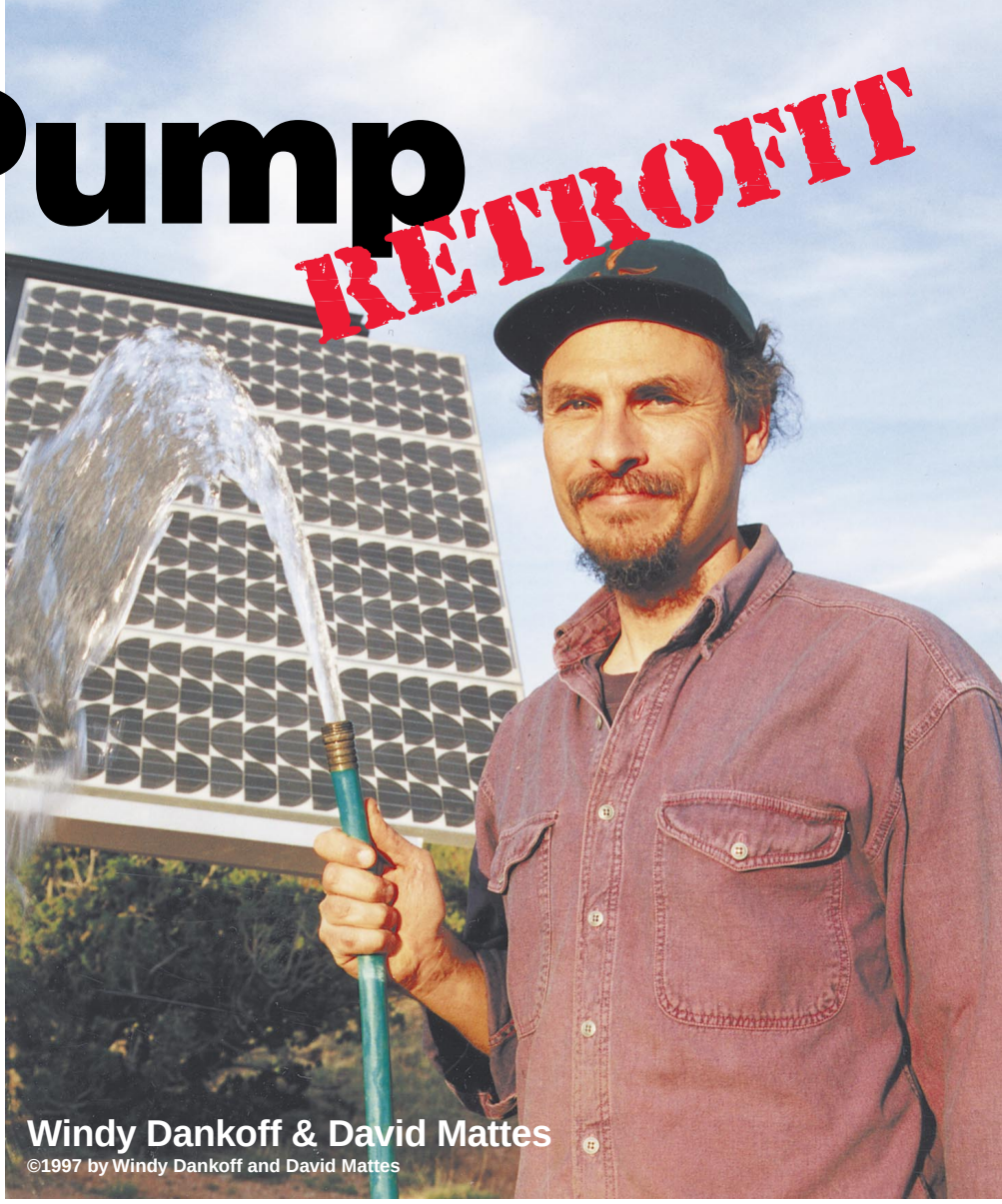
PV Pump RETROFIT

On a sunny plateau outside of Santa Fe, New Mexico, sits the home of Paul Benson and Stephanie Mattes. It's a modern and amenable home, a mile from the nearest power line. Built in 1995, it incorporates a state-of-the-art photovoltaic (PV) system to power their lights, tools and appliances. But there was one missing link. When their home was built, a solar pump for their 400 foot deep well was not available at an affordable price. A conventional 1.5 HP AC pump was installed, and connected to a 6.5 KW propane-burning generator.



Above: Windy Dankoff retrofits a PV-powered water pump eliminating the need for the propane generator.

Paul and Stephanie's power system had always produced a surplus of energy. It was a shame to run their generator to pump water, when their batteries are usually 90-100% charged. And besides, they need the most water during dry sunny weather when the most solar energy is available. All they needed was the right pump.

In 1996, the right pump became available. The SunRise™ Submersible Solar Pump can handle depths to 600 feet by pumping slowly on low power. It uses 1/3 to 1/2 the energy (Watt-hours per gallon pumped) of a standard AC pump. It takes power directly from a PV array, without battery or inverter losses. Stephanie and Paul are modest water users, so there was no need to expand the size of their power system. It now handles their water supply and still produces a surplus of energy. The installation took one day, and their total cost was less than that of the AC pump and generator!

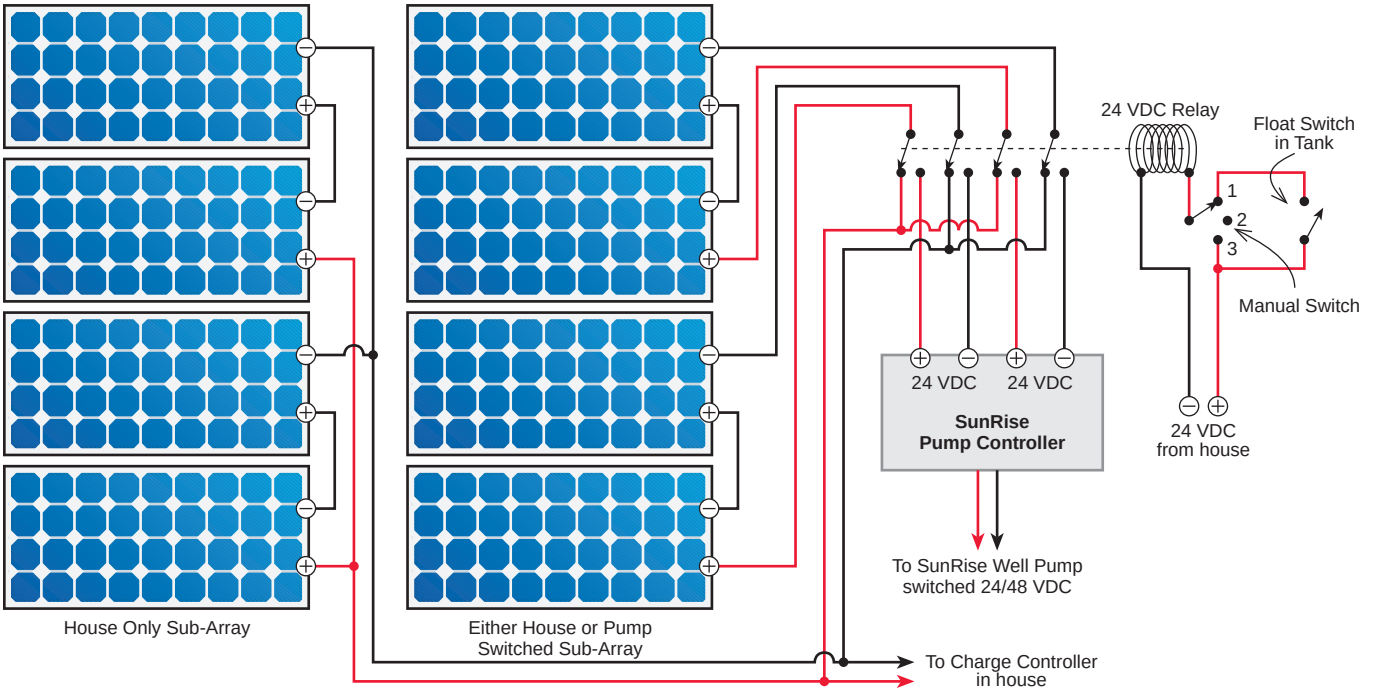
If you don't understand some of our terminology, please refer to the glossary at the end of this article.

The Power System

Paul and Stephanie's power system is typical of the mid-sized remote home PV systems being installed today. It uses 8 Solec 70 watt modules wired in series-parallel for a 24 volt, 560 watt nominal array, mounted on a Zomeworks passive solar tracker. Energy is stored in a battery bank of 1100 Ampere-hour capacity. 115 vac power is provided by a Trace 4000 watt inverter.

Before installing the SunRise pump, Paul and Stephanie used an average of 50 Ampere-hours per day, as recorded by their Tri-Metric Ampere-hour meter. Multiplied by 24 volts, that equals 1200 Watt-hours per day of average energy consumption. After inverter and battery losses, the system yields about 3800 Watt-hours per day (summer) and 2000 (winter). Clearly they have a surplus of energy, even in the winter months.

Stephanie & Paul's PV Water Pumping System



The Water System

Paul and Stephanie are typical residential water users, with a clothes washer, two dogs, small garden, and a few trees. Typical summertime use runs around 150 gallons per day, dropping to 75 gallons per day in winter. To make their generator-pump system practical, they have a 1500 gallon storage tank, so they only had to run the generator once a week. Their tank holds about ten days of water supply, to carry them through prolonged cloudy weather with a good reserve. The tank is buried, level with the house. A 24 VDC Flowlight Booster Pump supplies water pressure to the house, just like in town.

The well is 400 feet deep, with a static water level at 165 feet. When drilled, it was tested and found to produce 18 gallons per minute. Figuring that the level will not draw down very far, we placed the SunRise pump at 250 feet. Since the SunRise pumps slowly and can tolerate running dry, there is no point in placing it all the way at the bottom of the well as is usually done with conventional AC pumps. At 250 feet, the SunRise produces 2.5 gallons per minute (drawing 230 watts). On an average solar day of six peak-hours, it will produce 900 gallons. This is eight times their average daily usage. So, the pump will only run about 1/8 of the solar day while using just 1/2 of their PV array. They won't even notice the reduction in home energy input.

48 Volts from a 24 Volt Array

The SunRise requires a 48 V solar array, and the DC voltage of their home power system is 24 V. We reconciled the difference easily. When power transfers to the pump, it is reconfigured to 48 V within the pump controller. The transfer of solar power is triggered automatically by a float switch in the storage tank. When the tank level drops below full, power is transferred to the pump. When the tank is full, it is switched back to the home system without any human attention.

Why a 48 Volt Pump?

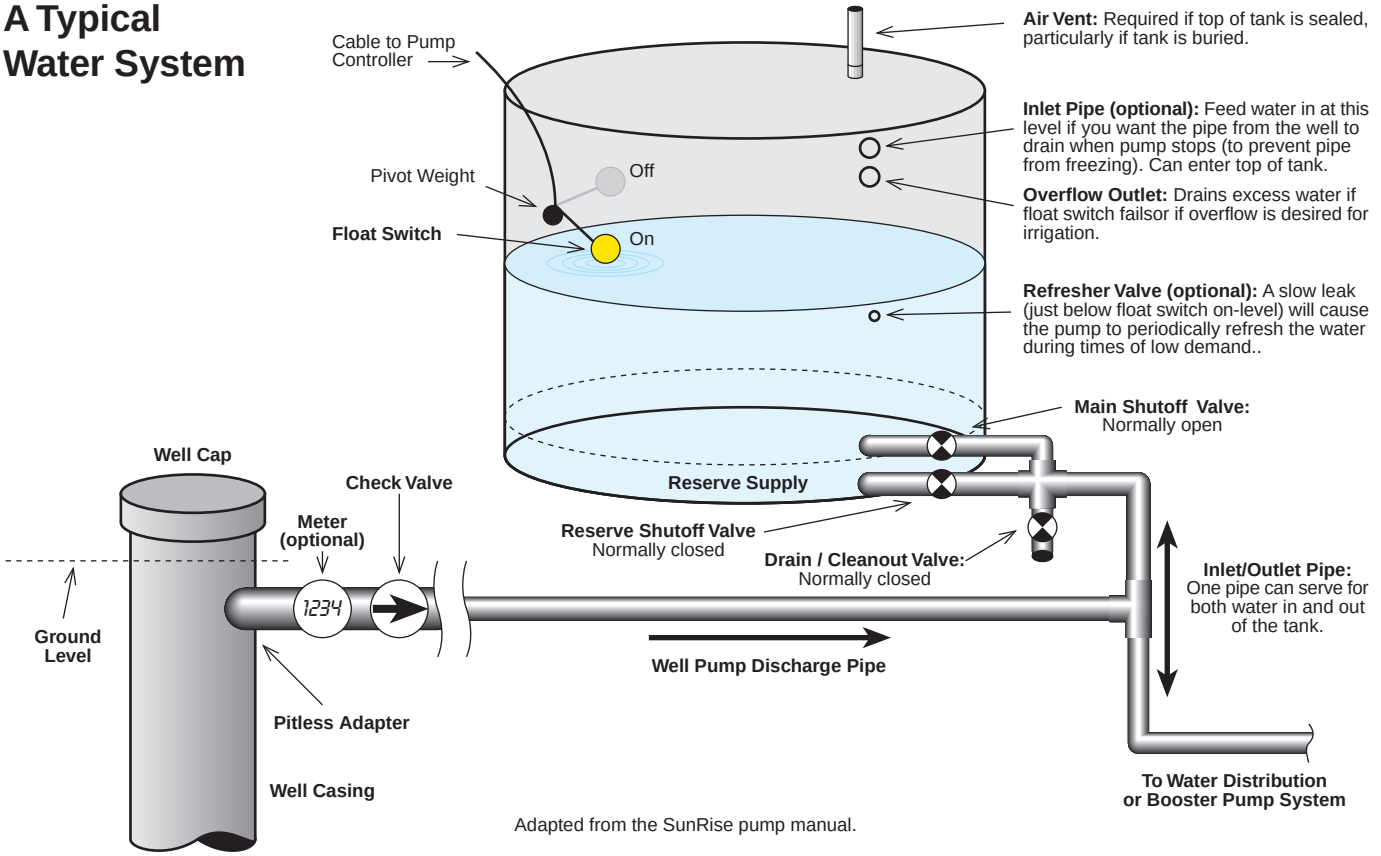
A 48 Volt standard was chosen by the SunRise pump manufacturer to accommodate the long lengths of wire required for deep well settings. The wire size requirement is drastically reduced by raising the system voltage. If the SunRise had been designed for 24 V, it would have required four times the wire size in order to maintain a low level of power loss! The electrical cable would cost much more, and the added weight of copper would make it impractical to install by hand.

More About the SunRise Pump

SunRise uses a unique "sealed piston" mechanism. It pumps more slowly than conventional centrifugal-impeller well pumps, but uses much less power. In typical full-time use, it will need minor parts replaced at 5–8 year intervals. Because the Stephanie and Paul will only pump 1/8 of the solar day, they will earn a lot of gray hair before they need to maintain their pump.

There are three models of SunRise pumps. They all use the same 1/3 HP motor, but have different piston stroke lengths to handle different ranges of vertical lift. Paul and Stephanie obtained the intermediate model 5226. They also got the electronic controller that is

A Typical Water System



Adapted from the SunRise pump manual.

required for the pump to run directly from their solar array (without battery connection).

The SunRise controller provides a starting surge, then sets the solar array configuration for varying light conditions. It also disconnects power to the pump during insufficient light conditions. The controller requires two separate 24 Volt array inputs, so the solar array must be split into two “sub-arrays”. It connects these into either a series (48 V) or parallel (24 V) configuration. In full sun, the pump gets 48 V to produce full motor speed and water flow. In cloudy weather or when the sun is low on the horizon, the controller switches the configuration to 24 V. This doubles the current to prevent the pump from stalling. It is the electrical equivalent of shifting from high to low gear, so that the pump continues to run in low light conditions.

The Float Switch

The float switch that we used looks like a plastic can on the end of a flexible electrical cord. The can floats. The cord is suspended from the top of the tank, and a weight is tied to the cord to act as a pivot point. The float swings up and down with the varying water level in the tank. The float contains a switch that turns on when the can hangs downward, and turns off when it floats back up.

A float switch was already installed in the tank. It was put there to turn the AC pump off when the tank reached full level. Most switches can handle DC as well as AC, so we rewired it to control our array transfer instead.

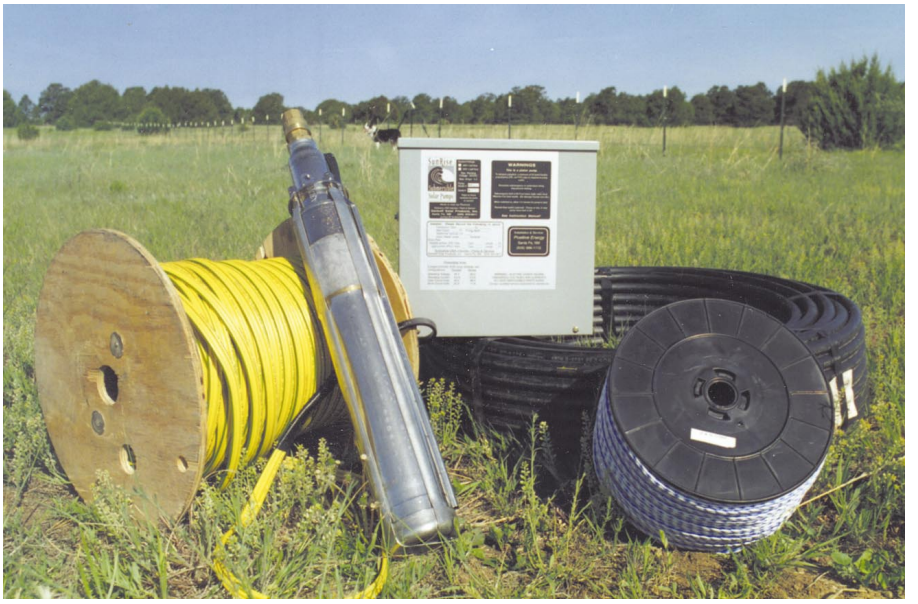
The Transfer Relay

The device used to transfer the solar power between the house and the pump is called a relay. A relay is an electrical switch that is actuated by an electromagnetic coil, instead of your finger (the coil uses very little power). When power is applied to the coil, it magnetizes and attracts a hinged piece of steel on which switch contacts are mounted. In our application, the coil is turned on and off by the float switch in the storage tank, just as a light in your home is controlled by a switch on the wall. The relay that we selected has four sets of switch contacts that work simultaneously. So, one simple circuit through the float switch works four transfer switches. The diagram shows this relay schematically as four switches, with a dotted line to symbolize their actuation by a coil. The transfer relay was preassembled in an outdoor junction box at Dankoff Solar.

Having it Both Ways

When the float switch hangs low in the tank, the circuit is closed and 24 V is connected to the relay coil. The

relay then transfers power from the home electric system to the pump system. When the float switch rises, indicating a full tank, the circuit is opened. With no power to the relay coil, the relay transfers the array back to charging the batteries in the house. It's simple, and no burden to the owner. Here is how we accomplished this amazing feat.



Above: Just add PV & Well, the SunRise before Installation.

Rewiring the Array

The PV array originally had its 24 V outputs joined to #2 AWG wires, which run 150 feet to the charge controller in the house. First we split the array wiring to create two sub-arrays of four modules each. One sub-array remains connected to the house, while the other will alternately be switched to the pump or the house by the relay. The sub-array to be used for the pump requires two 24 Volt panel pairs to feed the SunRise controller, so we split it yet again, and wired its two separate halves to the transfer relay. All this can get confusing, so we used a multimeter to check polarity and to verify the right voltage. Sure enough, each pair of array wires showed nearly 40 volts, which is normal for a nominal 24 V PV array in an open-circuit condition (disconnected from a load).

To supply power to the relay coil circuit we used an existing 24 Volt DC line that runs from the house to the nearby generator room. (We could have drawn power directly from the array instead, with the addition of a small capacitor to prevent the relay from chattering as the pump starts.) We also added a small 3-position toggle switch to let the owners override the automatic operation. The switch allows selection of (1) automatic control via the float switch, (2) pump off, and (3) pump on. Position 2 will be used if the house batteries are low and home energy is a priority. Position 3 will allow the water tank to overflow. Paul and Stephanie installed an overflow pipe from the top of their tank that will be directed to some trees and shrubs. This manual override switch is also handy for testing the system.

Below: Disassembly is easy, though rarely needed.

Removing the AC Pump

The next task was to remove the original AC pump from the well. A water well contractor was hired to pull the pump from its 390 foot setting. The well man also verified the static water level of the well at 165 feet. The AC pump and its 1 1/4 inch PVC drop pipe can now be sold for about $800.

Reusing the Original Pump Wiring

The SunRise system requires wire of sufficient size, or it won't work. We were happy to discover that we could reuse the existing buried wire and drop cable from the generator shed (near the PV array) to the well and down. The existing wire is buried for 250 feet from the generator shed to the well head. With a pump depth of 250 feet, we were looking at a total run of 500 feet.

The SunRise specification sheet has a wire sizing chart based on the power draw of the pump and the distance of the wire run. Stephanie and Paul's' pump will draw 230 watts at 250 Feet of lift. The chart indicated that in this application, we needed a minimum size of #8 AWG wire. The existing buried wire is #10 AWG (one size smaller than #8 AWG) but it has four conductors, and we needed just two. Rather than replace it, we paired

up the four wires into two parallel conductors. That is like having two wires that are bigger than #8. The drop cable that runs down the well has four #8 wires which we again paralleled, to make a two-wire line that was better than #6. Overall, we saved about $500, plus the work of trenching new wire.

Installing the SunRise Pump

Well pump installation is usually a job for a water well contractor with a boom truck. However, the SunRise pump uses smaller, 3/4 inch drop pipe. The pipe is flexible black thick-walled polyethylene (PE) rather than PVC. This keeps the assembly light in weight and easy to lower into the well by hand. Incidentally, PE pipe is more chemically pure than PVC, which is being phased out in Europe. The SunRise instruction manual is thorough and well illustrated, for both hand and machine installation. Although we (David and Paul) had no prior experience installing a well pump, we had no problems.

We unrolled our 250 feet of PE pipe and safety rope alongside the submersible cable, and bound them together with cable ties. We connected the SunRise pump to the drop pipe with massive bronze compression fittings made for the thick PE pipe, and spliced the pump wires to the cable using a submersible splice kit. At the top end of the drop pipe we attached one half of the pitless adapter (see glossary) that was used in the original AC pump installation. We were ready to lower the pump.

To lower the pump safely by hand, the SunRise instructions call for one strong person per 100 feet of drop. A neighbor came by to help with the installation, and Stephanie helped drag the bundle of pipe and cable so it didn't get caught on bushes. Indeed, it gets quite heavy as it goes down. After recoupling the pitless adapter, the last step was to tie the safety rope to an eye bolt that we had installed in the well casing.

Success!

We throw the switch. After waiting two minutes for the controller's starting capacitor to charge up, we hear a faint hum at the wellhead. The hum drops in pitch as water rises up the pipe. Minutes later, water issues from the hose. We feel "pumped!" With a hands-on sense of how far down the water lies under this desert plateau, solar pumping seems like modern magic.

All of the on-site work was performed in about eight hours. This included watching the existing AC pump being pulled by the water well contractor, installing the transfer relay, rewiring the array through it, installing the SunRise pump by hand, and earning a good redneck sunburn.

The water tank needed about 500 gallons to reach full. The next day, at mid-morning, the float switch had risen and disconnected the pump from the array as expected. We checked the meter in the house, and sure enough the charge current indicated that the entire array was now reconnected to the house. Since then, the pump has been coming on about 3 times every two weeks, for about 3 hours each time. Stephanie and Paul are liberated. Their generator collects cobwebs while solar power pumps their water and powers their home.

Glossary of Solar Water Pumping Terms

AC – Alternating Current, the standard form of electrical current supplied by the utility grid and by most fuel-powered generators. The polarity (and therefore the direction of current) alternates. In the U.S.A., standard voltages for small water pumps are 115 volt and 230 volt. Standards vary in different countries. See Inverter.

Booster Pump – A surface pump used to increase pressure in a water line, or to pull from a storage tank and pressurize a water system. See Surface Pump.

Borehole - Synonym for water well, especially outside of North America.

Cable Splice - A joint in electrical cable. A submersible splice must be made using special materials available in kit form.

Casing – Plastic or steel tube that is permanently inserted in the well after drilling. Its size is specified according to its inside diameter.

Centrifugal Pump – A pumping mechanism that spins water by means of an "impeller." Water is pushed out by centrifugal force. See also Multi-Stage.

Check Valve – A valve that allows water to flow one way but not the other.

Converter – An electronic device for DC power that steps up voltage and steps down current proportionally (or vice-versa). Electrical analogy applied to ac: see Transformer. Mechanical analogy: gears or belt drive.

Current – The rate at which electricity flows through a circuit to transfer energy. Measured in amperes, commonly called amps. Analogy: flow rate in a water pipe.

Cut-In Pressure, **Cut-Out Pressure** – See Pressure Switch.

DC – Direct Current, the type of power produced by photovoltaic panels and by storage batteries. The current flows in one direction and polarity is fixed, defined as positive (+) and negative (-). Nominal system voltage may be anywhere from 12 to 180 Volts. See Voltage, Nominal.

DC Motor, Brush-Type – The traditional DC motor, in which small carbon blocks called "brushes" conduct current into the spinning portion of the motor. They are used in DC surface pumps and also in DC submersible diaphragm pumps. Brushes naturally wear down after years of use, and may be easily replaced.

DC Motor, Brushless – High-technology motor used in centrifugal-type DC submersibles. The motor is filled with oil to keep water out. An electronic system is used to precisely alternate the current, causing the motor to spin.

DC Motor, Permanent Magnet – All DC solar pumps use this type of motor in some form. A variable speed motor by nature, reduced voltage (in low sun) produces proportionally reduced speed, and causes no harm to the motor. Contrast: Induction Motor.

Diaphragm Pump – A type of pump in which water is drawn in and forced out of one or more chambers, by a flexible diaphragm. Check valves let water into and out of each chamber.

Drawdown – Lowering of level of water in a well due to pumping.

Driller's Log – The written form on which well characteristics are recorded by the well driller. In many states, it is a legal requirement to register all water wells and to send a copy of the log to a state office. This supplies hydrological data and well performance test results to the public and to the well owner.

Drop Pipe – The pipe that carries water from a pump in a well up to the surface.

Efficiency – The percentage of power that gets converted to useful work. Example: an electric pump that is 60% efficient converts 60% of the input energy into work – pumping water. The remaining 40% becomes waste heat.

Energy – The product of power and time, measured in watt-hours. 1000 watt-hours = 1 kilowatt-hour (abbreviation: kWh). Variation: the product of current and time is ampere-hours, also called amp-hours (abbreviation: Ah). 1000 watts consumed for 1 hour = 1 kWh. See Power.

Foot Valve – A check valve placed in the water source below a surface pump. It prevents water from flowing back down the pipe and "losing prime." See Check Valve and Priming.

Friction Loss – The loss of pressure due to flow of water in pipe. This is determined by 3 factors: pipe size (inside diameter), flow rate, and length of pipe. It is determined by consulting a friction loss chart available in an engineering reference book or from a pipe supplier. It is expressed in PSI or Feet (equivalent additional feet of pumping).

Gravity Flow – The use of gravity to produce pressure and water flow. A storage tank is elevated above the point of use so that water will flow with no further pumping required. A booster pump may be used to increase pressure. 2.3 Vertical Feet = 1 PSI. See Pressure.

Head – See Vertical Lift and Total Dynamic Head. In water distribution, synonym: vertical drop.

Impeller – See Centrifugal Pump.

Induction Motor (ac) – The type of electric motor used in conventional ac water pumps. It requires a high surge of current to start and a stable voltage supply, making it a challenge to run from a solar power system. See Inverter.

Inverter – An electronic device that converts DC to high voltage ac power. In solar-electric systems, an inverter may take the 12, 24, 48 or other DC voltage and convert it to 115 or 230 volts ac, conventional household power.

Jet Pump – A surface-mounted centrifugal pump that uses an "ejector" (venturi) device to augment its suction capacity. In a "deep well jet pump," the ejector is down in the well to assist the pump in overcoming the limitations of suction (some water is diverted back down the well). Jet pumps are NOT energy-efficient.

Linear Current Booster – See Pump Controller. Note: Although this term has become generic, its abbreviation "LCB" is a trademark of Bobier Electronics.

Multi-Stage Centrifugal – A centrifugal pump with more than one impeller and chamber, stacked in a sequence to produce higher pressure. Conventional ac deep well submersible pumps and higher power solar submersibles work this way.

