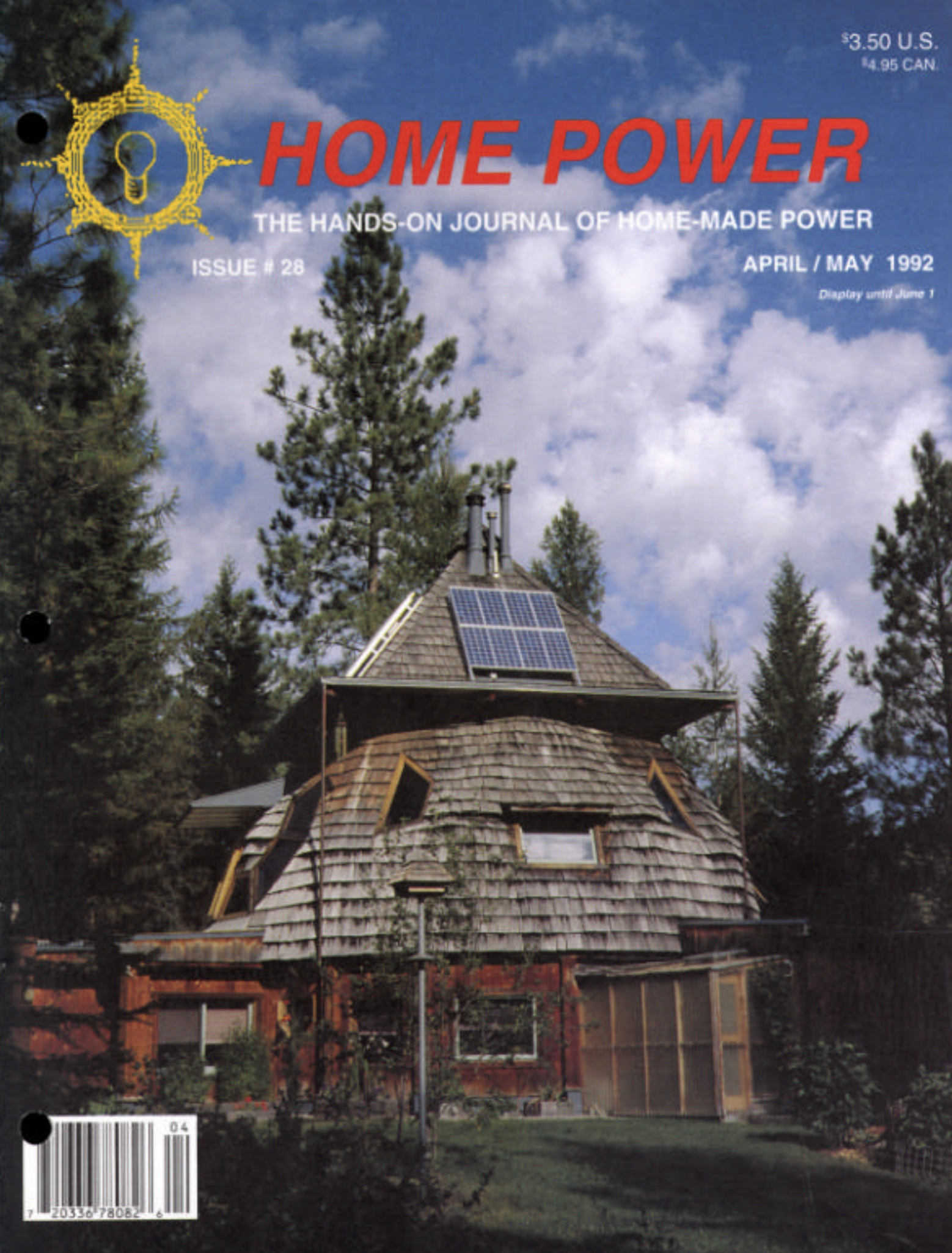
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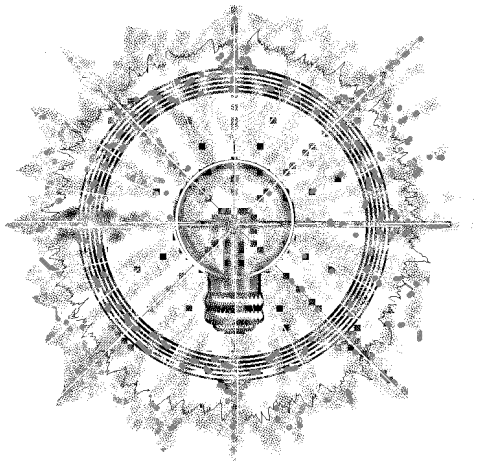


HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

Contents

Access

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

Think About It

"Whatever you do may seem insignificant but it is very important that you do it!"

Gandhi

Cover

Jorrie and Ken Ciotti's PV-powered geodesic home in Montana. Story on page 6.

Photo by Jorrie Ciotti.

From us to YOU

Spring

Every year it happens. Every year the coming of Spring amazes me. The cold, seemingly dead world around me comes alive with the improbability of new life. I stand in awe of Nature's ever renewable vitality.

This Spring is even more amazing. This Spring's greatest promise comes from the least attentive of Nature's children – humans. Home Power has been flooded with letters, telephone calls, computer disks, and FAXes. Seems like the power of Spring is awakening a Spark, the Spark that glows dimly in all of us, just waiting for the right moment to burst into flame.

The Spark is indeed as powerful as the Sun. This Spring, I have been talking to folks in America's electric power industry. All of a sudden, the long sob stories of renewable energy's immaturity and limitations are ending. Folks who were talking twenty years from now, are now talking next year, or even this year. It seems like America's power establishment has gotten a jolt from the Spark.

Recent developments (particularly in PVs from Texas Instruments and Southern California Edison), have interested people who previously spurned renewables. Big time companies are scrambling to be ready for an imminent revolution in power production.

Imagine my case of Spring Fever when corporate types start telling me about their Green Dream revelations! Five years ago corporate America couldn't spell photovoltaic, now they are beginning to see PVs as America's favorite form of roofing. Each roof a power producer, each roof contributing to a common energy pool shared by all. What is it about the Spark that gives birth to the Green Dream? How does this Spark appear new, unique and fresh for each of us? How does this Spark reach into the hearts of Nature's lost children and make us new again?

I doubt I will ever truly understand Nature's processes. I am content to take a big breath of fresh Spring air and smile. I urge you to do the same. And while you're smiling, take a look at the roof tops around you. They are ready to be sparked into Spring's renewal.

Richard Perez

The Night is mother of the Day,
The Winter of the Spring,
And ever upon old Decay
The greenest mosses cling.
John Greenleaf Whitter 1807-1892

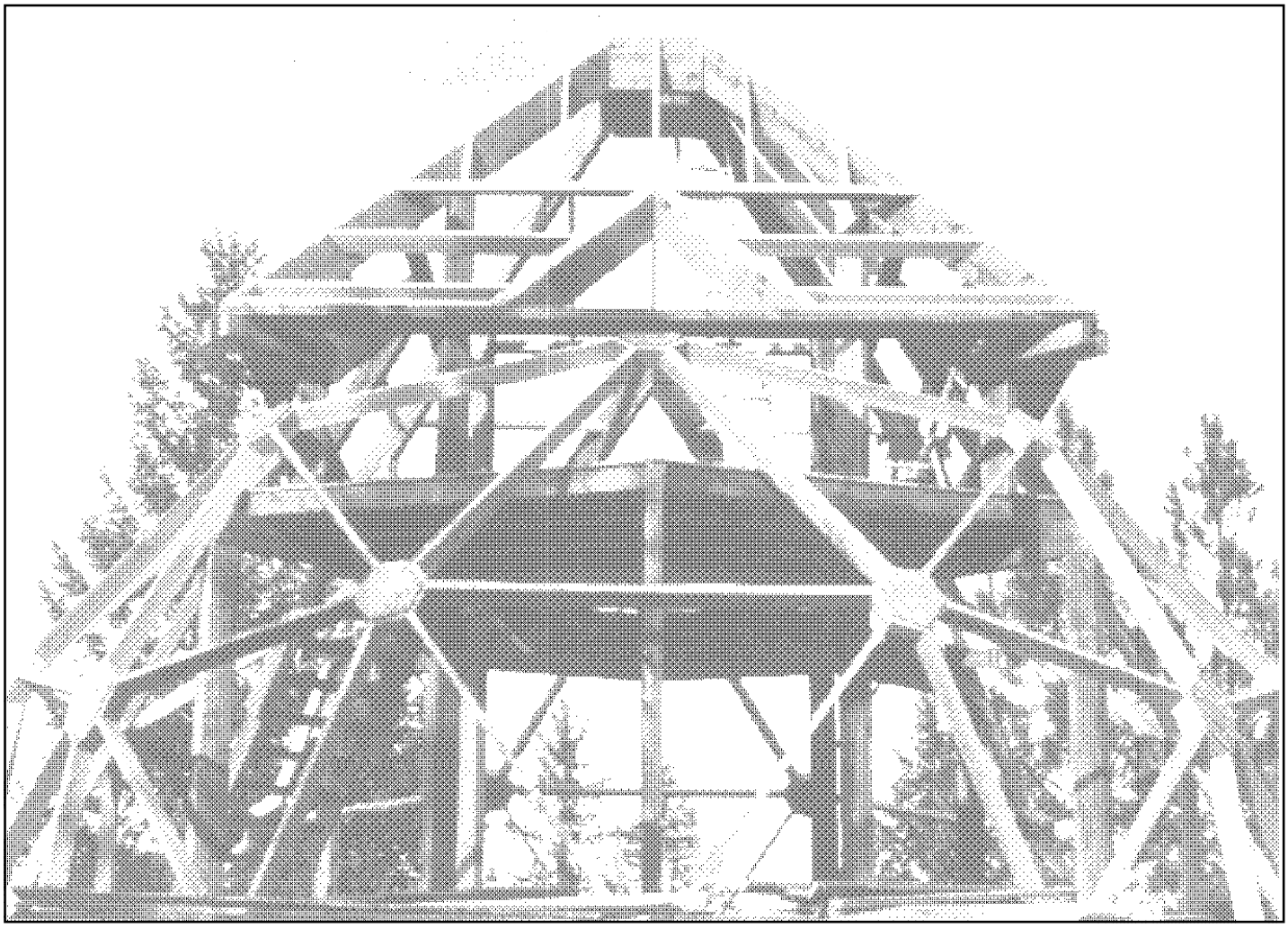
People

Barry Brown
Jorrie Ciotti
Ken Ciotti
Sam Coleman
Paul Cunningham
John Dailey
Chris Greacen
Kathleen Jarschke-Schultze
Kid's Corner Kids
Stan Krute
Tom Lane
Therese Peffer
Karen Perez
Richard Perez
Al Rutan
Mick Sagrillo
John Schaefer
Bob–O Schultze
Eleanor Frances Stranger
John Wiles
Paul Wilkins
Elizabeth Willey
Steve Willey

Printing

RAM Offset, White City, Oregon

Cover 50% recycled (40% pre-consumer, 10% post-consumer), low chlorine paper. Interior is recyclable, low chlorine paper. Soybean ink used throughout.



Above: The Ciotti Dome Home under construction. Photo by Jorrie Ciotti.

All Things Are Connected

Jorrie and Ken Ciotti

Living in harmony with nature is our prime directive. We help, save, and protect the critters Mother Nature has brought our way. In return, Mother Nature has provided us the privilege to live in her backyard in peace and harmony.

Location

We purchased our property in the summer of 1974. We found land with a spring, creek, meadow, rolling hills of forest, and pristine air. We began pioneering a home and carving it out of the wilderness in the Mill Creek Wilderness Area of the Flathead Indian Reservation, 15 miles west of Flathead Lake, 100 miles south of Glacier Park in Montana.

Preparation

Structures are an important part of our existence. We chose to marry the pyramid of the past with the dome of the future. Domes have the capability of naturally circulating the flow of air and are known for their structural integrity.

While renting a small house in the valley, we spent the winter reading, designing, and cutting the forms for the footings, walls, struts, and joists. When spring came, we had a D6 cat bulldoze the foundation. We poured 14

cubic yards of concrete for the footings and put up a four foot block wall. Within two months we started hauling our previously-cut struts and joists to the site and began assembling the structure like a tinker-toy set.

Generator Experience

For the first 15 years, we used generators when we needed ac electricity. Our first generator, a used 30 kilowatt (kw) gasoline generator, was purchased to power 3 homesteads. When the other two couples pulled out and went to warmer climates, we traded the generator for a wood cookstove and purchased a smaller used gasoline generator. But the used 3 kw Onan didn't last long. Hoping we'd have a trouble-free generator, we decided to purchase a new 4 kw propane Onan generator. It turned out to be a problem child. We finally purchased a new Honda EX5500 generator which has proven to be extremely dependable.

DC Beginnings

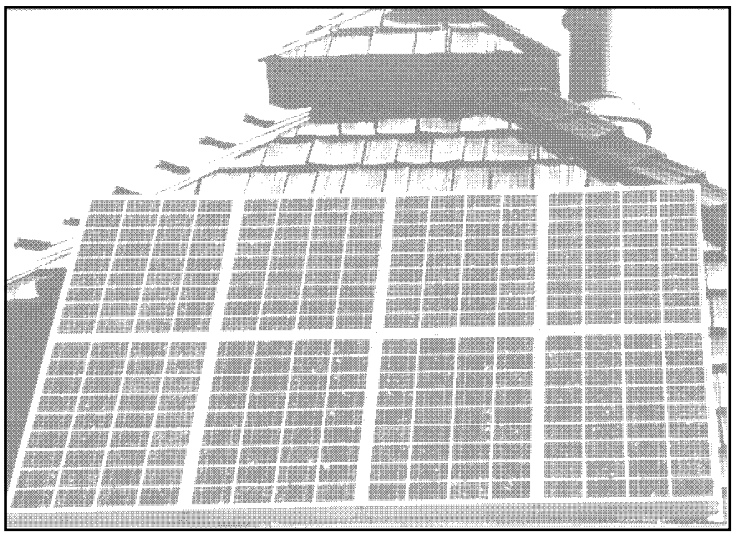
Our first attempt at inverter power to convert DC electricity to ac was a TripLite inverter. However, it was noisy, an energy hog, and easily burnt up. So we gave up on the inverter idea and installed a separate DC line. We started off using car batteries for storage. After a couple sets of car batteries, we were finally able to afford some deep cycle batteries. Our first set of Sears DieHard batteries died quickly. The next set were Trojan 105s which turned out to be a good lead acid battery. We used DC electricity to power a stereo and a DC fluorescent light so battery consumption was at a minimum. After 12 years, we bought a television (DC, of course).

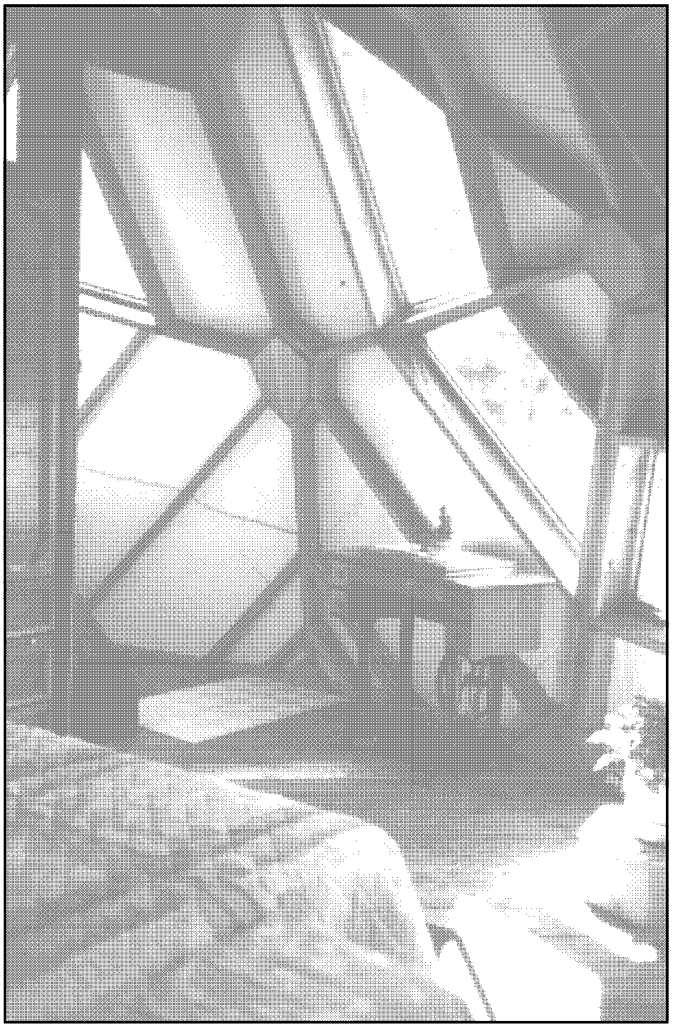
Going to the Sun

A few years ago, our next dome neighbor showed us a copy of Home Power. The content of the Home Power issue impressed us so much that we ordered all the back issues and decided to go to the Sun.