Open Discharge – The filling of a water vessel that is not sealed to hold pressure. Examples: storage (holding) tank, pond, flood irrigation. Contrast: Pressure Tank.

Perforations – Slits cut into the well casing to allow groundwater to enter. May be located at more than one level to coincide with water-bearing strata.

Photovoltaic – The phenomenon of converting light to electric power. Photo = light, volt = electricity. Abbreviation: PV.

Pitless Adapter – A special pipe fitting that fits on a well casing below ground. It allows the pipe to pass horizontally through the casing so that no pipe is exposed above ground where it could freeze. The pump

may be installed and removed without further need to dig around the casing by using a 1 inch threaded pipe as a handle.

Positive Displacement Pump – A mechanism that seals water in a chamber, then forces it out by reducing the volume of the chamber. Examples: piston (including jack), diaphragm, and rotary vane. Used for low volume and high lift. Contrast with Centrifugal. Synonyms: volumetric pump, force pump.

Power – The rate at which work is done. It is the product of voltage times current, measured in watts. 1000 watts = 1 kilowatt. An electric motor requires approximately 1 kilowatt per horsepower (after typical efficiency losses). 1 kilowatt for 1 hour = 1 kilowatt-hour (kWh).

Pressure – The amount of force applied by water that is either forced by a pump or by the gravity. Measured in pounds per square inch (PSI). PSI = vertical lift (or drop) in Feet / 2.31.

Pressure Switch – An electrical switch actuated by the pressure in a pressure tank. When the pressure drops to a low set-point (cut-in) it turns a pump on. At a high point (cut-out) it turns the pump off.

Pressure Tank – A fully enclosed tank with an air space inside. As water is forced in, the air compresses. The stored water may be released after the pump has stopped. Most pressure tanks contain a rubber bladder to capture the air. If so, synonym: captive air tank.

Pressure Tank Precharge – The pressure of compressed air stored in a captive air pressure tank. A reading should be taken with an air pressure gauge (tire gauge) with water pressure at zero. The air pressure is then adjusted to about 3 PSI lower than the cut-in pressure (see Pressure Switch). If precharge is not set properly, the tank will not work to full capacity, and the pump will cycle on and off more frequently.

Priming – The process of hand-filling the suction pipe and intake of a surface pump. Priming is generally necessary when a pump must be located above the water source. A “self-priming” pump is able to draw some air suction in order to prime itself, at least in theory. See Foot Valve.

Pulsation Damper – A device that absorbs and releases pulsations in flow produced by a piston or diaphragm pump. Consists of a chamber with air trapped within it.

Pump Controller – An electronic device which varies the voltage and current of a PV array to match the needs of an array-direct pump. It allows the pump to start and run under low sun conditions without stalling. Electrical analogy: variable transformer. Mechanical analogy: automatic transmission. See Linear Current Booster.

Pump Jack – A deep well piston pump. The piston and cylinder is submerged in the well water and actuated by a rod inside the drop pipe, powered by a motor at the surface. This is an old-fashioned system still used for extremely deep wells, including solar pumps as deep as 1000 feet.

PV – The common abbreviation for photovoltaic.

PV Array – A group of PV (photovoltaic) modules (also called panels) arranged to produce the voltage and power desired.

PV Array-Direct – The use of electric power directly from a photovoltaic array, without storage batteries to store or stabilize it. Most solar water pumps work this way, utilizing a tank to store water.

PV Cell - The individual photovoltaic device. The most common PV modules are made with 33 to 36 silicon cells each producing 1/2 Volt.

PV Module – An assembly of PV cells framed into a weatherproof unit. Commonly called a “PV panel”. See PV Array.

Recovery Rate – Rate at which groundwater refills the casing after the level is drawn down. This is the term used to specify the production rate of the well.

Safety Rope – Plastic rope used to suspend the pump, primarily in case of pipe breakage.

Sealed Piston Pump – See Positive Displacement Pump. A type of pump recently developed for solar submersibles. The pistons have a very short stroke, allowing the use of flexible gaskets to seal water out of an oil filled mechanism.

Solar Tracker – A mounting rack for a PV array that automatically tilts to follow the daily path of the sun through the sky. A “tracking array” will produce more energy through the course of the day than a “fixed array” (non-tracking), particularly during the long days of summer.

Static Water Level – Depth to the water surface in a well under static conditions (not being pumped). May be subject to seasonal changes or lowering due to depletion.

Submergence – Applied to submersible pumps: distance beneath the static water level at which a pump is set. Synonym: immersion level.

Submersible Cable – Electrical cable designed for in-well submersion. Size (in USA) is specified by American

Wire Gauge (AWG), in which a higher number indicates smaller wire. The specification “two-wire plus ground” indicates three wires (conductors) in the cable. It is connected to a pump by splicing.

Self-Priming Pump - See Priming.

Submersible Pump – A motor/pump combination designed to be placed entirely below the water surface.

Suction Lift – Applied to surface pumps: vertical distance from the surface of water in the source to a pump located above. This distance is limited by physics to around 20 feet at sea level (subtract 1 ft. per 1000 ft. altitude) and should be minimized for best results.

Surface Pump – A pump that is not submersible. It must be placed no more than about 20 above the surface of the water in the well. See Priming. (Exception: see Jet Pump).

Total Dynamic Head – Vertical lift + friction loss in piping (see Friction Loss).

Transformer – An electrical device that steps up voltage and steps down current proportionally (or vice-versa). Transformers work with ac only. For DC, see Converter. Mechanical analogy: gears or belt drive.

Utility Grid – Commercial electric power distribution system. Synonym: Mains.

Vane Pump – (Rotary Vane) A positive displacement mechanism used in low volume high lift surface pumps and booster pumps. Durable and efficient, but requires cleanly filtered water due to its mechanical precision.

Vertical Lift – The vertical distance that water is pumped. This determines the pressure that the pump pushes against. Total vertical lift = vertical lift from surface of water source up to the discharge in the tank + (in a pressure system) discharge pressure. Synonym: static head. Note: horizontal distance does NOT add to the vertical lift, except in terms of pipe friction loss, nor does the volume (weight) of water contained in pipe or tank. Submergence of the pump does NOT add to the vertical lift in the case of a centrifugal type pump. In the case of a positive displacement pump it may add to the lift somewhat.

Voltage – The measurement of electrical potential. Analogy: pressure in a water pipe.

Voltage Drop – Loss of voltage (electrical pressure) caused by the resistance in wire and electrical devices. Proper wire sizing will minimize voltage drop, particularly over long distances. Voltage drop is determined by 4 factors: wire size, current (amps), voltage, and length of wire. It is determined by consulting a wire sizing chart or formula available in various references. It is expressed as a percentage. Water analogy: friction loss in pipe.

Voltage, Nominal – A way of naming a range of voltage to a standard. Example: A “12 Volt nominal” system may operate in the range of 11 to 15 Volts. We call it “12 Volts” for simplicity.

Voltage, Open Circuit – The voltage of a PV module or array with no load (when it is disconnected). A “12 Volt nominal” PV module will produce about 20 Volts open circuit. Abbreviation: Voc.

Voltage, Peak Power Point – The voltage at which a photovoltaic module or array transfers the greatest amount of power (watts). A “12 Volt nominal” PV module will typically have a peak power voltage of around 17 Volts. A PV array-direct solar pump should reach this voltage in full sun conditions. In a higher voltage array, it will be a multiple of this voltage. Abbreviation: Vpp.

Well Seal – Top plate of well casing that provides a sanitary seal and support for the drop pipe and pump. Alternative: see Pitless Adapter.

Wellhead – Top of the well at ground level.

Access

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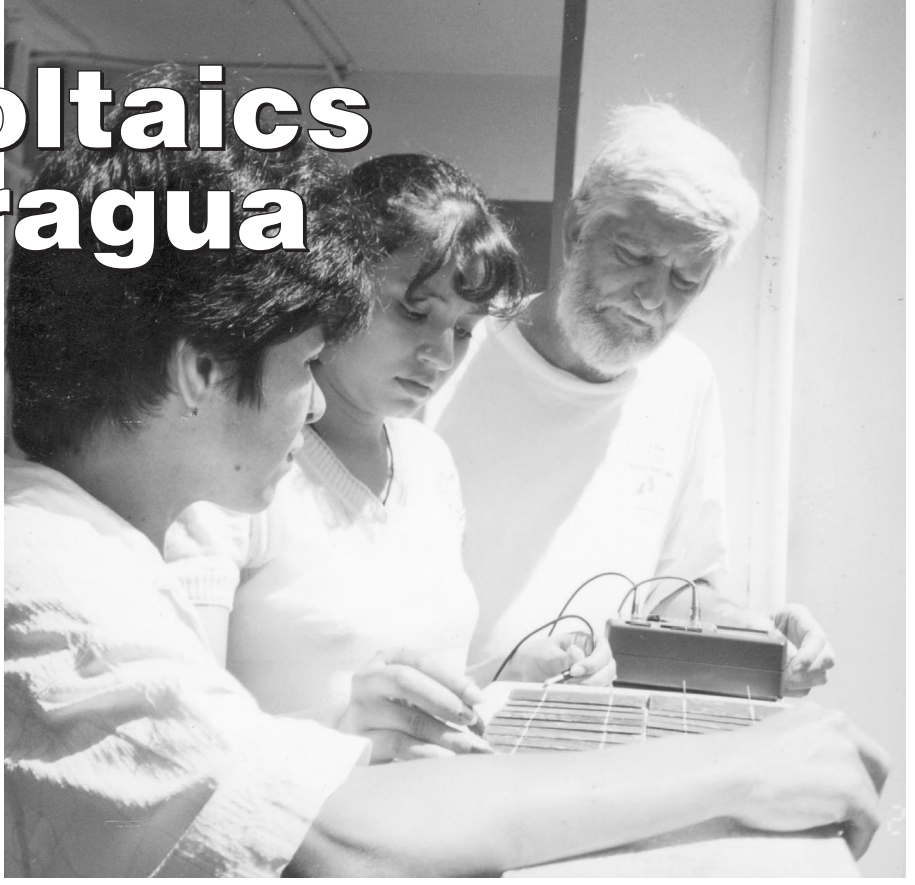
Video: *Renewable Energy with the Experts* series: Solar Water Pumping. Covers the fundamentals of solar powered water lift and pressurizing, and documents the installation of a SunRise pump. 1 Hour, available from Producer: Scott Andrews, PO Box 3027, Sausalito, CA 94965, or Dankoff Solar Products.

Photovoltaics in Nicaragua

Richard J. Komp



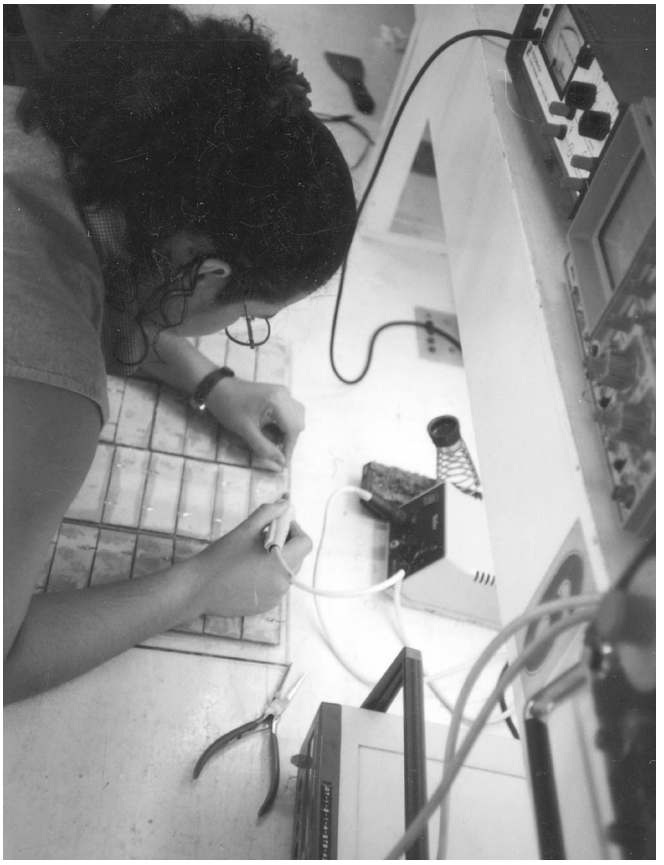
Above: Dr. Komp and electrical engineering students from UNI

Nicaraguans are extremely interested in using photovoltaic systems. That's the first thing I noticed when I started working on photovoltaics at the Universidad National de Ingieneria (UNI) in Managua. I have just returned from a successful two month trip to Nicaragua. To give a few of the highlights, there is a new company now manufacturing 20 Watt PV modules in Nicaragua, local people in the barrio where I stayed asked me to teach a solar box cooker workshop they had organized, we had three well-attended solar battery charger workshops, and I lost almost twenty pounds.

Below: UNI professor Susan Kinne and students test open circuit voltage on the panel they made.

The main purpose of the trip was to teach a group of engineering students about photovoltaics and give them as much practical, hands-on experience as possible in the 60 day visit. This was my first trip to Latin America and I had not studied Spanish before starting out. I spent a couple of weeks at a friend's home in Florida learning some basic Spanish before heading for Nicaragua. Fortunately, my host at UNI, Susan Kinne, is originally from Cincinnati and is bilingual (actually trilingual, since her first degree is in German literature). She had already scheduled a series of three public lectures on solar cells. These lectures were a complete success with her translating my English lecture. The attendance was so great that we moved to the biggest lecture hall at the University. I discovered that there already is an active photovoltaics market in Nicaragua using modules and other components imported from the US or Europe. All the people involved in this business showed up at the lectures, and half of them are former engineering students of Susan's.

We also scheduled a set of hands-on workshops where the participants assembled small 2 Volt solar battery charger modules. These are similar to the set of workshops that the Maine Solar Energy Association has organized at the local schools here in Maine. I taught the first workshop with the help of the electrical engineering group (called Fenix). For the next workshop a few weeks later, I only give the lecture while the Fenix group did the hands-on part of the workshop. For the final workshop I stayed in the



Above: Soldering cell inteconnects.

background while the students taught the entire workshop

Once we started to assemble the 20 Watt modules we arranged an installation workshop, mounting one of the first modules on the roof of Susan's home. We also worked with one of her former students, in charge of casting the lead plates at Nicaragua's only battery plant, to start manufacturing a deep cycle lead acid battery for solar electric storage. The first prototype solar electric battery made in Central America is now being tested at this installation. I also worked with three of the students to construct prototype charge controllers, 12 Volt electronic ballasts, and even an inverter. The idea is to make as much of the system as possible inside the country.

There are a number of photovoltaic systems in Nicaragua that had been installed by volunteers from non-profit groups. Many of these have fallen into disrepair or had been dismantled by the local people who were never adequately trained in their use. We contacted several non-profit groups, which included Terrasol in the US and a couple of German NGOs (where Susan's command of German came in handy). We proposed that the Fenix group see to the

WHO ARE WE?

by the Fenix group,
original translation by Susan Kinne

SUNI is a small business which is coming into being at this very moment. It stemmed from an already productive collaboration between the Nicaraguan National Engineering University and Sunwatt, of the U.S.A.

SUNI is a concrete response to a screaming need in the development of Nicaragua. About a year ago a group of faculty and senior students began doing research into renewable energy to develop that field in the Electrical Engineering Department and to prepare themselves for productive work in an area that the country desperately needs. The group calls themselves Phoenix (Fenix, in Spanish).

The sun is such an obvious resource in Nicaragua, but price is an inhibitive factor in the exploitation of photovoltaics. One of the goals they set for themselves was to construct photovoltaic panels in Nicaragua. They were fortunate to incorporate the assistance of Dr. Richard Komp, a photovoltaics specialist and designer, manufacturer, and promoter of solar panels.

After the successful construction of six prototypes, the group is now producing 15 more 20 Watt panels. The orders are coming in from NGO's who are interested in small scale electrical generation in remote locations. We just sent out a price estimate for 100 5 Watt panels and are researching materials for frequently requested 60 Watt panels.

A pre-thesis graduate student working in production in the battery factory is developing a prototype for a deep cycle battery designed for photovoltaic systems. Another young engineer is constructing a prototype of a charge controller. In other words, we are well on the road to being able to have locally manufactured, economically accessible, support devices as well as the panel itself. By the way, this is not re-inventing the wheel, but rather adapting to local circumstances. It is also being done in India and working well.

We welcome you to come see our operation at the university and to ask any questions you may have.

Access

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Above: Laying down traces.

refurbishing and maintenance of these PV systems. This led to several field trips to marvelous places like the Pacific Coast and the mountainous central part of the country. Unfortunately, I ran out of time before we got to the rainforest, but that's a trip for another time.

On the Terrasol field trip, the Fenix group arranged to give a photovoltaic installation workshop. This was totally their idea, and will result in Nicaraguans teaching solar energy to US Peace Corps workers. I hope I have started something.

UNI hosted a large, all day conference on solar energy a week before I left. We arranged for many of the solar practitioners to give sessions on all aspects of solar. The morning sessions were devoted to solar thermal processes while in the afternoon we discussed designing and installing photovoltaic systems. The Fenix group translated the relevant parts of the Maine Solar Primer into Spanish as a handout for the morning session and prepared an introduction to the solar electric home (also in Spanish) for the afternoon handout. These were given free with the registration fee of 50 Cordobas (about $5.30) for the whole day. We had working solar devices in the plaza in front of the meeting place and used the solar ovens we made at earlier workshops to cook soup for about 25 volunteers and others. The total attendance of 76 paid for all the expenses and left enough in the Fenix treasury for seed money for future events. One of the concepts we stressed is that of sustainability, financial as well as cultural and environmental, and I hope to have succeeded.

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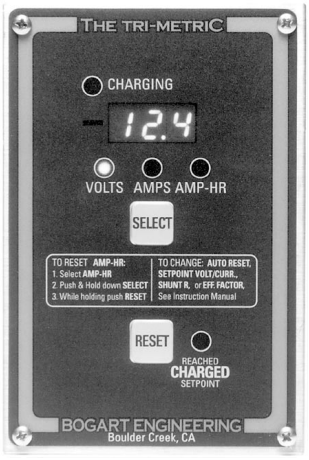

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What to Expect from your RE Dealer

Richard Perez

Every RE system begins its working life as a pile of equipment. Preparation, planning, and proper installation are all essential if the system is to be a success. You can do it yourself or you can get help from an installing dealer. Here is what to expect from your dealer. And here is what you may miss if you decide to do it yourself.

Load Analysis

Every renewable energy system begins with a complete, accurate, and thorough analysis of the appliances to be used in the system. If the load analysis is not properly done, then the system is bound to disappoint its user. If the system's energy consumption is estimated too low, then power shortages and dead batteries soon follow. If the estimate is too high, then the user is wasting money on unneeded equipment.

Who does this load analysis, the system's user or the person who sells the RE equipment? In most cases, both contribute information. The user lists and gathers data about each appliance (don't leave out even the smallest one and don't forget to plan for new appliances). How much and what type of electric power does the appliance consume? How much time will the appliance be operated? The dealer usually enters the appliance data into a computer and generates an estimate of daily energy consumption. A good dealer will also recommend appliance changes to reduce the system's energy consumption. The golden rule is: Every buck spent on an efficient appliance saves three bucks in system components. A good dealer knows this and will suggest replacing inefficient appliances (such as incandescent lighting and self-defrosting refrigerators which spit ice cubes out their door) with the most efficient type available. Listen to your dealer, he's not trying to sell you an expensive refrigerator, he's trying to save you three times the cost of that fridge in PV modules, controls, batteries, wiring and/or inverters.

Sad to say, many systems are purchased without ever doing a load analysis. Anyone who does this is wasting money and bound to be disappointed with their system. A good renewable energy system dealer will insist that a load analysis be done before selling you a system. If you haven't done the analysis, then he will nag you into it, or visit you and do the analysis with you. He deserves to be paid for this generously because he is really doing your homework.

A Budget is not a Load Analysis

Don't buy a packaged system just because its price is what you want to spend. Do the load analysis and if the system needed to power these loads is too expensive, modify the loads. Replace inefficient appliances, and if need be eliminate appliances until the system is affordable. It is not unusual to go through the load analysis and system design phases three or four times before the right system is found. This system costs what the user wishes to spend and the load analysis details the energy consumption of each appliance.

If you don't know how to do a load analysis, then see the article written by Ben Root in HP#58, pages 38–44. If you are hiring a dealer to do the load analysis, make sure they are listing all the criteria shown in Ben's article.

Site Survey

A site survey is an analysis of a specific location for its renewable energy potential. Every place is different, but your system is going to be installed in a specific location. You need to determine what types and amounts of energy are available to you. Site survey varies from simple to complicated. Let's look at surveying a site for PV potential.

Sunlight is the fuel used by PV modules to make electricity. The PV array needs to be located where it will receive the maximum amount of sunlight. With seasonal variations in the sun's declination, daily constant changes in the sun's azimuth, and possible shading from hills, trees, and buildings, finding the best spot for the PV array can be difficult. What is needed here is an instrument such as the Solar Pathfinder®. The Solar Pathfinder makes it easy to find the best spot and it produces a hardcopy , called a sun chart, of that exact place's solar insolation potential. If your dealer shows up to survey your solar site without a Solar Pathfinder or similar instrument, fire him. If you are doing your own site survey for PV, then borrow, rent, or

buy a Solar Pathfinder and learn to use it. See HP#57 and HP#21 for specific information on solar site surveys.

Wind is a difficult resource to survey. Most wind generators are installed without long-term, wind speed, data logging. The current best idea for wind site analysis is installing a small generator at the exact place and at the same height as the proposed big generator. Recording instrumentation monitors the small genny's performance for a period of a year or so and then this info is used to estimate the performance of larger gennys. An experienced wind dealer, while he doesn't know your site's measured wind potential, he can make a very accurate guess. He can also help you find a suitable location for the tower and encourage you to make it as high as possible. See HP#40 and HP#41 for specifics on wind site analysis.

Hydro is the easiest renewable energy source to survey. Use either conventional surveying methods, or the cheap, but none the less accurate, liquid level method. Surveying for hydro can be done either by the system's owner or by the dealer. All that counts is accurate head and flow measurements and some historical data on the water sources seasonal output. See HP#21 for hydro siting information.

Many installing dealers combine the load analysis and site survey into a trip to their customer's site. In addition to working on the load analysis and siting the RE equipment, the dealer also gleans more vital information such as all wiring lengths and battery location. From the site survey he is able to estimate how much RE potential is present. This RE potential coupled with the load analysis is all the information needed to proceed to the next stage—system design.

System Design

Designing a renewable system means using the system's energy requirements and its RE potential to generate a specific list of RE equipment. This RE equipment supplies the needed electricity as per the load analysis and site survey. Put into sentences it sounds easy, but really there is just as much art as science involved in system design.

Consider that a system designer can choose between at least eight different brands of PV modules with each brand having at least four models. Consider that you can choose many different battery types, wind genny models, inverter kinds, control makes, and instrument types. There are literally thousands of different combinations of equipment. A good system designer has learned through experience what works and what doesn't. He knows which equipment plays well with other equipment. He knows details such as: should we use a PV tracker, what size pipe to use in hydros, how tall should the tower be, how should the battery be configured, what kind and size of cable/wires are required, and inverter/appliance compatibility. They know your local RE environment. When you pay someone to design your system, you are buying their expertise. In almost all cases, professional help with system design pays off—mistakes in the design phase are expensive to fix after installation.

Every system, regardless of size and without exception, should be safely designed. Over current protection devices, disconnects, and proper conductor use make for a safe system. If your dealer doesn't do NEC® compliant systems, then get another dealer who does. If you are doing the design yourself, learn the NEC and follow the rules. Renewable energy is real. It can burn down your home as easily as the grid.

Once the system designer has a specific list of RE equipment we find out an essential bit of information—the system's hardware cost. At this stage the system's customer usually chokes and says, "I can't afford that!" Does the system's designer begin deleting PV modules and batteries to bring the system down in cost? NO! A good system designer goes back to the load analysis. Can we do anything more efficiently? Can we do without some of the luxury appliances? The system's user and the designer work on the load estimate until the system becomes affordable. A good designer will revise the design until it satisfies the current load estimate and the customer can afford all the hardware. This is an essential give and take process. One very important product of this process is that the user is made aware of the system's capabilities. If the designer knows what he is doing, then the customer knows what the system will power.

System Purchase

With the load estimated, the site surveyed, and the system designed we have arrived at the first big milestone—the one where you get to part with your hard earned bucks.

Now is a good time to pause. Are you comfortable with your dealer/designer? Do you trust them? If you have doubts, now is the time to get a second opinion. If you decide on a second opinion, pay the first dealer/designer at this point. Pay them for their help in load analysis, their site survey, and their work in designing your system. This makes their design yours—you just bought it. If you decide to buy from another dealer, then this essential information is yours to use. Most dealers/designers charge from a measly $200 to about $600 for the load analysis, site survey, and system design. Many will refund this charge if you buy the gear from them and have them install it.

If you designed your system yourself and are shopping around for the cheapest deal in hardware which you intend to install yourself, then you should get a second opinion. Hiring an experienced designer/installer to review your load analysis, site survey, and system design is money very well spent. Most designer/dealer/installers will do this for less than 5% of the money you are planning on spending for hardware. A second opinion before purchasing your first-time design can save thousand of dollars later.

It is not uncommon for installing dealers to ask you to pay for some or all of the hardware prior to installation. This allows them to use your capital to finance the job. It is not uncommon for installing dealers not to have all the equipment for your system in stock. Inventory costs money and a little patience on your part keeps installing dealers from having to charge you more for your system. You should never have to pay for installation labor until the system is installed and working to your satisfaction. It is not uncommon for an installing dealer to refuse to install hardware which they did not sell. The installing dealer is working on very slim profit margins. Installing dealers are beset on all sides by competition with companies that offer low prices instead of on site service. If you appreciate the help that your installing dealer has given you and will give you, show it by paying them enough to live on.

At this point money changes hands. Everything must be on paper, one copy for the installing dealer and the other for the system customer. In this packet of paper work is: a copy of the final load analysis, a copy of the site survey complete with sun chart, a printout of the system design, including system schematic, with all estimated RE production data, manufacturer's spec sheets for all components, and a copy of the hardware bill. If you don't have all this paper work at this point, then don't sign the check until you do.

Your installing dealer will now take your check, order your gear, and prepare to return to your site for installation. This entire process may take two to six weeks, so be patient.

Shipping

There may be some of you who are acting as your own designer/installer and are now getting ready to accept the equipment you have purchased from a company who doesn't install. Check every box and every item for damage before you accept shipment from the carrier. Once you've signed off and accepted the shipment, claims for damage are very difficult. If you notice any damage, then refuse to accept *all* the damaged goods and have it returned to the shipper. Let your supplier and their carrier discuss who is to pay for the broken equipment.

If you purchased your system from an installing dealer, then you can forget shipment hassles. The dealer will show up at your site with all the equipment in good condition. You have already paid them to deal with any broken batteries or smashed PV modules that may have occurred. This is their problem not yours.

Installation

This is the phase which really determines if you were right in deciding to install your own design, or whether you should have hired an installing dealer to help you. This is where months of planning and many dollars should become electricity.

If you are installing your own system, then I can only hope you have done your homework. We at *Home Power* have tried to help with technical information, schematics, and everything we could think of that would make you as informed as an installing dealer. What we cannot supply through *Home Power* is experience. Only time and many systems installed and working can do that.

If your system is being installed by an installing dealer, then you should consider becoming his shadow. This person has done dozens, maybe hundreds, of these systems. He is a wealth of information and will explain every wire and every device if you have sense enough to ask. The installing dealer should explain to the user battery watering and any other routinely required maintenance. The dealer should also explain how to operate the system's controls, how to use the inverter, and how to understand the information displayed by the system's instruments.

Most installing dealers will let you work with them. Most dealers would rather that you dig the wiring trenches or wind machine tower foundation holes. Building the power shed housing the PVs, batteries, and inverter yourself can save your money. Sweat equity pays off here. Installing dealers are highly skilled and mostly very busy. You can pay them to dig trenches at about $35+ an hour or you can do it yourself.

Also under the heading of sweat equity is system maintenance. During installation is a great time to learn routine system maintenance, such as battery watering, from your dealer.

Most installing dealers will not install hardware which they did not sell. Please don't shop around for a cheap deal on RE equipment and then ask your local dealer to install the system. If you want installation, then pick a dealer and involve them from the very beginning. An installing dealer must both sell the hardware and install it if they are going to make a living. Respect this and your local dealer is a terrific resource.