After studying Home Power issues #12, #13, #15, #16, and #17 on batteries, we decided on nickel-cadmium batteries (nicads) to power our business and home. We needed batteries that could withstand our freezing Montana winters. The long service life was also important (we had 15 years experience with replacing, cleaning, refilling, and checking lead acid batteries – yuk!).

Nicads can be more deeply discharged, without damage, than lead-acid batteries. Nicads don't need reserve capacity and aren't damaged by operation at low states of charge. Because the output voltage is nearly constant, the entire storage capacity can be utilized. These were very important considerations for us.





Above: eight of the sixteen photovoltaic modules mounted on the roof of the complete dome.
Left: the interior of the dome. Photos by Jorrie Ciotti.

However, finding the right nicads was difficult. We tried to get reconditioned batteries but ran into problems with availability, delivery, and size. We ended up getting a set of ten new Edison 160 batteries.

We installed four Kyocera photovoltaic (PV) modules to convert the sun's energy to DC electricity, and a Trace 2012 inverter to convert the DC into 110 volts ac. The Trace 2012 has the following options: battery charger, digital voltmeter, and the cooling fan.

With the Trace inverter, four PV panels, and ED-160 nicad batteries, we were able to start using solar instead of the generator. It sure was an exciting moment to turn on the Macintosh computer with sun power instead of generator power. What an awesome feeling of true independence that gave us! Best of all, it was quiet – no more exhaust, no more generator vibrations.

Power System

Our present electrical system (see power system diagram to the right) has sixteen Kyocera K51 solar panels (grounded for lightning protection) that can supply 816 peak Watts at 16.9 Volts DC (VDC). Eight panels are wired in parallel with 10/2 AWG (American Wire Gauge) wire. All terminals are soldered. Each eight-panel sub-array is connected within a junction box to 6/2 AWG wire which feeds an interior quick-disconnect. The positive and negative lines made from 2 AWG Radaflex welding cable are twisted around a bare copper conductor (6 AWG) and connect to a Heliotrope CC-60B controller which regulates the PV input when the batteries are full. The bare copper wire continues to an 8 foot copper grounding rod. The bare copper wire added strength to the wire bundle while snaking it through the 2 inch x 6 inch struts and is used as a system ground.

The lines (2 AWG) from the CC-60B controller go to the Photron DC Source Center. The positive line is fused and switched through a quick-disconnect. The DC Source Center allows us to connect several DC sources, such as hydro, PV, and a DC generator. It also allows us to completely cut off the electricity for servicing and emergencies. The fuses add a measure of safety to the system.

From the DC Source Center, the lines run to positive and negative busbars, which are large copper bars that carry current. The busbars are used for our multiple DC connections. For instance, a Perko battery selection switch on the positive busbar allows us to use a two battery bank system. This selection switch allows four choices: the first battery bank, the second battery bank, both battery banks, or off. Also attached to the positive busbar is a 400 Amp fuse which protects the Trace 2012 inverter from overcurrent; 4/0 wire was used from the busbar to the fuse and from the fuse to the inverter. From the Trace 2012 inverter to the standby Honda generator, the Trace T220 transformer, and the ITE Circuit Breaker is 8/3 wire.

The busbars made the multiple electrical connections safe and efficient. Using busbars made it convenient to connect the Emon Energy Monitor (a volt and amp-hour meter), and a 2/0 wire to the 8 foot copper grounding rod on the negative busbar. The busbars allow easy access to attach any other DC instrumentation. The terminals of the wires connected to the busbars are soldered.

Nickel cadmium batteries

We have a two battery bank system, consisting of ten Sunica 52-1 batteries and ten Edison 160 batteries. It's a small system but nicads are expensive. Unlike lead acid batteries, nicads can be added as time goes on. The Sunicas, made specifically for solar applications, need little maintenance – just add distilled water after 10 years. They have a service life of 20 years. The ED-160s need to have the electrolyte checked on a regular basis. The nickel cadmium batteries aren't damaged by freezing as lead acid batteries are, and they can withstand elevated operating temperatures. Lead acid batteries at low temperatures lose useful capacity.

The Sunicas come with 10 AWG wire and quick disconnects. We found that the 10 AWG wires were hot to the touch when running large motors and the small wire size caused difficulty in starting and/or running some large motors as the washer, dryer, radial arm saw, bench grinder, and water pump. By changing the 10 AWG wire to 2 AWG and soldering all the connectors, the problems were resolved. The wires were no longer hot to the touch and motors didn't have any trouble starting.

Trace T220 Transformer

Trace has a 220 option for their inverter to transform 110 volts ac to 220 volts ac. After installing the T220, we were able to run our 220 vac central vacuum, 1/2 hp submersible pump, and 10 inch table saw.

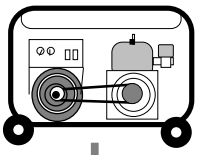
At first, the 220 vac 1/2 hp submersible pump wouldn't run. After referring to Home Power #17, page 25, we removed the 1/2 hp solid state starter and replaced it with a 3/4 hp relay starter in order to get it to work. The T220 works like a champ.

LineTamer

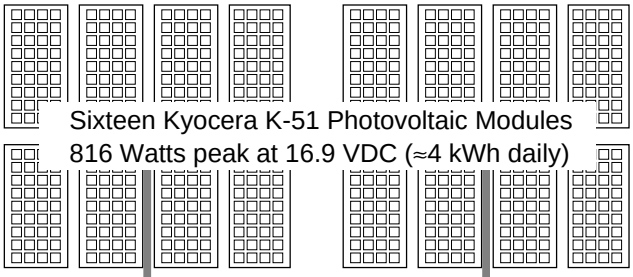
Until recently, the LaserWriter Plus printer was the only tool that needed a generator's power. It turned out to be torture to have to turn on the generator. Most inverters,

POWER SOURCES

- **Sunshine is converted directly into electricity by the photovoltaic modules**
- **Gasoline fires the engine generator**

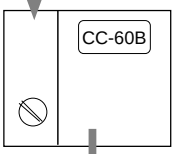


Honda EX5500
Engine / Generator



Sixteen Kyocera K-51 Photovoltaic Modules
816 Watts peak at 16.9 VDC (≈4 kWh daily)

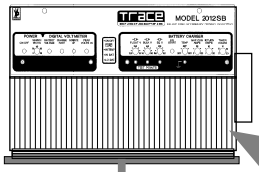
Junction Box



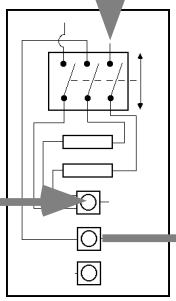
Heliotrope
CC-60B
PV Controller

POWER PROCESSING

- **PV control**
- **Overcurrent fuses and disconnects**
- **Generator supplied battery recharging**
- **Inverting battery-stored PV power into 120 / 240 vac.**

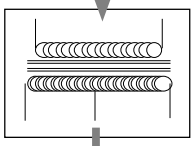


Trace 2012
Inverter / Charger



Photron
DC Source
Center
Disconnects
and Fuses

400 Ampere
Inverter Fuse

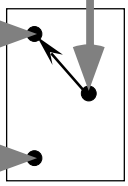


Trace T220
Transformer
120 / 240 vac

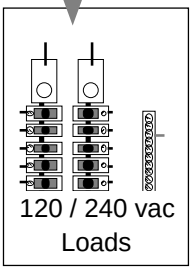
POWER STORAGE - 12 VDC BATTERIES

Ten Sunica Nicads
537 Ampere-hours

Ten Edison Nicads
160 Ampere-hours



Perko
Battery
Switch



120 / 240 vac
Loads

POWER USE

- **120 vac, 60 Hz. appliances**
- **240 vac, 60 Hz. appliances**
- **12 VDC appliances**

12 Volt DC
appliances
supplied by
the battery

like the Trace 2012, send out a modified or square sine wave. We read about a device called a Photron LineTamer that filters the modified sine wave inverter output into a sine wave. The Line Tamer's filtered output is very similar to the alternating current electricity that the generator and commercial utility supply. Most equipment will run with a modified sine wave. However, the LaserWriter Plus requires sine wave ac power. We connected the LaserWriter Plus to the LineTamer 1200, held our breath, turned it on, and are happy to report all works well. We are finally one with the Sun.

Security Systems
For security, we installed a DC vehicle announcer that can have other security systems and related equipment attached. The vehicle announcer is tied into an X10 security system that runs external sirens, door and window sensors, and surveillance cameras.

Tweeking the DC System
"Tweek" was applied to all 12 VDC connections in our system. Electrical conduction takes place where the molecules of the contact surfaces actually touch. However, the two parts of an electrical connector never fit together exactly and contact is made over only a small percentage of the total surface area. Although metal contact surfaces appear smooth, they are actually rough and irregular on a molecular level. "Tweek", a product normally used in audio, video, and computer connections is a contact enhancer. It's a unique long-chain organic polymer that fills in the microscopic pores and gaps between the mating metal surfaces, thereby increasing the area of conductivity. Note that you can't use "Tweek" on unplated copper contacts in very moist environments. "Tweek" is produced by Sumiko, Inc., POB 5046, Berkeley, CA 94750 • 510-843-4500.

Energy Eaters
A Fluke 87 multimeter with an 80i-410 DC/AC current probe was used to obtain the starting, running, and maximum amps consumed in the following equipment:

Jorrie and Ken's Big Power Consumers
all measurement in DC Amperes into the inverter

Equipment	Start Amps	Run Amps
Kenmore Washer (110 vac) Model 110.823880100	98	55
Kenmore Gas Dryer (110 vac) Model 110.875581110	265	66 / 27
HP VacuFlo (220 vac) Model 28	191	117
Craftsman 10 inch Radial Saw (110 vac) Model 113.23111	357	98
Jacuzzi 4 inch Submersible Pump (220 vac) Sandhandler	282	140

System Cost
The table below doesn't include cost of wire, two ITE/Siemens Circuit Breaker Panels, circuit breakers, grounding rods, and other incidentals.

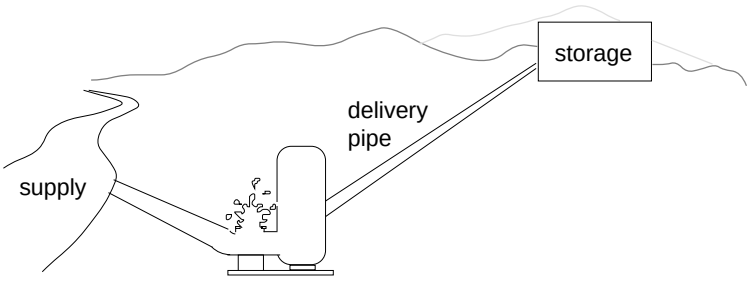
Jorrie and Ken's System Cost

Equipment	cost	%
10 Sunica 52-1 nicad batteries	$5,500	34.6%
16 Kyocera K51 solar panels	$5,280	33.2%
Trace 2012SB inverter / charger	$1,560	9.8%
10 Edison 160 nicad batteries	$1,440	9.1%
LineTamer (power filter)	$605	3.8%
Emon Energy Monitor	$339	2.1%
Photron DC Source Center	$299	1.9%
Trace T220 (120/240 transformer)	$250	1.6%
Heliotrope CC-60B PV controller	$246	1.5%
DC Load Center	$237	1.5%
Heliotrope Accu-Slope Meter	$119	0.7%
Perko Battery Switch	$29	0.2%
Total	$15,904	

The right to "Rife"
In 1975, we installed a Rife hydraulic ram to pump water. It has pumped a continuous flow of water day in and day out without one cent of operating cost. Rife hydraulic rams have been manufactured since 1884. They use no gasoline and no electricity – no power bill! The flow and fall of the water does the pumping. See the diagram on page 11. The ram pump needs to have a fall of water, or head, of 20 inches or more. For every foot of fall, it pumps 25 vertical feet. (For example, with a 4 foot fall, the ram pump moves a good volume of water 100 feet high.)

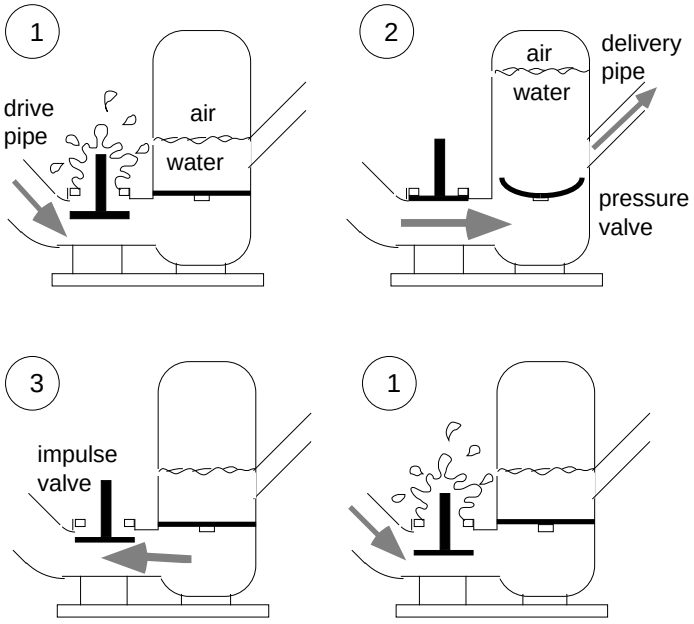
Our supply line is 600 feet of 4 inch PVC pipe which we hand-buried in the creek. This 600 feet of pipe feeds the supply tank. The supply tank is made from 2 inch x 4 inch cedar wood, and is 4 feet x 4 feet x 6 feet. The tank is lined with concrete and asphalt emulsion. Water falls eight feet down a 2 inch drive pipe to run the ram pump.

To understand how a ram pump works, consider the start of the cycle with the impulse valve open, and the pressure valve (a rubber diaphram) closed. Water falls down the drive pipe, gushing easily out of the impulse valve (1). When it reaches a certain velocity, water friction closes the



Above: A ram pump moves water by using the force of falling water.

Below: a step-by-step diagram of ram pump operation.
Diagrams by Chris Greacen



impulse valve. The water has substantial momentum at this point (it's called a water hammer), and no place to go except to force open the pressure valve. This forces water up the delivery pipe, and pressurizes the air in the chamber (2). As the water hammer decays and rebounds, or flows back the other way, the pressure valve is closed by the pressure from the delivery pipe. The impulse valve drops open (3), readying the ram pump for another cycle (1). This operation is repeated from 25 to 100 times per minute.

Clivus Multrum Composting Toilet

In 1976 we installed a Clivus Multrum ("inclined mulching room"). It's 9 foot 4 inches long and 3 feet wide. Because it is set on a 30˚ slant with a midsection, it's 8 foot 4 inches from top to bottom. At the upper end is a 16 inch vertical tube leading straight up to a toilet seat. A 6 inch tube vents water vapor and carbon dioxide to the outdoors, and a kitchen waste chamber receives organic garbage.

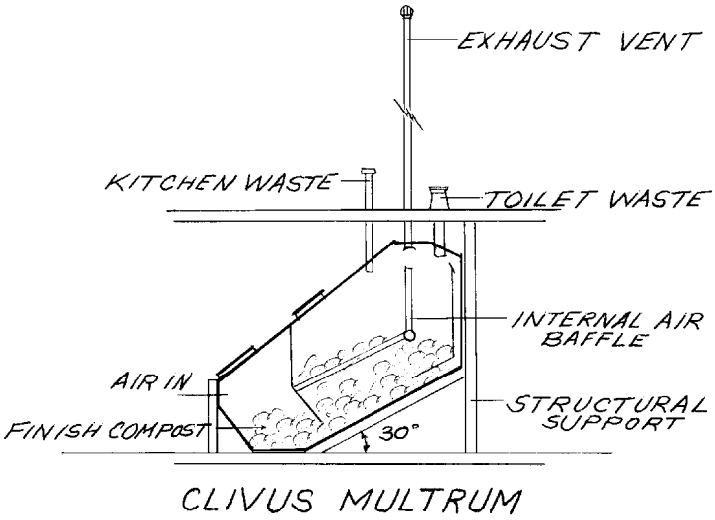
The toilet composting system uses no water which saves 10,000 gallons per person per year of water for an average household – a 40-50% reduction in water usage. No sewage is dumped into our water supply, so there is no water pollution. It seems that Thomas Crapper's invention of the flush toilet may join the gas-guzzling automobile as another of mankind's big technological mistakes!

Not only does it treat toilet wastes that are normally flushed into a sewer or septic system, but it also composts kitchen and other wastes. Anything organic, from grass clippings to laundry lint to paper towels used in the kitchen, becomes a rich fertile soil. The wastes slowly decompose in the oxygen-rich environment.

The principal by-products of decomposition, water vapor and carbon dioxide, are drawn through a 6 inch exhaust vent to the outside air. As the wastes decompose, their volume is reduced by more than 90%. The final product is fertile, organic compost – just like normal garden soil. It's safe to handle, odorless, and easily removed from the storage area for use in the garden.