At this critical installation phase, the self-installer should consider every cable, wire, connector, over current device, and disconnect in the system. Is it designed properly? There is no such thing an an unimportant connection. Every wire and connector must be done right. For example, it takes a $300 crimper the size of pruning shears to properly attach the connector (@$2.50) to a 0000 copper cable. It takes a set of punches costing over $200 to make holes in electrical boxes. It takes a conduit bender to make bends in EMT conduit. While the bender is cheap, it's easy to waste $200 worth of conduit learning to use it. Installing dealers have all these tools and know how to use them.

Passing Electrical Inspection
Many installing dealers are also state-certified electrical contractors. Those who are not, hire an electrical contractor to oversee their work and show up for the electrical inspection. Chances are that your installing dealer has met with your electrical inspector before and knows what he is looking for. If the system is done to the local specs, then there will be no problems here.

If you installed your system yourself, then expect critical examination by your electrical inspector. Don't be offended or angry, the inspector really has your best interest at heart. He knows that this is the first system you have done. He is merely safe guarding your home and family. If the electrical inspector finds faults, listen to him. Make any changes he requires regardless of what it costs. If there are substantial changes at this stage of the process, you have only yourself to blame—you did not do your homework.

Dealer Support
Your installing dealer should support you. If any component fails while under warranty, the dealers should remove it from your system and seek warranty repair on your behalf. When the component is repaired or replaced they should reinstall it in your system at no charge to you. You should be able to call your dealer and ask them questions about your system's operation. If you are not getting this type of service from your dealer, then change dealers.

If you designed and installed your own system, then you have little recourse to service. If things go wrong or don't work when installed, then calling the catalog business which sold you the hardware is going to do little good. Troubleshooting a botched installation requires an on-site visit by a sharp technician. Many mail order companies are not equipped to spend hours on the phone with you trying to find what is miswired or improperly applied. If you are going to install your own system, then you should learn enough not to need outside technical support.

System Buyers treat your Installing Dealer right!
Your installing dealer is your best avenue for getting a system that works well at a reasonable price. Please realize that they cannot compete with discount mail order firms. Don't ask them to. Instead of a cheap deal, the installing dealer offers you expert personal service. Please realize that your installing dealer has overhead and expenses. It is not uncommon for them to wear out pickup trucks like you wear out tooth brushes. Expect your dealer to charge you mileage and realize that they must do this in order to stay in business. If this personalized service is worth the approximately 15% extra a system will cost when designed by, purchased from, and installed by professionals, then your dealer is your man. If not, then there is the phone and you are on your own.

Installing Dealers treat your Customers right!
This article details your responsibilities to your customer. If you are not providing this level of service, then you are in the wrong business. Have patience with non-technical customers who call in the middle of the night saying their batteries are broken because their voltage went down at sunset. Not everyone is a tech weenie and most customers will need considerable schooling from you before understanding how their systems work. This is your job. Your customers are part of your family, treat them as such.

Still want to design and install your own system?
I don't mean to discourage you, in fact we do our level best here at *Home Power* to give you all the information you need. You must do your homework. Take a hard, honest look at your abilities and available time. Failing in this leads to expensive, barely working systems which are often safety hazards. Renewable energy is not rocket science. You can learn to do systems properly and safely if you take the time to learn everything thoroughly. Be prepared to buy some expensive tools such as the monster lug crimper mentioned earlier. Be prepared to make mistakes and pay for those mistakes. While the information in *Home Power* is as complete and thorough as we can make it, it is not a substitute for on the job experience.

Access
I spent over ten years as an installing dealer of RE systems. During this time I established over one hundred systems before becoming editor of *Home Power*.

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Solar Power and Amateur Radio

Richard Perez N7BCR

The more we use the tools of technology, the more we become dependent upon them. While technology does make our lives easier, it extracts a price—dependance on infrastructures beyond our control. Sometimes technology lives up to its promise and gives us tools which free us and make us more self-sufficient. Solar energy and Amateur (Ham) radio are two such tools.

Independent Power

While regular readers of *Home Power* are familiar with PVs, wind gennys, and microhydro turbines, the public at large still thinks electricity can only be made by a centralized utility or a gas generator. Home power people know that electricity can be independently made on-site using sunshine, wind, and falling water. During times of emergency or disaster, RE systems continue to make electricity when grid power fails and/or the gas runs out.

Independent Communications

Amateur radio, or Ham radio as it is commonly called, is just like independent electricity, only applied to communications. Home power systems have only been around for twenty years or so. Ham radio has been happening for over 100 years.

Ham radio is an international network of people who operate their own radio communications equipment. These radio amateurs are licensed by their government. Hams must take an exam in order to secure this license, called a "ticket". The name Amateur is really misleading because Hams actually pioneered most of the developments we now take for granted in radio and television communication.

Who do Hams talk to? Well, other Hams of course, and there are millions of us worldwide. Hams talk in virtually every known mode of communication: Morse code, radioteletype, voice, computer data, and video. Their communications spans from across town to the other side of the world.

OK, so Hams talk worldwide, but are we saying anything worth listening to? Yes, we are! You can find virtually every subject imaginable under discussion on Ham radio. If your interests are in electricity and electronics, then Hams are a gold mine of practical and useful information. And Ham radio is two way, you don't have to be content with just listening, you can jump into the discussion and ask questions, or air your views.

Many Hams specialize in what's called "Handling Traffic" which means relaying communications for others. Ham Traffic Nets span states and continents, delivering messages quickly and accurately. Other Ham radio nets are much smaller, such as our Backfence Net here around Agate Flat. Within six miles of Funky Mountain Institute there are four full time households, three are occupied by Hams. We just leave our radios (at home and in our vehicles) on all the time. If anything happens anywhere around our neighborhood, we all learn of it instantly.

You may ask if we *really* need to have independent communications. In this day of telephones, FAXes, Internet, and cell phones why would anyone need to have their own personal Ham radio? Here is just one example of many. Last summer a big lightning storm came through this area. The lightning started a forest fire close to us, french fried the entire local telephone network, and blitzed the local cell phone site. All standard communications were dead and our neighborhood was burning. We were able to get word to the professional fire fighters, and mobilize everyone. A close neighbor and Ham (Jim WD6EEY) located the fire site and directed all of us to it, all via amateur radio. Kathleen KB6MPI was in her car some 20 miles from the fire, but she heard our communications on Ham radio. She drove to the local fire station and told the pros where the fire was. And this is just one of many, many instances where Ham radio has saved lives and property during emergencies.

When the complex networks of technology, be it either electric power or communications, fail, then we are on our own. Ham radio is very like renewable energy. Do it for yourself and you can rely on it.

Solar-powered Ham Radio

Ham radio is a natural for solar power. Most Ham stations can easily be sourced by one to two PV modules. The Ham radio equipment loves the smooth,

ripple free, power delivered by a battery. The real effectiveness of Ham communications is very apparent when the grid fails. What good is all the radio gear if there is no electricity to power it? Solar electricity and battery storage is the answer. All Hams should consider PV/battery systems for their radio systems. For under $1000 of RE hardware, most Ham stations could operate without the electric power grid entirely.

Ham radios come in many sizes (from hand held to fills the room), power levels (a few milliWatts to 2,000 Watts), and operating frequencies (DC to Daylight). We use several hand held transceivers here which operate on the 2 meter ham band. They use small NiCd batteries and are easily recharged using a small PV module. I'd rather leave the house without my boots than my handheld. Most Ham radios come in 12 VDC versions for automobiles. These same radios work great in 12 VDC home systems. Power levels are mostly low, 100 Watts or less on transmit and around 5 Watts or less on receive. If you already have a home power system, then you won't notice the energy consumption of ham radio gear.

RE users here is Ham radio!

If you already appreciate the self-sufficiency of making your own electricity from sustainable sources, then you are going to love independent communications. While I have stressed the dramatic, emergency, aspects of Ham radio, it's really the day to day convenience which keeps me using it. Little things like being able to work in the field and have solid two way communications with home and vehicle. Being able to pull into a town in a distant state and get the straight scoop on local eateries. Being able to arrive at the chaos of setting up for an Energy Fair, and have everyone (the whole HP Crew are Hams) in contact. Passing an idle moment by meeting a new Ham and talking about solar power. The thrill of talking to another Ham in Australia while using less than 10 Watts of power. If you plan to go for a Ham ticket, then take your significant other along—it's much more than twice the fun and utility.

Hams here is Renewable Energy!

What's the scoop, Hams? You folks already know enough electrical theory to understand how renewable energy works. Your station should be sustainable—you need to have solar power for your radios. Next time Field Day comes around, up root that solar Ham station and go to the nearest mountaintop. Next time an emergency shuts off power and phone, be in a condition to handle traffic.

A Special Event Station at MREF '98

What we need to introduce the RE and Ham communities to each other is a Special Event Station at next year's Midwest Renewable Energy Fair. I've already talked to the MREF Folks and they say, "Go for it!" Electricity will be supplied by the Fair's solar and wind systems. The event could introduce many RE folks to the world of Ham radio. It could also introduce many Hams, on the air, to the world of renewable energy. This is a marriage made in heaven!

What we need to make this happen is help. We need people with feet in both worlds, RE and Ham. These people must make sure that all radio gear and ops are on site and working on time. They must also make sure that the Ham booth is populated and on the air while the MREF is open to the public. I am not up to this job. I teach two seminars daily and try to spend much of the rest of my time in the Home Power booth answering questions. We need Hams who know RE who are willing to accept this task. How about it? Contact me directly and I will act as coordinator until the group gets organized.

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The Little EV that Could

Shari Prange

Above: Steve Hill drives a late model version of Clark Beasley's "Slingshot."

"Oh, how cute!" you think to yourself. "A little electric car for kids." Then the car stops, its roof no higher than your knees. The canopy opens, and a six-foot-tall man steps out, like some kind of stage magic trick. You've just encountered your first Electrathon racer.

Where It Began

In 1978, EV enthusiasts in Great Britain formed the United Kingdom Electric Vehicle Association (UKEVA), and decided to hold an EV competition, with the assistance of the Institute of Mechanical Engineers.

The competition had two parts: a design and theory part, and a practical construction part. Many entrants were excluded from the second part because they could not afford the expense of bringing their design to life. To eliminate this problem, competitors were encouraged to develop very simple, economical designs. Since the vehicles were never intended to mix with regular street traffic, it was possible to make them much smaller, simpler, and more affordable.

The vehicles they built would compete in an electric marathon—an electrathon. This competition was the Lucas Electric Vehicle Endurance Run. All vehicles were supplied with identical 25 kg packs of Lucas batteries, and the race was on.

Next Stop—Down Under

(Australian-to-American translations in parentheses.)

In 1979, John Stevens, president of the Australian Electric Vehicle Association (AEVA), saw the Lucas competition in the UK, and decided to start a similar event back home. The first Australian race ran in 1980 in a shopping centre carpark (shopping center parking lot), with a course laid out with witches hats (traffic cones). It had seven entries, all electric bicycles. The course was so short that the vehicles completed a—literally—dizzying 130 laps in two hours.

In 1981, the race was moved to a caravan park (RV park). This was not a good move. The course was L-shaped, and created congestion where competitors made U-turns at the ends.

In 1982, the event moved to a better site at another shopping centre. While it was a better course, it did have one problem. There were cars parked in the "infield", and riders soon made the rude discovery that at least one car was parked across the course. In addition, this was the first—and only—electrathon in which drivers "came off their vehicles" involuntarily and suffered injuries.

Sorting It All Out

As a result, major changes to the rules were made. Since schools and student drivers were heavily involved, safety was a high priority. It was decided to have a specific class for an Electrathon vehicle with emphasis on safety requirements. Then these vehicles would run separately from electric cycles and other vehicles with less stringent requirements and different handling characteristics. Thus, the Electrathon racer was born.

Below: Courses may be flat road courses, like this, or banked ovals.

The event also found a suitable track: trapezoid shape, smooth bitumen (asphalt) surface, .6 km in length, with just enough grade to present a decent challenge.

Above: This low sleek shape is typical of Electrathon bodies.

Today in Australia, a typical Electrathon event will have an Electrocycle race and an Electrokhana race as warmups to the featured Electrathon competition. (The Electrokhana involves cycles and vehicles similar to Electrathons negotiating a twisty course and stopping at designated times and places to pick up or put down a small cargo box—much like relay runners handing off a baton.)

Next Stop California

Australian Electrathon racing was well established when Clark Beasley and his bride moved to southern California in 1989. Clark immediately entered his Electrathon in the three-wheeled class of the local EV rally, and won his class. Of course, he was the only three-wheeled entry, which didn't hurt.

However, Clark didn't stop there. For the next couple of years he took his "Slingshot", and a second Electrathon he built, up and down the state doing display and demonstration events. He attracted attention and enthusiasm wherever he went.

By 1992, there were enough Electrathon builders and competitors to formalize the events into full-fledged Electrathon competitions in the mold of the Australian rules. Electrathon America was formed as a sanctioning body. The sport has proved so popular that there are now sanctioned events in twenty-eight states. The southern California chapter has just completed a deal to allow once a month races at the Encino Velodrome.

The goals of Electrathon racing are threefold: to foster research and development and designs at a grassroots, economical level; to provide a spectator event to promote electric vehicles to the public; and to have fun. They succeed on all levels.

Rolling Chassis

The vehicles seat a single person, and must have three or four wheels. These can be arranged in three configurations. A tricycle has one wheel in front and two in back. A cyclecar has two wheels in front and one in back. An autocar has four wheels at the corners. All wheels must all be load-bearing and in contact with the road at all times. Also, the vehicle must be independently stable at rest and in motion. In other words, you can't lose your balance and fall down.

There are very detailed braking requirements, reflecting the focus on safety. Regenerative braking is allowed in addition to conventional braking.

Tires must be inflatable, with a minimum diameter of sixteen inches. This differentiates Electrathons from go-karts, which use very small tires. Many Electrathons sit down between tires that are actually taller than the car's body.

The vehicle must have a fully enclosed body, with a roll bar capable of supporting car and driver in the event of a rollover. In addition, drivers are required to wear protective clothing, helmets, and three-point safety belts. No kneeling or head-first positions are allowed. These requirements are more examples of the focus on safety.

The car's body cannot be more than four feet wide or twelve feet long, and the tires must be at least two feet apart. There is no maximum height, but physics dictates that they will be as low to the ground as possible for best performance.

Drive System

Batteries are limited by type and weight. They must be deep cycle lead acid batteries, and the total pack weight must not exceed 64 lbs. In Australia, this limit is 25 kg, or 56 lbs. However, American batteries are larger and heavier, so a compensation is made. The batteries must be securely mounted to the chassis and enclosed, and cannot be charged, removed, or exchanged during the race.

Solar panels are permitted, but not generally used, since the body shapes and the demands of the event itself don't really lend themselves to solar power.

The electrical system must include fuses, circuit breakers, and emergency kill switches as further safety devices. Also, the traction electrical system must be completely isolated from the chassis. This is also true of full-size electric conversions, but not of conventional gas cars, which use the chassis as a ground.

Competitors can use only brush or series DC motors in the standard class, but they can use as many motors as they want. In the experimental class, any type electric motor is allowed.

The power is transmitted to the wheels by a drive chain or belt. The nuances of different vehicles and different courses will effect the gear ratio chosen, and some vehicles use multiple gears.

The entire vehicle can be built for $1,500-$2,000.

Typical Electrathon Racer Specs

Car Type	Purpose Built, Open/Closed Wheel
Design Constraints	3–4 Wheels; Dimensions; Enclosed Body; Batteries Type & Weight
Weight	165 lbs.
Voltage	12-36 volts
Racing Speed	30-35 mph
Course Type	Oval or Road (Closed Course)
Course Length	1/4 km - 1 mile
Start Type	Standing
Duration	Enduro (1 hour)
Field Size	12–14
Winning Criteria	Distance
Sanctioning Body	Electrathon America

Driver Specs

Drivers must be at least 16 years old and hold a current valid driver's license, as well as a Competitor Membership. They must also have at least one hour's driving experience in the vehicle they will be racing.

While the battery packs have a maximum weight, the drivers have a minimum weight of 180 lbs. in their protective racing clothes and helmet.

Since many drivers are under this minimum, they must carry ballast, just like the drivers of transcontinental solar racers. The ballast must be firmly secured to the chassis, and cannot be liquid, which might slosh and shift, or "accidentally" dribble away.

"Performance related items" such as communications equipment or computers are not acceptable as ballast. However, amenities such as cameras and music systems are allowed. So far, no one has tried psychological warfare by blasting "The Ride of the Valkyries" from their speakers, but it could happen.

There is one more driver requirement. In the event of an emergency, he or she must be agile enough to exit the vehicle in 20 seconds without help.

The Course

The races are run on a variety of tracks, including parking lots, auto tracks, and bicycle velodromes. The course may be simple oval, or a road course. The tracks are usually level in the direction of travel, but auto and bicycle tracks may be banked from side to side, as much as 33 degrees. During the race, the course is closed to all other traffic.

A variety of course types is encouraged to minimize vehicles that are optimized in one design direction only, at the sacrifice of other elements. The courses also vary direction of travel—clockwise or counterclockwise—to offer more variety, and equalize wear and stress on components.

Course length varies from 1/4 km on a banked velodrome to 1 mile on an auto track.

The Race

Starting positions on the grid are picked randomly, and the cars line up three abreast. When the green starting flag drops, the race begins from a standing start.

Bicycle velodromes are banked from 22 to 33 degrees. For this reason, there are some special rules for racing on velodromes. For one thing, the grid starts two abreast instead of three. The cars are required to race on the lower, inside portion of the track. They are only allowed to go higher in order to pass, which they are required to do on the outside.

The winner is the car that covers the most distance in one hour. The white flag is waved, not to indicate the last lap as in conventional racing, but to indicate the last minute of race time.

Points

In addition to trophies or prize money, points are awarded based on a formula that grants one point for starting the race, and an additional point for each vehicle the competitor beats at the end.

At the end of the year, the points are totalled for each vehicle for its best races. This is a little complicated. Two-thirds of the races run in a region are totalled for each competitor. So if a region ran 15 races, the best 10 scores for each car would be totalled. The top scorer is the champion for that region.

In addition, there is an annual national event. This is not limited to regional champions. Any competitors from any region can participate. This year it was held in Michigan.

Good Things In Small Packages

Electrathons aren't as practical as Tour de Sol cars, or as high-tech as transcontinental solar racers, or as glamorous as dragsters or land speed record cars. But they offer young students and ordinary folks a chance to try their hands at some design and engineering, on an affordable level, and they can't be beat for pure fun per pound.

Access

Shari Prange, Electro Automotive, PO Box 1113, Felton, CA 95018 • phone: 408-429-1989
E-mail: electro@cruzio.com

TRACE ENGINEERING

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on film

7.125 wide
4.5 high

MORNINGSTAR

four color on film

3.5 wide
4.5 high

STATPOWER

four color on negatives
3.5 wide
9.175 high

Solar Sprint

Don Kulha

Above: PV panel angle adjustability aids collection of maximum energy.

Welcome to Home Power's new series on Solar Sprint racing. Solar Sprint is an opportunity for young and old to have fun with solar energy, learn some useful lessons, and introduce new folks to renewable energy. We'll be promoting the sport, sharing vehicle construction tips, resource info and report on race events.

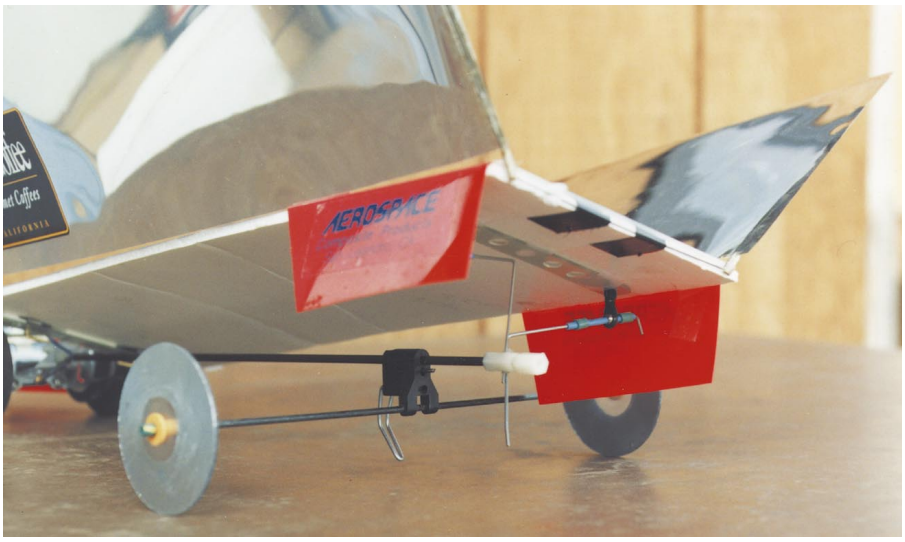
Though fairly new to SS racing, my experience in big car racing helped win the inaugural Senior SS race at MREF this year. Many of the same principles apply directly to SS in terms of efficiency, chassis design, gearing and testing to name just a few. It worked for me and I'll share what I've learned.

The Rules of Solar Sprint Racing

The official rules for Junior Solar Sprint (also used for the Senior edition) are posted on NREL's SprintWeb site and in a sidebar within this article. The race consists of a twenty meter drag race down a tightly stretched guide line using a specified PV panel and motor for propulsion. Two or more cars compete at a time in an elimination tournament until a winner is declared. It is a test of ingenuity, attention to detail, and teamwork. Contestants all use the same specification motor and PV panel which must be used unmodified. This levels the playing field and puts the emphasis on design, planning, and construction.

Any number and type of wheels, transmission (usually belt, friction, or gear), chassis material and design, bearing type, or line guide strategy can be used. The choices are numerous and all yours to make. That's the challenge, to research possible designs, make the best

Below: Adjustable mount attaches panel to chassis and allows easy and accurate angle changes. Note line guide below rear axle.



Above: Long wheelbase aids directional stability and aerodynamics with little weight penalty.

choices and work together as a team to build, tune, and race your creation. Along the way lies the opportunity to learn a great deal, develop new skills, and have a lot of fun. Not everyone competing will win that final race but the path to it can yield substantial rewards.

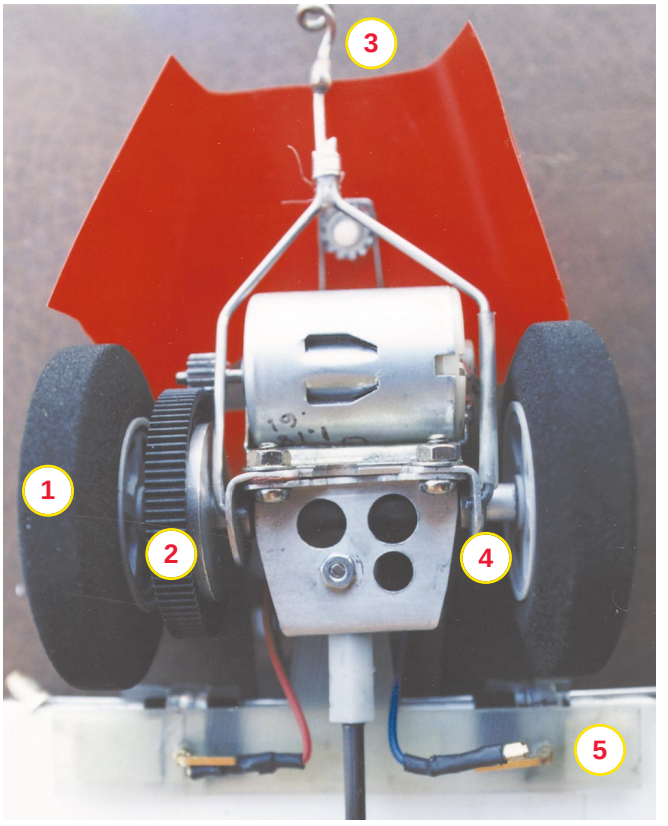
Solar Sprint Hardware

Currently Pitsco is the prime supplier for SS kits. They offer a basic kit consisting of the regulation panel, motor and instructions for $29.95 and a deluxe kit including axles, wheels, gears and a few other parts for $10 more. My recommendation is to get the basic kit and hunt up the drive components on your own (better components are available for those willing to hunt for them). The PV panel provides about 3 volts open circuit, 1.6 short circuit amps and is 4.75 inches wide and 13 inches long. The spec motor is a Mabuchi model 280 plain bearing, metal brush motor with a 0.078 inch diameter output shaft. Tests on a batch of motors yielded about a 2% variation in power tested against a “prony” brake (another motor used as a load) using the PV panel to power the motors being tested. While this is a pretty tight spread for a batch of mass produced motors it points out one area for optimization. 2% over a 65 foot course is over a foot, a possible margin of victory (more on motor testing soon).

Parts for your racer can be had from many sources. Radio controlled (R/C) vehicle and slot car shops can yield a variety of useful items as can surplus electronics outlets. Gears, bushings, and shafts can be recycled from old computer printers and VCRs. Tires and wheels can be had from R/C planes, toys, or made from plastic lids, CDs or other items. I’ve listed some online resources for information and parts in the Access section at the end of this article.

Misc....

I’m going to use this section to provide random notes and food for thought in the form of brief bits of info...



1. Reshaped R/C airplane tire; 2. Precision 64 pitch nylon spur gear; 3. Pivoting front line guide; 4. Shielded ball bearings (0.187 inch I.D.); 5. 0.04 inch fiberglass sheet mounts electrical connections (0.10 inch square pin) and front PV panel pivot

Junior Solar Sprint Race Rules and Vehicle Specifications

Official JSS Rules

Materials:
1. The motor and solar panel must be used without any modification.

2. The remainder of the vehicle must be your own design and can be made from any other material.

Vehicle Specifications:
1. The vehicle must be safe to contestants and spectators, e.g., no sharp edges, projectiles, etc.

2. The vehicle must fit the following dimensions: 30 cm. by 60 cm. by 30 cm.

3. Decals of the sponsor organizations (provided by JSS) must be visible from the side on the body of the car. A 3 cm. by 3 cm. space must be left for the assigned car number.

4. The sun's light is the only energy source that may be used to power the vehicle. No other batteries or energy storage devices are permitted.

5. Any energy-enhancing devices, like mirrors, must be attached to the vehicle.

6. The vehicle must be steered by the guide wire using one or more eyelets affixed to the vehicle. The vehicle must be easily removable from the guide wire, without disconnecting the guide wire.

7. The body of the car must be three dimensional. Teams will NOT be allowed to bolt the axles and wheels to the solar cell. The solar cell cannot be used as the body of the car.

- Start a project log book to include notes, sketches, specs, resource info, test results, ideas, etc. Folks in professional racing do this for good reason. Try to identify possible mentors, resources, and sponsors. The more brains you apply to the task the better your results are likely to be.
- Aerodynamic resistance equals your vehicle's frontal area times it's drag coefficient (slipperiness) times the velocity squared. You control the first two elements of the equation.
- Weight is critical - shave every gram you can without weakening your vehicle. Multiple races will be required in the process of eliminations. You must finish to win.
- Vehicle mounted reflectors improve performance by increasing panel amperage and motor torque output. More torque allows higher gearing hence more speed. The downside is increased aero drag and sensitivity to crosswinds.
- Spur gear systems using properly designed and profiled gears can be 98% efficient at power transmission. Profile refers to the shape of the contacting gear faces. Gears designed for R/C racing are designed for maximum efficiency and come in different tooth counts allowing gear ratio tuning.
- Pinion gears used on slot car motors fit the 0.078 inch shaft of the Mabuchi motor. I attach mine to the motor shaft with a good grade of CA glue allowing them to be changed easily.
- Races in any league are rarely won by applying one major tweak to the car. It's the team that best optimizes the most factors in their overall design that usually wins. When competition is close this attention to detail often provides the winning edge.

Okay, start your logbooks, get your team together, identify potential resources (people, information, parts sources, sponsors) and start planning.

Access
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NREL Education Office, Event host technical assistance, 1-800-NEW-ENGY.

Builder and Host info at:
www.nrel.gov/business/education/SprintWeb

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

Some Parts Suppliers on the World Wide Web

Sheldon's Hobbies: www.btown.com/sheldon.html

Tower Hobbies : www.towerhobbies.com/index.html

Kimborough Racing Products (R/C racing gears): kimbrough-products.com

Aerospace Composite Products: www.acp-composites.com

Reflections on The Sunlight–Glass Interface

Lowrey Brown

Both solar ovens and PV panels have glass between the outside air and the place where work gets done. This glass can interfere with the transmission of sunlight which is the lifeblood of both these technologies. As the sun moves overhead, the angle at which the solar radiation strikes the glass surface changes. The amount of energy which is reflected by the glass is a function of the angle at which the radiation strikes it. This article presents a simple calculation showing how much energy is reflected from a pane of glass as the angle at which the solar radiation strikes the glass changes.

Reflection and Refraction

When an electromagnetic wave (sunlight is electromagnetic radiation) travels from one medium to another, some of the radiation is reflected back into the first medium and some is transmitted to the second medium. The radiation which is transmitted into the second medium may be refracted (bent). How much radiation is reflected or transmitted depends upon, among other things, the wavelength of the radiation, the properties of the mediums, and the angle at which the radiation strikes the interface between the mediums. This angle is the angle of incidence and is measured in degrees from perpendicular to the interface.

In the case of a pane of glass, the electromagnetic radiation must pass from outside-air into glass, and from the glass into the working-space in order to be useful. Not only must the radiation pass through two material interfaces, but the light is refracted as it enters the glass so the angle of incidence as the light strikes the glass to working-space interface is different than the original angle of incidence when the light passed through the outside-air to glass interface. See figure 1.

Calculations

The percentage of radiation which is reflected or transmitted at a given angle of incidence is calculated using Maxwell's equations. Below are graphs of the solutions to Maxwell's equations for light (electromagnetic radiation of wavelength about 589 nm) entering glass from air, and light entering air from glass. See figures 2 and 3.

We must first figure out how much light is reflected and how much is transmitted as light hits the glass for a given angle of incidence (lets say 60 degrees). This is easy, we just look at graph 1 and read along the axis labeled, "Angle of Incidence" to 60 degrees and then read up, parallel to the axis labeled, "Energy in %," and see where the reflected wave curve crosses the 60 degree grid line (9%), and where the refracted wave curve (which is also the transmitted light) crosses the 60 degree grid line (91%). These should add up to 100%, unless our radiation is disappearing somewhere.

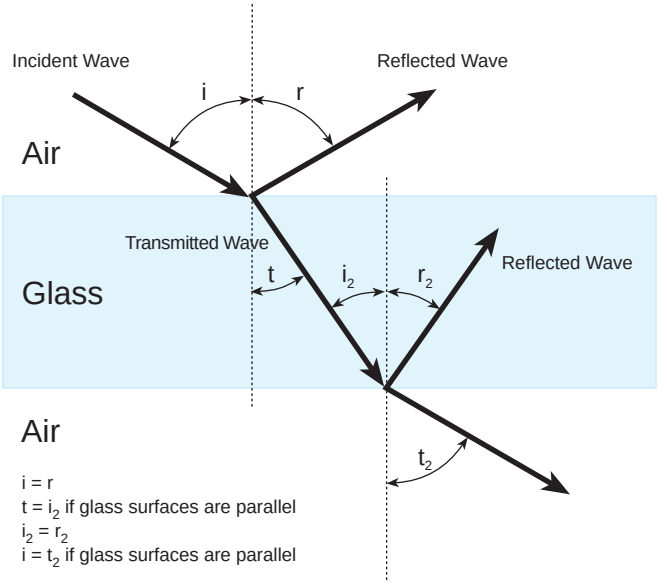
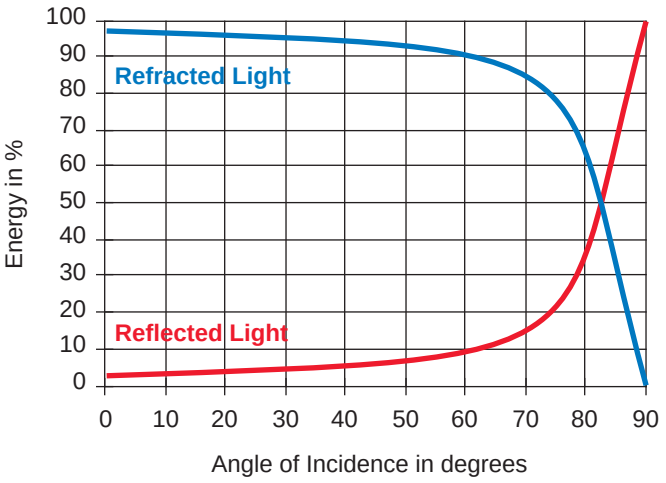


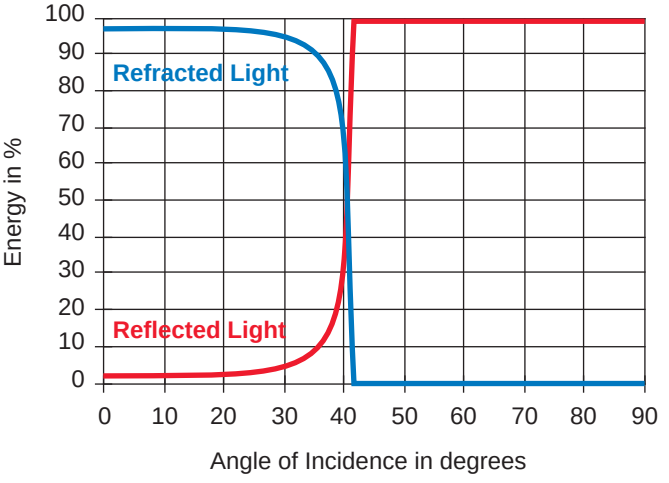
Figure 1: A light wave in air passing through a plane of glass and back into air.
*For a light wave passing through an air to glass interface, the angle of incidence is **i**, the angle of reflection is **r**, and the refracted angle of transmission is **t**. The angle of incidence is equal to the angle of reflection*

*The angle of incidence as the wave strikes the glass to air interface is $\boldsymbol{i_2}$ and is not equal to **i**. Assuming the glass surfaces are plane and parallel, angle $\boldsymbol{i_2}$ is equal to angle **t**.*

Graph 1: The Reflection and Refraction of Light Air to Glass Interface



Graph 2: The Reflection and Refraction of Light Glass to Air Interface



Now we have 91% of our radiation approaching the glass to air interface, but we don't know what the angle of incidence is because the light has been refracted (see figure 2). However, there is an equation which relates the angle of incidence, **i**, to the new angle formed between the perpendicular and the light after it has been bent, **t**. Assuming the outside-air to glass interface is parallel to the glass to oven-air interface, angle **t** is also the new angle of incidence for the glass to oven-air interface.

$$\mathbf{n_A}\ sin\,\mathbf{i} = \mathbf{n_G}\ sin\,\mathbf{t}$$

$\mathbf{n_A}$ and $\mathbf{n_G}$ are constants called the, "index of refraction." An index of refraction is a property of a given medium for a given wavelength of radiation. We have the indices of refraction of typical crown glass and air for a wavelength around 589 nm.

$\mathbf{n_A}$= index of refraction of air for a wavelength about 589 nm = 1.00029

$\mathbf{n_G}$= index of refraction of glass for a wavelength about 589 nm = 1.5

We know our original angle of incidence, i = 60 degrees, and we know our indices of refraction so we can solve for t which will be the angle of incidence as the light passes through the glass to oven-air interface.

$$\mathbf{t} = arcsin\left[\left(\frac{\mathbf{n_A}}{\mathbf{n_G}}\right)(sin\,\mathbf{i})\right]$$

in our case

$$\mathbf{t} = arcsin\left[\left(\frac{1.00029}{1.5}\right)(sin\,60)\right]$$

$$\mathbf{t} = 35°$$

We now have the angle of incidence of the light as it hits the glass to oven-air interface. To figure out how much of the wave is reflected or transmitted, we simply repeat the process we used to find out how much of the light wave was transmitted into the glass from the outside-air, except we use graph 2 which shows the solutions to Maxwell's equations for electromagnetic radiation passing from glass into air. We find that, at an angle of incidence of 35 degrees, 10% of the energy is reflected, and 90% is refracted (and transmitted). So of our original light, 91% was transmitted into the glass, and of that 91%, 90% was transmitted through the glass into the oven-air.

(90%) (91%) = (0.9) (0.91) = 0.82 = 82%

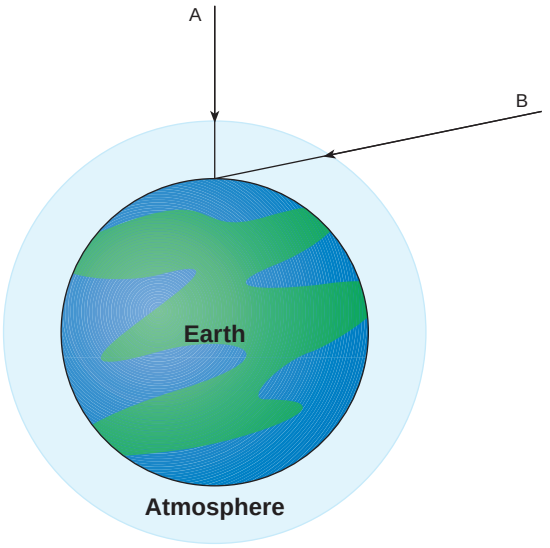
At an original angle of incidence, **i**, of 60 degrees, about 82% of the radiation reaches the oven-air.

You have probably noticed, however, that the reflection and refraction curves are not linear. As the angle of incidence increases past a certain point, the percentage of the energy which is reflected begins to grow quite quickly. Using 60 degrees as a center point, if you decrease the angle of incidence, **i**, to 45 degrees, 90% of the energy is transmitted, but if you increase the angle of incidence, **i**, to 75 degrees, only 63% of the energy is transmitted.

Conclusions

This is a gross approximation for a number of reasons. Visible light is a spectrum of wavelengths, not simply 589 nm, and each wavelength has its own index of refraction for a given medium. Some UV and infrared reaches the earth, as well, thought they are largely absorbed by the atmosphere (assuming we don't destroy it). In addition the light reflected from the glass

Figure 2:
Light wave **A** *is perpendicular to the surface of the earth and is equivalent to the sun being directly overhead. Light wave* **B** *travels through the atmosphere almost twice the distance that* **A** *does.*



to oven-air interface can be re-reflected back towards that interface from the glass to outside-air interface (a diminishing but repetitious cycle). This would increase the percentage of transmission very slightly.

What is more important is to get a general sense of how the angle at which the light strikes the glass affects how much of that light is reflected. Other factors also effect how much radiation passes through the glass. The angle of the glass also determines how much light strikes the surface in the first place. The aperture, or exposed area, decreases as the angle of incidence increases (*cos***i**). Also, if the glass surface is dirty, light will reflect off the dirt particles, so keep your glass clean.

Also, the atmosphere absorbs radiation, and the amount of atmosphere the sunlight travels through to reach the oven changes as the sun passes overhead. When the sun is directly overhead, the sunlight has the shortest path through the atmosphere. The further the sun is from directly overhead, the more atmosphere the radiation must travel through. The further the radiation travels through the atmosphere, the less intense it will be when it reaches the earth. This becomes increasingly significant as the sun approaches the horizon.

While this information applies to both PV panels and to solar ovens, the conclusions one comes to are very different. PV panels are comparatively expensive and any additional efficiency you can wring out of them helps to give you bang for your buck. Because of this, you always want your PV panels working, even when the sun is low on the horizon and the intensity of the solar radiation is low. To combat the reflection problem, however, there isn't too much you can do. A dual-axis tracker keeps the angle of incidence as close to zero as possible, but trackers are expensive. Routine maintenance and cleaning keeps the panel surface free from dirt and deposits, but you should be doing that anyway. Most PV panels already have an anti-reflective coating impregnated into the cells, so you cannot improve the reflective properties that way.

With a solar oven, however, there are lots of low-cost ways to make sure you're getting the most out of your oven. It is also very important to get as much as possible out of the sun when solar cooking because, while you may be able to generate power at 50% insolation, you cannot cook in any reasonable amount of time at 150 degrees F. Cooking at such a low temperature is also unsafe because it may not kill bacteria or parasites. The first, easiest, and most important thing you can do is to keep your oven pointed directly at the sun. This involves moving the oven from time to time. Unless you're making a lot of money (or having a whole lot of fun with your oven), a tracker is hardly cost effective; this is also true of anti-reflective coatings. To cut down on reflection you might want to invest in low iron glass, however, which is relatively cheap and is less reflective than regular glass.

You can also build reflectors for your solar oven to focus sunlight into the oven. This is not a simple option with PV panels because you can easily overheat the panels and reduce, rather than increase, their efficiency. Unless you plan to be cooking all day, try to keep your cooking hours as close to noon as possible when the suns radiation will be the most intense. Of course, like PV panels, you'll want to keep the glass clean.

Access

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NEW ENGLAND SOLAR HOMES

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Mike Brown

I got a call the other day...

"I went out to my EV to drive down to the store and when I turned the key and pressed the accelerator pedal nothing happened. I think it's the controller. How do I find out what's wrong?"

The question was in a typical format—no information about the failure other than "nothing happened", and the immediate assignment of blame to the least understood and most expensive component. It took two more phone calls to get the car running, and no, it wasn't the controller.

Let's take a look at the troubleshooting or fault finding system I used to get the EV back on the road. In my gas car mechanic days, there were three elements needed to make the car run: fuel, air, and spark. Without all three in the right ratios the engine wouldn't run. With an EV, it's a little easier. Air is necessary only for the driver to breathe. Spark could be taken to mean 12 Volts from the auxiliary battery to run the car's accessory electrical system and some of the EV control system. Fuel in an EV is the volts and amps from the traction battery pack.

The first step is to observe what happens when you turn the ignition key on. Does the "car on" indicator light (if the car has one) go on? If not, it is time to grab our trusty voltmeter and measure the auxiliary battery's voltage and check the condition of its cables. A bad auxiliary battery ground will stop an EV as completely as a bad controller. The auxiliary battery supplies power to the relays that turn on the traction battery pack voltmeter, as well as, to the main contactor which connects the traction battery pack to the controller.

Given a good auxiliary battery output, does the traction battery pack voltmeter or fuel gauge give you a reading? If not, it's time to look at the traction battery pack.

Hook your voltmeter (set to the proper range if it is not auto-ranging) across the most positive and most negative terminals of the battery pack. No reading? Time to to dig deeper. Since we have the traction batteries in series we must have an open connection in the series. At this time, a quick visual inspection of the battery interconnects and terminals for obviously burnt terminals or open connections is in order. If nothing is obvious, we will have to look a little closer.

Since most EVs have their battery pack in more than one box, we should check one box at a time, starting at box furthest from the controller. This is usually in the rear. We must isolate the box to test it, so we disconnect the cables between the rear box and the front pack. Since we don't know where the open connection is, extreme care must be taken when working with these cables. Remove one cable at a time and cover the lug with a piece of hose or wrap it with electrical tape.

With the rear pack isolated, put the voltmeter across the two terminals you removed the cables from (the most positive and most negative terminals of the rear pack). If you get a reading equal to the total nominal voltage of the pack (for example, 8 batteries x 6 Volts each = 48 Volts) the problem is not in that pack. Repeat this test on the front pack at its most positive and most negative terminals.

If you find one of the packs with an open circuit (no voltage), examine the battery connections. If the pack is equipped with a fusible link between two of the batteries (as it should be), give the fusible link a close examination. The EV the phone call was about had an open circuit in the rear fusible link caused by loads beyond its rating which exceeded its time delay curve. It was open circuit, but not blown visibly like it would have been if the pack were shorted.

If the interconnects and fusible link check out, check the voltage of each battery. A battery with 0 volts would indicate an internal open circuit, which is usually in the strap that connects the battery plates inside the battery to the battery terminal on the outside.

If both packs show their nominal voltage, we should check the cables that connect them to each other. The easiest way to do this is to locate the terminals or components the cables connect to when they reach the front of the car. If a cable attaches to a battery terminal, disconnect it and isolate it from the car's chassis and the front pack. If a cable is connected to a component such as a circuit breaker or main contactor, identify it but leave it connected. Next, carefully reconnect the cables you disconnected at the rear of the car.

Returning to the front of the car, check the voltage at the cable lug and component terminal you located earlier. (When checking voltage at a component, check it at the input side of the component.) You should get the nominal pack voltage of the rear pack.

Finding and correcting any open circuits found in the above tests should get total battery pack nominal

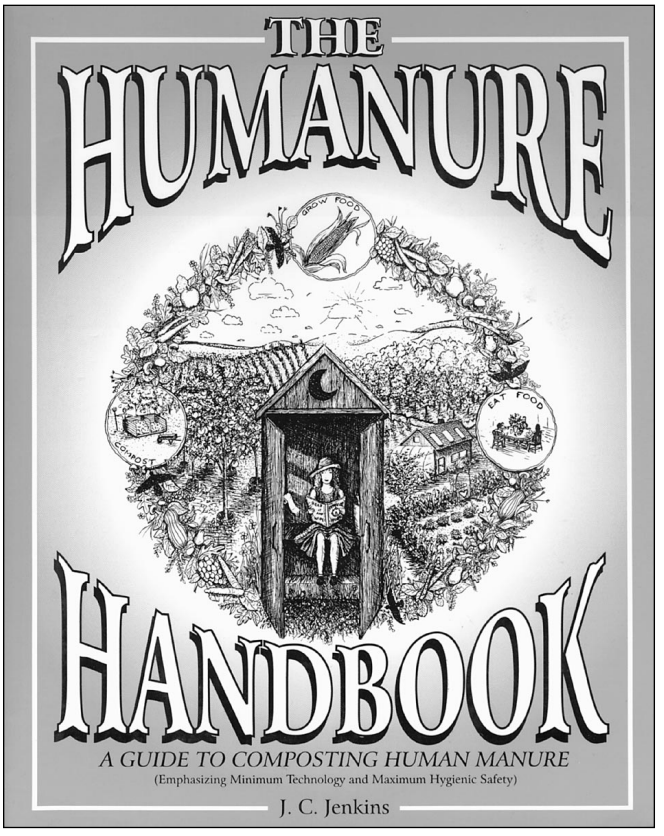
voltage to the circuit breaker, main cut-off switch, or main contactor.

Next issue we will talk about checking out the rest of the components in the EV drive system.

If you are trying to check out a failed EV before you get the next issue, call or E-mail me and I'll talk you through the rest of the test sequence.

Access
Mike Brown's TechTalk, Electro Automotive, PO Box 1113, Felton, CA 95018 • Phone: 408-429-1989
E-mail: electro@cruzio.com

Good Books



The Humanure Handbook

Written by J.C. Jenkins

Reviewed by Don Kulha

The Humanure Handbook is subtitled “A Guide To Composting Human Manure (Emphasizing Minimum Technology and Maximum Hygienic Safety)”. This book delivers a frank and sometimes humorous discussion of how we can close the nutrient cycle by safely composting the bi-products of our own digestive processes. This self-published book springs from the author’s belief that millions of people in developing countries can benefit from hygienic recycling of all their organic refuse including humanure.

He points out that people in China, Korea and Japan have managed to maintain the fertility of their soil over forty centuries of continuous use. Humanure is one of the keys to that enviable record.

Sanitation methods practiced around the globe, both primitive and advanced, are discussed as are the mechanics of the composting process. Great attention is given to the types of dangerous pathogens present in human waste and the exact conditions necessary to completely and safely neutralize them. Moldering and thermophilic humanure composting systems are discussed and their performance in killing pathogens analyzed in depth. The author’s 15 years experience composting humanure for use on his family’s food crops, development of his low-tech, low-cost process and extensive research provide us with a valuable reference for safely dealing with what can be an odious issue.

This book may not be right for everyone, particularly those who take easy offense at the earthy humor sprinkled throughout the book. “Mr. Turdley” pops up from time to time to pass on the occasional tip and fun is poked at what’s considered the civilized way of dealing with our waste. I thought it was great. This is important and useful information and this book brings it all together. After reading it I’ll never look on the process of elimination quite the same way.

Access

Correspondence and/or book orders may be addressed to: Jenkins Publishing, PO Box 607, Grove City, PA 16127. Humanure has 198 pages and costs $19.00 U.S., ISBN 0-9644258-4-X

DEEP ROCK MFG. CO.

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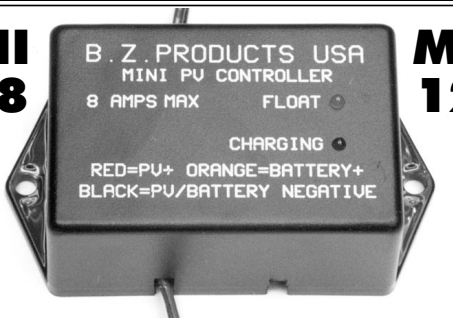
MINI 12/8



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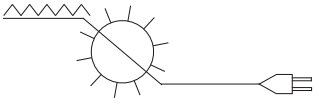

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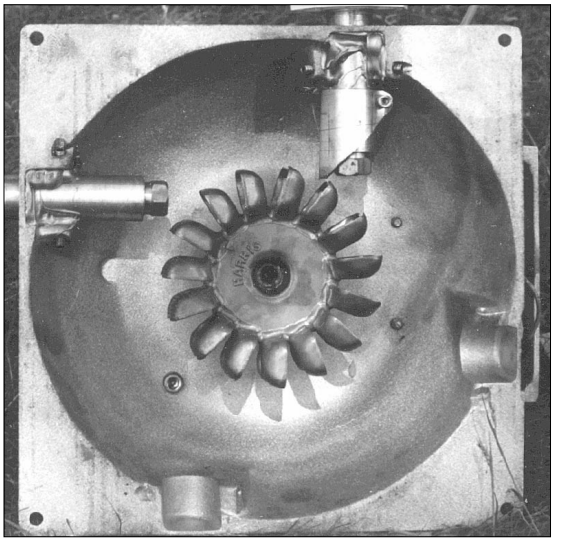

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Stop the Bailout

Don Loweburg

The Competitive Transition Charge (CTC) debate continues to heat up. We closed last issue's column with the mention of arrests at a PUC protest in Philadelphia. Public Citizen's Critical Mass Project has also just issued a statement of principles for the "Stop the Bailout Coalition". IPP supports the Coalition and would be happy to forward by e-mail the full statement of principles to interested parties. I would like to share some supporting comments made by Charlie Higley, Senior Policy Analyst with Critical Mass.

"For decades electric utilities reaped fat profits from over-priced power plants. Now, with competition threatening the money harvest, the utility lobby is spending millions of dollars in campaign contributions to buy the vote of state and federal lawmakers. The word has come down from a new legion of robber barons: "Bail out our bad assets."

Forcing consumers to bail out the utilities for their bad investments in nuclear and coal-fired power plants will keep our rates high, stifle competition and pollute the environment. Utilities made these bad investments. They should eat the losses, not make the consumer pay for bad judgement.

Instead of bailing out over-priced power plants, they should be shut down and replaced with renewable energy resources–such as wind, solar, biomass and geothermal plants–along with a new commitment to energy efficiency, the cheapest, cleanest way to "produce" electricity.

Bailing out power plants that would otherwise have to be shut down will stifle competition. New or smaller companies will not be able to compete against giant utilities receiving billions of dollars in taxpayer and consumer subsidies.

The utility bailout also endangers the environment. The most un-economic power plants are often the most polluting–spewing millions of tons of toxic pollution and greenhouse gases into the air and leaving a legacy of nuclear wastes that will remain deadly for thousands of years.

Utilities receiving a bailout will fight against renewable energy, which directly competes with the existing fleet of polluting fossil fuel and nuclear power plants.

A grassroots backlash against the bailout is already starting to build in California, Massachusetts and other states. Public Citizen's founder Ralph Nader, along with leading consumer groups, recently launched a campaign called Californians against Utility Taxes (CUT) to oppose the utility bailout in the Golden State. For more information and a free CUT Action Kit, see access.

In Massachusetts, Public Citizen and allied organizations are working with sympathetic lawmakers to heed the concerns of consumers to drastically limit the utility bailout. Similar efforts are underway in Pennsylvania, Texas, and other states.

The question is, do we as consumers want to bail out the utilities for their bad investments in dirty power plants? Or, do we want to stop throwing good money after bad, shut down these power plants and invest in clean, renewable technologies and energy efficiency? To Public Citizen and our allies, the answer is clear: "Stop the Bailout!"

It Gets Worse

An especially onerous aspect of the CTC has become clear to me. Initially, my reaction to the bailout was to accept it as a necessary evil. I assumed that at least the nukes would be shut down. That assumption was dashed when I spoke with Harvey Wasserman at Solfest last June. Harvey was a featured speaker at the conference and author of *Inherit the Wind—Will Clean Energy Pass Us By?* which appeared in the June 16,

1997 issue of *The Nation*. He expressed the conclusion that the CTC will extend the operation of the nukes by making their high priced power competitive. Dan Berman author of *Who Owns the Sun?* states, "If Congress goes with the California model and bails out the nukes, you'll see American renewables set back a decade at least." From this perspective, restructuring could be disastrous for renewables. Rather than promoting competition as is supposed to be the case, restructuring will help the utilities reposition themselves in the marketplace while maintaining renewables at a competitive disadvantage. This is how I see the "big picture".

The demand for baseload power (provided by nukes and big fuel powered plants) has been flattening (the rate of increase is decreasing) for a decade. At the same time cogeneration (on site produced thermal and electric power) has made significant inroads. For utilities, cogeneration has been the real competition and the trend has been understood for some time. During this period wind, solar thermal (the LUZ plant as an example) and PV technology continue development and renewables begin to be competitive; offgrid they already are. Cogeneration and renewables now are referred to as Distributed Generation. DG represents the next big market for generation and energy technology while at the same time baseload power as a bulk commodity represents a declining and less lucrative market. From the utility perspective, they need to enter the growing and potentially lucrative DG market. Now here comes the "genius of restructuring".

Utility strategists propose that power generation become "competitive". Actually, generation is already well on its way to being competitive. Under restructuring however, the less competitive baseload plants are propped up with subsidies, continue operating, and the utilities artificially maintain a lower price for power. This hurts their competitors–especially renewables. Meanwhile the utilities are recapitalized by way of the CTC (bailout). Now, well positioned and with cash in their pocket, they enter the DG market. If this scenario is not insulting enough, consider the fact that utilities wish to enter the DG market as regulated monopolies, though there is clearly no monopoly franchise here. (For more on DG see IPP #59 or send for the CPUC-ORA-IPP (there are a total of 10 signing parties) position letter on utility DG).

IPP wants competition. Real competition could happen if the bailouts were halted and the regulated utilities were prohibited from doing DG. Restructuring as it is presently being implemented constitutes a government (read–"taxpayer") bailout and subsidy to major regulated corporations as they reposition themselves advantageously to enter unregulated markets. Heck of a deal! Maintaining the present course of restructuring may indeed set US renewables back another decade. I feel we are already behind a decade.

A wealth of information about utility activity is available through the free news clip service offered by Cybertech. (see access) Just reading the headlines make it clear what the trends are. Not a day goes by without mention of numerous buyouts and mergers, New utility business activities like security services, telecommunication services, DSM energy management consultation, and residential electrical repair appear daily. As a sample, here are some clips from 8/15/97.

Metricom And KN Energy Expand Ricochet Wireless Networks To Include Nearly Two Dozen Mid-Western Towns

Metricom, Inc., and KN Energy, Inc., today announced expansion of the Ricochet wireless network to ten towns in America's heartland, with plans to deploy in an additional twelve targeted rural areas, covering more than 200,000 residents.

Virginia Power Gets Approval To Enter Telecom Market

Virginia Power has received the green light to enter the telecommunications market next month, joining its neighbor, Potomac Electric Power Company (PEPCO) in the wave of utility companies entering the telco business.

New Jersey Telecom Plans Partnership With Electric Utility

A New Jersey telecommunications company and an electric power utility will team up soon to offer phone, Internet and cable services to customers in Washington, D.C. RCN, a division of C-Tech Corp. of Princeton, has agreed to work with the Potomac Electric Power Co. to provide a package of services to the 682,000 households the utility serves in Washington and its Maryland suburbs. (see access for Cybertech sign up)

The California PV Alliance (CALPVA) met in June. Among the participants were representatives of the California Energy Commission, CALSEIA, IPP, Enron, BP, Atlantis Energy, SMUD, SCE and Sierra Pacific. A large part of the meeting was devoted to work on the PV component of the California restructuring plan to be administered by the CEC. The details are not final, but it looks like around $30 million will be allocated to a program that includes buy downs, financing, and customer education (advertising) to be targeted at residential and commercial applications of PV.

Another project of the Alliance is to see that a simplified net metering interconnection standard is adopted in

California. Tom Starrs, renewables policy consultant, commented on the possibility that unfair interconnection standards adopted by utilities could constitute exclusionary practice (see his comments in IPP #60) and require court action as in the case of the Telcos some years back. The Alliance endorsed the concept of a simplified national interconnection standard and unanimously supported a CPUC protest in progress.

Some time ago, I chronicled the events surrounding the efforts of Dave Morgan in Central California to obtain net metering from his utility, Pacific Gas and Electric. Well over a year ago, Dave was ordered to remove his PV system from the grid or suffer loss of service. The Morgan system had been approved by the local building inspector, complied with all sections of NEC 690 (the section of the electric code that covers PV systems) and used UL components throughout. This heavy handed attitude on the part of the utility did not go well with Dave and he filed a protest. Presently he is appealing the initial unfavorable CPUC ruling and is committed to a full formal protest before the Commission if necessary. He will be supported by the Alliance in this matter.