Propane

We started off with two propane lights, a propane refrigerator and water heater. Within 15 years we increased our propane consumption to three refrigerators (Servel, Dometic, and Consul), a water heater, and a clothes dryer. The efficient electric SunFrost refrigerator and Copper Cricket solar hot water heater are planned for the future. We no longer use propane for lighting. We use eight Osram 120 vac compact fluorescent lights and other fluorescent lights.



Above: a diagram of the Clivus Multrum

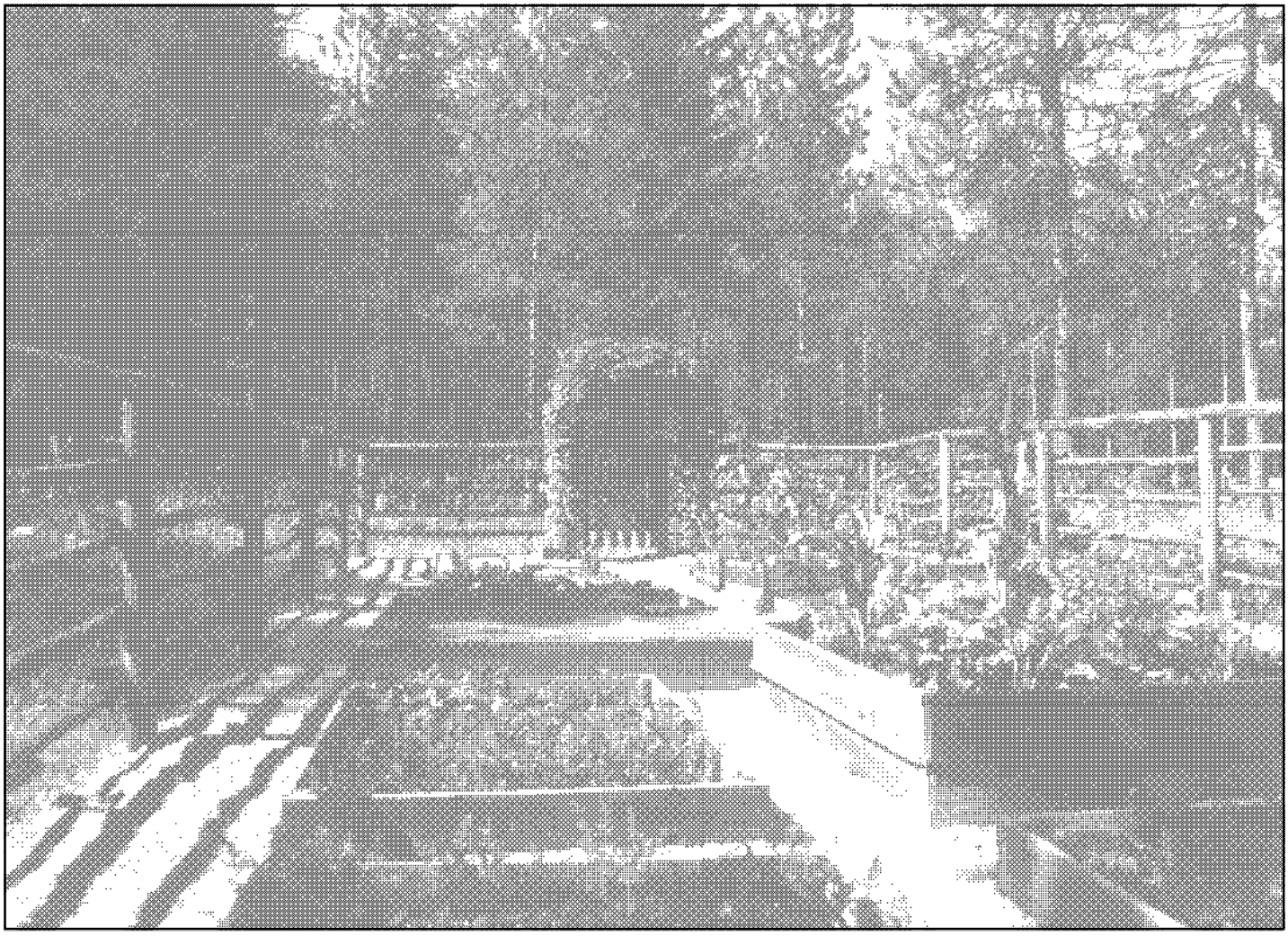
Hydronic Heating
Besides a catalytic wood stove in the base floor of the dome structure, we have a gravity-feed hydronic heating system. The hydronic heater, a Tyrolia wood-fired cookstove, is installed on the bottom floor of the 20 foot by 30 foot building. This Austrian air-tight cookstove has a built-in water jacket with 1 1/4 inch pipe connections. The oven is very accurate and has an insulated lid over the cooktop. We used 1 1/4 inch copper pipe for the heating loop and a 40 gallon storage tank. The circulating hot water heats a two-story 20 foot by 30 foot building and a 15 foot by 15 foot utility area. We prefer hydronic heating over the normal wood stove or fireplace because it heats evenly, effectively, and leaves humidity instead of static dryness in the air.

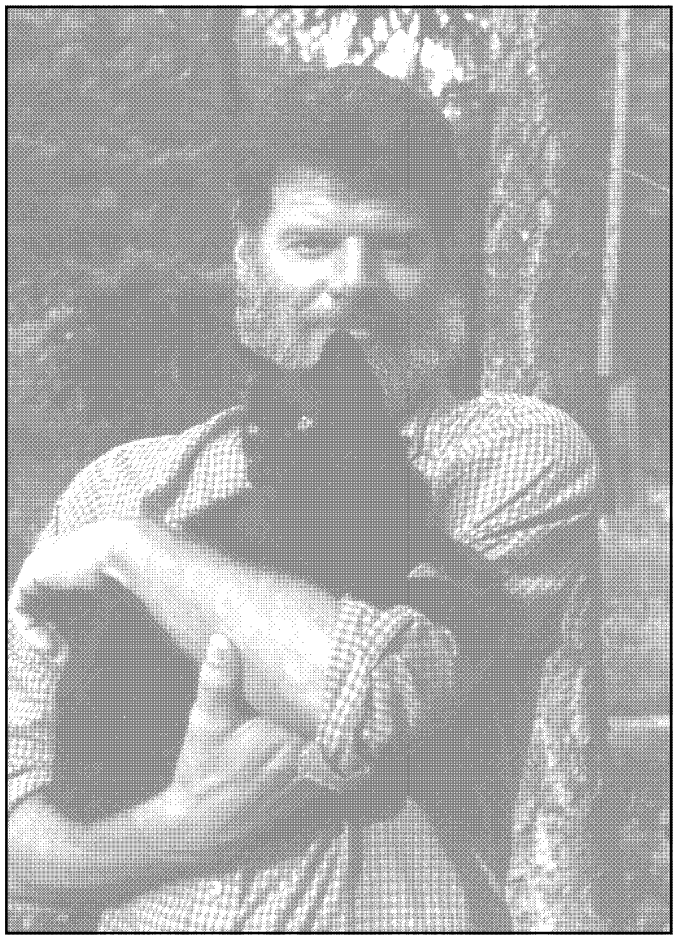
Sauna
The sauna is an icosahedron dome with a 14 foot diameter. Heated with a wood stove, it takes 15 minutes before the sauna is ready. Because domes have a natural ability for circulating heat, it makes an excellent hot and spacious sauna. It also doubles as an herb drying room during the summer.

Gardens
The water for the gardens is supplied with the ram pump. We installed a timer on the garden water supply so the water is automatically turned off to refill the 1,400 gallon storage tank.

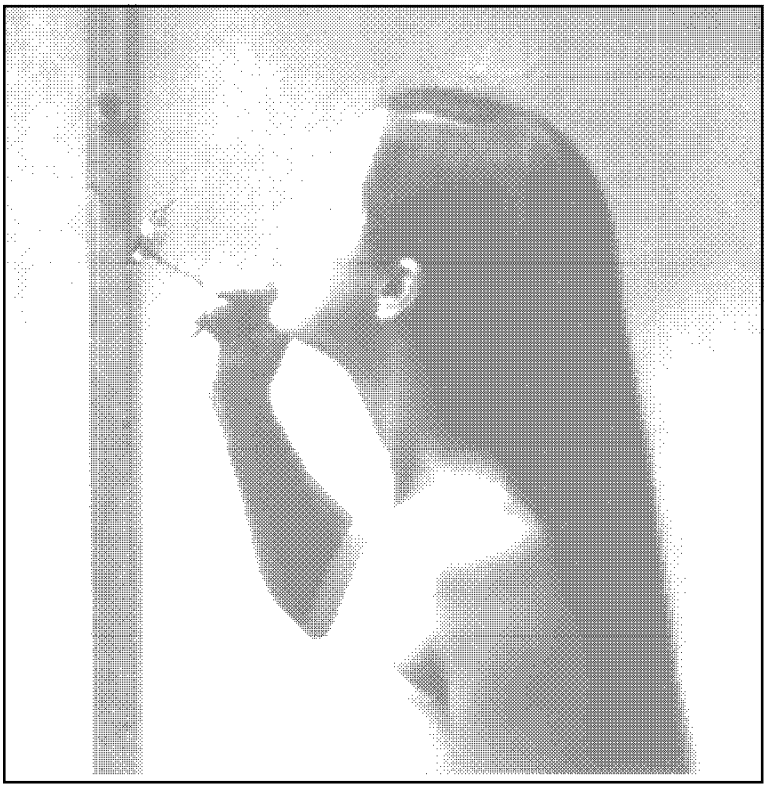
Our last spring frost is typically mid-May (sometimes June) and our first fall frost is mid-September which doesn't give a long growing season. We have extended our growing season by using 4 foot by 6 foot covered boxes. Each box has a removable fiberglass lid and acts like a mini-greenhouse. This system gives a 6 to 8 week head start, provides cover from hail or too much rain, and affords bug protection. Each box can have its own dripper system or the garden can be watered as a unit. The

Below: Jorrie and Ken's garden. Photo by Jorrie Ciotti.





Above Left: a black bear visits the garden. Above Right: Ken Ciotti and Raison the cat.
Below Right: Jorrie Ciotti visits with a hummingbird. Photos by Jorrie and Ken Ciotti.



This we know. The earth does not belong to man; man belongs to the earth. All things are connected like the blood which unites one family. All things are connected.

Whatever befalls the earth befalls the sons of the earth. Man did not weave the web of life, he is merely a strand in it. Whatever he does to the web, he does to himself.

Chief Seattle 1854

gardens were featured in Mother Earth News and in Flower and Garden magazines.

The Fur and Feathered

Our spot in the wilderness has enabled us to thoroughly enjoy our "Fur and Feathered" friends. We've had the opportunities of raising an abandoned hummingbird, saving a fawn from drowning, relocating a mama woodrat with her four blind babies, saving a flying squirrel, and watching the humorous black bears. We try to provide food, water, and shelter for the wildlife. After all, it's the least we can do since we've moved into their homestead.

Conclusion

Learning to live in harmony with nature, whether the wildlife or harnessing the power of the sun, gives us an incredible kinship with our planet. The journey is beautiful when we realize and practice Chief Seattle's words.

Access

Authors: Jorrie and Ken Ciotti, 3000 Mill Creek Rd, Niarada, MT 59852.

Above: Chris Greacen designed and built this portable system to power a Macintosh SE computer, hard drive, and printer. Here Chris is computing on the lawn of Reed College in Portland, Oregon. Photo by Andy Page

Getting Your Solar Feet Wet: the Hermit PV Power Box

Chris Greacen

The difference between no electricity and a little bit of electricity is huge. If your needs are small, do-it-yourself solar electricity becomes simple, inexpensive, and portable! The PV Hermit Power Box provides electricity for lights at night, a small stereo system or radio for communications, and/or a computer.

Building the Hermit PV Power Box

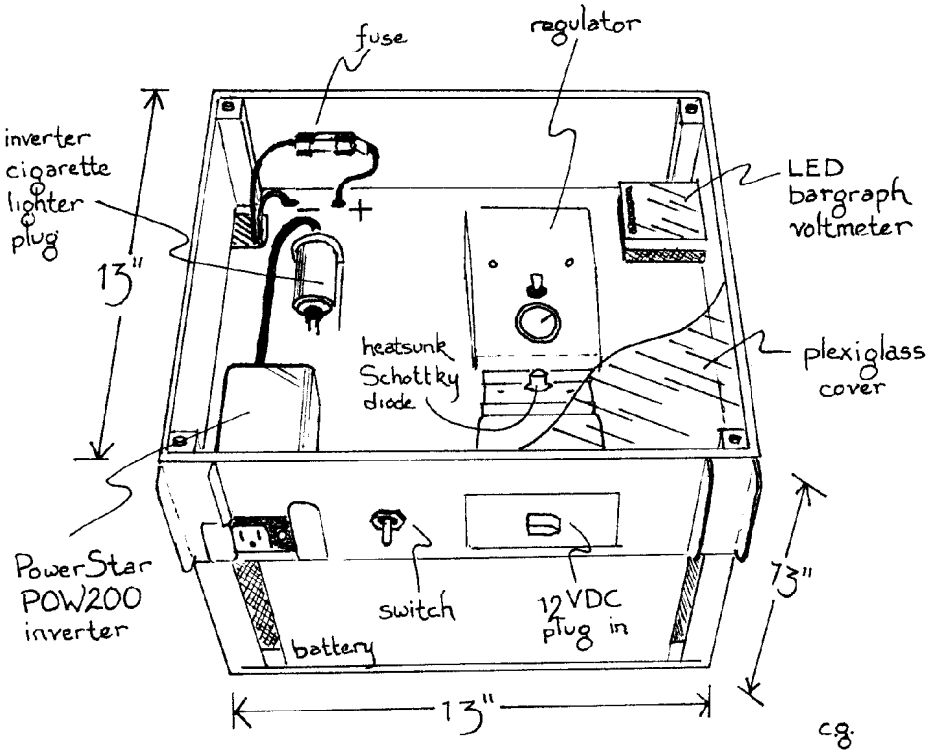
The system was not planned from the beginning. I found myself accumulating renewable energy components, and one summer afternoon realized I had all the parts and just needed to assemble them in a box. The heart of the system is a 48 Watt Kyocera J48 panel which charges a circa 1970 SAFT sintered-plate, nickel-cadmium 12 Volt 40 Ampere-hour battery. This battery was originally used to start the turbines on a DC 9 airplane. These cells won't leak if tipped at an angle, and they came securely packed in a stainless steel box. I got the battery from a battery recycler for a college project to turn my bicycle into an electric vehicle. The electric bike worked, but it was not a speed demon, nor very maneuverable. I drove it in a Fourth of July parade, and that was about it. These sintered-plate nicad battery packs are not readily available. If you can get ahold of one, count yourself lucky. Keeping safety and portability in mind, a reasonable alternative is sealed lead acid gel cells. If you use lead acid gel cells, use at least an 80 Ampere-hour pack to avoid excessive deep cycling.

A 25 Ampere short circuit PV regulator (see Homebrew in this issue) prevents the panel from overcharging the battery by short circuiting the panel when the voltage climbs above a threshold level (set at 15.0 Volts). A homemade bar graph voltmeter (Home Power #11, p. 26) shows the battery's state of charge. I fabricated the voltmeter as a summer project, three years previous, at Home Power headquarters, so I had it on hand when I started putting together the Hermit PV power box. If you're starting from scratch, I'd recommend buying a multimeter to monitor the voltage – you'll want to use one to put together a system like this.

A PowerStar™ POW200, 200 Watt inverter converts the 12 to 15 Volt DC current to 110 vac to run the computer or anything else I want to plug in. If I were to do the system over again, I would install a bigger inverter able to put out 700 watts or more. The usefulness of a tiny portable system like the Hermit PV Power Box increases if it can power intermittent big power users like Skil™ saws. All parts except the PV panel are contained in a cube 13 inches on a side and weighing 62.5 lbs. This makes the whole system portable, and suitable for demonstrations.

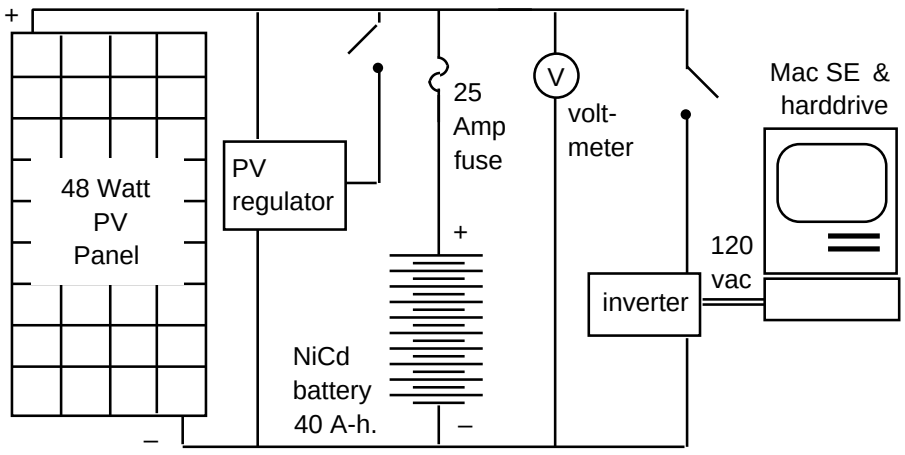
A Note about Regulators

Be careful that the voltage does not exceed 15 VDC while the inverter is operating. If you're careful to disconnect the panel when you're not using the system during several days of sunshine, then you can do without the regulator entirely. Everyone makes mistakes though – better to be safe than sorry. I learned this the hard way recently by accidentally leaving the regulator turned off and the inverter on and unloaded during a sunny day. The boys at PowerStar are serious when they say don't run the POW200 inverter at over 15 Volts!