Maine Net Metering Alert!

IPP member Bill Lord sent a disturbing memo outlining how recent Maine restructuring legislation may undo the State's existing net metering law. He referred to the "sinister forces lurking in the restructuring morass". Bill maintains a beautiful web page (see access) from which one can download the Maine Solar Energy Association article titled, "Maine Net Metering Law Trashed". Check it out. Maine readers please pitch in.

NY Net Metering Bill Signed

RE Ellison writes that NY Governor George Pataki signed legislation to allow net metering for up to 30,000 New York homeowners with PV installations up to 10 KW. Like the California law, it applies to PV only, not to wind or residential microhydro installations. Pataki said the law would encourage the use of clean energy in New York without "unduly burdening utilities". Half a loaf, but far better than nothing. Congratulations to all the IPP members in NY who helped pass this bill.

A Bad Joke Turns Real

During a moment of dark humor not long ago, Cynthia and I were making up horror stories regarding restructuring and the "transition charge". At one point we fantasized folks disconnecting from the grid and installing PV instead of utility service. Cynthia said, "in that case the utilities would try to charge you for disconnecting and not using their power". We both chuckled uneasily. Last June Southern California Edison Company initiated a move that tries to do exactly that. The filing titled CTC-DL (Competitive Transition Charge- Departing Load) proposes that a fee be levied against any power consumption reduction. Thus customers who initiate efficiency measures, install a solar water heater or PV could be charged the CTC for power that they don't use. SCE argued that, based on fairness to other customers, departing load should also be charged its share of the CTC. A strong protest authored by CALSEIA's Les Nelson and cosigned by IPP, Pacific Energy Group and Foresight Energy Company was filed with the CPUC. Because of wording in the California restructuring law that protects residential customers from this kind of charge, Edison had to back down. However, commercial customers may still be subject to the CTC-DL charges! Bill Lord was certainly right about the sinister forces lurking in the restructuring morass!

Next Issue

Besides the latest on restructuring and issues involving renewable energy, interconnection policies, we'll look at some marketing issues/opportunities as some large non-utility players enter the PV end user market. Look for and use the IPP logo. IPP businesses offer service and knowledge in addition to competitive pricing on hardware. Membership is now over 160 and we plan to grow even more. Members, look for some exciting news we'll be getting to you this Fall.

Access

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Phone: 209 841 7001 E-mail: i2p@aol.com

Public Citizen: http://www.citizen.org

Cybertech: service@cybertech.com (include the word "signup" in subject field)

CUT Information and Action Kit, Harvey Rosenfield, 310-392-0522, 1750 Ocean Park Blvd#200, Santa Monica, CA 90405 • Web: www.consumerwatchdog.org

Bill Lord's web page:
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Questions Questions

John Wiles

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Every week, I get calls from around the country from electrical inspectors, electricians, PV dealers and installers, PV manufacturers, and PV users. These calls cover a wide range of subjects related to the installation of PV systems and how they are to comply with the requirements of the National Electrical Code® (NEC®). Here are some of the more common questions and the best answers that I have.

Where can I find large, flexible cables for inverter and battery connections?
Automobile battery cables and welding cables do not meet NEC requirements and, while readily available, are not suitable for inverter-to-power center and power center-to-battery connections. What is needed is a flexible cable that is UL-Listed and is marked as a building-type of cable such as USE, THW, RHW, XHHW, etc.

For the individual installing a single PV system, many of the PV Dealers and Distributors are stocking the appropriate cables. For the dealer who installs a lot of systems, the major cable distributors like Anixter can get the proper cable. Cobra Wire and Cable also makes an appropriate cable and will accept orders of at least $250.00 (see access).

What can I use for conduit between modules?
In the last Code Corner, I pointed out that non-metallic flexible conduit did not have the proper temperature range needed for connections to modules where a 90°C wet rating was required. The non-metallic flexible conduit is rated for only 60°C wet.

Unfortunately, the metallic flexible liquid-tight conduit that I suggested using in the last Code Corner may have this same limitation, but I have not been able to complete the research in this area. For now, it appears that we are limited to rigid electrical PVC conduit. It can be bent when heat is applied with a heat gun so it is possible to connect adjacent modules even though there is frame structure between them. Of course, metal conduit can be used if you are a professional and have that experience.

There are some types of metal covered cables that could be used.

Where conduit is not required, the single-conductor USE-2 cables are permitted by the NEC as is tray cable and other wiring methods.

Where can I get Ground-Fault Protection Equipment?
Section 690-5 of the NEC requires that PV systems installed on the roofs of dwellings have a device that detects ground faults in the PV array, interrupts the ground fault current, and disables the array. This requirement has been in the NEC since 1987 and electrical inspectors are beginning to require it.

Such devices are available as an integral part of listed, utility-interactive inverters from Trace Engineering and Omnion Power Engineering. Both Trace Engineering and Alternative Power Technologies (APT) are working on ground-fault units that will be listed and that can be used with stand-alone PV systems (see access).

Where can I get a copy of the National Electrical Code?
Most electrical supply houses and some major bookstores have the NEC for sale. It is also available directly from the National Fire Protection Association (see access).

What is a current-limiting fuse?
By definition, a current-limiting fuse limits the short-circuit current flowing in a faulted circuit to a level that is significantly below the short-circuit current that would be flowing in the same circuit without the fuse under the same fault conditions.

Don't all fuses limit current by blowing?
In a given circuit without a fault, the current is at zero or some nominal low value (e.g. 20 amps). When a fault occurs in a circuit without a current-limiting fuse, the current increases very rapidly from the initial value to a maximum determined by the system voltage, the available current from the source, and the circuit resistance. The fault current may increase to 10,000 amps or more in a battery circuit. The current-limiting fuse senses the rapidly increasing fault current and opens the circuit so rapidly that the current never reaches the maximum, but is limited at the 2,000-4,000 amp level by the opening fuse. Fuses that are not

designed as current-limiting fuses may let the current reach the maximum value before opening the circuit.

While the current-limiting fuse limits the fault current, it may also be designed so that it has a time delay that allows it to carry normal surge currents from motor starting actions without opening. These currents may be 4-10 times the rating of the fuse (e.g. 600 amps for a 100 amp fuse).

What is the relationship between the current rating and the interrupt rating of a fuse?
The current rating (e.g. 100 amps) is the current that the fuse can carry continuously. The fuse is required to open for currents above 110% of rating, but there is a time dependent function involved that is different for each fuse. The interrupt rating (e.g. 20,000 amps) is the maximum short-circuit that the fuse can interrupt under fault conditions. Both the current rating and the interrupt rating are given with an associated voltage rating (e.g. 125 volts direct current (DC)).

While the current rating of a fuse may be the same for ac and DC use, the interrupt ratings and the voltage ratings for ac and DC circuits may be considerably different. For example, a 100-amp fuse may have a 300-volt , 200,000-amp interrupt rating for use in ac circuits. The DC rating for the same fuse may be 125 volts and 20,000 amps - both of which are significantly lower than the ac ratings.

Is a current-limiting fuse necessary in all systems?
If the PV system does not have a battery or other source of high short-circuit currents, then a current-limiting fuse is not necessary. Non-current-limiting fuses or circuit breakers may be necessary, however, for proper conductor protection.

If the overcurrent device, either a fuse or a circuit breaker, has sufficient interrupt rating for the circuit, then a current-limiting fuse is not required. For example, the Heinemann circuit breakers used in Trace and APT products have an interrupt rating of 25,000 amps at 65 Volts DC and this is in excess of the available fault current in most battery systems.

However, if Square D QO breakers are used, they have an interrupt rating of only 5,000 amps at 48 volts dc and require the use of a current-limiting fuse between the circuit breaker and the battery. The current-limiting fuse limits the current under fault conditions to 3,000-4,000 amps which is within the interrupt capability of the circuit breaker.

Are there current-limiting circuit breakers?
I have not yet seen a DC-rated, UL-Listed circuit breaker that meets the definition of current limiting. Some circuit breakers are advertised as current limiting, but they are either rated only for ac or are rated by European Standards that are not the same as the US UL Standards.

Why don't you use more diagrams and pictures in Code Corner?
I am only partially computer literate and am just exploring the capabilities of Word 6, Excel 5, Mac Draft, Power Point, and the Power Mac 7300/200 64 Meg 12 x CD ROM/166 Pentium 48 Meg computer that I use for the Code Corner columns. Maybe next issue.

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 at the location below. 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 multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy.

Access
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Code Curveball— *Safe vs. Silly*

Bob-O Schultze KG6MM

Once again, I find myself having to take umbrage at the author of Code Corner for his unreasonably restrictive opinions concerning the proper installation of PV modules. In Coder Corner *HP* #60, Mr Wiles, along with some unidentified electrical inspector, is of the opinion that flexible nonmetallic conduit should not be used with PV modules. He would prefer instead that we use liquidtight flexible metal conduit. Failing that we should use rigid PVC or metal conduit which renders most commercially available adjustable mounts and trackers less than useless.

Let's look at the facts. I called two major electrical distributors and a giant electrical mail order outfit regarding the temperature ratings of flexible nonmetallic conduit (fnc) and liquidtight flexible metal conduit. All the suppliers carried a different brand name. All the fnc they carry (Alflex, Carlon, and Kaftech) is rated at 80°C Dry and 60°C Wet, none are rated 70°/60° as Mr. Wiles states. Interestingly, all the liquidtight metal flex offered (Alflex, Kaftech, and Electroflex) is rated only from -10°C to +60°C. One manufacturer claimed their liquidtight is "suitable" to 80°C and one even claimed a 90°C rating for "intermittent use". I don't think we can categorize 20 years on a PV array as intermittent use.

80°C = 176°F. The junction boxes for a PV module are located on the back of the module and are always made from plastic. Since the front of the module must face the sun in order to work, the wiring is–by definition–in the shade. Not that the back of a PV module doesn't get warm, it does–just not that warm. During the hot weather tests at Home Power central (HP#49, pg28) where the ambient temperature was 31°-35°C/88°-94°F in the shade, we measured temperatures from 49°-55°C/120°-131°F with a probe directly on the PV's back. Any fnc connecting those modules would have been connected between junction boxes in free air and NOT in actual contact with the PV back. Simple logic tells us that if anything, the fnc would be subjected to less, not more heat. Of course, there are hotter places in North America than Agate Flat, OR during August. But even in the worse case scenario of the deserts of the SouthWest, the air temperature doesn't get above 49°C / 120°F. Assuming a corresponding temperature on the back of the PV, we MIGHT get to 70°C. That's directly on the back of the module, mind you, not on or in the fnc in free air between modules.

Where There Is Error

I think where Mr Wiles goes wrong is in his interpretation of 351-23(b)(2) and the fact that the PV manufacturers suggest using wire with insulation rated to 90°C. The NEC reads "Where any combination of ambient and conductor temperature is in excess of that for which the liquidtight nonmetallic conduit is approved." By the way, the exact same language is used to describe conditions unsuitable for liquidtight metal flex as well. Apparently Mr Wiles surmises that you either "add" the ambient to the conductor rating, or we assume the wire is running at full rating and the ambient only makes things worse. Neither is the case. Taking a common sense approach to the letter and spirit of the NEC, my interpretation is this: Current flowing in a wire causes a certain amount of heat. If the ambient temperature causes the wire temperature to increase past the temperature rating of the conduit, you have a possible problem.

No competent electrician or PV system designer would EVER waste expensive photovoltaic delivered watts by sizing PV interconnect and feed wires anywhere CLOSE to the current rating of the wire. It's just plain foolish. Barring conditions found near an active volcano or in a certain air-conditioned office somewhere in New Mexico, I believe using fnc rated to 80° is not only safe, but NEC compliant with all temperatures found in the natural or concrete jungles of North America.

The Wet Real World

So much for dry conditions, now let's take a real world look at that 60°C Wet rating. PVs make electricity, not hot water. Any wet conditions the fnc would be subjected to would be caused by rain. 60°C=140°F. I submit to you, that if you are experiencing a 140°F

rainstorm, the possibility of your conduit failing would be of very little consequence indeed. End of story.

These are my own thoughts and opinions based on my interpretation of the NEC guided by common sense and many years of hands-on experience installing PV systems. For another opinion, I consulted with Mr Redwood Kardon. Mr Kardon is the author of Code Check-A Field Guide to Building a Safe House (see HP#56,pg 92) and an electrical inspector for the city of Oakland, CA.

He writes: " I think your approach is lent credence by the industry trend toward 'performance driven' criteria. You can present performance criteria that shows ambient temps below 60 degrees C. The Authority Having Jurisdiction can buy into this and do whatever they feel like.

Important NEC Article

Article110-14 says: 'Temperature Limitations. The temperature rating associated with the ampacity of a conductor shall be so selected and coordinated as to not exceed the lowest temperature rating of any connected termination, conductor, or device (I would add conduit to the intent here-rk). Conductors with temperature ratings higher than specified for terminations shall be permitted to be used for ampacity adjustment, correction, or both.' Playing it conservative, I would say size the wire for the lowest rated portion of the system, the fnc. Figure the wire from the 60 degree column and there shouldn't be any argument."

The Problem, The Solution

The problem, as I see it, is Mr Wiles unbelievably strict interpretation of the minutia of the letter of the NEC and his disregard of the intent or "spirit" of the Code. One does not stand alone without the other. Fortunately, on the other side of the table sit the vast majority of electrical inspectors and industry professionals who work on and with actual PVs systems every day. The furtherance, rather than the hamstringing, of PVs and the existing PV industry as a significant part of the energy supply for North America is our goal. Toward that end, safety is always on our collective minds. Happily, these experienced industry professionals know the difference between safety and silliness.

Access

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Response to Code Corner—HP #60

David Katz

I think John Wiles' conclusion that fuses or blocking diodes should be placed in every series string of photovoltaic modules in an array to prevent excessive reverse current in the event of a wiring fault is carrying code issues too far.

While it is true that connecting a 24 volt battery to a 12 volt module will cause damage to the module, I do not think it should be the user's job to install fuses in each module. Requiring this protection would be the same as requiring everyone in utility powered homes to put a small fuse on every radio, television, lamp and appliance to protect them in case of a "loss of neutral" fault that could subject each 120 volt appliance to up to 240 volts. Since overcurrent protection is usually provided for the conductors in the system, the ratings of these overcurrent devices, usually 15 to 20 amps is many times the value needed to protect a light bulb, fax machine, computer or television.

In a 12 Volt system, there is no wiring fault possible between a 12 Volt battery and 12 volt modules that would cause an over current situation in the module, unless, as John pointed out, there was a short circuit in a bypass diode connected across 18 cells of the 36 cells in the module. Fortunately, there is no reason to have blocking diodes in modules in a 12 Volt system. If you have a 12 Volt system using modules with blocking diodes wired across 18 cells, such as in a Siemens M55 or M75 or BP 275 or 590, it would be far easier to remove the diodes than to install fuses or diodes. The only other possibility for over current in a 12 Volt system would be in the case that there was a short circuit inside the module. This type of fault could cause overcurrent in the module, but at this point the module is beyond repair anyway.

In 24 Volt and 48 Volt systems, there is more room for damage from incorrect wiring by people who know only enough to be dangerous, but asking the same people who cannot wire modules correctly to install fuses in each one will probably not make things safer or better protected. Using the 6 Amp, 400 Volt diodes that John suggested would cause nearly 1 Volt of drop from the output of the module. At a typical operating temperature of 47° C, this would cause a 10% loss of output amperage in a module operating near the peak power point in a system with only 2% wiring loss between the modules and batteries and as much as a 20% amperage loss in a poorly wired system. Since PV modules cost about $100 per Amp (in a 12 Volt system) using this 65 cent diode may cost $40 to $100 in lost output power, because it would require more modules to do the same job.

If John Wiles thinks there should be a fuse installed in each module junction box, it should be done by the manufacturer, where the cost would be very low, since it could be done when the junction boxes are molded.

Don't require everyone who installs an off-grid PV system to spend more money because a few people may make stupid mistakes in wiring. The current requirement to provide overcurrent protection for conductors is adequate to prevent fires. If all PV systems are installed according to code by trained and qualified installers, there will very few system problems that will be prevented by blocking diodes and individual module fuses. If John Wiles manages to get these devices required by code the installation cost and the added module cost will be much higher than the cost of the few modules lost to damage from high voltage backfeed. I have been selling PV modules for 18 years and have sold many millions of dollars worth of modules. I can count the modules that have been damaged this way on one hand.

Access

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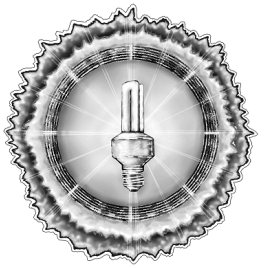

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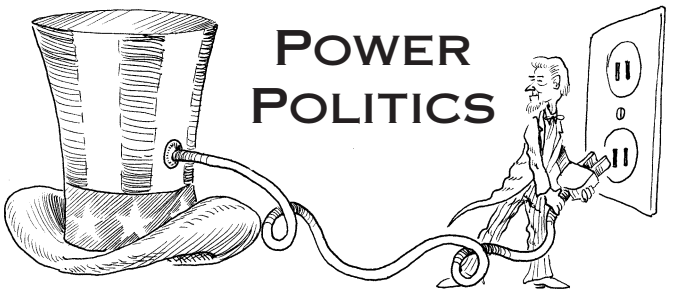

Restructuring Requires Local Vigilance

Michael Welch

Many folks seem unempowered to have an effect on how utility restructuring comes down. There's often not too much we can do when the heavy hitters get together in our state and federal capitals to influence the outcome of "deregulation." If that's the case in your community, you can still have an effect on how the new rules are enforced and whether or not your local utility abuses them. You just need to keep an eye out for the occurrences.

In California we are already fighting a potential abuse, and it serves as a warning to other communities to continue a high degree of vigilance. CA's new restructuring laws provide a method of bailing out the utilities' poor decisions to invest in uneconomic power plants, the nukes. Past PP columns have dealt with this issue, so suffice it to say that past utility regulations encouraged massive investment in power generating facilities: the more money spent, the more money made. And what more expensive generating method is there than nuclear?

CA's nuclear bailout is in the form of a Competitive Transaction Charge that gets tacked onto everyone's utility bills and goes mostly to pay off the utilities for their uneconomic investment in nukes. The money the utilities gain from the CTC charges is a fixed amount. No further increases available. Naturally, the utilities are looking forward to getting their huge bailout, but at least one CA utility is already trying to pry even more money from electricity consumers.

There are other funds that were paid into by California ratepayers and are separate from the CTC monies. Because the utilities are guaranteed the fixed CTC funds the only other way they can get extra money, which means extra profits, is to try to raid the funds that are outside of the CTC program. One such fund is the Humboldt Bay Nuclear Power Plant Decommissioning Trust Fund. DTCs are funds that are set aside so that when a nuke plant is retired, there will be enough money available to dismantle and clean up the site even if the owner is insolvent. DTCs are generally built up over the lifetime of the plant with money that is added onto consumers' electric rates. In Humboldt's case, the plant has been sitting idle since 1976 with no significant decommissioning activities because there is no identifiable place to put the high level radioactive waste.

At the now-closed Humboldt nuke plant, PG&E (Pacific Gas & Electric Co.) had a problem with groundwater leaking into their reactor caisson (the pit where the reactor is suspended). This in-leakage was approaching levels that could become greater than the pumps could handle. Now, this is an easily definable operating and maintenance problem and therefore should be funded directly out of the available CTC funds that were set up strictly for this purpose. But the utility knows that any amount of those fixed funds spent will eat into profits for their owners.

This is where a rather twisted reasoning comes in. In order to fix this maintenance problem, they had to remove some radioactive components of the plant, ones that would normally wait for removal during the final decommissioning process. So, they figured that since there is an action which involves what would have been a future decommissioning related activity, why not go for the DTC money so they wouldn't have to dip into their own funds to pay for it?

And, they used a pretty sneaky way to try to get it past scrutiny. In CA, utilities can use an Advice Letter which is designed to let the Public Utilities Commission know when a utility plans to take advantage of a process which is already approved and should not require any public hearing or public notification. Nice try. Redwood Alliance was informed of it and immediately filed an official protest requesting denial of the request and asking for a formal hearing process to determine the letter's merits, or lack thereof.

So, we will most likely get the opportunity to prove that most of the money requested from the DTC is actually an operating and maintenance cost and should be

borne by the utility. We have already stirred up enough interest to be granted a public information session that will be held by the PUC, and the letter was taken off the fast track that most Advice Letters take.

OK, enough of the particulars. The important point is to remind all of you that it will require continued vigilance to catch your own utility's shenanigans with regard to how they operate under new restructuring laws. Restructuring may provide a lot of opportunities for renewable energy in your community, but it may also provide your public utility with a new means of bilking consumers. Vigilance can pay off.

Watchdogging the utilities can be expensive and time consuming, specially if it results in the need to go to trial to fight for ratepayer rights. But most states have laws set up to make the utility reimburse citizen advocacy groups when they significantly contribute to the outcome of such a case. Redwood Alliance has been reimbursed several times for Public Utility Commission interventions. When reimbursed, our attorneys did not need to work "pro-bono" and therefore felt better about becoming involved in other such cases. And, we were able to bill the utility for our own expenses and staff time doing paralegal work, which made it practical for us to keep our doors open and consider involvement in other cases.

MOX: New Nuke Industry Pork

With orders for nuclear power plants nonexistent in the U.S., the nuke industry is continually on the lookout for income to survive. For the last couple of decades they have relied on building new nuclear power plants in other countries that allow little public input and have few regulations about building and siting their poisonous plants. They have also relied on huge amounts of R&D money from our own government that seems intent on helping them out in spite of public opinion.

Now there seems to be yet another financial bailout for the industry looming on the horizon. It is the conversion of vast stockpiles of weapons grade plutonium into MOX to be "burned" in conventional nuclear power plants.

Because of international arms agreements and the end of the cold war, the U.S. finds itself in possession of about 50 metric tons of plutonium that it no longer needs for its nuclear weapons programs. Russia is thought to have even more, as much as 200 tons (from unclassified sources). Of course, there is a lot of concern that some of these materials may end up in the hands of terrorists and/or countries that would like to become nuclear powers. It is quite clear that something needs to be done to safely and securely dispose of the materials, and many experts believe that the U.S. needs to take the first steps in that direction before Russia will do the same.

There are two methods that the Department of Energy (DOE) wants to use to accomplish this disposal. One is called vitrification which immobilizes the plutonium by mixing it with glass or a ceramic compound. The DOE is recommending that at least 8 tons of the materials be dealt with in this manner.

The second, and most disconcerting, method is to blend an unspecified amount of the bomb materials with uranium to make mixed oxide fuel (MOX) and use it in the reactor cores of conventional nuclear power plants. Using it in the fission-based nuke plants will fragment it over the course of several years. Some additional plutonium is created in this process, but the fragmentation with other radioactive by-products makes all of it very difficult, though not impossible, to reprocess into weapons-grade materials. Then the "spent" fuel can be disposed of along with other high-level radioactive waste with whatever method the feds finally come up with to take care of this material. (There is currently no such disposal method available.)

The Russian government considers weapons plutonium to be a valuable national energy resource and wants to use it in reactors. But the U.S. is concerned both about the security of long term storage in Russia and, mostly, that wide spread use of plutonium fuel could increase opportunities for diversion of the materials to nuclear weapons programs. In September of 1996, a joint U.S. - Russian task force concluded that the MOX concept was the most technically mature option, followed by yet another option, blending the plutonium with high-level nuclear waste for disposal.

The U.S. is not planning on disposing of its surplus plutonium unilaterally, but is waiting for reciprocal action from Russia. Disposal is further complicated by the fact that Russia is still producing weapons grade plutonium and that they will require financial assistance to build the facilities to implement the disposal program. It may be quite awhile before necessary plans are fully developed and agreed upon.

In the meantime, the U.S. is moving forward with developing plans and increasing R&D for dealing with the excess bomb material. And the nuclear industry is chomping at the bit to get their hands on "fissile materials disposition program" monies that are increasing every year: $36 million in fiscal year 1996, $68 million in 1997, and a requested $84 million for 1998. Program activities include analysis and design of facilities, preparations for the MOX fuel option, and joint tests and demonstrations with Russia.

"Burning" MOX in civilian nuke plants is not as simple as it may sound. Significant modifications to reactors and fuel handling facilities will be required, and that takes a big capital investment. So utilities are not about to participate in MOX burning programs unless they receive solid assurance that the programs will continue once they begin. The feds will want similar assurances that utilities will not bow out once a program is under way. Legislation will probably be required to lock both parties into these commitments. Substantial subsidies to nuke plant owners will prove necessary, specially in light of competition from utility restructuring placing the long term economic viability of nuke plants in question.

Canadian deuterium-uranium (CANDU) reactors were being touted as a good possibility for the MOX burning option since they could be a neutral party in a parallel program between Canada, the U.S., and Russia. An agreement between the U.S. and Canada was reached to test MOX fuel in Canadian reactors, but was blocked when citizen advocacy groups charged that shipment of MOX could not occur without environmental impact statements. Further complication arose when Canada announced the closure of several CANDU reactors because of ineffective internal oversight and management programs.

There are many other concerns, like the fear of plutonium and MOX shipments crisscrossing the world, but this should give readers a sense of the plutonium disposition programs being considered. One thing that does not come out in the "objective" government reports and analysis is that most of the players in the decision-making processes are either representing the nuclear industry, representing international nuclear agencies (made up of "revolving door" employees formerly from the nuke industry), or representing government agencies (also of the "revolving door" category). Not to mention the industry's lobbyists working on Congress and the White House. In other words, the fox is building the hen house.

Access

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Nuclear Information and Resource Service, 1424 16th St. NW #404, Washington, DC 20036 • 202-328-0002
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MOX info from: Congressional Research Service's "Disposal Options for Surplus Weapons-Usable Plutonium, Library of Congress Document #97-564 ENR, also available from NIRS.
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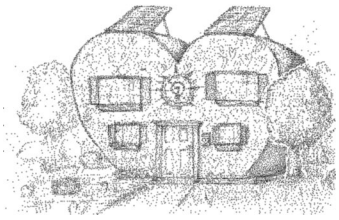
Home & Heart



Kathleen Jarschke-Schultze

I talk a lot about the Home part of the RE lifestyle but there is another facet that is equally important, the Heart part. Besides taking care of and maintaining your power system you also have to work at maintaining your partnership with each other.

The Dream

The RE lifestyle dream includes having an energy-efficient, earth-friendly house, usually very rural. This is where you and your lifemate will live in blissful solitude, spending your days producing your own power and growing your own food. No neighbors or noise nearby to disturb or distract you. You both know it will take extra effort on your part but the satisfaction will be worth it.

The Reality

More often than not the reality means you have to make a living from your remote location. The very fact that you are remote means your social life takes a distinct downward spiral. There are chores that must be done, contingencies to be dealt with, and the odd emergency to make it through. I am reminded of the Buddhist saying, “Before enlightenment, haul water, chop wood. After enlightenment, haul water, chop wood.”

Livelihood

Will you have to continue to make a living from your remote home? Can you work at home or will you have to commute? These are huge issues, really. Time, money, and a dependable vehicle are all in the equation. People who can work at home, at least part of the time, will not have to delete time spent commuting from their lives. There is also substantial savings on gas.

Some friends of ours bought remote, undeveloped property. They spent years building their dream home. They became parents, their jobs changed, and the children came of a social (after school activities) age. The priority of not driving for an hour to an hour and a half to get to and from home every day became very important. They bought a place 5 minutes out of town. They save $300 in gas every month. The vehicles get a lot less and more benign wear. They’re happy, the kids are happy.

Convenience

When Allen was still in school Bob-O would drive him the two miles to the pavement to catch the bus at 6:40 am. We got him a Honda mini-trail bike and in good weather he could drive himself. Then the school thought it was too far to come to our road so they changed the bus stop to 7 miles away. The pick up time was still 6:40 am. Bob-O had a deal with a parent down the road. He would take the boys in the morning and the neighbor would pick them up at 4:00 pm when the bus returned. When Allen turned sixteen, he got his license and an old Toyota pickup.Then he was able to drive himself to and from the bus stop. This whole scenario went on from 5th grade to 12th and was more complicated and frustrating than I can tell you.

My point here is that children are a factor. You must consider their needs along with your own. Some people home school their kids, but there is a certain age when a child wants to congregate with his own generation.

Lifemates

Any problems you have with your mate will be magnified in the remote RE setting. You spend a lot of time together. You won’t be zipping over to the junior college for an interesting night class or two. You have to make an effort to have a social life. Whatever interests you have must be sustainable without a lot of outside input.