Flying the Hermit Power Box

The Macintosh draws about 30 watts, and the hard drive about 10 watts. Under full sun the panel puts out about 50 Watts, so on a sunny day the computer can run indefinitely. When the computer is not running, the panel charges the battery for night time use. A fully charged battery powers the computer and hard drive for about six hours. When my college thesis was finished, I lent the Hermit PV box to a friend to power lights and a radio in his remote cabin. I found I had very few instructions to give him. In day to day operation, the system takes care of itself. The regulator prevents overcharging. When I'm using the computer during sequential cloudy days, I'm careful not to run it when the voltage drops below 11.5 Volts. At 10.5 Volts the inverter shuts itself off. Inverter shut off is no great loss if you're just using lights and a radio.



I opened up the battery and cleaned the tops of the cells with a damp rag after a year and a half of operation. The electrolyte contains potassium hydroxide which reacts with CO_2 in the air to form potassium carbonate, a non-corrosive white powder. I added distilled water to a couple of cells, but didn't really need to. Then I completely discharged the cells through a resistor, and charged them up again. A complete discharge reduces the memory effect for which sintered plate nickel cadmium cells are renowned. Now I look forward to years of more service.

Conclusion

Small systems like this are especially rewarding – they provide the little bit of very useful power for lights and communications at a remote site. With a bigger inverter, they provide for intermittent use of power tools. Small systems do this without power lines, and without the high cost and tons of batteries. They're portable, and the circuitry is simpler than that of large systems. The secret is keeping needs small from the beginning. If you eventually plan to build a larger home system, building one of these will get you comfortable working with batteries, low voltage wiring, and the balance of components. Make your mistakes on a small scale first. So if you haven't already... get yer feet wet now!

Access

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Above: Chile's Alternative Energy Fair in November of 1991attracted hundreds. Photo by John Schaefer

Alternative Energy in Chile

John Schaefer

Chile boasts amazing contrasts and variety. Its capital, Santiago, is comparable to any other international city, with wealth, sophistication, traffic, and smog. Here it is easy to forget that Chile is a developing nation and that much of its population is quite poor. The economic dualism – prosperous sectors coexisting with very poor, underdeveloped ones – is apparent when one compares Santiago's center with its poverty-stricken outskirts or with the rural communities in the north.

Chile is like a long and thin South American version of California. If Chile were in the northern hemisphere it would extend from Ketchikan in Alaska to Manzanillo in Mexico. Chile stretches higher, too; along the *cordillera* that forms the mountainous border with Argentina, Cerro Aconcagua reaches 22,800 feet. Many of the communities visited during the project were located on the *Altiplano* (high plateau) at elevations of 10,000 feet or more.

Energy Fair in Chile

Other similarities to California were apparent. Chile's solar energy fair last November looked like last summer's Solar Energy Expo & Rally (SEER) event in Willits, California. Its official name was the *Segunda Feria Internacional de Creatividad Popular, Tecnologias Alternativas y Medio Ambiente* – the Second International Fair for Popular Creativity, Alternative Technologies and the Environment. Exhibits included product displays with wind water pumps,

wind electric generators, and PV systems. Organizations gave classes on efficient wood burning ovens, composting toilets, organic gardening, solar cookers, and energy efficient buildings. Representatives were from Colombia, Uruguay, Bolivia, Paraguay, Brazil, and several African countries.

Not everyone in Chile is as enthusiastic or informed about these technologies as were attendees at the Feria. Attendees were mostly urban, sophisticated and well-educated, and none that I saw appeared to be *campesinos* from the countryside.

Economic Background

Besides sunshine, Chile's desert regions contain minerals. The mineral exports have fueled economic growth that is the envy of most other South American countries. First silver, then gold, nitrates, and – most recently – copper provide needed foreign exchange.

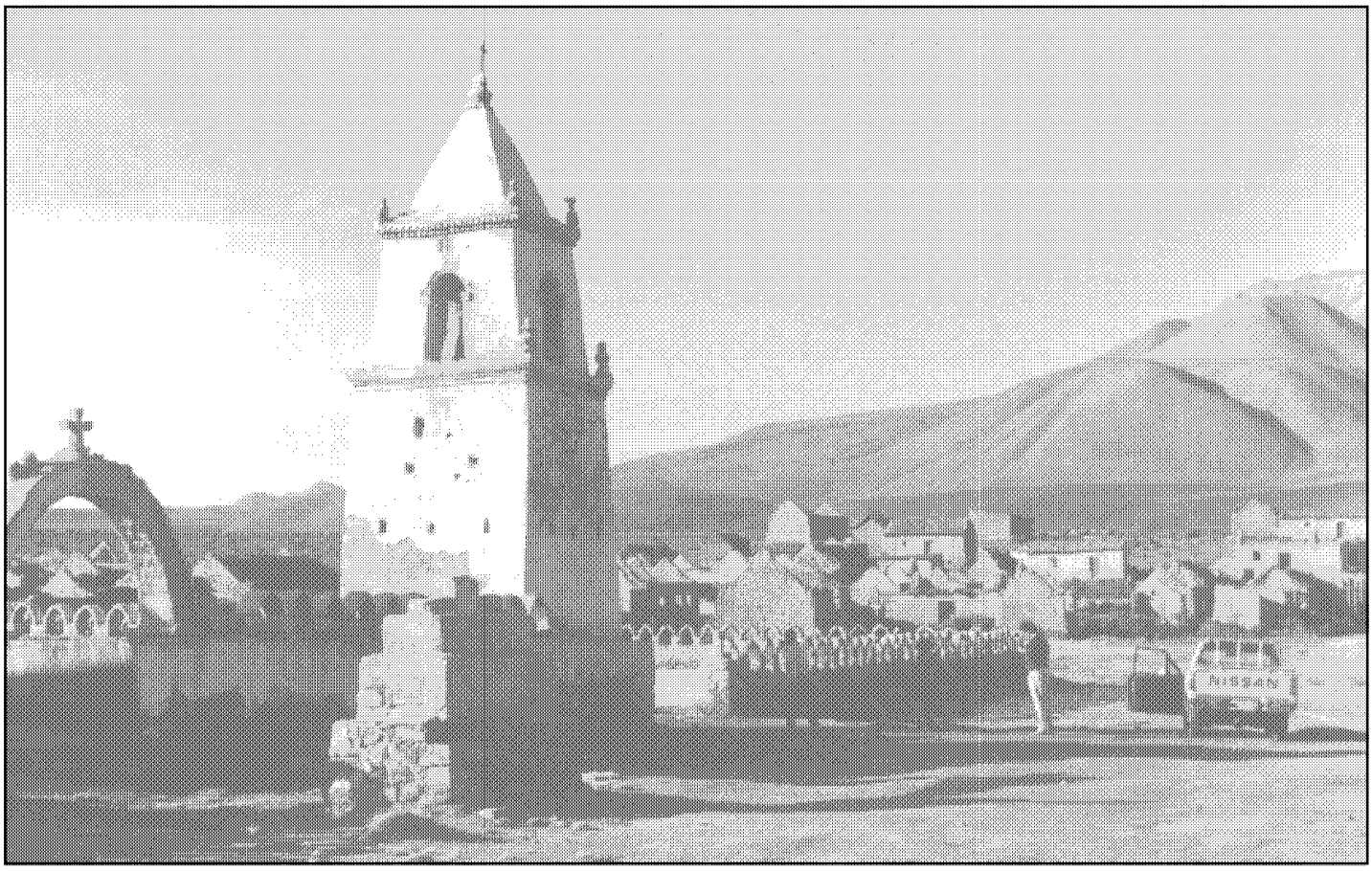
Agriculture has also provided substantial economic growth in recent years. Historically, settlements were made only along the river valleys that carry melted snow from the *cordillera* to the sea. Irrigated agriculture here is as old as human habitation, but its productivity has recently declined. Communities whose history spans a thousand years and several imperial civilizations can no longer survive. Coastal cities like Antofagasta and industries such as the copper refineries have taken water from the rivers and piped it away. This makes economic sense at a national level, but it does come at a social cost.

Without work in their home towns, many young people migrate to the cities. Unfortunately the cities offer few jobs, but as in much of the developing world, people would rather be unemployed in the cities than in the countryside. Government agencies, private groups, and universities have grown increasingly concerned about both the urban problems and the loss of indigenous, traditional communities. Some once prosperous communities in the *Altiplano* are now totally deserted, as well as desertic.

How Can Renewable Energy Help?

We investigated the potential of several options: photovoltaics for electrical needs like communications and lighting and for pumping, solar cookers, solar distillers, hydroelectric power, and wind power for electricity and water pumping. We found successes and

Below: Everyone has left the town of Isluga for lack of work. Photo by John Schaefer



failures which can be attributed to economic, cultural, and physical factors.

Photovoltaics
Almost all photovoltaic installations appeared to be operating well. The Chilean Telephone Company uses PV systems remote from the national grid and in towns where diesel generators provide several hours of power each night. The telephone service throughout Chile was excellent.

We did find one PV module with several burned cells; that particular module must have suffered improper installation or serious abuse. Otherwise, PV has the same high reliability in Chile that it has everywhere else. PVs are as expensive in Chile as everywhere else. Only government agencies or companies with money and a need for small quantities of electricity can afford PV.

Small farmers or even small communities would spend that kind of money on something else if they had it. They are not likely to use PV even for lighting, let alone irrigation pumping. Part of the reason is that their cost for fossil-based energy is too low. The government supplies diesel generators for most small communities and subsidizes the fuel. Each family pays about three dollars a month for electric service regardless of how much electricity they use. As a result there is no incentive in these communities either for an investment in a PV lighting system or for conserving electricity.

Wind generators
Wind generators for charging batteries have evidently had a mixed history in northern Chile. We saw several that were out of service and whose owners' lack of understanding made me wonder if the generators ever ran. Wind generators require more understanding and maintenance than most of them apparently got, so they failed. On the other hand, some have performed quite well. We saw a Wincharger installed on a water pipeline station to a copper refinery (used for communications, not for pumping) that might have run for fifty years before being replaced by a PV system.

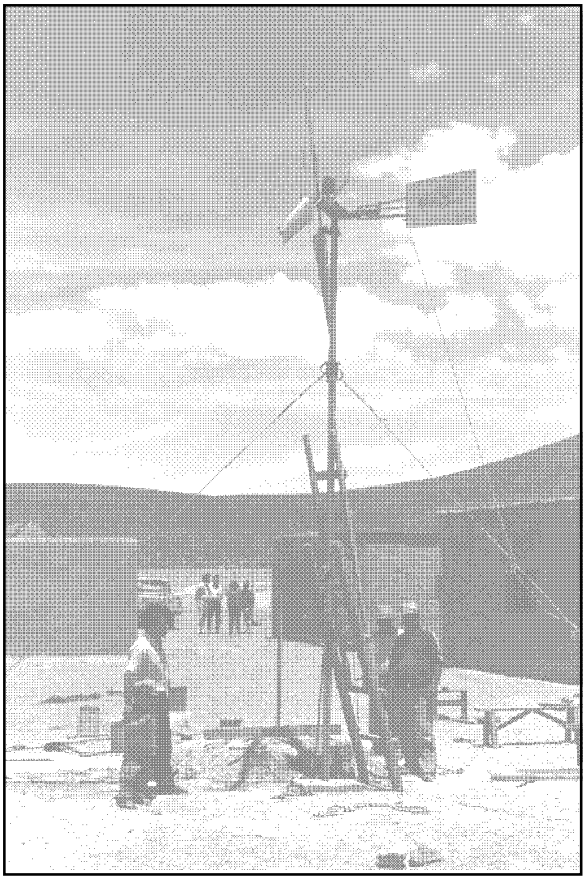
Wind-powered water pumps
The desert conditions make water pumps favorable. The further downstream one looks in the Loa River, the less water and the more salt, arsenic, and boron there is. People drink the water even though they know it contains too much arsenic to be safe. By the time the river reaches the last town along its route, Quillagua, what little water is left is too salty and mineral-laden for anyone to drink. They do irrigate alfalfa with it. For drinking, Quillagua imports water by truck at a substantial cost.

Although its water is the worst, Quillagua's story is repeated in many small northern towns. Several such towns had installed wind-powered water pumps and found that they didn't provide enough water or that they failed in high winds and couldn't be repaired. One owner complained he couldn't find parts. In a few cases well-meaning priests or church groups had supplied the pumps. Gifts given by distant donors to communities without proper groundwork and followup don't seem to last long.

Success Stories
Only a few examples of operating wind-powered water pumps could be found in the north of Chile. These few, however, illustrate some important lessons about conditions where wind-powered water pumps do operate successfully.

One requirement for success is community interest; Ancovinto has it, along with a number of other communities. We arrived just as Ancovinto residents were reinstalling a wind water pump in the town square. Originally it had been located outside of town for irrigation, but it didn't produce enough water to raise crops. The residents hoped it would pump enough for domestic use in town.

Near Toconao was a single wind-powered pump that was used for irrigation. Its owner, who also made crafts for sale, told us that he had built it



Above: Residents of Ancovinto install their new wind-powered water pump in the town plaza.
Photo by John Schaefer

Above: a successful water pump design in Punitaqui. Photo by John Schaefer

three years ago and that it ran with no trouble at all. Obviously mechanical aptitude helps too.

In the vicinity of Punitaqui, we counted hundreds of homemade, wind-powered water pumps like the one near Toconao. The design was brought to Chile by the Jesuits around 1900. The farmers have constructed them from locally available wooden poles and mechanical parts. The owner of the shop where the fan, shaft and crank were made told us that he had build hundreds of sets, as had his father before him. He charges about $300 U.S. for a set.

The design is remarkably robust – many are still running long after being abandoned. These pumps require hardly any maintenance at all, which may be the key to the design's success. The rotor is driven by a multibladed fan with 3 or 4 meter wood or steel blades. Shaft bearings are blocks of wood and the pump operates with suction and a flap valve below the water level.

The design is inefficient – it turns very slowly and does not capture much of the wind's energy. That may be an advantage, however. One university researcher's improvement was so much more efficient than the Jesuits' design that its bearings caught fire and burned the whole thing down. The major disadvantage to the design is its inability to yaw into the wind; it faces only one direction. It would not be effective in a location where the wind came from all directions.

Why aren't these robust, easily constructed turbines found all over the Chilean desert? I asked a gentleman in Trapiche, north of La Serena, who was building his third pump, why there weren't more crops planted in the area where his two pumps were running. He replied that people in Trapiche were miners and had no interest in farming. He was doing it basically for fun.

The fortuitous combination of mechanical ability, a workable design from the Jesuits, a need for water in agriculture, and the decline in mining employment enabled this design to take hold in Punitaqui. In the last century, one of Punitaqui's major activities was mining; it is not now, as they ran out of silver. Miners in Chile are evidently more mechanically oriented than farmers are, and they understand about pumping water out of holes in the ground.

The epilogue to this Punitaqui success story is that in the last twenty years the government constructed a huge dam not far away, providing water to the valley. Some valley residents now say they keep the wind pumps for nostalgia only. The dam was quite expensive. One Colombian advocate of small wind turbines observes that it would have been cheaper for Chile to use wind pumps instead of building the dam and its associated canals.

Precious Water

Chile has historically used flood irrigation, widely recognized as wasteful. More recently the producers of export grapes have used drip systems. Drip systems require capital investment and careful maintenance, both of which are unfamiliar to traditional farmers. University-based agronomists urge farmers to use drip systems as well as to try different crops. The traditional farmers tend to resist anything new until they are convinced that it will work.

Financing for investments to make agriculture more productive is available from the Chilean government. This financing has been used for export agriculture, but with the proper economic analysis it could be used for smaller projects too.

Hydro

We observed a number of unused hydroelectric sites. Two abandoned sites were relatively close to Quillagua, which now runs a diesel generator several hours every evening. The one closer to town, built seventy years ago for now defunct mining projects, would easily supply all of Quillagua's needs. But its owner wants more money to sell it than the town can afford, so Quillagua continues to burn subsidized diesel fuel.

Another potential hydro site is right in Toconao; a hydro site at the

existing dam there would probably supply all of the town's needs. Apparently it was easier to install a diesel set than to put in a hydro system – Toconao continues to burn subsidized diesel fuel too.

Solar Distillers and Solar Cookers

Solar distillers would obviously be useful in Chile's desert, where the little surface water available is of such poor quality. This idea is not new one, as the world's first solar distiller was reportedly constructed a hundred years ago an hour south of Quillagua, at the intersection of the Panamerican Highway and the Tropic of Capricorn. All that remains are tiny pieces of glass. Calculations done by several universities suggest that although water from solar distillers is expensive, it is cheaper than trucking the water to Quillagua. The calculation is valid only if the investment capital can be found and the distiller can be maintained.

There are few trees for fuel in Chile's deserts. Several solar cooker models were exhibited at the Feria, and there is a successful demonstration project, sponsored by the Nutrition and Food Technology Institute, in Villaseca. Researchers at the University of La Serena report the greatest success with parabolic reflector cookers, even though users have to align them more often than box cookers.

Factors for successful projects

Site survey of the resources (wind speeds, insolation, and hydroelectric potential) and specification of the equipment to harness the resources must be done before anything is installed. In the case of water pumping, wind speed data must be developed to assure that the system will pump enough water to justify the investment. In Chile's indigenous communities, this engineering analysis is expensive. There is no wealth in those small communities to pay for it. Some outside help is necessary, and help from Chilean and foreign sources is available.

Outside help in the form of gifts sometimes does more harm than good, unless it includes all of the appropriate technical and community assistance. Simple gifts of wind powered water pumps without the accompanying technical help will almost surely fail in the future as they have in the past. Projects are more successful if the initial impetus comes from within the community itself. What outside agencies can offer is technical and engineering help to communities that request it.

Any program in technology transfer for traditional communities must be long term in nature. The project starts when a community is informed about the technical assistance they can obtain. After a year or two they request help and the technical assistance program measures wind speeds for a year or more. At that point the program determines which wind pumps can provide adequate water and, in conjunction with agronomists, which crops and irrigation system make economic sense. All of this is done in cooperation with the community. Then the community has to decide to make a commitment to invest in the project. Only after financing is obtained can the wind pump be installed and the new crops planted.

The water and electricity provided must be rationed somehow. Water usage may have to be measured everywhere it is used in the desert, and users should somehow be obliged to use it efficiently. The same is true of electricity. Nobody likes to pay for something that was once free, but the alternative to charging is that there won't be enough to go around – which is the case now. This is not easy, but history suggests no other choice. Most of the Chileans I talked with want to move ahead. Perhaps there's something we can learn from such enthusiasm.

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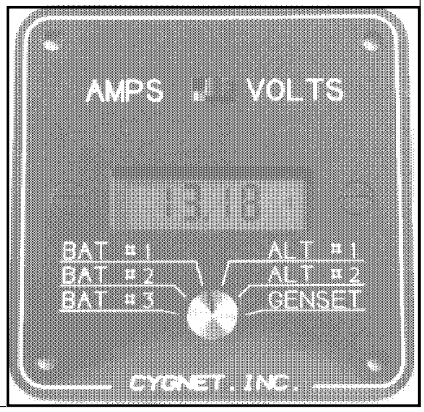


Backwoods Solar Electric
Camera-ready

Pole / Pipe Wind Turbine Tower

John Dailey

Having purchased a Windseeker II wind electric turbine, we faced the daunting prospect of erecting a tower. The tower has to be at least 15 feet above surrounding obstacles. In our case this worked out to be 50 feet above the ground. Here are plans for a tower that is inexpensive, easy to build, and can be raised and lowered by a single person.

Our Homestead

Our homestead is located on the north side of the Alaska Range where the gusty and powerful Chinook winds are common. Any tower we built had to be rugged enough to withstand these high winds.

The Tower and Tools and Safety

This tower will support small to medium sized wind turbines. The tower consists of a 20 foot guyed utility pole with a three inch sleeve pipe U-bolted to the top. A smaller diameter pipe, with the wind turbine mounted on top, is winched up through this sleeve. The tower "telescopes" from full operating height to the partially-lowered maintenance position.

You will need some common shop tools, including a good 1/2 inch drill, and a stout 24 foot extension ladder. Please wear a hard-hat and keep your wits about you while you work on the tower. Keep curious kids and loyal pets away. Always have an escape route planned, just as if you were felling trees; the forces and dangers are similar.

Utility Pole Installation

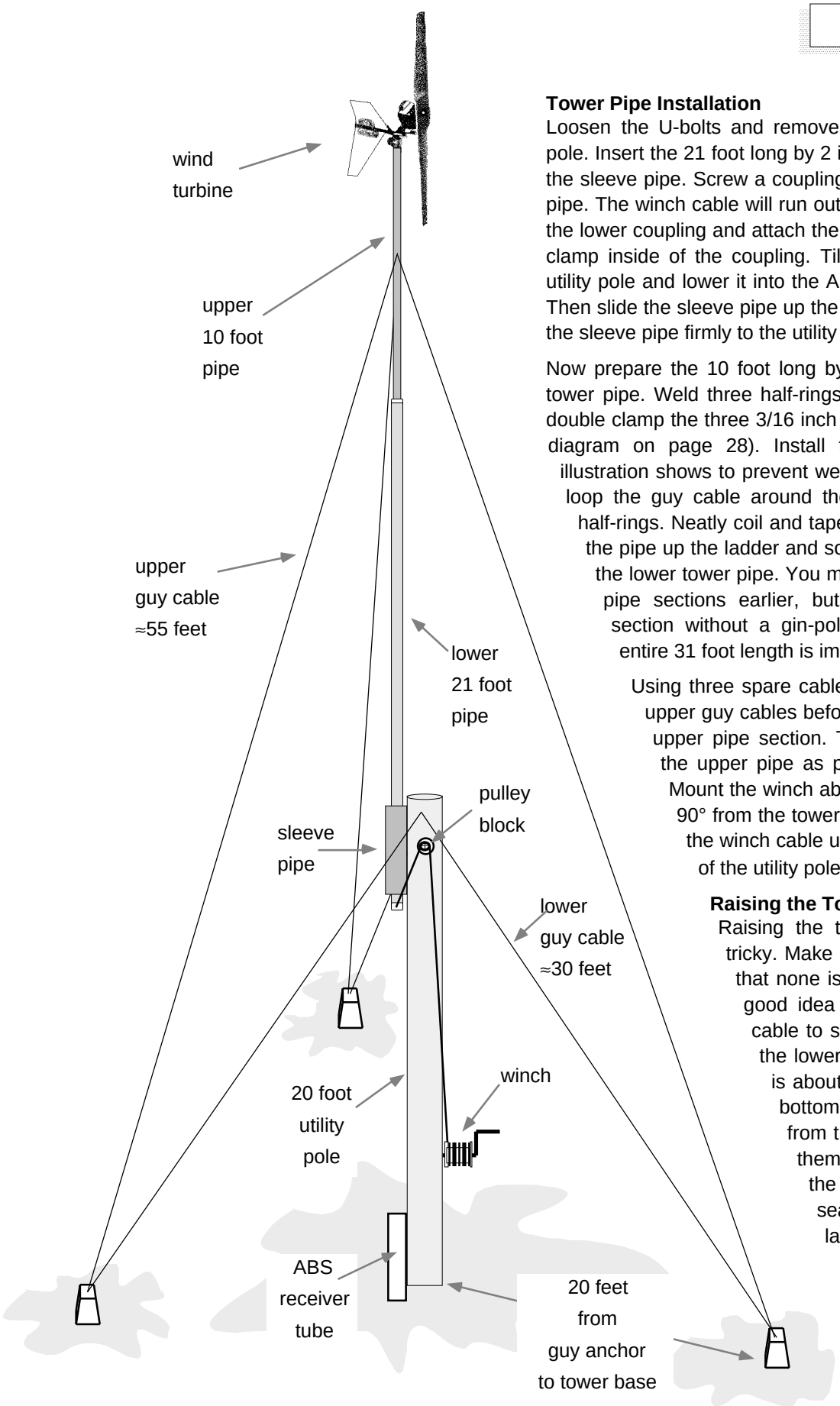
First, stake out the position of your tower and its three guy anchors. The anchors must be carefully placed at 120° intervals. The anchor locations must be at least 20 horizontal feet from the tower's base. If your site is not level, then make sure to place the guy anchor's ground position farther from the tower's base (if downhill) or closer (if uphill) to keep the guy wire at the same angle to the tower.

In our case, earth augers are used to secure the guy wires to the ground. These earth augers have been used for decades by the phone companies to guy their poles. Screw the three augers securing the guys to the ground first, before you locate the utility pole. This allows for change in case you hit a big rock with one or more of the earth augers. Make sure you screw all the augers in deeply and securely. You don't want them pulling out; the success or failure of a tower is a digital event! If your soil is loose, or hardened bedrock, then earth augers are not appropriate and you must use concrete pads for the guy anchors. Be sure to use enough concrete, each pad will take at least 1/4 of a cubic yard of concrete.

Excavate 16 inches deep for a concrete pad to support the utility pole. Don't skip the pad unless you have very firm substrata; vibration from the wind turbine will eventually break down even hard-packed soil. If the tower's base sinks, then the guy wires will become slack and ineffective.

Dig a deeper hole next to the utility pole's base to set in a three foot section of three inch diameter ABS pipe. This ABS pipe will socket the tower's metal pipe when it lowered. Locate the ABS pipe next to the utility pole and radially midway between two of the guys. Bury the ABS pipe so its top is a few inches above grade. Pour a concrete pad at least 4 inches thick and throw in plenty of steel rebar. The downward force is considerable when the wind is blowing hard.

Lay the utility pole out with its bottom near the concrete pad holding the ABS pipe. Drill holes and temporarily U-bolt the 3 foot long by 2 1/2 inch diameter sleeve pipe to the top of the utility pole. Mount the pulley block next to the sleeve and about two feet from the top of the utility pole. The pulley block should be bolted through the utility pole. Use heavy bolts and washers, don't use lag screws. Install the special eye-bolts, used to attach the guy wires to the utility pole, about four inches from the top of the utility pole. Tilt the pole up, and rotate it so that the sleeve pipe is directly above the ABS receiving tube. Tamp dirt around the utility pole's base to hold the pole approximately vertical. Clamp the 3/8 inch guy cables into the anchors and tighten the nuts on the angle eye-bolts to tension the guy cables and plumb the pole.



Tower Pipe Installation

Loosen the U-bolts and remove the sleeve pipe from the utility pole. Insert the 21 foot long by 2 inch diameter lower tower pipe in the sleeve pipe. Screw a coupling on each end of the lower tower pipe. The winch cable will run outside the tower pipe. Drill through the lower coupling and attach the 30 foot winch cable with a cable clamp inside of the coupling. Tilt the tower pipe up against the utility pole and lower it into the ABS receiving tube in the ground. Then slide the sleeve pipe up the tower pipe to the U-bolts. Clamp the sleeve pipe firmly to the utility pole with the U-bolts.

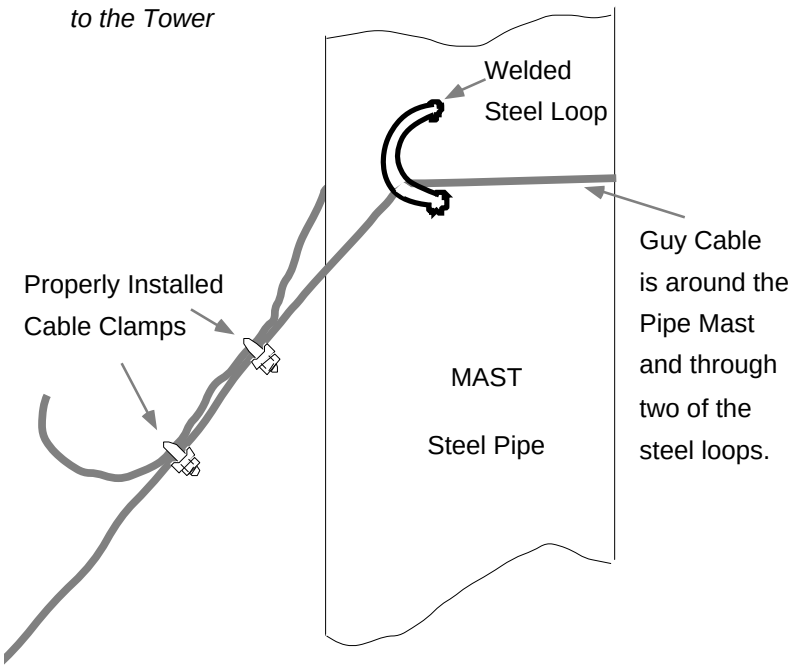
Now prepare the 10 foot long by 2 inch diameter top section of tower pipe. Weld three half-rings 5 feet from the pipe's top, and double clamp the three 3/16 inch guy-cables to the half rings (see diagram on page 28). Install the cable clamps only as the illustration shows to prevent weakening the cable. Make sure to loop the guy cable around the pipe, and through two of the half-rings. Neatly coil and tape the guy wires to the pipe. Take the pipe up the ladder and screw it into the coupling on top of the lower tower pipe. You might think it easier to join the two pipe sections earlier, but tilting up the shorter 21 foot section without a gin-pole is difficult enough; lifting the entire 31 foot length is impossible.

Using three spare cable clamps, temporarily tighten the upper guy cables before leaning the ladder against the upper pipe section. Then install the wind turbine on the upper pipe as per its manufacturer's directions. Mount the winch about chest-high on the utility pole, 90° from the tower-pipe/receiving tube axis. Thread the winch cable up through the pulley block on top of the utility pole, and down to the winch.

Raising the Tower

Raising the tower for the first time can be tricky. Make sure that there is NO WIND and that none is even remotely expected. It is a good idea to have a helper on each guy cable to steady things as they rise. Winch the lower pipe up until the lower coupling is about 2 inches from the sleeve pipe's bottom. Then gently remove the slack from the guy cables and double clamp them. Now raise the tower pipe all the way up until the bottom coupling seats against the sleeve pipe. This last raise should tension the cables fairly tightly. You may have to readjust the cables so that the tower pipe is exactly vertical. Don't over tighten the guys; a few

Attaching the Guy Wires to the Tower



Above: the correct method of attaching the clamps to the guy cables. Note that the U-bolt side of the clamp is placed over the unused, free end of the guy cable.

Parts List for the Hybrid Pole/Pipe Tower

Quan.	Item
2+	sacks of ready-mix concrete
1	rebar 5/8 inch by 8 feet
1	treated utility pole, 20 feet long
3	earth augers (guy wire anchors), 4 feet long
1	roll aluminum utility pole guy cable, 3/8 in. by 100 feet
6	cable clamps for 3/8 inch guy cables
3	galvanized angle eye bolts
1	schedule 40 galvanized steel pipe, 2 inch by 21 feet
1	schedule 40 galvanized steel pipe, 2 inch by 10 feet
1	schedule 40 galvanized steel pipe, 2.5 inch by 3 feet
2	galvanized couplings for 2 inch pipe
1	ABS sewer pipe, 3 inch by 3 foot
1	roll 3/16 inch galvanized aircraft cable, 250 feet long
16	cable clamps for 3/16 inch cable
1	small boat winch with mounting lag screws
1	pulley block and bolt, 1,000 pound test
2	custom U-bolts, washers and nuts for 2.5 inch pipe

inches of lateral tower movement under high wind is OK. The three earth augers securing the guy wires to the ground provide a modicum of grounding. But these augers are no substitute for a good grounding system using copper wire and several ground rods.

Finally, drill a hole through the utility pole underneath the bottom of the tower pipe coupling and insert a large bolt. Slacken the winch cable and rest the pipe sections of the tower on this bolt. Keep a small amount of strain on the winch cable, just in case this bolt fails.

Operational Considerations

When the wind turbine is in its lowered position, use a few spare clamps to temporarily guy the pipe before you lean the ladder on the top ten foot section. Make sure to winch the tower pipe up and down only during NO WIND conditions. If the sleeve pipe fits tightly enough, then helpers aren't need to raise and lower the installed tower. As the tower reaches full extension, the already adjusted guy cables tighten up and plumb the tower exactly vertical. To safely climb a ladder which leans only on a 2 inch pipe, we bolted a piece of 2 x 4 lumber to the top rung of the ladder. This 2 x 4 has a notch cut in it which fits the pipe.