I grew up in the Napa Valley, just an hour away from San Francisco. I know the museums, parks, zoos and auditoriums. I’ve seen King Tut’s tomb and Nureyev dance. Every national exhibit or band tour would come to the Bay Area sometime.

The national tours don’t stop here. Bands don’t see Medford, Oregon, the largest town close to us, as a real money making spot. Maybe, by driving seven hours in one direction or ten in the other we could see the new Smithsonian Museum tour. Again: time, money, and a vehicle come into play.

Some couples can’t take the constant closeness of the remote RE lifestyle. Some take to it just fine. We know several people who are living alone in their remote RE setting because one mate decided it wasn’t for them anymore and the other decided it still was.

This leads into how to find a like-minded mate when you don’t live in a well populated area. I know a couple who met through the Sierra Club singles club. Bob-O and I met through the mail. A mutual friend gave him my address and suggested he write to me. After a veritable flurry of letters I went to his extremely remote location to meet him for a week. One month later we drove to Napa in his truck to get the rest of my stuff, and a year later we were married. That was twelve years ago.

There is no easy answer to the question of how to find a like-minded mate no matter where you are. I am partial to the old-fashioned introduction system. This is where someone you know knows someone you might like, and introduces you. That way you have some assurance they're not a weirdo. Case in point, my sister-in-law was my best friend before (and after) she became my sister-in-law. Plus the fact that it worked for Bob-O and me.

Remote Emergencies

This can be a really tough one. Medical help can be a long distance and time away. When the tree fell on Bob-O and broke his leg he called on our Ham radio (which his falling partner had brought him from the truck) and started his own rescue operation within minutes of the accident. Even with a helicopter transport it was five and a half hours before a doctor saw him. I saw him another four hours after that as I had to drive to the hospital where he was flown. It was a long, lonely drive.

At the time Bob-O and I were in EMT training classes. We were organizing a local volunteer rescue squad because our very dear friend, Phil, had died after a long time on a mountain side waiting for medical help. I heartily recommend emergency response training and a good well-stocked medical kit if you are remote. Ask your doctor for a bee sting kit, just to have on hand.

A lot of hospitals now have a Mercy Flight program you can sign up for that covers you if they have to send a helicopter for you. My parents have retired to some rural mountain property.They joined the Mercy Air program at the closest hospital and they know where the closest designated helipad is to their house.

Most rescue helicopters do not fly at night. I know the Coast Guard does because they tried to save Phil. None of the others in our area have licenses for night flight. Find out about your area.

Conclusion

Don't think for a minute I don't love or appreciate my remote lifestyle and partner, I do. It is very different from my former life though. There are opportunities that I miss. My comrade, Myna, and I have decided to make a real effort at getting out and doing social things more often. Here at the house I always have several projects in progress that work to relax me. I guess, to make it work you have to make it play.

Access

Kathleen Jarschke-Schultze needs to try her hand at wind sculpture design at her home in Northernmost California, c/o Home Power Magazine, PO Box 520, Ashland, OR 97520 • 916-475-0830
E-mail: kathleen.jarschke-schultze@homepower.org
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HAPPENINGS

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AUSTRALIA
The World Solar Challenge is now a biennial (previously every three years) event and will run October 18–27, 1998. The World Solar Cycle Challenge will run in the alternate years to create an annual focus on solar car racing in Australia. The 1997 Cycle Challenge will run September 27 to October 6, 1997. The World Solar Challenge is the premier solar car race in the world and contributes vital research and development towards the quest for sustainable future transportation. An exciting development is the introduction of an Entry Competition open to school and tertiary entrants. To ensure another great entry response from educational institution the World Solar Challenge is offering free entry to the first school and tertiary teams to register in the 1998 World Solar Challenge. For further information on entry details or regulations please contact Ray Wieland, Event Manager, level 7 178 N Terrace, Adelaide 5000, South Australia • Phone: +61 8 8303 2021, E-mail: wsc@saugov.sa.gov.au • Web site: www.wsc.org.au

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, greywater heat exchangers, LED and electroluminescent lighting, solar cookers, and others. Under development: hydrogen fuel cells, Stirling co-generator, Tesla bladeless steam turbine, and others. Contact: Jorg Ostrowski, Autonomous & Sustainable Housing Inc/Alternative & Conservation Energies Inc, 9211 Scurfield Dr NW, Calgary, Alberta T3L 1V9, Canada • Phone: 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 Today. Meetings are held on the 3rd Thursday of each month, September through June. New Members are always welcome! Contact: Howard Hutt, 21 Barritt Rd, Scarborough, Ontario, M1R 3S5 Canada • Phone/FAX: 416-755-4324

Renewable Energy Technologies in Cold Climates '98, incorporating the 24th Annual Conference of the Solar Energy Society of Canada Inc. (SESCI) will provide a forum for the exchange of information, research and development for the implementation of 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, Tel. 613-234-7004, Fax 613-234-2988 • Email: RETCCC.98@simpatico.ca

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The Asia-Pacific Initiative for Renewable Energy and Energy Efficiency Event '97, October 14–16, Jakarta Convention Center. The largest collection of RE and energy efficiency companies in Asia. Includes top speakers and focus on marketing strategies, project financing, policies and incentives for implementation in the Asia-Pacific region. For info: Alternative Development Asia Limited, 5/F 3 Wood Rd, Wanchai, Hong Kong • +852 2574 9133 • FAX: +852 2574 1997 • E-mail: altdev@hk.super.net • Web: www.hk.super.net/~altdev/

MONACO
3rd Monte-Carlo International Rendezvous of Electric Vehicles, October 16–19, 1997. The Event is composed of a salon, a forum, a conference and prestigious rallye. It offers a veritable panorama of the current electric vehicle market. For more information contact: EPI SAM - 11, Bd Albert 1er - MC 98000 Monaco • tel +377 93 30 00 88 • FAX: +377 93 16 03 75

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Energy Efficiency and Renewable Energy Clearinghouse (EREC) offers free info: Small Wind Energy Systems for the Homeowner (FS135) The publication reviews system requirements, site determination and costs of residential wind turbines. Also available; The New Earth-Sheltered Houses (FS120) Photovoltaics: Basic Design Principles and Components (FS231) ; Cooling Your Home Naturally (FS186); Automatic and Programmable Thermostats (FS215). To obtain a copy of FS135, FS120, FS231, FS186, and/or FS215 contact EREC: 800-363-3732 • PO Box 3048, Merrifield, VA 22116 • E-mail: energyinfo@delphi.com • TDD: 800-273-2957 • BBS at 800-273-2955 • Web: www.eren.doe.gov

Visit American Wind Energy Association home page on the World Wide Web: www.igc.apc.org/awea. Visitors to AWEA's home page can obtain information about the

US wind energy industry, AWEA membership, small turbine use, and much more.

Last year's American Solar Energy Society & USDOE's & Interstate Renewable Energy Council National Tour of Solar Homes was a great success. To participate in the 1997 event (October 18) contact: American Solar Energy Society, 2400 Central Ave #G-1, Boulder, CO 80301 • phone 303-443-3130 • Web: www.ases.org/solar/

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. Copies are available free by writing to: EnergyGuide, The Federal Trade Commission, room 130 6th St and Pennsylvania Ave NW, Washington, DC 20580 or call 202-326—2222, or 202-9326-2502 (TTY for the hearing impaired). The full text of these and more than 160 other consumer and business publication are available through the FTC ConsumerLine: http://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. Sponsored by the NASA Mission to Planet Earth Program, 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. The data is accessible free of charge from the WWW at: http://eosweb.larc.nasa.gov/DATDOCS/Surface_Solar_Energy.html

The Interstate Renewable Energy Council (IREC), in cooperation with the Solar Energy Industries Association and Sandia National Laboratories has developed a handbook to guide state and local government procurement officials and other users in the specification and purchase of commercially available renewable energy technologies. Information on biomass, photovoltaics, solar domestic water and pool heating and small wind systems. Product descriptions cover technology specs about equipment, photographs and vendor contact info. The Guide also contains general information on simple methods for estimating the pollution benefits of any size RE system in any region of the US. To order 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 payable to American Solar Energy Society).

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Offline will have an Introductory Residential PV Design workshop on Oct. 18 for beginners. Costs $35. Enrollment limited. Contact: 209-877-7080 • Email: ofln@aol.com.

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

The Oceans and Life on Earth is a midcareer educational conference bringing journalists together with experts on environmental and economic issues concerning the oceans. The conference is conducted by FACS at Scripps Institution of Oceanography, Oct. 24-26 in La Jolla, CA. The $100 registration fee covers the conference and meals. Contact: Foundation for American Communications, 3800 Barham Blvd., Suite 409, Los Angeles, CA 90068 • Phone: 213-851-7372 • FAX: 213-851-9186 • E-mail: facs@facsnet.org

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. The workshops are 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

Visit the new 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.

Energy Efficient Building Association Inc. (EEBA) Conference November 5–8 and EEBA Exposition November 6–7, 1997 in Denver, Colorado. For more information contact EEBA, 2950 Metro Dr Ste 108, Minneapolis, MN 55425, Phone: 612-851-9940 • FAX: 612-851-9507 • Web: http://www.eeba.org

Solar Energy International teaches Environmental Building Technologies including straw bale, adobe and rammed earth techniques. Get your hands-on at our weekend workshops in September 1997. Tuition is $250. Learn about homes that take less from the earth and give more to people. Contact: SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • FAX: 970-963-8866 • E-mail: sei@solarenergy.org

FLORIDA
14th International Electric Vehicle Symposium, December 15–17, Walt Disney World Dolphin, Orlando, FL. Contact: Pan Turner, EVS-14 Symposium Manager, c/o First Option, 15 N Ellsworth Ave Ste 202, San Mateo, CA 94401 • 415-548-0311 • FAX: 415-548-9764 • E-mail: firstopt@aol.com

The Florida Solar Energy Center is again offering courses leading to a "Certificate in Solar Energy" this fall. Individual courses offered include: Introduction to Photovoltaic System Design (Oct. 13), Principles of Photovoltaic System Design (Oct. 14),

Residential Solar Hot Water Heating Design and Installation (Oct. 15), Residential Solar Hot Water Heating Service and Troubleshooting (Oct. 16) and Commercial Solar Systems (Oct. 17). The fee for each course is $145 and continuing Education Units/redit is awarded all participants. Contact FSEC Continuing Education Office, 1679 Clearlake Rd., Cocoa, FL 32922 • Phone: 407-638-1014 • FAX: 407-638-1010 • Web: www.fsec.ucf.edu/

INDIANA

The First Annual Halloween Fest, A Traditional Halloween Festival is being held Oct. 31 - Nov. 2 at the Lothlorien Nature Sanctuary, in Needmore. Featuring ancient traditions, magical circles, merchanting, good people and magical times. Cost: advance registration $35 adult, $25 teen, at-gate: $50 adult, $40 teen. On-site camping available. Contact: Lion's Nest Trading Post, RR 18 Box 78, Bedford, IN 47421

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 • Phone: 319-338-3200 • FAX: 319-351-2338 • E-mail: irenew@igc.apc.org

LOUISIANA

Building Energy Alliances, How to Successfully Negotiate, Implement & Manage Strategic Partnerships: October 30–31, 1997 New Orleans, LA. For more information call 800-817-8601

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

Fall 1997 NSC/QBC's "Sustainable Series" of Workshops and Lectures: Photovoltaics Design and Installation; Financing Better Buildings; Model Energy Code (MEC) & Weatherization Workshops; & Home Depot Product Seminars, to name a few.October 18, ASES National Tour of Solar Home. November 18–20 Four Workshops at "build Boston", Passive Solar Design (101); Straw Bale Construction; Energy-efficient Residential Lighting and Daylighting; and Buildings That Work Over Time. If you are interested in any of these Events/Workshops contact: NESEA, 50 Miles St, Greenfield, MA 01301-93212 • 413-774-6051 • FAX: 413-774-6053

NEW MEXICO

New Mexico Solar Energy Association's 25th Annual Life Technics Conference & 11th Peter VanDresser Workshop, October 3-5, Ghost Ranch Conference Center, Abiqui, NM. A solar & sustainable village conference. $45 for non-members, late fee after Aug. 22. Contact: NMSEA, PO Box 8507, Santa Fe, NM 87504 • 505-776-2012 • E-mail: ksolar@laplaza.org

Utility PV Experience, Conference and Exhibition will share the current experience of energy service providers engaged in introducing solar electricity to customers in the U.S. and abroad. Hosted by Utility Photovoltaic Group, 1800 M Street, NW, Suite 300, Washington, DC 20036 • Contact: Erin O'Donnell, Phone: 202-857-0898 • FAX: 202-223-5537 • E-mail: eodonnell@ttcorp.com

NORTH CAROLINA

Announcing a hands-on Photovoltaic Design and Installation workshop. Bought to you by Solar Energy International—experts in renewable energy education. This six day event will take place in Ashville, NC. Topics include: solar site analysis, system sizing, PV modules, controllers, batteries, inverters and appliances, demonstrations, lab exercises and hands-on installation. All for a tuition fee of $500. Everyone welcome to join us from October 13 to 18. Contact: SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • FAX: 970-963-8866 • E-mail: sei@solarenergy.org

OHIO

The Great Lakes Electric Auto Association's mission is to contribute to the freeing of the US automobile market from dependency on petroleum through advancements in electric and hybrid/electric technology. Their Third Annual Transportation 2010 Conference will be held Nov. 7th in Dayton Ohio. Cost for the one day conference is $50. For more info on the conference and GLEAA ongoing activities contact: Larry Dussault, GLEAA, 568 Braxton Pl. E, Westerville, OH 43081-3019 • 800-GLEAA-44 • 614-899-6263 • FAX: 614-899-1717 • E-mail: DUSSAULT@delphi.com

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.

The Lane Community College Energy Management Program is offering a PV design course for the Spring term. Content includes PV electricity basics, modules, batteries, controllers, inverters, lighting, appliances, and installation guidelines. Includes a tour of PV installations and culminates in a design project, David Parker, Instructor. Contact: Roger Ebbage, LCC, 541-747-4501 ext. 2451 • out of area 800-769-9687 • E-mail: ebbager@lanecc.edu • Web: lanecc.edu:1080/webpages/lcc/science/home.htm

TEXAS

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

Photovoltaic Design and Installation! SEI is offering a hands-on workshop in Austin, TX from November 10–15. Tuition cost is $500 for all six days. Topics include: solar site analysis, system sizing, PV modules, controllers, batteries, inverters and appliances, demonstrations, lab exercises and hands-on installation. No prior experience necessary. Everyone is welcome and we especially encourage women participants. Contact: SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • FAX: 970-963-8866 • E-mail: sei@solarenergy.org

Green Building Conference '97 is being held at the Austin Convention Center Oct. 30-Nov. 2 with the theme: Linking Practice with Place, How To Do Your Best Where Your Are. Green and Sustainable building practices are the focus of this event featuring 40 speakers and 200 trade show exhibitors. Contact Green Building Conference, POB 90008, Austin, TX 78709, • 512-264-0004, • Fax: 512-264-3444, • email: nick_denner@greenbuilder.com • Web: www.greenbuilder.com/conference/aus97.html

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, first Saturday of most months. Interest will determine which of the following topics will be discussed and demonstrated (as practical): site selection, PV modules, batteries, safety, charge controllers, inverters, DC lighting, 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. This is a freebie so bring your own lunch and coffee. Contact: David Palumbo, RR1 Box 3054, Hyde Park, VT 05655 • Voice or FAX: 802-888-7194, E-mail: indeppower@aol.com

WASHINGTON
GreenFire Institute is offering workshops and information on strawbale construction. For more information contact: GreenFire, 1509 Queen Anne Ave #606, Seattle, WA 98109 • Phone: 206-284-7470 • FAX: 206-284-2816 • Web: www.balewolf.com • E-mail: wilbur@balewolf.com

Solar Energy International teaches the Photovoltaic how-to in a hands-on way! Announcing a six day Design and Installation workshop in Seattle for a total cost of $500. Topics include: solar site analysis, system sizing, PV modules, controllers, batteries, inverters and appliances, demonstrations, lab exercises and hands-on installation. No prior experience necessary. Everyone is welcome. We especially encourage women participants. Contact: SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • FAX: 970-963-8866 • E-mail: sei@solarenergy.org

WISCONSIN
The Midwest Renewable Energy Association Workshop Schedule. 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 with you for 1/2 price. Contact: MREA, PO Box 249, Amherst, WI 54406 • Phone: 715-824-5166 • FAX: 715-824-5399

the Wizard speaks...

Magnetic Motor?

Consider the following device. It has two concentric circular rings of permanent magnets. The outer ring is the stator, while the inner ring is the rotor. The poles of the stator magnets point in the circular direction. The north pole points counter-clockwise, while the south points clockwise. There is an air gap between the stator and the rotor. The rotor magnets have their poles radially positioned. The north pole is at the outer edge, and the south towards the center. The rotor is fastened to a turnable shaft.

There is a good possibility that this device will rotate on its own. The number and arrangement of each set of magnets should be such as to maximize the turning force to weight of rotor ratio. Both sets of magnets could be extended into the air gap and a notch placed in the stator magnets for the rotor magnets to turn through.

Even if this device rotates on its own, it may not be able to produce useable power. I don't know, but I thought I'd run this by you all. Maybe someone can make this design work. It may also be possible to build an electrostatic device on similar principles. If so, much dielectric insulation will be necessary.

Adopt a Library!

When Karen and I were living with kerosene lamps, we went to our local public library to find out if there was a better way to light up our nights. We found nothing about small scale renewable energy.

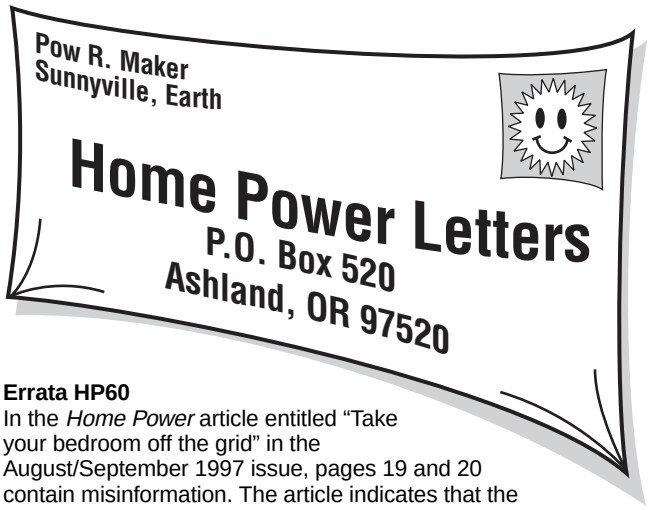
One of the first things we did when we started publishing this magazine nine years ago was to give a subscription to our local public library.

You may want to do the same for your local public library. We'll split the cost (50/50) of the sub with you if you do. You pay $11.25 and Home Power will pay the rest. If your public library is outside of the USA, then we'll split the sub to your location so call for rates.

Please check with your public library before sending them a sub. Some rural libraries may not have space, so check with your librarian before adopting your local public library. Sorry, private or corporate libraries are not eligible for this Adopt a Library deal—the library must give free public access. — Richard Perez

To Adopt a Library write or call

Home Power®
PO Box 520, Ashland, OR 97520
1-800-707-6585 or 916-475-0830 or FAX 916-475-0941



Errata HP60
In the *Home Power* article entitled "Take your bedroom off the grid" in the August/September 1997 issue, pages 19 and 20 contain misinformation. The article indicates that the featured Exide battery is a T–105, which is actually a Trojan model number. The battery is actually an Exide GC–4.

Jon Entine's area code was listed incorrectly in the Power Politics column. His number is (614) 258-9492. Davy Rippner's email address in "Take Your Bedroom..." article was incorrect. The entry should have been E-mail: energy@alt-energy.com • Web: www.alt-energy.com

The Real Costs
I would like the people of the United States to realize how much the various traditional energy sources are subsidized, i.e. in health costs (air/water pollution), security costs, and the "eternal vigilance" necessary to guard nuclear facilities and waste, not to mention the nuclear radiation problem for 20,000 years.

I would like this information to be in the mainstream press, on TV, magazines, newspapers. In other words, I would like to "beat" people over their heads until they realize what a ridiculous path we have taken.

I just don't think people are made aware of the real costs. Unpleasant things are hidden in our society. John Luker, Norfolk, Virginia

Well, John, the American Solar Energy Society (ASES) did some research during 1989 and came up for the following hidden energy costs.

Hidden Energy Costs in the USA (ASES 1989)

Hidden Cost Classification	Minimum in Billion $ per Year	Maximum in Billion $ per Year	Average in Billion $ per Year	Hidden Cost per US person in $ per Year
Subsidies	$43.3	$55.2	$49.3	$197
Health Impact	$11.8	$82.0	$46.9	$188
Military	$14.6	$54.0	$34.3	$137
Employment	$30.6	$30.6	$30.6	$122
Radioactive Waste	$4.3	$31.2	$17.8	$71
Crop Loss	$2.5	$7.5	$5.0	$20
Corrosion	$2.0	$2.0	$2.0	$8
Totals	$109.1	$262.5	$185.8	$743

While this info is surely out of date, it does show the magnitude of the problem. I'd like to quote Michael Nicklas in the ASES report., "Our free market economy operates best when both the buyer and the seller have complete knowledge of which choice will benefit them the most. With energy, this is obviously not the case. How many people know that sulfur dioxide from just our coal burning plants is costing Americans $82 billion per year in additional health costs? How many farmers are aware that they are annually losing $7.5 billion per year due to reduced crop yields caused by air pollution? And, how many people are really aware that nuclear waste and decommissioning costs (which, for the most part, we have not seen yet) are the equivalent of $31 billion per year?"

What is really shocking is that we are actually paying between $109 billion and $260 billion yearly in hidden energy costs. In terms of an individual, each of us is paying over $740 yearly in hidden energy costs. I urge you write your elected representatives and let them know how you feel about energy issues. Encourage government to support renewable, non-polluting energy technologies. This is the long, slow path. Our government agencies have access to the information presented here—they already know what's going on. What they don't know is how YOU feel about it. Let your elected officials know that you consider energy a political issue. Ask them what they are doing to help solve our energy related problems. Let them know that when you cast your vote, you will have energy on your mind.

Conservation can be practiced by everyone. Whether you make your own power or buy it from the grid, conservation saves energy. Implement conservation techniques in your home. Install efficient lighting. Turn off unused appliances. Find and isolate those "phantom loads". When you buy an appliance make efficiency your prime criteria. If each of us practices conservation, then I estimate we could reduce America's electric bill to half. And this means half the environmental damage. Conservation offers immediate, short term relief until we can mass-implement non-polluting renewable energy sources.

Perhaps the best thing any of us can do as individuals is to actually use renewable energy sources. And the best place to start is at home. Every time any one of us puts up a PV panel, a hydro turbine, or a wind generator we are directly helping solve America's energy problems. Every time a renewable energy source is used, then power that would have been produced by combustion or nuclear reaction is instead made by clean renewable methods. It's not often we get a real chance to change this world and stay at home at the same time. Put up a PV panel, develop that creek, put that wind machine up! Show the World that there are alternatives to life in a polluted greenhouse! Richard Perez

DC Experiences Wanted
Do you live in a DC powered house or do you just like to turn that inverter off? I am compiling experiences of living with DC power: why people like it; how it affects their health, creativity, relationships, feelings, children, guests, plants, pets etc.; any technical problems, annoyances and any solutions. I would be grateful for any observations or anecdotes you have. I will ask your permission before publishing anything using your comments. E-mail is best: GrahamD603@aol.com Snail-mail goes to: Graham de Freitas, 1976 Savanna Circle, Fairfield, IA 52556

A Big Help
Just built a house! As a result, I lost track of my subscription. Please rush my back-orders and restart my sub. I've noticed that I've started to develop a "twitch" lately. I'm hoping this goes away when I get my "fix" of back issues!

Wish you folks could see what you helped us put together. Our new house is 100% PV powered with no furnace and an indoor garden to boot! Used our library of HP issues to work out lots of details. Couldn't have done it without you! Still have lots to do—wind generator, electric car, aquaculture ponds, and horse-powered farming are all on the docket. Oh yeah, I'm also gonna round up all the people that laughed at my design and bring 'em

thru. I can't even begin to tell you the static I've taken from contractors. "You wanna do WHAT with the vapor barrier?" "That's really stupid, why can't you just do it like everyone else?" "Do you want to borrow my generator?" These are just a few examples! Actually, the one I liked best was when the contractor actually broke out into uncontrollable laughter. I just smiled and let him have his fun. The funny thing is, high winds took the grid power out of most of the county last month. I'm quite certain I was the only one for miles with power!. Steve Heyer, Waterford, Wisconsin

We are glad to have been of help, Steve. I have been wary of experts all my life. Experts know how it was done, pioneers show us how it will be done in the future. Let them laugh, you have lights when the grid goes out! Richard Perez

Keeping the Dream Alive
I checked my label, just seems hard to find time to fill out sub. etc. Wish we had the intestinal fortitude to get out of the "city" and work exclusively on harvesting sunshine and vegetables but there always seems to be family and business commitments and we only inch towards that goal making do with a small garden and hodgepodge on-again off-again temporary renewable energy experiments and lots of dreams. HP helps keep the dreams alive and provides the knowledge and access to make them come true. All changes to HP so far, in my opinion have been improvements. The ideas of providing an online subscription alternative sounds great. I wonder when all the factors of manufacturing, even a PC with all their exotic materials, are added up if that ole stack of HPs might have been just as efficient a delivery medium and with your careful choice of paper and inks, just as environmentally sound. But if we already have the hardware and can isolate ourselves from all the nasty stuff that comes in thru snail mail (we once got a free sample of weed killer-YUMMY) then a reduction in the production and distribution of that junk over a few years will, I think, put us about even in energy used and well ahead in the peace of mind department. Thanks for HP. James Naizby, Transylvania, Pennsylvania

Che Guevara
I was amazed to see Che Guevara referred to in Aug/Sept HP as a hero! He died fighting for a failed cause! I don't want to think of solar energy as a failed cause, nor do I seek to die! "He stuck it through to the end, and we will too." Jeez!

Guevara was out of touch with how the world works. HP gospel could be to convince readers that in the long run, solar is more in touch with reality (including in the economic sense) than the conventional alternatives.

Guevara favored an economic model that relies on state ownership and control. The ultimate monopoly. Another reason he failed. Solar works against monopolies. Therefore, unlike Guevara, it may succeed. J. Morris, Terra Linda, CA

Hello J. I think you may have misunderstood my purpose. The editorial was about perseverance, not politics. The value of a "cause" has nothing to do with its success or failure.

Our readers understand the economics and politics of solar energy far better than most folks. In many cases, HP readers live on solar because it is cheaper than utility power. Many relish the personal and environmental freedom solar energy gives them, and indirectly all of us.

Che was not an ideological revolutionary. He fought for the people, not for a political system. Witness his departure from Cuba as the regime he fought for turned oppressive. My admiration for him is based on his dedication. This spirit of "doing it until the job is done" is what solar energy needs to overcome the utilities' monopoly on power production. Success or failure is not really the point here. Che tried until he died — that's really my point. May the strength of that spirit energize us all. Richard Perez

Hi J. Due to all the controversy I feel I must add my two cents. When we first moved to Agate Flat we were classified as hippies. A lot of "hippies" moved into the area around that time. The "locals" spoke of hippies in very derogatory terms—yet the locals liked all the hippies, once they got to know them personally.

The point I am trying to make is that labeling can close peoples' minds. I understood that Richard wasn't advocating violent revolution. Richard was advocating perseverance. Unfortunately, some folks didn't understand. Personally I think someone like Mother Theresa would have been a far better example of perseverance. I am someone who does not believe in bloody confrontation—period! Karen Perez

More on Che
I have been a *Home Power* reader for many years and have every issue published. I am intensely interested in renewable energy, have studied the field, and several years ago opened my home for the National Home Tour. In the past, I have found your magazine to be one of the few that I read cover to cover, including the ads. I do, however, take great exception to your portrayal of Ernesto Guevara as a "hero" in your August/September issue.

We all have blind spots created by our early childhood, traumas introduced by our coming of age years, and later calamities experienced as an adult. These experiences can result in glamorizing individuals who in real life were both good and bad, saint and devil, and virtuous and evil. When we make heros of someone like Ernesto, we tend to see only the white of the black and white. The ardent supporters of the "Che" legend see the "evil" C.I.A." in every story and the USA as capitalistic oppressors of the downtrodden masses. They don't see a man who executed his opponents in cold blood and killed to achieve his aims.

Likewise, the "commie bastard got what he deserved" opponents of Ernesto paint an equally opposite picture. They don't see the man who wept for the lepers, was a heroic fighter, and was a charismatic leader.