Access

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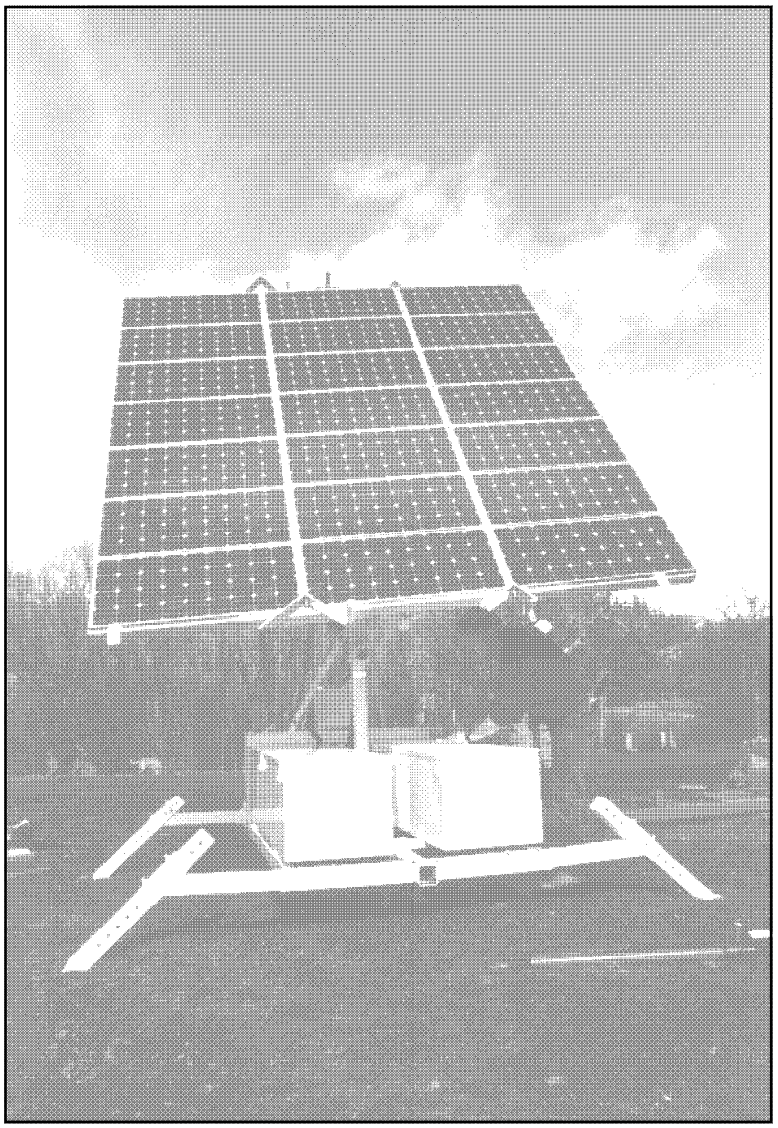


Voltar – King of the Solar Gypsies

Richard Perez

This solar power station travels in a pickup truck. Voltar is self-contained with a kiloWatt tracked PV array, batteries, and inverter on board. I saw it unloaded, set up, and operating in 42 minutes. This solar power station can be hauled anywhere a pickup will go and provide silent reliable solar power within minutes of arrival.

Meet Voltar

Gary Lucas, Voltar's inventor, has created complete PV power system that collapses and fits into a pickup truck. This is not a low powered system. I was surprised to see 21 Hoxan PV modules positioned by the electric linear actuators (similar to those on satellite TV dishes and the Wattsun trackers). Voltar packs enough solar energy to run an entire household. All the wiring is already done within Voltar, and the user need only plug into the 125 foot long, 120 vac power output cord.

Voltar's Specs

Voltar is capable of supplying 6 to 9 kilowatt-hours of 60 Hz., 120 vac electric power daily.

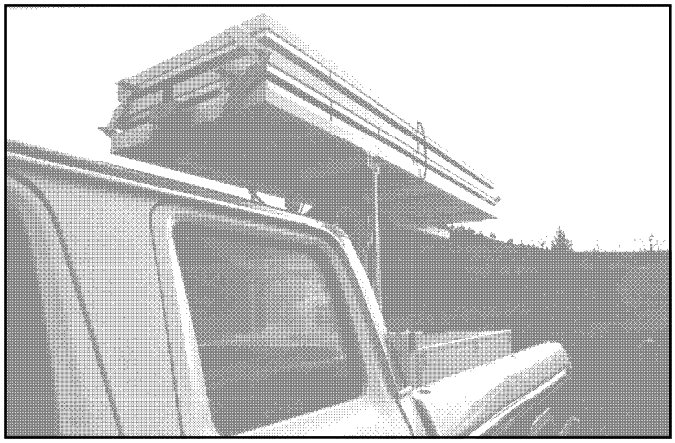
This particular Voltar uses Hoxan photovoltaic modules. Gary can also outfit Voltar with Siemens or Solarex modules. This Voltar was equipped with Johnson Control (6SC200), sealed lead-acid batteries (1,300 Ampere-hours at 12 VDC), a Trace 2012 inverter, three Trace C/30A PV controllers, and an SPM 2000 system monitor. Voltar is available with vented lead-acid cells and fiber plate nicads as battery options. Voltar also can be outfitted to the user's specified inverter(s), instruments, and controls.

Voltar uses Thomson Saginaw 36 Volt linear actuators operating at 14 VDC for reliability and smoothness. These actuators track the array in two axes with the aid of a Wattsun control head.

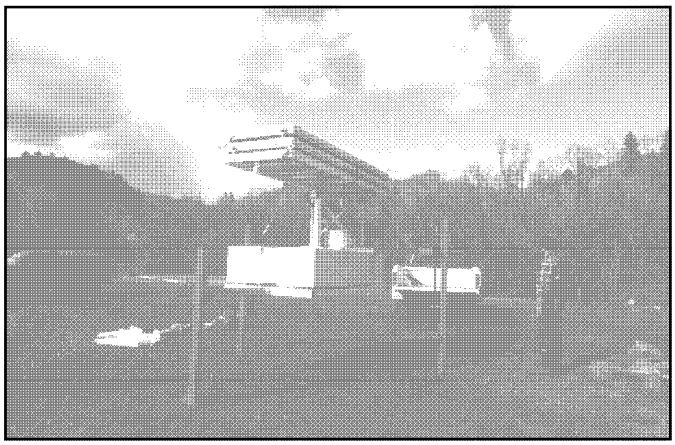
Square steel tubing (3.5 inch) is used for the framework. The footprint of the framework is four feet by eight feet on the floor of the pickup. This particular Voltar weighed in at 3,000 pounds completely ready to run, with its batteries aboard. The welded steel framework alone weighs in at 1,300 pounds, including the battery boxes which are superinsulated with closed-cell aircraft insulation. Gary hauled Voltar in a Ford F250 crewcab pickup. Voltar can be hauled in a standard half-ton pickup if the batteries are transported separately.

Setting Up Voltar

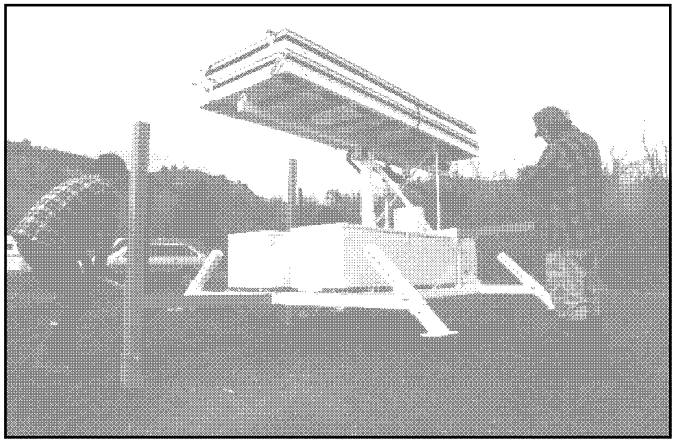
A single person can set up Voltar in less than an hour. Two people can do it in less than half that time. Setup is simple. Drive the pickup to a good solar site. Three handyman-type jacks are used to raise Voltar a few inches off the floor of the pickup's bed. Drive the pickup out from underneath Voltar and install its steel legs. Lower the three handyman jacks until Voltar sits on the ground. Gary provides a



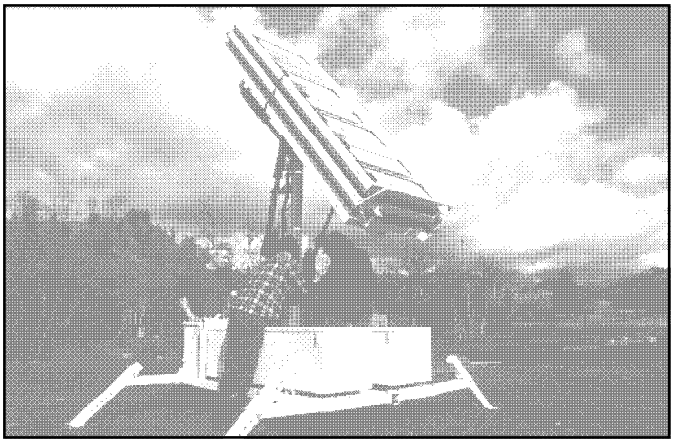
① Above: Voltar and Gary arrive at Camp Creek, California in a pickup truck after a five hundred mile drive from Seattle, Washington. Photo by Therese Peffer



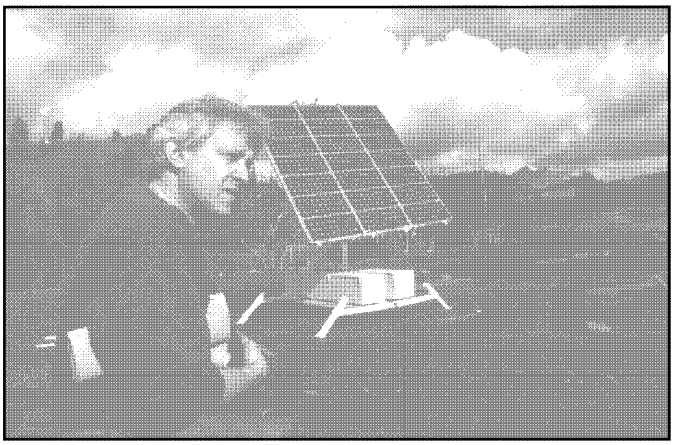
② Above: Voltar is jacked up and the pickup drives away. We used three jacks and a special jacking kit provided with Voltar. Photo by Therese Peffer



③ Above: Voltar has its legs attached and is then lowered to the ground using the three handyman jacks. Photo by Therese Peffer



④ Above: Voltar's array is jacked up, then unfolded and positioned. Photo by Therese Peffer



⑤ Above: Gary Lucas, with Voltar up and running in the background. Photo by Therese Peffer

built-in bubble level to aid in leveling Voltar on the ground. Voltar's legs are adjustable to accommodate very steep and/or uneven terrain. Voltar's footprint on the ground is eight feet by ten feet. The entire jacking down and leveling procedure is very secure with safety locking pins and super secure jack supports. After Voltar is on the ground, the mast for the tracker is jacked up and the array unfolded. The electric actuators aid greatly in array positioning; most of the work is done by pushing buttons.

Reloading Voltar is the reverse of setting it up. Reloading time is about 30 minutes. With Voltar secured in the pickup's bed, the entire power station is ready to hit the road.

Voltar's Mission

Voltar looks like a PV-powered moonwalker, and works like a powerhouse. Voltar is specifically designed for mobility and quick setup/takedown. It is the largest

portable PV system I have ever seen. It should interest anyone who requires between six and nine kilowatt-hours of power daily, and needs this power system to be portable.

The cost of a Voltar unit varies from $16,000 for a batteryless array direct water pumping model, to $26,825 for the model pictured in this article.

Access

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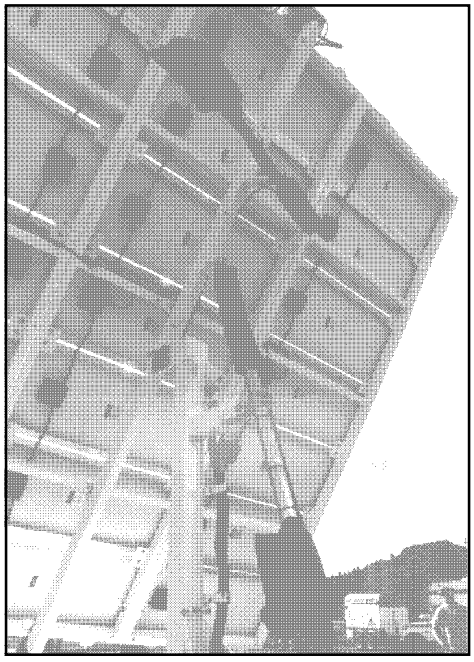
Maker: Gary Lucas, Lucas Industrial Control, POB 169, Buckley, WA 98321 • 206-829-2732 • FAX 206-829-2420



Above Left: The backside of Voltar's array showing the linear actuators.
Above Right: Gary Lucas, inventor of Voltar. Photo by Therese Peffer

Long Distance Power Transmission for Hydro and PV Systems

Paul Cunningham

Many times the best site to generate power must be overlooked because of the distances involved. You may have located your house in the shade of trees because of their summer cooling value and the aesthetics of being in the midst of the woods. Likewise the brook with hydroelectric potential may be too distant from the chosen house site. This article explains how power can be generated at a high voltage for easy transmission and then converted to battery voltage.

DC to DC Switchers

Long distance power transmission is made easy by DC to DC switching voltage converters like the Todd line of battery chargers, or the Linear Current Boosters (LCBs) made by Bobier electronics. The Todd chargers are described in HP#17, and were also sold under the Heliotrope brand, with higher quality control. LCBs were introduced in HP#6, and discussed #12, and #25. All of these convert high voltage DC to lower voltage DC at a higher amperage. They do this using high frequency switching, resulting in power conversion efficiencies around 90%. The Todds receive power at 90 to 130 Volts and produce a regulated 12 VDC nominal output. Inside the converter the input is rectified, so the input can be ac or DC of either polarity. The Todds are available in sizes of 30 to 75 Amperes output. LCBs receive power at 12 to 50 Volts DC and put out any voltage lower than the input voltage. The LCB20 is available as a 100 Volt model. 100 and 200 Volt models of each LCB can be special ordered. LCBs are available in a range of output amperages: 4 Amperes (LCB3), 10 Amperes (LCB7), 40 Amperes (LCB20), 80 Amperes (LCB40CC), and 100 Amperes (LCB60CC). All of these switchers are compact, lightweight, and run quietly.

For Photovoltaic Systems

To use switchers in a PV system where long distance power transmission is needed, wire panels in series strings to produce 24 to 200 Volts. (If you use a Todd, 100 to 130 VDC) Transmitting the power at higher voltage allows efficient transmission for long distances without monster cable diameters. The high voltage DC is fed directly into the switcher, which in turn feeds high amperage power at a lower voltage to the nearby batteries (see Figure 1 below). With these switchers, voltage regulation is easy. For the Todds it is built in: as battery voltage rises to a certain threshold (13.8, 14.8, and 16.5 VDC are available), the charger reduces its output to the batteries. If you've got a 24 Volt system, it is possible to use two Todd chargers with the outputs in series. LCB model's 40CC and 60CC have a built in, user adjustable voltage cutoff threshold. For the LCB20, the ECM-1 voltage regulator module is easily installed to give user adjustable voltage cutoff.

When the PVs aren't producing, simply plug the Todd into the old gasoline generator. Transformer-based chargers "brown out" when given alternating current from a genset with low peak voltages. These switchers, however, continue to convert power efficiently.

Induction Generators (For Hydro Folks)

Hydro systems can make use of the same high voltage long distance power transmission scheme by using high voltage generators attached to their turbines. I've found that an inexpensive and efficient alternative to a permanent magnet alternator is a three phase induction

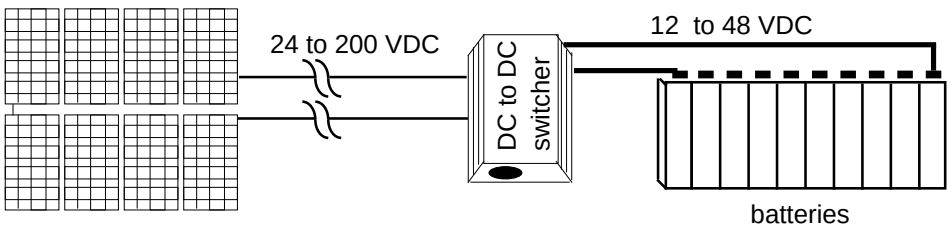


Figure 1 PV long distance power transmission system

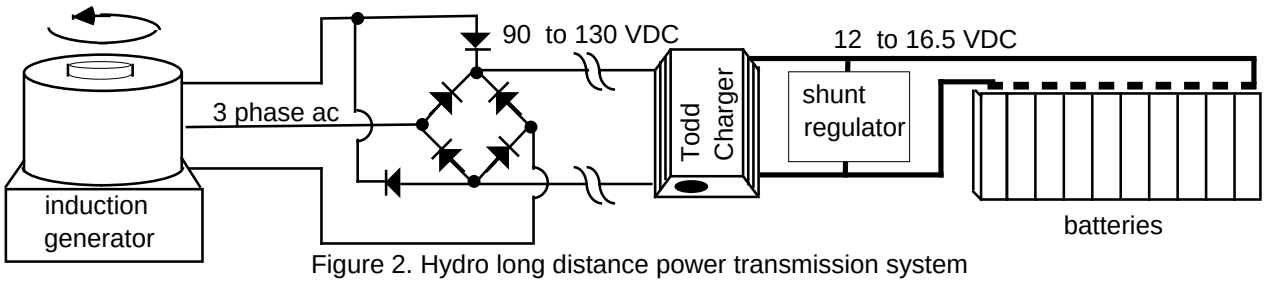


Figure 2. Hydro long distance power transmission system

motor as a generator. Induction generation was introduced to Home Power readers in HP#3 (now out of print), and time has proven it reliable. Modifications are easy. Connect capacitors across each of the motor's power lines. You'll need 10µF to 60µF of capacitance between each line. Use "ac motor run capacitors" (not DC electrolytics!). Varying the size of the capacitors provides a method of tuning the system so that it operates at the maximum power point. Output voltage can be in the range of 100 to 400 volts ac, but you'll want less than 130 volts if you're feeding it into a Todd charger. To change the three phase ac current to DC, use the rectifier shown in Fig. 2. All of my work so far with this power transmission scheme has used a Todd charger for voltage conversion. I've had no problems. According to the manufacturer, LCBs will also happily take DC input rectified from three phase alternators.

Before Todd chargers, the conversion of high to low voltages in hydro systems was done with standard 60 Hertz transformers. This required assembling an expensive custom circuit for each job. The efficiency was poor under normal conditions and wretched in low head sites where the induction generator frequency drops substantially below 60Hz. The efficiency of the generator and Todd charger together is undiminished at even 30 Hz.

As the battery voltage climbs above the preset threshold and the Todd begins to regulate current, it does so by switching off the input power. Running unloaded, the hydro generator's voltage rises to levels which may damage the generator or the charger. For this reason, a separate shunt type regulator (e.g. Trace C-30 or Enermaxer) is needed. It must operate at a voltage lower than that of the charger set point.

I've specified and sold equipment for some 20 hydro systems following the induction generator/ Todd charger scheme suggested here. They've operated reliably and with high efficiency. Alternative Energy Engineering has installed several PV systems using switchers. In general they report good results, with the exception of a number of Todd failures when the PV array was putting out a low voltage. They suggest such a system has advantages even where long distance transmission is not an issue, because it eliminates the need for a PV regulator, and because wire runs to the array can be small gauge (a major consideration if using conduit).

Access

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PV systems: Wes Edwards, Alternative Energy Engineering, POB 339HP, Redway, CA 95560 • 1-800-777-6609

LCBs: Bobier Electronics Inc., POB 1545 Parkersburg, WV 26101 • 1-800-222-3988

Todd Chargers: Todd Engineering Sales Inc., 28706 Holiday Place, Elkhart, IN 46517 • 219-293-8633

Induction motors and ac motor run capacitors: Order from Paul Cunningham (above), or Grainger Inc, 5959 West Howard St., Chicago IL 60648 • 1-800-323-0620.

Diagnosing Battery Problems

Richard Perez

If a battery is like a bucket, then a sick battery is like a bucket with holes in it. Batteries and buckets share some common characteristics. When they are full they will hold no more. When they are empty, they will deliver no more. Both batteries and buckets can leak. In the case of a bucket, we get a puddle on the floor. In the case of a battery, we get a diminished capacity to store power. Here's how to find out if your battery stores as much energy as it used to.

Different Batteries, Similar Diagnostics

This article deals with diagnosing capacity loss in both acid and alkaline electrochemical cells. High-antimony, deep cycle lead-acid cells and pocket-plate nickel cadmium cells have radically different chemical reactions. The causes and cures of lost cell electrical capacity are different between the two types of cells. However, this method of diagnosing which cells are sick, and how badly they are affected, is just the same for both lead-acids, nickel cadmium (nicads), and nickel-iron cells. This diagnostic technique uses electrical measurements to identify which cells have lost capacity and quantifies the cell's loss in capacity. If you don't know the battery basics such as capacity and voltage and so on, please read the article entitled Battery Basics in HP #27, page 30.

Don't Panic

Most users who suspect that their battery has lost capacity, in fact, have nothing to worry about. This perception, which commonly occurs to PV users during the winter months, is untrue. A battery is like a bucket. If you don't put it in, then you can't take it out. Most folks who think that their battery has lost capacity really just need to give it a full recharging.

The Diagnostic Procedure

This procedure is simply recharging and discharging the battery (or better yet, each cell individually) and making measurements of its performance. Just fill the battery or cell until you are really sure it is full and then measure how much you can get out of it.

There is a big difference between running this diagnostic procedure on a series-connected string of cells (a battery) and running the procedure on a single cell. The capacity of a series string of cells (a battery) is limited to the capacity of the weakest cell. Consider this example: A 12 Volt lead-acid battery is composed of six series-connected 100 Ampere-hour cells. One of the six cells has lost capacity and now holds 50 Ampere-hours. The entire battery will have a capacity of 50 Ampere-hours, even though five of the six cells still contain 100 Ampere-hours.

If this procedure is applied to a battery (a series connected string of cells), then it will yield the capacity of the weakest cell in the string. If the procedure is applied to each cell, then you will know exactly which cells are good and which are not.

Before beginning this procedure, give each cell in the battery a name or number. Get a clipboard and get ready to record all the measurements you will make. If you have a battery Ampere-hour meter (like the Cruising Equip. models), then you already have an instrument that will be of great aid in diagnosing lost capacity. You will need an accurate voltmeter like the Fluke, Beckman, or even a Radio Shack digital multimeter (DMM). If you are making your own power and operating a battery, you should have a DMM. If you don't have one, then now is the time to buy one because you are going to need it.

First Really Fill Up the Bucket

Recharge the battery or cell. Since most perceived capacity loss is actually chronic undercharging, first examine your charging system. Number one on the hit parade is any regulator or charge controller. If the voltage cutoff or regulation point of the regulator is set too low, then the battery is not being fully recharged. Check your regulators. Set the regulator for 1.6 VDC for each series connected cell in an alkaline system. This means 16 VDC for a ten series cell nicad or nickel-iron battery. In lead-acid systems, set the regulator at 2.66 VDC per series connected lead-acid cell. This means 16 VDC for six lead-acid cells in series. This information applies to

PV, wind, and hydro systems using either series or shunt regulators. This level of voltage regulation is higher than the system normally operates. We are setting the regulation points higher to make absolutely sure that the cells are being fully and equally recharged. We accomplish this by giving all cells a controlled overcharge. This insures that each and every cell is totally recharged.

How do we know when the battery or cell is fully recharged? Just look into the cell. Is it gassing furiously? Is the electrolyte alive with millions of bubbles bursting on its surface? Sustained, heavy gassing is a sure sign that the cell is as fully recharged as it is going to get. Measure the voltage of each cell that makes up the series connected pack. Write this data down next to the cell's number on the clipboard. While still undergoing recharging, the voltage difference between the highest and lowest cell should be no more than 0.1 VDC. If continual recharging does not bring the cells within this voltage spread, then the lowest cells have problems and should be singled out for treatment. If you have an Ampere-hour meter, then overcharge the battery to between 125% to 150% of its rated capacity.

This equalizing recharge is a radical procedure. The cells will gas violently and will require distilled water replacement AFTER the equalizing charge. The cells will get warm to the touch. This is therapy for lead-acid cells and not recommended as a steady recharging diet. We are performing this equalizing charge because the battery is suspected of having lost capacity. In my experience, lead-acid cells (except sealed cells) love a regular equalizing charge, so do it every five deep cycles or every three months. Alkaline cells generally require no equalization if the regulator is set at 1.6 VDC per series cell. We operate our nicads at 1.61 VDC regulation per cell and their voltages seldom diverge. If you are regulating your alkalines lower than 1.6 VDC per cell to accommodate your inverter or DC loads, then equalize your nicad or nickel-iron cells every six months.

Charging Single Cells

Charging each cell individually is tedious, buteinsures that each cell is totally full while not unnecessarily overcharging the other cells. We have used single ARCO M52 PV laminates to recharge single cells. The M52 (better known as one quarter of a QuadLam) produces over six Amperes at 2 to 3 VDC. This power is ideal for recharging a single lead-acid or alkaline cell. Use the same methods to determine if the cell is fully charged as with a battery. Look for violent gassing, high voltage (1.6+ for alkalines and 2.6+ for a lead-acid cell), and 125% to 150% overcharge if you use an Ampere-hour meter.

Then Really Empty the Bucket

The next step in the procedure is to discharge the battery or cell and measure number of Ampere-hours that it delivers. This is simple to determine if you have an Ampere-hour meter. Discharge cutoff voltage for a lead-acid cell is 1.8 VDC and for an alkaline cell is 1.1 VDC. Discharge the battery until it reaches the cutoff voltage. Then read the number of Ampere-hours removed from the battery on the Ampere-hour meter. Manufacturer's Ampere-hour ratings are usually based on a discharge cutoff voltage of 1.75 VDC for lead-acids and 1.0 for alkaline cells. I use a higher discharge cutoff voltage because it better represents our battery usage in home power systems.

If you don't have an Ampere-hour meter, then discharge the battery or cell at a constant rate, measure this discharge rate with an ammeter, and multiply this rate by the number of hours it takes the battery (or cell) to reach the discharge cutoff voltage. This results in the number of Ampere-hours removed from the battery – its capacity. A Fluke 87 DMM, in record mode, measuring discharge current through a shunt is an excellent way of measuring Ampere-hour capacity. Simply multiply the average current reading of the DMM by the elapsed time of the discharge in hours.

When the battery reaches discharge cutoff voltage, measure the voltage of each individual cell, while still under discharge, and record the data. Any weak cells will have much lower voltage by several tenths (or more) of a volt than the other cells at this point. These are weak cells which are limiting the performance of the remainder of the cells in the battery.

Lead-acid cells don't like being fully discharged. This is an experiment to diagnose suspected capacity loss, not a regular or recommended way of cycling lead-acid cells. Perform this procedure on your lead-acid battery only if you strongly suspect capacity loss. Never do this to your lead-acid battery for idle curiosity. Nicads however, enjoy a good deep cycle, and occasional use of this test will do the alkaline cells no harm.

Emptying Single Cells

Discharging single cells can be a problem because it is hard to find a suitable load. We use a coil of 14 gauge insulated copper wire as a load resistor. Consult a copper wire table and figure out a proper length of 14 gauge or smaller wire. Size this wire so that its resistance allows a C/10 rate of discharge for the cell. Wire of 14 gauge or smaller will get warm, but we've never come close to

melting its insulation. It makes a cheap, handy, and user-programmable load resistor. Discharging single cells gives rock solid data. Instead of a weak cell skewing the data for an entire string, we have real data from each cell. This method allows grouping weak cells into a single series string where they will do the least harm and be most effective.

What's next?

After doing at least one of these procedures, you will have a fair idea if your battery is delivering its rated capacity. Chances are that you will find that the equalizing charge totally refilled the battery for the first time in months. I often do this procedure several times and find that the repeated equalization charges bring back some of the lost capacity (especially in alkaline cells).

If you discovered a weak cell or cells, then tune in next issue when we'll run information about rejuvenating weak lead-acid or alkaline cells. If you haven't discovered any weak cells, then great! You have still accomplished several things. You have investigated your charging system and made sure that the regulators are properly set. You have equalized the battery. And maybe most importantly, you now have recorded data on the performance of your cells. Next winter, during the deep dark days when those niggling capacity loss feelings come again, you will have solid info about your battery. This info and the experience you gained by using this procedure will make it far easier to determine if all is well.

Access

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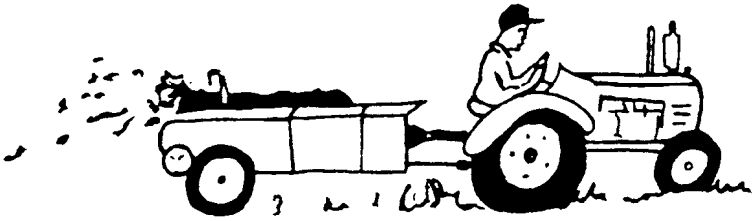
The Methane Process

Third in a series by Al Rutan, the Methane Man

Al Rutan

Mold and mildew have been seen by everyone. Most people have observed the process of rotting. We know it is common in nature. Methane gas is just as common, but not as observable. Anyone near a sewer manhole or a plumbing vent pipe can get a whiff of the methane process in action. The reason for saying this is to alleviate the apprehension that the methane process is going to be difficult to harness. It's no more difficult than making a loaf of bread. If the conditions needed are present, the desired result will invariably occur.



What we are considering is a biological process in which we use the waste product of bacteria. We shouldn't even call the little creatures bacteria but more accurately "methogenic micro-organisms."

Primeval Life

In the process of evolution, they antedate the formation of bacteria. They are one of the very earliest forms of life. When scientists explore outer space with telescopes that can separate light spectrums, they look for the presence of methane gas. If the gas is present, there is evidence for the beginning of life.

For our purpose, we are going to refer to these methogenic micro-organisms simply as "bacteria." They are curious little critters. Their waste product burns. Not only does it burn, it burns very well. Combustion produces only carbon dioxide and water vapor. There is no ash, no soot, no tar, no dirt of any kind. It's a very efficient fuel.

Characteristics

This fuel is composed of carbon and hydrogen. Its chemical formula is CH_4. It has an octane rating of 110 and produces around 1,000 BTUs (British Thermal Units) of heat per cubic foot of gas. Because most gas is invisible, it seems mysterious. If we think about our own chemistry for a minute, it won't seem so strange. We know that we breathe in oxygen and exhale carbon dioxide. So we, ourselves, are gas producing organisms.

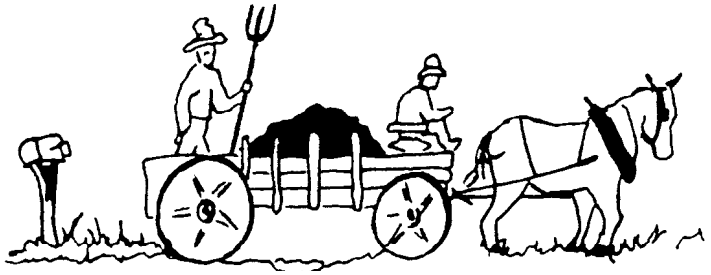
Gas Makers

If we think about this, then the process of the methane bacteria doesn't seem so strange. The part that is "strange" is that it burns. If mixed with sufficient amounts of air, it burns very rapidly... explosion!

In nature, some bacteria operate best in the presence of air because they require oxygen, and some function only when air is excluded. The methane bacteria are of this latter type. When exposed to air, they die. Because they live and function only when air is not present, they are called anaerobic or "without air" bacteria.

Natural Gas and Sewage Gas

What is the difference between natural gas and sewage gas? Virtually none. For all practical purposes the bacteria which make the gas are the same. Natural gas sold by the utilities is 90%, or better, methane. It has been made in the ground over eons of time and in most instances is almost pure methane because the ground has purified or "scrubbed" the gas. The only difference between gas produced in the earth and gas made in



sewage plants is that in the sewage plants the process is speeded up. In speeding up the action there are several gases produced, notably, carbon dioxide. In a sewage plant the mixture is about 70% methane and 30% carbon dioxide, with trace amounts of hydrogen sulfide. The carbon dioxide largely dissipates from "natural gas" over time. The speeded-up process product, including the carbon dioxide, is referred to as "biogas."

Actually all natural gas is "biogas" because all of it was produced from something that was at one time living. The only distinction is that so-called "biogas" is produced in a shorter time from things that have been living recently. Making methane for ourselves, we hasten the process.

How Does it All Happen?
There are two types of "without air" or anaerobic bacteria that work together to make methane. The first type we'll call "acid forming." Their function is to feed upon raw organic material. They produce no methane, only carbon dioxide and some acids and "food" for the second bacteria type, the methogenic micro-organisms. The "food" consists of simple sugars, simple alcohols and peptides. When the methogenic micro-organisms in turn feed upon this simpler fare they produce methane. Thus when organic material is placed in a container where air is excluded, both carbon dioxide and methane are produced.

Need for Balance
The methanogenic micro-organisms need the food provided by the acid-forming bacteria, but they also need a neutral environment. If the right balance between acid and base (alkaline) is not present, the methane micro-organisms are in trouble and no methane is produced. They have to have a pH of 7 to 8.5 in order to be normally active.

What Does pH Mean?
I think it's important not to assume that everyone is familiar with pH. Websters defines pH as "the negative logarithm of the effective hydrogen ion concentration... used in expressing both acidity and alkalinity on a scale of 0 to 14 with 7 representing neutrality. Numbers less than 7 represent increasing acidity and numbers greater than 7 represent increasing alkalinity."

So the term pH means percentage of hydrogen, or more precisely, proportion of hydrogen in relation to the hydroxide ion in a given material. It's the negative logarithm of the hydrogen ion concentration, so a pH of 7 means that the concentration of hydrogen ions is 10^{-7}. Aren't you glad you asked?

Anyway, it's important information for keeping the digester healthy and happy. The ideal pH for digestion is from 7.5 to 8.5.

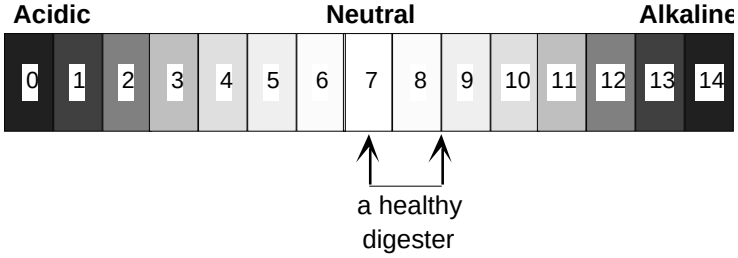
How to Get a Reading
How does one measure pH? This is the easy part. Chemical supply houses and even most drug stores sell rolls of paper (called litmus paper) and/or little plastic strips that turn color when dipped in solution to tell you what the pH is. There is a slightly different color for each of the different pH numbers. You tear off a piece of the litmus paper about 1 1/2 inches long and dip it into a little of the slurry. The paper will start to change color within seconds. When compared to the color scale on the container, you can tell right away what the pH of the slurry is.