If you need to believe that Guevara was a hero, great. I do, however, find it offensive and inappropriate to use your great magazine as a personal forum for your biased beliefs that have little or nothing to do with the focus, mission, objective, and values of renewable energy. Sincerely, Dick Leatherman, Ph.D., CEO, ITC Inc., Richmond, Virginia

Hello Dick. You are right. I should just stick to energy and leave radical politics out of Home Power. Energy is the arena I have chosen for my life's work. The Che editorial was not tactically effective, it offended more folks than it inspired. I sometimes forget the wide diversity of Home Power readers. We speak to all political persuasions. We can all agree on the technical aspects of energy, but on the political aspects we are widely divergent. I have taken your advise to heart—from now on I'll stick with volts and amps and leave politics to other publications. Richard Perez

Article Bug
Hi, I was pleased to find my article on the low voltage disconnect in the *Home Power* #60, pages 38-40. Unfortunately, the day before the article arrived, I discovered a bug in the circuit. Fortunately, the fix is easy. If certain loads are connected to the circuit, in some cases, the off switch will not shut the load off completely, it may go into a "half power" mode. A quick check with the oscilloscope reveals a high frequency oscillation at the power MOSFET transistor. To cure the problem just insert a ferrite bead or other small inductor in series with the gate terminal of the transistor. A suitable inductor would be about 10 turns of small (30) gauge wire on a Q-reducing 10 ohm 1/2 watt resistor.

When dealing with higher current loads, the circuit may not always start up, especially if the battery is low, to fix this, it is necessary to increase the value of C11 from 22uF to 200 uF, an alternate fix is to use two pushbuttons for on-off instead of the dpdt switch, that is described in the article.

Meanwhile — I have another circuit for the homebrew column, this is a companion charge controller circuit. I plan to put both circuits on a single PC board and sell it as a kit on my new web page. Thanks, Forrest Cook WB0RIO • e-mail: cook@stout.atd.ucar.edu • http://www.eklektix.com/gfc/elect

Net Metering in Maine
It is now clear that net metering in the State of Maine has been essentially eliminated due to a new electric utility restructuring bill passed and signed this summer (LD 1804). An excellent article on this issue is in the current edition of The Maine Sun, the newsletter of the Maine Solar Energy Association. It's available on the web at http://solstice.crest.org/renewables/wlord

Section 9 is the killer portion of the bill. It states: "...an electric utility or transmission and distribution utility may not be required pursuant to Title 35-A, chapter 33 to enter into a contract to purchase power from a qualifying facility after the effective date of this Act (Sept, 97). Nothing in this section abrogates existing law or rules that provide qualifying facilities with the right to sell energy to an electric utility prior to March 1, 2000 on an as-available basis at the utility's short-term-only rate or to sell capacity and energy to an electric utility at any time before or after March 1, 2001 on a basis voluntarily and mutually agreed to by the qualifying facility and the electric utility."

I currently have a contract through the end of this decade, however Central Maine Power Company has taken the position that it is no longer required to enter into any future contracts thus bringing to a halt any significant growth in utility intertie systems in the state for the next several years —.not good public policy.

Several of us here in southern Maine (myself, Peter Talmage and Naoto Inouye) met with our state legislator and communicated our shock at the abrupt reversal of the state's energy policy. We did out best to provide him with background and documents so that he could understand the issues. He concluded that our concerns were reasonable and is willing to sponsor a bill to reinstitute the previous net-metering policy.

Time is short since the schedule for bills to be presented to the new legislature in January, 1998, is determined in September. Therefore, it has to be entered as an "emergency" bill, designed to right a wrong that was unintended by the legislature when they passed the bill.

While we have many hoops to jump through in the coming weeks and months, the process to reinstate net-metering as a keystone in the state's energy policy has begun. We look forward to your input as we move along this track. Bill Lord (wlord@bu.edu), Peter Talmage & Naoto Inouye (tse@talmagesolar.com)

Problematic New Jersey PV Location
I hope this year's MREA show was as good as it looks in Issue # 60 ! My friend and I were out there last year and we were very impressed. All you folks set a good example of being unselfish and caring.

I have a home in NJ on the back side of a hill with a lot of trees that makes it difficult to set up a permanent PV site. I don't want to give up, and the only idea I can come up with is a small array on a sturdy "wagon" from Northern Hydraulics and some type of SJ cord that would allow me to seasonally relocate.

I only want to take my refrigerator off-line because I have minimized my power bill. I think all I need is enough battery storage for grey winter months and an inverter that would be compatible with a compressor load. Is there a back issue that would address this scenario?

Obviously the charge controller/batt monitor and other peripherals are important as well. Maybe input from someone in my latitude would help. I have been watching my solaration areas and feel that this type of project is feasible. Please help if you can, and keep up the excellent work! Sincerely, Tony Maciorski • EBEMIS@AOL.com

Well, Tony, in an energy efficient home the refrigerator/freezer is a major load. First thing to do is analyze the fridge's energy consumption. I bet you find it consumes between 2,000 and 3,000 Watt-hours per day. This can be sourced by around eight PV modules and needs to have a battery of around 750 Ampere-hours at 12 VDC. A relatively small inverter, around 500 to 1000 watts should do this job with room to spare for other appliances. We are printing your E-mail address so folks can get in touch with you. Richard Perez

Illuminated Flying Balloons
On page 94 (HP#60). Dr KS Dhalhathreyan from Madras, India, enquired about illuminated helium-filled balloons he had seen on TV. We are aware of a supplier in Singapore who sources these things in Italy:

The product is called: "Griven Flying Planet" & you can order it from: Hawko Trading Co Pte Ltd, Mr Samuel Seet, 605 Macpherson Rd #01-15, Citimac Industrial Complex, Singapore 368 239, Telephone: +65-287-0011, Fax +65-288-5805.

When I contacted Hawko Trading In march this year, I was told there are three models available: 180cm diameter, 1000W halogen, 240cm diameter, 2X1000W halogen and 240cm diameter, MSR575 discharge.

The balloons manufacturer's address in Italy is: Griven, via Bulgaria 16, I-46042 Castel Goffredo (MN), Italy, telephone +39-376-779-483, Fax +39-376-779-682.

For further information, please contact Griven or Hawko Trading directly, since I have no direct experience with these balloons. Christopher Inglin, Siemens Showa Solar Pte, Ltd, Singapore

Furling Tail
Regarding you reader's letter about 'keeping out of mischief' in HP 60, I have successfully put a furling tail on a 200W Wincharger. It is true that the Winco centrifugal airbrakes are not really built to take the sort of weather you find on a good wind site.

I have been building furling tails since 1978 and I am still learning, but I am getting pretty good at machines of that size. The best type of tail is hinged at the root, where the tail boom fixes on to the chassis of the wind machine, and it has no springs, but uses gravity to provide the necessary forces.

You start by mounting the generator/alternator/main shaft eccentrically on the windmill. For a 200 watt, 6 foot diameter machine this means you put it three or four inches off centre. As the wind blows through the windmill's blades, it presses them backwards, and this thrust force, combined with the offset, creates a tendency to 'yaw' sideways. You may have to rebuild the windmill to do this, but it is necessary. Using a sidevane to create the 'yaw moment' just isn't stable.

Ok, so the machine wants to yaw away from the wind, but most of the time you do not want this to happen, so you use a tail to prevent it, i.e. to hold it facing the wind. The tail needs to be 'cocked' slightly the other way, to balance the machine and hold it facing the wind squarely. And it needs to be big enough: maybe about 3 square feet area of vane, on a 3 foot pole.

The trick is to make the tail give way and allow the windmill to yaw away and face sideways when the wind reaches the speed where you are getting full power, and yet not to yaw so far that you loose out entirely. The ideal tail will fold just enough to keep the windmill running and powering your system, even in the highest windspeeds it will see.

The best type of tail hinges at the root, and as it swings sideways it lifts. This is achieved by using an inclined hinge. The weight of the tail brings it back down when the wind thrust has decreased. It is the balance between the wind thrust and the restoring moment (turning force) of the tail which keeps the windmill at the correct angle to the wind.

You can measure the restoring moment of the tail using a spring-balance hooked onto the tail at the trailing edge (end) of the vane, at right angles, pulling it horizontally. As you pull the tail it should swing through about 90 degrees but the force should always be about constant. We are talking about a force of approximately 3 pounds weight for this size of machine, but you will need to use trial and error. I cannot explain all the angles and stuff in text but if you mess around you can work it out for yourselves.

By altering the way the tail is hung, you can get more power in high winds, less power in high winds or whatever you like. In reality the output power will surge with gusts etc, but this is a simple, reliable method of governing your windmill output.

I have written a few books on the subject which I recommend if you want more detail. Hugh Piggott, Hugh Scoraig, N.W. Scotland • hugh.piggott@enterprise.net

Wanted: Net Pal
It has been said “experience is the best teacher; especially if it is someone else’s experience”. That is why I always read the personal experience articles of home system builders you feature first. However, I wonder if it would work in my little corner of the world. Therefore, I was wondering if there are any other *Home Power* readers who live in the north of Seattle to southern B.C. Canada area who have systems, small or large, complete or incomplete who would be willing to contact me via the net so we can chat and perhaps arrange a visit. My e-mail address is rnymeyer@juno.com Thank You, Richard B. Nymeyer

The Spreading Word
In the year since I first subscribed to HP, I’ve noticed more and more PVs appearing in urban locations: billboards, telecommunications installations, automatic gates and highway warning signs. As PV usage increases and costs go down, I’m sure we’ll see even more of them. Til then, HP is chock-full of information and advertisers you just can’t seem to get anywhere else. I love this mag! Tom Thompson, Fairfax, California

Working Assets talks about Green Power
Home Power recently ran a story by Michael Welch entitled “Power Politics.” Mr. Welch discusses our participation in two pilot programs in New England, where we along with many others were given the opportunity to test customer demand for alternative power sources and suppliers. Because the article contains some misinformation from one of the sources Mr. Welch quotes, Mr. Jon Entine, we’d like to take this opportunity to set the record straight.

The mission of Working Assets is to be a catalyst for building a more just and sustainable world. Over the past decade, we have donated over $10 million to progressive groups and generated nearly 3 million calls and letters to selected officials on critical matters of public policy.

We have worked to achieve this by being a telephone company, and have recently started considering the energy industry—one of the most environmentally destructive industries in the world.

We believe that the energy industry needs a fundamental overhaul. Here are six critical positions we have taken, all of which are pro-consumer and pro-environment:

1. Every single utility must incorporate renewable power. Our own Citizen Action program has generated more calls and letters to Congress in support of these so-called portfolio standards than anyone else.

2. Every single marketer or distributor of energy must be required to disclose the sources of their power.

3. Public financial support should continue for developing renewable power sources.

4. Ratepayers or taxpayers should not bail out nuclear utilities from having to pay for their earlier costly and foolish investments in nuclear power.

5. Much tougher new clean air standards must be imposed on utilities. Again, our own Citizen Action program has generated more calls and letters in support of such standards than any other group.

6. Consumers should have the ability to choose an electricity provider other than their local monopoly just as soon as big businesses can do so.

We have been strong and consistent supporters of renewable power, working to hold giant utilities accountable, and charging fair prices which are clearly disclosed. We have set up a special site at http://www.wald.com/thefacts for those who would like additional information about our energy business, and the bottom line on the allegations Mr. Entine wrongly makes against us.

Below we provide corrections to specific facts that are wrongly cited in the article.

First, this article does not explain the nature of Working Assets’ agreement with New England Power. We are purchasing power from eleven specific facilities. If our customers demand more power, we buy more power from those facilities. If they demand less power, we buy less.

When combined with the positions stated above, we believe that over the long haul, consumers who buy power in this way will lead to higher utilization of desirable facilities and lower utilization of dirty facilities. We understand that not everyone agrees with this approach to changing the power mix.

Second, our customers are not paying more for the same energy they received before. All of our customers in New Hampshire save money compared to what they paid before the pilot. While it is true that our customers in New England are paying more to us because of the power sources we use as opposed to those of our competitors, it is also true that each one is saving money compared to what they paid before. We promised savings compared to their current supplier and we have delivered them.

Furthermore, Working Assets was not the highest priced supplier in the Massachusetts Electric pilot. Massachusetts Electric, the company that sponsored the pilot, sent a ballot to interested customers that listed the price of power for each supplier in the pilot, as well as other features, including generation profile. According to this ballot (“Be Among The First,” October 1996), the most expensive residential supplier was a company called AllEnergy. It is worth noting here that Working Assets was the only company in the pilot that is not a subsidiary or joint venture of an investor-owned utility.

Third, the article states that only 1.2 percent of those eligible to participate in the Massachusetts pilot chose a “green” provider. This is very different from the number reported by the pilot administrator, Environmental Futures, to the Massachusetts

Department of Public Utilities. In January 1997, the pilot administrator reported that 31 percent of the residential customers participating in the pilot chose a "green" provider ("green" was determined by the pilot administrator). Of that 31 percent, over half of them chose Working Assets, giving us 54 percent of the "green" market share in the pilot, and 16 percent of the overall market share.

Fourth, the article cites the Center for Energy Efficiency and Renewable Technologies' proposal that customers who buy green power shouldn't have to pay for stranded costs. Working Assets agrees with this position, and was one of the few groups that argued for this last fall before the California Energy Commission. In January, Working Assets' members also generated several thousand cards and letters to the President Pro Tem of the California Senate, Bill Lockyer, telling him that small consumers want to buy renewable power and shouldn't have to pay for the utilities' foolish investments in nuclear power.

The pilots in New Hampshire and Massachusetts have shown what surveys have tested for years: that there is significant consumer interest in alternative energy sources. What is needed now to help renewables thrive is the right combination of public policy initiatives and fair market rules to allow a competitive electricity industry to develop for all customers, particularly residential consumers. Sincerely, Michael Kieschnick President Working Assets

Jon Entine responds to Working Assets
Working Assets asserts that a number of statements in the article are not accurate. Here is more context to help interested readers.

(1) Working Assets says it "buys" electricity from "eleven" different facilities so that "over the long haul, consumers who buy power in this way will lead to higher utilization of desirable facilities and lower utilization of dirty facilities." What it doesn't reveal: - WAGP buys all its electricity from NEES. Its purchases are purely paper transactions that will not have that stated result.

"Working Assets and Wisconsin Electric Power Company produced results that were less than exemplary," writes Michael Vickerman, an energy activist and director of RENEW Wisconsin. "They did not get us what we want: new renewables on the ground to displace dirty power."

MIT Economics Chair Paul Joskow said in a taped interview about green marketers in New England, "I think that people who sell green power have an obligation to reveal precisely what it is they're selling. In some cases you can sell green power and you use the money to develop new power sources that wouldn't have otherwise been developed and they're environmentally benign. In New England, they're basically reselling contracts ... designated for hydroelectric facilities...."

(2) Working Assets correctly states that "our customers are not paying more for the same energy they received before the pilot." True, but that wasn't the issue. Working Assets rates are among the highest of the pilot competitors. In NH, WAGP's customers pay 2.29 cents per kilowatt hour to 3.5 cents—53% higher than the lowest-cost supplier. In Massachusetts, WAGP charges 3.35 cents—46% more than the lowest cost provider at 2.3. Only its business partner, the NEES subsidiary AllEnergy, charges fractionally more. All their customers in both states received the identical energy mix.

(3) WAGP writes that "31% chose a green option." Slippery statistics. While 31% of residents chose a green option, WAGP does not say that only 60% of the energy available to residents was subscribed. Reviewing the pilot as a whole, the green marketing effort was a bust. It turns out that only 3% of small businesses, which make up the vast majority of customers under deregulation, chose green. Only 10.1% of the total energy subscribed was green. Moreover, only 1.2% of all eligible participants chose green.

(4) Working Assets asserts its opposition to the write-off of stranded costs. That's all well and good, but the plan of action it is pursuing may well lead to just that result. Good intentions are not a 'get-out-of-jail-free-card.'

Critics of reckless green power marketing, such as renewable energy generators, various PIRGs, the Union of Concerned Scientists, and countless other organizations do not dismiss out-of-hand market-oriented strategies for obtaining positive clean energy results. The experience in New England has just reinforced their concern that an unfettered free market is dangerous without disclosure and controls.

Behind Working Assets is ... assets of course! Let's be clear: the company has no products of its own. Working Assets is a shell that buys products at wholesale (long distance access, Internet, paging, and electricity), then slaps on a pricey green label. California Energy Markets wrote in June that, "Working Assets has become a target for environmental groups, primarily because it charges a substantial premium for its phone services."

"Working Assets, the politically-correct purveyor of credit and telephone services...is in hot water from some environmentalists [who report that] Working Assets' 'green portfolio' contains electricity from nuclear plants and has not done anything to make New England's energy mix more environmentally acceptable." - The Electricity Journal, August/September

"I as a Working Assets telephone service customer am planning to write in protest. I encourage other Working Assets customers to do the same." - Laura Levison, Director of Communications, Union of Concerned Scientists

It consistently claimed that its energy was "nuclear free" when it wasn't. According to the San Jose Mercury (from information originally posted on WALD's web page which has now been deleted), it represented that it had a "commitment" to provide "100% renewable energy" including "solar" and "wind" power. Commitment? It bought ZERO solar and wind generated power. Jon Entine

Michael Welch adds his two cents...
Clearly, the points made in my article still stand. If you are going to sell green power, you better offer full disclosure and leave the marketing flunkies out of the picture. The best way to screw up a good thing is to turn it over to the suits and ties that only care about the bottom line, not a clean and safe environment.

Information I received about the remarketing of products has opened my eyes. For many years I was a proponent of using a "green" telephone company because the others don't care about progressive issues. But now I see that it's a ruse to get more of my money. A Redwood Alliance supporter and former Working Assets telephone customer walked into the RA office last week and said (paraphrased), "I am now paying rock-bottom rates for my telephone service and will be writing checks to Redwood Alliance to match the substantial difference in my phone bills instead of lining the pockets of yet another corporation." Enough said. Michael Welch

Green Power
I agree that full disclosure of "green power" sources is good. And I personally don't have much sympathy for the people who invested in nukes back in the '60s and '70s. But still I think Michael Welch is unreasonably hard on Working Assets' "green power" scheme. Maybe things look different in California or Oregon—big states, big markets, big empty areas to put new plants into. Here in New England, I don't expect new investment in large-scale renewable power sources to happen until there's a market for it.

First, as he notes, there's a surplus of power already. Whether or not the original investors take a bath, Quebec Hydro and the nukes will still be there, and the only way anyone will make any money back on them will be to run them. The nukes will eventually shut down, when an expensive repair is required that isn't worth new investment, but the dams won't silt up for a century or more. So, unless demand rises a lot inside and outside New England (which I think we all agree would be A Bad Thing), for the foreseeable future, there's going to be power available at low-ball prices from non-green sources.

Second, stranded assets exist because of previous regulatory intervention. Even though as far as I know no state other than New Hampshire is actually refusing to pay off nuke plant investors at less than 100%, it's still an issue. Would I personally invest in something where I'd lose both interest and principal if the government changed its mind? Not in this day and age. But the nukes were built because the government made it attractive. The screaming every time getting rid of the home mortgage interest deduction is proposed arises from the same basis — you invest for 30 years and expect the laws to stay the same for the life of the investment.

I contacted Working Assets about their pilot program, but I needed special metering - there's an Intelligen diesel co-generation unit already running grid-intertie with Exeter & Hampton Electric at one house, and I want to upgrade an existing off-grid PV setup at another to PV-wind with grid-intertie. WALD wasn't prepared to do any special metering on the pilot, so I passed. I can understand not wanting to get involved in special cases right at the start, but as soon as someone comes along who's prepared to buy green power in small increments, I'm signing up. I don't want to wait ten or twenty years for changes in the political climate or the power market.

At any rate, pillorying WALD for buying pool power for a pilot program is a little excessive. Utility deregulation in NH has been a moving target, and now the issue of who pays for stranded assets is before the courts. All (or almost all) the generating plants in the region are already under contract to sell their output to the pool, and nobody is going to get out of the pool just for a pilot when there's an overall power surplus. Even NH regulatory action couldn't have gotten them non-pool power because except for some small biomass and hydro plants, the "green" sources I know of are either outside NH entirely, or are Connecticut River hydro plants divided down the middle with Vermont. James B. VanBokkelen, South Hampton, NH • Jbvb@farm.netJbvb@farm.net

Green Power Marketing

Hi Michael Welch, I have given some thought to your Power Politics column in HP60. I have gotten to be friends with the people in our local cooperative electric utility, Golden Valley Electric Association (Fairbanks and surrounding communities). Our discussions have sort of gone like this:

1. We have agreed to include a question on Green Pricing on the questionaire that we send out to all cooperative members each year; "Would you pay extra for Green Energy?", and "How Much?" We think the response will be positive because there is a sizeable population of environmentally concerned people here. This will give people an opportunity to 'put their money where their mouth is'.

2. Since we do not have any hydro potential in the winter (everything's frozen), and questionable wind (we are currently putting up a 10 kW Bergey to fully evaluate this), PV solar, especially during our long summer days, seems to offer the best RE bang for the buck. The problem is, that solar, too, disappears during the dark winter months.

3. Our best hope would be to install a large number of tracking PV arrays, that would follow the sun all the way around during the summer months, and be fixed towards the south during the winter months. My company has had some good success with WattSun trackers in a project we did for the Army Corps of Engineers' soil remediation project, where we needed to pump a lot of air to soil microbes during the warm summer months.

4. So any model would have to include fossil fuel generation during the dead winter months, from Oct thru Jan.

We would market green power under the 'net green kW produced' model, promising that "for every kW of green power you have purchased, a kW of green power has been produced, on an annual basis." The net power produced by the green source would be metered, and only that amount of green power would be sold to the consumer. There would be a net surplus of green power produced during the sunny summer months, and a net deficit during the dark winter months.

5. Customers who could not afford a 100% net green menu, could opt for a percentage, let's say 10, 25, or 50% green, with a commensurate green surcharge. That way customers wouldn't have to be 100% gung-ho, or 100% apathetic. Even the 10 percenters would know they are helping, and, from my point of view, would be a vocal constituency during annual cooperative meetings. I have a feeling the the low sign-up in the Massachusetts pilot program you refer to in your column is perhaps due to an "all-or-nothing" approach, which demands too high a commitment from today's consumer, who basically feels that, "we've taken care of all that environmental stuff."

It is a peculiarity of our northern climate that our energy in the form of solar insolation is bountiful in the summer and practically disappears in the winter. Until hydrogen storage becomes more practical, fossil fuels will continue to be used extensively in the winter. Certainly those of us living on RE supplied homesteads must still run generators in the winter. I can't wait to see the steam power articles coming up in HP. I'd love to have an 'African Queen'-type steam plant, when it acted up, I could kick it like Bogart.

Anyway, Michael, just some Northern musings for you. Thanx for your wonderful work with HP. HP is like a bi-monthly energy infusion for me. Really. I flip thru the rag when I get it, and then end up waking up at 3am and really perusing it. Then comes the energy jolt and I get back to our Sisyphean struggle towards a RE future, a letter to the editor here, a phone call there, some field work... John Dailey, Alaska Wind & Solar, Ferry, Alaska • 907-683-2327 • E-mail: jdailey@www.denali.k12.ak.us

Hydro Quebec

I read with respect your comments on Power Politics.... On page 82 of HP #60 your sentence said, "Hydro-Quebec (famous for its destruction of native lands for the sake of selling power to U.S!) Well, well, there is a hard sentence to read.

Please, please Michael, before writing such a sentence, inform yourself of the truth for your readers sake. Quebec country is the largest in North America with a superficies of 1,540,660 square kilometers, more than twice of Texas 629,400 and larger than Alaska, 1,518,800. Of this, Hydro Quebec uses less than 1/10th of 1% of the "native land" as you said. Besides, the "native lands" are almost all in the very far back country where nobody can live due of the harsh climate and no actual possibilities to cultivate anything. Besides, those "native lands" where paid a fairly large amount of money, billions of dollars – sometimes twice that, to the "native peoples" saying that they own those lands!

Many dams, for example, are some 200 to 600 miles north of the province of Quebec where we can only find some wild animals, some species of trees not commercially exploitable for now, and

few “aboriginal” hunters sometimes staying there for a few days. The impact is minimal on mother nature compared to other big dams of the world, including U.S. Hydro. Quebec, by provincial law, restores completely the sites used for the construction of those monstrous dams by planting new trees (millions of them) small natives plants, and restoration of the animals wild life. Michael, between you and I, tell me where in the world do you see that: a big corporate restoring an area? The actual project of Grande Baleine is (if not stopped) at least staying still for the moment. If this project goes ahead who do you think will be using this power? The U.S., of course, and the project will be go ahead IF our big brother from the South says GO. And, we don’t speak of the fresh water desperately needed by some parts of the U.S. That is the story for now and tomorrow. There is too much misinformation about our province and our “problems.”

Bad treatment for our aboriginals! Well, I would like to have some advantages that our “Indians” have here. No taxes, right to hunting anywhere, etc., etc. Yes, Michael, I’ll agree that there are some exceptions, particularly those that our federal government calls “reserves,” but what about the plight of some “Indians” south of the 49 border? There is also misinformation about our politics in wanting to have at least some kind of autonomy (refer to the BIG Canadian Federal Government…) but, I don’t like to speak of politics! And now, misinformation about our manner of treating the “natives lands” of our country. Please Michael be serious!

This is a part of the story. It would take hundreds of pages to restore the truth. There is more to be said about Hydro Quebec and (why not?) others. Hydro Quebec sells only a small fraction of is production to the U.S., a low 5% or less, to a max of 15 to 20% during some hot summer periods or when the U.S. faces a big blackout. Do you remember the two last ones and the help from Hydro Quebec to help restore the grids in Eastern USA? Do you remember the year when New England faced one of the biggest winter storms. Who do you think they call for help? You got it: Hydro Quebec people and technicians to help restore high voltage lines and residential ones. There is more to say.

Our big dams suffice just enough for our own use in peak periods of very cold winter (over 30,000 megawatts) so actually we don’t have so much to sell. Maybe if Hydro Quebec goes ahead with Grande Baleine your sentence saying that we sell power to U.S. will be true. Utility deregulation will, maybe, see a reverse case of U.S. corporations selling electricity to Quebec, who knows? Hydro Quebec probably has one of the lowest prices in North America and maybe in the world if we except a few Middle West countries where petroleum is so abundant—well, you know! In fact our residential price per kilowatt is a mere 6.4 cents Canadian including two taxes. This is a low price of about 4.5 cents U.S. and we have a very nice and efficient service.

That is why we can call it GREEN ELECTRICITY because this electricity doesn’t hurt anybody, because this power is truly renewable and not polluting except minor impacts on local climate. We cannot say the same for other big dams in our world. If, for example, we make comparisons with other big dams for hydro electricity use we see thousands of people moving away, and cities, archeological and historical sites submerged, not to mention fertile areas (this is not the case for Quebec province!). Native lands, you said. That’s your opinion, I respect your opinion but I don’t partake it.

May we speak about some big dams for hydro electricity around the world?

- GRANDE COULEE, USA. What is the real impact on the environment?

- NEW CORNELIA TAILINGS, USA. Same comments.

- HOOVER DAM USA. Same comments.

- COLORADO DAMS, USA. Same comments. (I probably missed some others in USA.)

- YACERETA-AGIPE, Paraguay-Argentina. How many people moving away? How many square miles of forest lands submerged?

- ITAIPU, Brazil. Same as before … and worse.

- ASSOUAN, Egypt. How many archeological sites submerged, how may people displaced?

- 3 GORGES, China. The biggest project in the world. This one will move away hundred of thousands of people. Villages and cities submerged. Fertile lands missing forever….

Can we also say some words about pollution coming from the West? You should know that the Eastern areas of North America are the most subject to acid rain mostly due to the pollution “friendly power” created by our big brother (power centers to generate electricity with fossil combustibles and worse, nuclear). In south of 49, states affected by this pollution include: Maine, Vermont, New York, Ontario, and, of course, the Quebec and New Brunswick provinces. Did you know that USA is the first polluting country in the world? And you have the “!” to comment about the abuse of “native lands.” Please, Michael, please.

Well Michael, that’s my comments. I can say more and more on this subject or others related to Green Power (we usually call this “Free Power” because since you erect dams, wind mills, and geothermal units, the power driving your alternators is free but, of course, not the maintenance and salaries of workers). Not to mention the payback period of construction.

Michael, keep doing your nice job of “fighting against BIG corporations abusing us” but please, when is time to make such affirmation take info from more than one source or, best in the case of Hydro-Quebec, you could have all info you need by calling on Web: http://www.hydro.qc.ca (Hydro-Quebec site) or http://irec.ca (center for experimentation on electricity, Institut de Recherche en Electriciti de l’ Hydro Quebec). Hoping you understand my points. Friendly yours, good Winds and nice Sun. Michel.

Hi Michel. Thanks for your comments, they definitely represent the other side of the story of Canadian dam construction. I could write an entire column or even a book on the controversy surrounding Hydro Quebec or other large scale hydro projects. And there is no doubt injustice in Quebec’s lack of autonomy and if you are a regular reader of my column, you already know that when I see an injustice in my own land, I point it out. I don’t believe you’ll find geocentrism in my writings. The U.S. companies and governments are the worst of the worst when it comes to environmental destruction, environmental racism, and the abuse of resources and native peoples. If I can be so bold as to speak for U.S. residents, I apologize wholeheartedly to our friends in the East and Midwest for the acid rain foisted upon your lands by corporate greed. As an energy activist, I have put in hundreds of hours over the years trying to correct that unacceptable situation.

I and millions of others on both sides of our border believe such rampant flooding of wilderness and native lands is an unmitigated disaster. In California, for example, for most of this century there were feelings similar to yours about vast lands otherwise “unusable” that could be serving a supposedly higher purpose. In a matter of four decades we managed to completely “tame” nearly every wild watershed. Boy, we sure wish we had some of our rivers back! There are only a couple of medium sized and no large rivers that are undammed. Between the dams and inappropriate timber harvesting methods, our once plentiful King Salmon is nearly extinct. Sorry, you’ll never find me calling large scale hydro “green power.” Defining that term is one of the things that needs to be hammered out as utility regulators wrangle with their own disclosure rules for green power.

Your comments address a small portion of my column. I hope that the main point is not lost on readers who may disagree with any single part of it. There needs to be full accountability and a net positive result for RE when anyone markets green power to the public. Michael Welch

Down Loading
I received your e-mail concerning the ability to download the magazine and decided to give it a try. I downloaded Acrobat Reader 3.0 first, installed it, and then HP60. It took about 15 minutes to download but everything worked fine when it came up (I am running Windows NT and Netscape). I looked around in the magazine and had no problems getting around. The color pictures were all good. The only comment I have is that when reading an article, after finishing the first column, you have to scroll around looking for the top of column two. If the next column starts at a different height then you have to search for it. Just doesn't flow like web based data that I am used to. Other than that it is fine.

Would I prefer this over the paper copy? No. I enjoy reading and highlighting info in the paper editions. I like the CD-ROM back copies just as a way of storing alot of good data without the bulk of alot of copies hanging around. I am not sure as to your plans for this but I think I remember reading that some wanted this to "save trees". My view on this subject is that trees are a renewable resource and it is the paper and forest products companies that have millions of acres dedicated to nothing but growing trees. To eliminate the need for trees would eliminate their need for all of this acreage and put it up for sale to "development". So I have no problem with paper. Recycling makes more sense to me as a way to utilize resources to their maximum potential. Thanks for the e-mail and keep up the good work. Kent Tannery

Electronic HP
I used up part of a morning on my vacation downloading your test "electronic" issue at my modem's 14.4 snail's-pace (AOL won't let you just walk away from the downloading process; every five minutes or so there is a prompt that asks you if you want to continue). Anyway, an hour or so later, I was able to see the issue on the screen using Acrobat.

What can I say? I received the same print issue the same day. It's just not the same! Staring into a screen is intrinsically tiring to the eyes (you are staring at a bright light, basically), and no one yet has invented a flat-white screen that is as easy to look at as paper is. So my attention span is interrupted, my interest level drops, my irritation level rises, etc.

Unfortunately, you have evolved such a well laid-out magazine (you've avoided all the temptations of using juvenile-looking and distracting art elements, theme-related text fonts, etc.), presented on good quality coated stock, with clustered ads (bravo), in a nice size, perfect bound, and the electronic version just can't match it.

HOME POWER is one of the few magazines I try to read cover-to-cover (the others are a few electric vehicle magazines I get, and *WHOLE EARTH REVIEW* whenever it comes out). This means I move around the house from the couch, to my bed, to a chair without stuff on it, using the bits and pieces of free time that are available in "modern" life to eventually read most every article. I am already liking the first article about the passive solar + photovoltaic house, 1,000+ sq. ft.; it is a nearly perfect solution! Now, reading the same article on the computer, scrolling up and down, I would likely just give up, or go do something else.

At Honda R&D I must, as part of my research work, look up quite a bit of research material on the computer, web pages, etc. It is a pain; if I find something useful, I print it out. It is a way of getting information you couldn't get other ways, that is for sure. But it is a bit awkward in any case. I suppose some day print magazines will disappear. Home printing may eventually improve in quality and convenience, but right now, I'm not eagerly embracing the shift to electronic publishing. I receive a CD-ROM with each issue of *MacAddict* (an irreverent, silly, X-generation magazine that I take), and find it somewhat useful to peruse it for "stuff". It is quicker for me to get a CD-ROM up to speed than to download a 5.1 MB magazine issue. So, receiving *HP* as a CD-ROM would be preferable to downloading it, unless I buy a faster modem. I'm guessing your production and mailing costs would be drastically reduced if you mailed out CD-ROMS, though it's hard to gauge how many of your readers could use them.

I can see the handwriting on the wall, of course. Magazines are a medium that don't make sense anymore in terms of transportation, use of trees or Kenaf (sp?), binding, gluing, recycling, printing pollutants, and on and on. Someday I will have no choice, even if I am willing to pay more! Perhaps someday home printers will more closely approximate the functions of book/magazine, printing: they will collate, staple or bind! That won't be too bad. Your will push a button and out comes a book 15 minutes later!

You may print any of my remarks though I didn't craft the wording as I might in a snappily-worded "letter to the editor." Now I need to go back to my room and curl up with my REAL copy of *Home Power*. Best, Steve • Jnevets@aol.com

Hello Steve, and thank you for helping us test electronic distribution of Home Power. Most AOL users have reported slower download times than other ISP users.

I agree that the electronic edition just doesn't match up to the printed version. I have to squash the graphics to the max (JPEG High compression and downsampling from 280 dpi to 72 dpi) to reduce the file size enough to make it work on the Internet. The original PostScript files which generate an issue contain some 600 to 900 MB of data. This is compressed down to 5 MB for the net version of an issue and around 25 MB for the CD-ROM version. Even the 5 MB file is too large for many, for example Jeevan at Lotus Energy in Kathmandu, Nepal reports that he is unable to sustain a phone call long enough to download the 5 MB file. We are considering breaking the file up into a series of smaller files for users with flaky phone connections.

The major advantage of the electronic edition is only apparent when many issues are collected together on a CD-ROM. Here the indexing features in Acrobat make it an easy job to completely find info on any subject.

The folks who like the single issues distributed on the Internet are international readers. International mail is very slow. It sometimes takes several months for a copy to arrive. Sometimes the copy never arrives. Internet delivery takes hours instead of months.

I doubt that electronic magazines will replace printed versions in our lifetime. I know that we will not stop printing Home Power. Our mission is spreading renewable energy information. Some of our most important readers view Home Power with a kerosene lamp or a candle, not a computer. Richard Perez

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
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Ozonal Notes

Richard Perez

Progress on the straw bale green house / bath house

I thought you might enjoy an update on our endless construction projects. What with the Energy Fairs being over for the year and winter coming soon, we've been back to work on the new straw bale building. It looks like we may have it operational this fall. We now have water and propane plumbed to the building, but not yet plumbed around inside the building or hooked up to any appliances. Still to be done are the native stone floor and stuccoing the bale walls with our wonderful local adobe mud.

Then it's on to plumbing and wiring the building. While wiring holds no mysteries for me, I really don't know diddly about plumbing. I've done some plumbing with copper pipe and sweat soldering and it didn't leak. I get the feeling that there must be a better way, something less costly and difficult to modify. I think about changes because we've never had a building here which wasn't constantly being modified. I hear that there is now plastic pipe suitable for hot water, but I've never used it. Does anyone have any feedback on using something other than copper for hot water pipes?

We are planning on having two solar hot water systems in the building so we can test one system against another. The collectors will go on the building's 45 degree south-facing roof. Each system will have its own 80 gallon tank with a heat exchanger built in. We plan to datalog the solar hot water systems' performance. There is also an efficient, propane-fired, tank style, hot water heater selected for this system by Larry Schlussler of Sun Frost. Larry speced the propane heater to match his Low Power Shower which will also be installed in the building. The Low Power Shower is a bathing cubicle designed to have the absolute minimum energy and water consumption. It is super insulated and can be operated outside, even in the winter. Larry was concerned that the ultra low flow shower head would not use enough hot water for reliable operation of a tankless hot water heater, hence we are using a 20 gallon tank unit. In addition to the Low Power Shower, we are installing an ancient cast iron bath tub we scrounged from a dump many years ago. It weighs over 400 pounds and soaks up heat, but it is huge in comparison with the modern plastic bath tubs. I don't imagine that the tub will get alot of use, but when we want to soak we really want to soak. Most modern bath tubs are too small and uncomfortable for soaking. Also part of the hot water system will be a Staber System 2000 washing machine which will end 27 years of hauling our clothes to town for washing. Boy, is Karen happy about this!

Like most home style construction projects, this one is mushrooming. In addition to the straw bale building, we now have an elevated walkway from the back of our existing building to the composting toilet which is located on the side of the straw bale building. This toilet, made by Advanced Composting Systems, is a huge model with the toilet seat located more than ten feet above the ground level. It has been operational now for about four months and is working fine. The elevated walkway was necessary to get to the toilet. Once the walkway was done, Karen noticed that a little more framing and a roof would give us a large (8 feet by 20 foot) pantry, so Ben and Joe built it and we now have a pantry. We are going to move our Sun Frost RF-19 from the kitchen where it is hot all the time in the winter. Because of limited space, this fridge now lives less than four feet from our woodstove. The RF-19 will go into the unconditioned pantry space which is much cooler. We expect to save about 200 watt-hours daily by moving the Sun Frost.

Just when the Crew thought they were nearing the end of the project, I noticed that the east wall of the straw bale building would be a great place for our new power shed. We've outgrown the power room we scabbed onto the side of the main building five years ago (See HP#30 pages 101–108). We want to move our RE system from 12 VDC to 24 VDC and this expansion needs more room. So the construction crew has just finished pouring the footings for the new power room. I will write up our system's expansion when it's done. Right now we're still in the design and equipment acquisition stages.

The HP Construction Crew is readying a series of articles about this building process. With any luck we should run the first article in the next issue. It will deal with the design process of this straw bale building. The design criteria were low energy impact (minimum use of processed building materials), low site impact (no bulldozing or backhoe work), low cost (way under $20 per square foot), and high performance passive solar space heating. Other articles will follow detailing this building's dirt bag foundation, timber framing, windows, stucco, and eventually its performance. We've learned alot and want to share this info with you. Many thanks to the Construction Crew: Ben Root—Building Designer, and Joe Schwartz—Construction Straw Boss. Thanks also to friends who have worked on this project—George Patterson, Michael Welch, Don Kulha, and Copco Dave.

Solar 2 CD-ROM
We have been getting much feedback on the new Solar 2 CD-ROM. It has been almost all positive. Folks seem to like the index and search engine. I have a complete set of Home Power back issues right next to my desk. I have been using Solar 2 instead because it is faster than sorting through thirty pounds of paper to find the info I want. Even though I helped to put each and every one of these issues together, the index on the ROM beats my memory every time. The only problems with the ROM have been caused by improper installation of the Acrobat Reader from the ROM. We have added extra documentation to help Windows users get a good install first time.

Solar 2 users, please send me any feedback about what you like and don't like about this ROM. We are already hard at work on Solar 3 which should cover HP#43 up to maybe HP#60. We won't know the actual content until all the issues are distilled and we get a byte count. We are thinking of including some bells and whistles on Solar 3. I would like to add programs for system sizing, wire sizing, and other CAD features. Don Kulha, our CD-ROM Honcho, is hot to include audio and possibly some small amount of video. So let us know your preferences and Solar 3 will be even more to your liking.

Home Power issue distribution on the Internet
Folks are continuing to down load the current issue of Home Power from the Internet. Most folks say that it will not replace the paper version, but it sure travels faster. Eventually we will offer an electronic subscription to Home Power. We are at a loss as what to charge for this, so I am going to ask all of you. What do you think an electronic subscription to Home Power is worth?

You can still download the latest issue of Home Power for free by using your web browser to go to:

http://www.homepower.com/download.htm

The issue is in Adobe Acrobat PDF. If you do not yet have the Acrobat Reader for your machine, then use the link on our website to download it directly from Adobe. There is no charge, the Acrobat Reader is free.

The latest issue of Home Power is about 5 MB in PDF. Most folks report download times on the order of one hour.

Back issues on the Internet?
Many readers of the electronic edition of Home Power are requesting that we place Acrobat files of all of our back issues on the Internet. We could do this, but if we do we must charge something for the download. A significant part of the revenue that keeps this magazine alive comes from sales of our back issues, either on paper or on a CD-ROM. So my question is, "If you want back issues downloadable from the Internet, what's it worth to you?"

Bus Stuff
Many thanks to all the readers who responded to my plea for information on busses. I got a complete short course in RVs and bus conversion for RV use. What surprised me were the costs involved. I guess I should have realized it would be expensive, but I had no idea that it was soooo expensive. Since all this new construction is blitzing our bank account, it looks like the bus will have to wait until at least next year.

And more thanks!
I want to speak for the whole Home Power Crew when I say Thank You to everyone of our readers. You folks are great! You're doing something about this planet's problems by working on your own lives. In a time when everyone expects the government or big business to solve all our problems, you are doing it for yourself. In a time where all the breaks are given to utilities, you are going for clean, independent, and renewable power. You know that you could, in many cases, buy this power for less from a utility, but you install those PVs, put up those wind gennys, and plumb up those hydros anyway. You are our kinda crazies!

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E-mail: richard.perez@homepower.org

Q&A

Hydrogen
Great news magazine, you and staff work very hard to generate such quality issue after issue.

Question about hydrogen gas: isn't there very serious problems with its interaction with metal in tanks & tubing?

Another question: what is happening in the field of flywheel storage? James Webb, San Jose, California

Hello, James. Hydrogen can infiltrate into the structure of metals and make them brittle. This enbrittlement takes place only at high pressures (over 300 psi) and so it is not a problem in low pressure systems.

I spoke with a fellow recently who was working with a company making flywheel energy storage systems for spacecraft. He claims that the technology has greater energy density than batteries and higher reliability. It seems that the same flywheel used to store energy can also act as a stabilizing gyro for the spacecraft. When we got around to discussing cost, I found out that only spacecraft can afford it now. But this was the way with PV thirty years ago. I'm sure that eventually we will see flywheels storing energy for a variety of applications from vehicles to home systems.

Since both your questions concern energy storage, I guess you are looking for something better than a battery. At this point in time, it is very difficult to beat an electrochemical battery for energy storage. For the job they do, batteries are inexpensive (about 7¢ per watt-hour stored), efficient (≈85%), and are recyclable (over 95% of lead-acid batteries are recycled). In home power systems, we don't really care what the battery weighs. It's not like a vehicle where every pound counts. Expect it to be quite awhile before we commonly use some other storage method in home power systems. Richard Perez

PV Frame Retrofit
I have one 75 Watt Siemens panel that is a cheaper variant of the PC4-JF (now SP75). It was called a "Pro". The only difference from the standard model is that it is not aluminum framed. It has a cheap set of plastic strips on the perimeter.

I think I recall reading somewhere that there is a retrofit kit or firm that will provide a replacement aluminum frame. If you hear of it, please let me know the contact info? Phil McNamara, Centerville, Massachusetts

I *remember that the aluminium frames for this module were available, but I can no longer locate the source. How about it HP readers? Anyone know where Phil can find a replacement frame for his PC4? Richard Perez*

Terminals
The wire connections to the thin plated metal terminals on my 12 Volt, 1 Amp photovoltaic (strip type) module (a second!) has slowly increased in resistance, now about 40 ohms. I tried repairing these, using fine stranded, tinned copper wire (15 or so strands) spread out and pushed against the thin metal plating (insulating varnish (or plastic?) removed with acetone) and glued with epoxy. These connections worked well for most of one summer, but now have about 50 ohms resistance! These have not come loose but have lost the initial good contact. Do you have any information on how to repair these connections? A W Einarsson, Los Gatos, California

PS: Our first hydro (1933) hydro electric plant for our summer cabin were telephone ringing magnets rewound to give 6 volts ac at about 2 watts, run by a small pelton wheel, three inches in diameter, 45 foot head, running two flashlight bulbs.

Hello A.W. The answer for your problem is soldering. Mechanical connections such as you describe will not last long on a PV module. You need to solder the wire, or better yet some thin copper tape, to the tape on the module. Here are the basic rules of soldering:

1. Make sure all parts are clean of dirt, oxides, and grease. Polish the parts with emery paper or steel wool if necessary until they shine and are bright. If you don't do this surface preparation, then you cannot make a good solder joint regardless of what else you do or how big you soldering iron is.

2. Use a soldering iron or gun or torch of sufficient wattage for the job. Soldering on modules is difficult because you can overheat, and damage, the connections easily. You might think that using a low wattage 20 Watt iron would be the thing, but it isn't. For this job, use a 240 Watt soldering gun. Get in and solder the joint, and get out as quickly as possible before the heat has time to transfer to the PV. Iron time on the joint should be no more than five seconds. If you get into soldering you will have at least three irons—a 20 watt temperature regulated model for electronics, a 240 watt soldering gun for big connections, and a propane torch for monster connections.

3. Use a good grade of electronics solder (60% tin and 40% lead) with rosin core flux. My favorite brands are Kester (for big stuff) and Ersin (for electronics). Be sure to check out the metallic content of the solder. Both these companies make all kinds of solder, you want the

60%Sn/40%Pb type with rosin flux. Never use acid flux solders in electrical service. They are for plumbing and make poor electrical connections.

4. Make sure that the tip of the iron is clean and freshly tinned with solder. I use a bit of clean paper towel (be careful and don't get burned) to wipe the tip. Then I immediately melt clean solder onto the tip and give it a shake which sheds excess solder. The tip is clean, smoking, and ready for work. Some folks use foam pads wetted with water to clean the tip, but I find that this introduces moisture to the hot tip which oxidizes it and also cools it. Good solder joints are made by a hot, clean, tip freshly coated with solder.

5. For difficult jobs such as soldering to modules, tin the parts with solder first and allow them to cool before soldering them together. Tinning means giving the parts to be soldered a thin clean coating of fresh solder.

6. Give the parts as good a mechanical connection as possible before soldering. Soldering provides a low resistance, durable, electrical connection. It is not a substitute for a solid mechanical connection. A good mechanical connection has as high a surface contact area as possible and the parts are as close as possible (high contact pressure).

7. Melt the solder on the work, not on the tip of the iron. Solder contains a rosin flux which chemically deoxidizes metals as it melts and burns. If you melt the solder on the iron's tip, then the flux merely eats up your tip and is spent before it reaches the work. If you melt the solder on the work, then the flux deoxidizes the work, you get a better solder joint, and your soldering iron tip will last much longer.

8. Making a good solder joint takes experience, so practice. Start out with bits of scrap wire, then graduate to junk circuit boards and monster inverter/battery cables. There is a good reward for those who learn to solder. You get homemade, cheap, low resistance electrical connections which will last longer than you do. Richard Perez

Regulators & Inverters

I have been on the HP mailing list since October last year. Thank you for all the magazines I have received and will continue to receive.

I am interested in getting to know how charge regulators and inverters work and maybe even try to put some together. Initially of course, I would like to figure out how the really simple ones work and later on progress to the more sophisticated ones. I wonder if you could advise on where to get the relevant material or put me in touch with people that will assist me in this endeavour. James Wafula, Nairobi, Kenya

Well, James, there are no books strictly about inverters or charge regulators. The subject is too narrow and too new. The first step in understanding how charge regulators and inverters work is to learn basic electricity and then basic electronics. Here there are a number of good texts, but my favorites are written by Forrest Mims (available at Radio Shack, in the USA at least). Mims approaches learning electronics from a hands-on perspective. Buy a breadboard and piles of components and go for it! I learned about electricity from my high school Physics teacher, Walter Novak. I learned electronics by doing it. Home Power has published a number of articles on homebrew charge regulators. See our index in HP#59 (or on line for downloading on our web pages), under the heading "Controls" and under "Regulators." Inverters are far more complicated, but we have published articles and even a homebrew, see index under "Inverters."

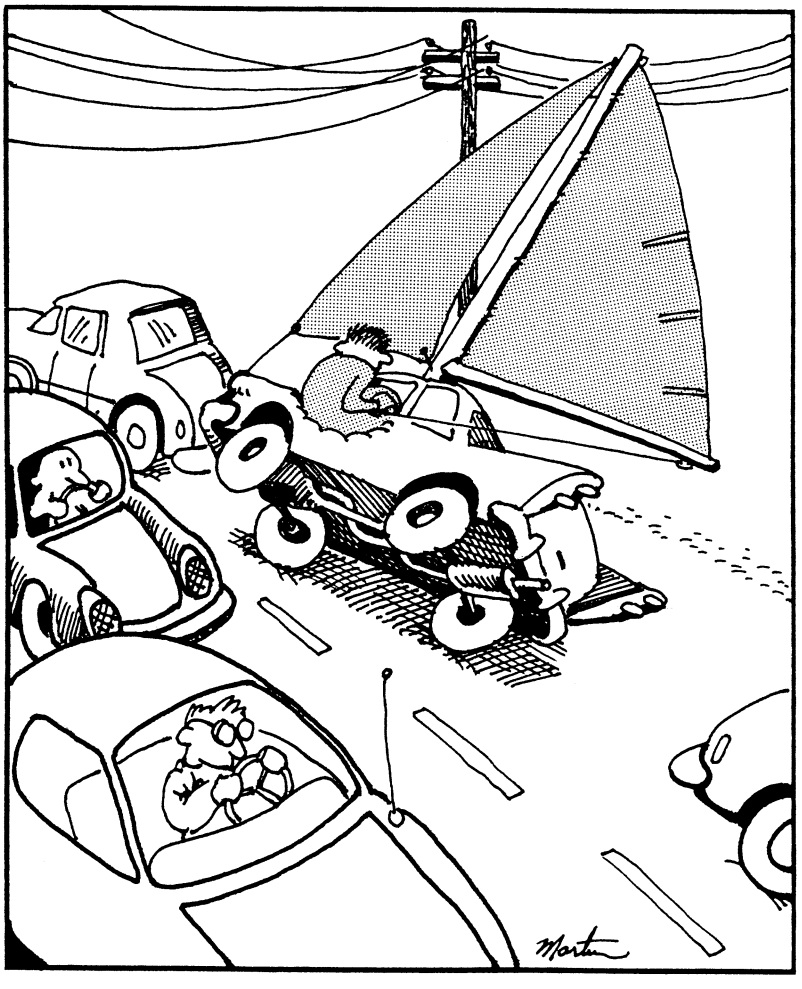
Regulators work by reducing the amount of current flowing into the battery. There are two types of regulators—series and shunt. Series regulators control current to the battery by disconnecting the RE source—either altogether, or pulse width modulated rapidly. Shunt regulators reduce battery current by diverting the current from the RE source elsewhere (usually a heater). There are many types of logic circuits and regulation concepts which control the regulator. Most modern regulators try to keep the voltage of the battery at a constant level by adjusting the amount of current fed to the battery. Homebrewing simple regulators is easy, inexpensive and a great way to learn basic electronics. It is not until current levels get high (over 20 Amps) and we demand high efficiency that homebrew becomes difficult.

Inverters are entirely another matter. An inverter basically switches low voltage DC, runs this pulsating DC (which is now alternating current) through a transformer to increase its voltage, and hopefully changes the incoming DC energy into near sinusoidal alternating current. In this sentence hides volumes of information and technology. Making an output 120 (or in your case maybe 240) vac waveform with acceptable peak and average (rms) voltages is difficult enough. If you want low harmonic distortion (hopefully less than 5% THD) and high (at least 85% or better) efficiency while powering a wide variety of loads (some nasty, like motors), then you have a very difficult design problem.

Considering the state of the art, you should buy rather than homebrew. Inverter design has become very advanced and refined over the last ten years. Commercial inverters now make sine wave electricity which is purer than that supplied by the utility grid (less than 5% Total Harmonic Distortion [THD]). Inverters

now have efficiencies in the 85% to 95% range, and efficiency is very important in RE systems. No inverter manufacturer I know of publishes their schematics. In fact, they closely guard their developments. And now microprocessors are being used in inverters to provide cleaner and more efficient power. Inverter design and manufacture has exceeded the ability of almost all homebrew ElectroTechies.

While regulators are relatively simple devices, inverters are very complex. Add to this complexity, handling substantial amounts of power (between 100 and 4000 watts), and you have a difficult to design and build electronic device. Consider the transformer in the inverter. Most inverter makers custom build their own transformers. While it is good to understand the basic electronics embodied in power inverters, it is far cheaper to buy one than build it. Richard Perez



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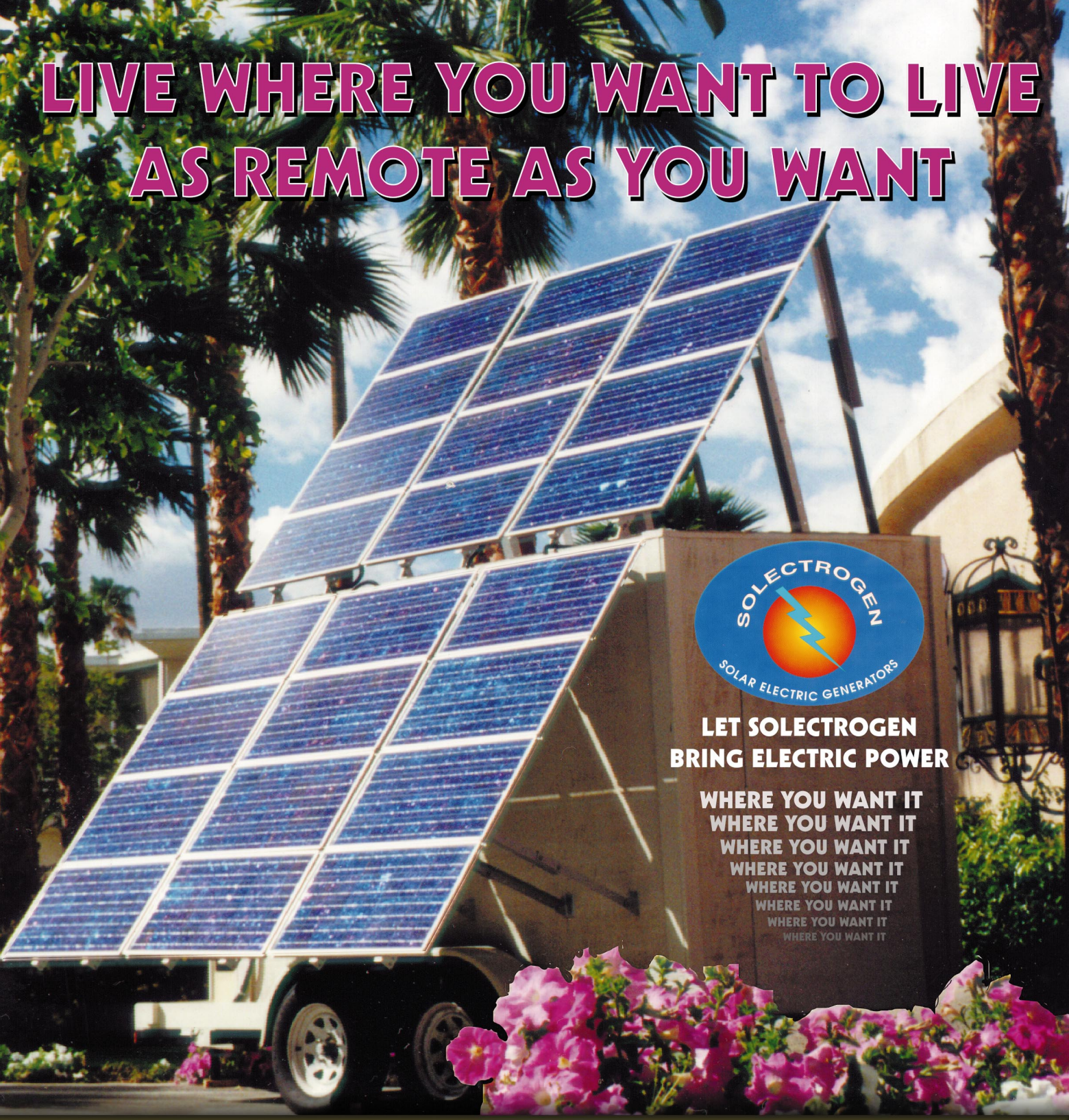

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