Why the Process May Drag
Generally if there's a problem, it's that the slurry is too acidic (pH below 7).

If there is a lot of new, raw, green material placed in the digester, the acid forming bacteria have a field day. The methane bacteria are so annoyed by the high acid concentration, they simply can't function. When this occurs, it can take a long, long time for the methane process to get under way naturally.

This generally occurs only in the beginning with start up or if too much new material is added at any one time. If a measured amount of new material – no more than 1/40th of the total liquid volume of the tank – is added, then the new material is dilute enough not to upset the balance. At start up, though, there's a lack of micro-organisms, and an inclination towards excessive acidity. Understanding this, we can see why some of the early literature on making methane states that the start-up time can be anywhere from three weeks to three months. This is assuming that one is beginning with totally "new" material without the assist of some already partially digested slurry. A three month start-up would discourage almost anyone from attempting to harness the process.

The pH Scale



Starting Up

Partially digested slurry is kind of like sourdough starter. It has large populations of the right kind of micro-organisms to digest raw material and make methane. You can start from scratch, but it's faster if you can get some activity that's already established.

When I started a small digester in 1976, I seeded it with some slurry from the St. Cloud, Minnesota, sewage plant. The plant engineer told me at the time that the plant was so overloaded with wastes from a local meat packing house that the digester was just "going through the motions" and really not working properly. I took some of the slurry anyway. What the heck. It was free and I needed something to get the tank producing.

After a few days I started to get methane and then I lost it. The tank was still producing a lot of gas, but it was carbon dioxide – it didn't burn. The pig manure I had begun to feed the digester along with the slurry from the St. Cloud plant was just too much raw material for the process. So there was a lot of carbon dioxide and acid. The acid forming bacteria were having a feast.

I mentioned the problem to friend with whom I was working at the time. He said, "I make a lot of wine at home. Every once in a while I have the same problem. When I do I add a little baking soda. It straightens out the condition right away. The nice thing is it doesn't leave an after taste. In your case that isn't a problem!"

The Benefits of Baking Soda

So I tried the baking soda. It worked like a charm. Within three days I had methane on the way. At a seminar I was presenting a few weeks later, I mentioned this to the group. Baking soda was my "discovery" for straightening out the pH in the digester.

One of the people at the seminar sent me a clipping from Business Week magazine a couple weeks later. It was dated June 14, 1976. The headline for the article read "Dosing Sewage With Baking Soda." It went on to say this was a whole new idea for treating sewage plants; they used to use large amounts of ammonia.

The article further proclaimed that soda not only assisted in the more efficient digestion of sludge but increased the volume of burnable methane gas. The most surprising statement of all: bicarbonate of soda "acts as a sort of vitamin for bacteria."

This is the secret for keeping your digester sweet and happy. Just add a little at a time until the pH is just right. Keep adding it periodically if the pH keeps dropping until the acid forming bacteria are no longer producing an override of acid. Don't be fooled if a lot of gas starts coming. The baking soda itself will produce some carbon dioxide.

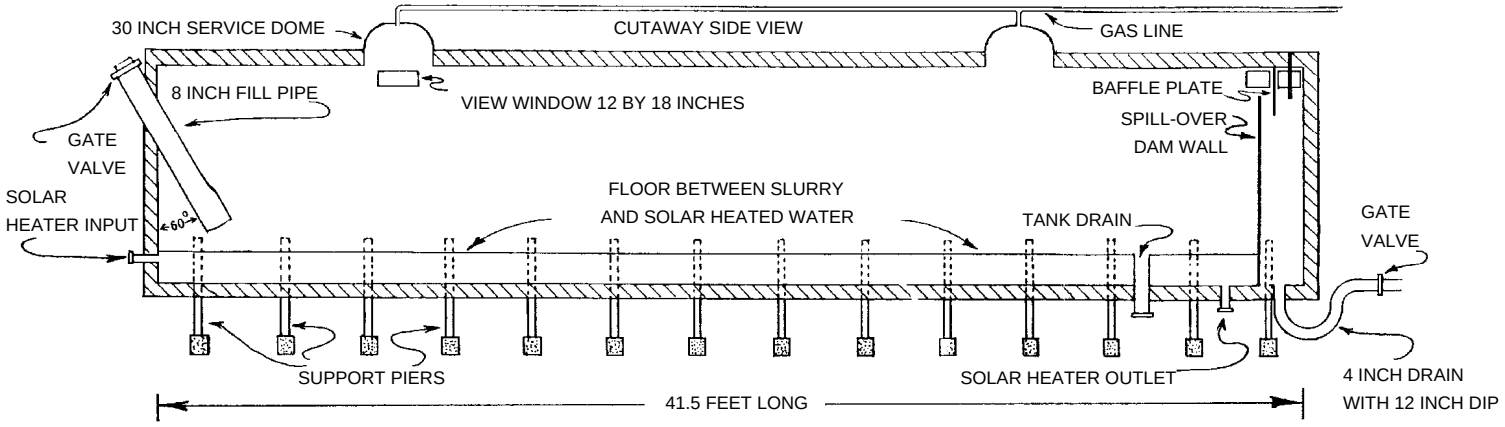
The Nature Of Heat

Heat is essential for abundant methane production. In warm climates the process works with little help when the other conditions needed occur. For many of us who live in a cold climate, making methane work is a challenge.

One needs to keep in mind that heat stratifies, whether in air or water. Heated fluids are less dense and tend to rise. This natural thermal stratification in liquid is, of course, the very reason why the thermal syphon principle in water heaters works so well.

It was this very fact which suggested a digester design with a false floor containing only water. The bottom, the lowest point of the "working" tank, could be heated by a thermosyphon action from some heat source such as solar, or even a little of the gas itself.

Al Rutan's Methane Digester Design



The heat from the lowest part of this "double boiler" type design would rise through the slurry so that the very bottom of the "working" tank could more easily be kept at the desired temperature in the entire digesting area. Such a tank would most easily be constructed of fiberglass. It could be virtually any size.

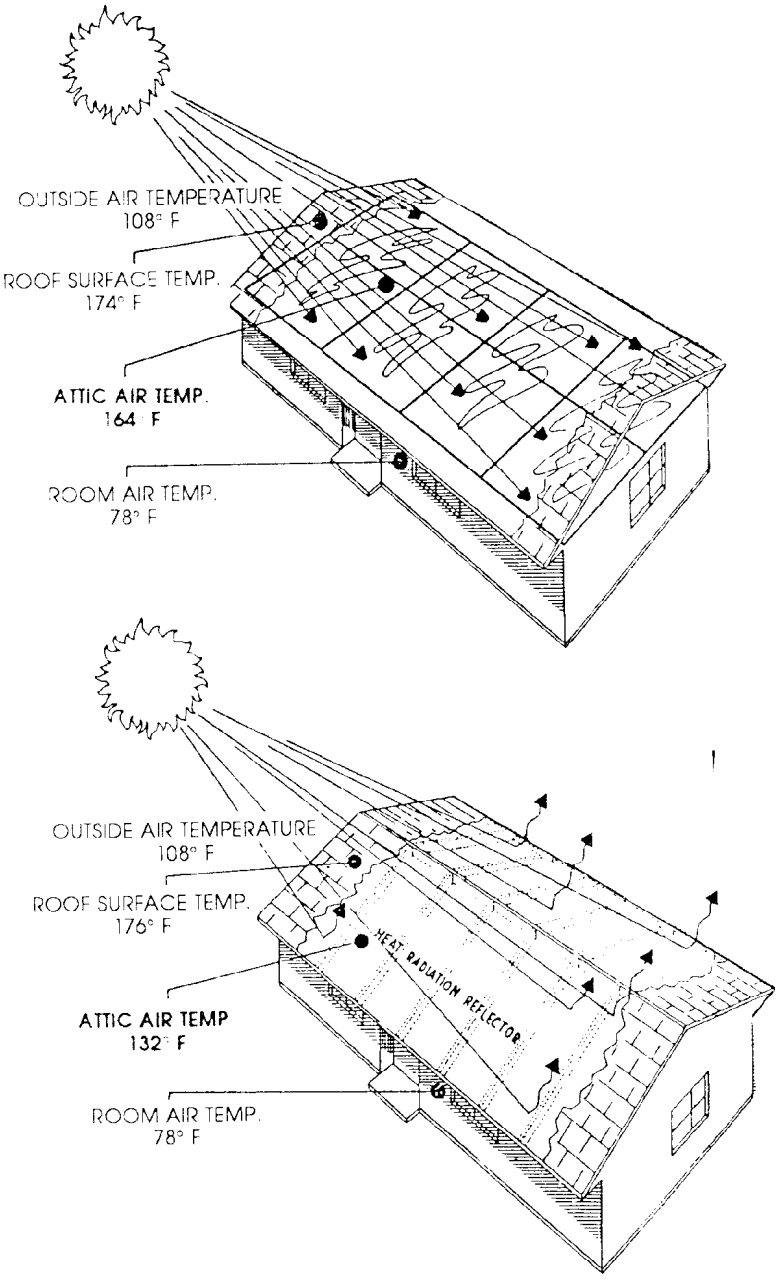
Next time we'll think about the barriers to the transfer of heat – insulation – a critical key to any successful operation. This brings us to the question of whether the operation is a net energy producer or an energy consumer.

Access

Author: Al Rutan, POB 289, Delano, MN 55328

Stop the Summer's Heat – Radiant Barriers

Tom Lane



As if by magic, the magic of Physics, radiant barriers stop the summer's heat from invading your home. Radiant barriers are very cost-effective in hot climates because they sharply reduce cooling loads. In solar-powered homes, radiant barriers offer a low cost, no energy consuming solution to summertime overheating. Radiant barriers are incredibly more effective than attic fans and other passive "beat-the-heat" schemes.

How Heat Moves

There are three ways that heat travels: conduction, convection, and radiation. Heat transfers by conduction if the materials involved are physically touching. Convection is the transfer of heat via the movement of air or other gases. Radiation is the way heat travels through space, just as the sun's heat reaches us through 93 million miles of vacuous space.

What is a radiant barrier?

Radiant barriers prevent heat transfer because they will not absorb or transfer infrared heat energy. A radiant barrier reflects heat from its surface. There are two types of radiant barriers used in home construction, aluminum foil and LO/MIT-1 (a spray-on radiant barrier). The surface of any radiant barrier has what is called low "emissivity." This means that the surface is very sluggish at absorbing and transmitting radiant heat. A single low emissivity coating can reduce thermal radiation by as much as 95%.

In new homes, construction grade aluminum foil is stapled to the underside of the roof deck. Or a spray-on radiant barrier is applied to the underside of the roof. This low emissivity coating prevents the radiant heat of the sun from penetrating the roof and heating the home. It is like putting your home under a shade tree!

Are radiant barriers the same as insulation?
No, they are not. Insulation is a material that resists (slows down) convective and conductive heat transfer. Radiant barriers resist only the flow of heat by radiation, and does nothing to prevent heat transfer via convection or conduction. A well-made home uses both insulation and radiant barriers. Insulation keeps the heat inside during the winter, and the radiant barrier keeps it out during the summer.

How does a radiant barrier work in a home?
The radiant barrier reflects heat from the roof instead of allowing this heat to penetrate the attic, and eventually the home's living spaces. During the summer, this means a more comfortable home and lower utility bills.

How will a radiant barrier affect my cooling bills?
In hot climates, radiant barriers can cut air conditioning bills by 8% to 20%. Radiant barriers can eliminate the need of air conditioning in the late spring and early fall months. In addition to saving power, the radiant barrier reduces the operating time of cooling equipment. This means longer air conditioner life, and lower maintenance bills.

Do radiant barriers work in the winter?
Yes, although the radiant barrier is much better at keeping out summertime heat. Heating bills drop only about 3% to 7% when a radiant barrier is installed. Most winter heat loss occurs through conduction and convection. Since radiant barriers are effective only against radiant heat, they do little to keep in heat during the winter.

Do radiant barriers work in a ventilated attic?
Yes, and they increase the effectiveness of the attic fan. Most ventilated attics do not move enough air through the attic to dissipate the roof's heat. With a radiant barrier, less heat enters the attic and the attic ventilation system is more effective.

Will a radiant barrier in my attic bake the shingles?
No. According to the Florida Solar Energy Center (report number FSEC-CR-GS-82), using a radiant barrier only increase shingle temperature by 2° to 4°F. This rise in temperature is insignificant because the shingles are already between 130° and 170° F.

Have government agencies promoted the use of radiant barriers?
Foil and spray-on radiant barriers have been thoroughly tested by the State Energy Center at Cape Canaveral, Florida. The Federal Government has given General Services Administration approval numbers for foil radiant barriers, and for LO/MIT-1 a spray-on radiant barrier (GSA# TFTC 88-CK-N115-01).

What is the difference between aluminum foil and spray-on radiant barriers?
The method of application is the main difference between foil and spray-on barriers. The spray-on barrier is about 20% less effective as a heat stopper than is the foil barrier. The spray-on radiant barrier usually costs less because it is much easier to install.

How do you install a foil radiant barrier?
Construction grade aluminum foil comes in 24 inch to 50 inch wide rolls that are 500 feet long. The foil usually has a mylar or kraft paper backing containing a web of fiberglass strands to prevent tearing. The material cost is 10 to 15 cents per square foot. In new construction, the foil is stapled to the plywood or composite board, then trimmed with a knife. The roof decking is then nailed to the joists with the shiny side of the foil facing the attic cavity. The foil can also be stapled to the inside of the roof after the roof is already in place. Stop laying the radiant barrier a few feet below the attic's ridge vents.

If you are doing the job yourself, then get some help from friends. Have a radiant barrier party. Buy several staple guns, a couple of boxes of 1/4 inch staples, a couple of 500 foot rolls of foil, and several 2 inch by 12 inch by 10 foot boards. These boards will allow you to walk in the attic without squashing the insulation or damaging the ceiling of the room below you. Don't have a radiant barrier party during the summer, you will fry and die in the attic along with the folks who used to be your friends. Do it on a cool overcast day. Apply the foil to the undersides of the roof decking. Do not apply the foil over the insulation on the attic's floor. Covering this insulation with the barrier will cause moisture to build up in the insulation, and still allow heat buildup in the attic.

How do you install a spray-on radiant barrier?
In new construction, the radiant barrier (like LO/MIT-1) is sprayed on the underside of the roof before it is sealed from exterior ventilation. It must be applied before the attic is sealed because LO/MIT-1 uses xylene as a solvent. Xylene, a common paint solvent, is too toxic to be sprayed by humans in enclosed areas. Typically a single man with an airless sprayer (#613 Graco tip) can cover 1,200 square feet in an hour and use about five gallons of LO/MIT-1. LO/MIT-1 can also be brushed or rolled on like a paint. Since thicker coatings have no benefit, it is best to spray LO/MIT-1 onto the surface. Material cost of LO/MIT-1 will be about 11 to 15 cents per square foot, with installation costing about 5 cents per square foot.

If the house is already constructed and sealed, then LO/MIT-1 must be applied to the exterior of the roof.

LO/MIT-1 can be sprayed on top of shingle, metal, or tar/gravel roofs. LO/MIT-1 can also be sprayed on east walls, west walls, and garage doors. LO/MIT-1 is only available in an architectural grey color.

Where can I get more info on radiant barriers?

Call the publication department of the Florida Solar Energy Center at 407-783-0300 and ask for the following three free publications: *Radiant Energy Transfer and Radiant Barriers in Buildings* (DN-6), *Designing and Installing Radiant Systems* (DN-7), and *Dealing with Heat and Humidity in Homes* (EN-10).

FORTIFIBER CORP., POB 9591, ATTLEBORO, MA, 02703, 508-222-3500
LAMTEC CORP., POB 37, FLANDERS, NJ, 07836, 201-584-5500
ALFOL, INC., 9839 YORK ROAD, CHARLOTTE, NC, 28241, 704-588-2170
SOLAR SHIELD, INC., 1054 BRANCH DRIVE, ALPHARETTA, GA, 30201, 404-343-8091
RICH'S ENTERPRISES, 2734 EL DORADO PLACE, SNELLVILLE, GA, 30278, 404-979-9671
ECS SOLAR POWER STATIONS, 4110 S.W. 34TH STREET, SUITE 15, GAINESVILLE, FL, 32608, 904-373-3220
DENNY SALES CORP., 3500 GATEWAY DRIVE, POMPANO BEACH, FL, 33069, 800-327-6616
ROBERTS CO., 322 WESTMINISTER ROAD, WEST PALM BEACH, FL, 33405, 407-659-7485
FI-FOIL, INC., 612 BRIDGERS AVE. W., AUBURNDALE, FL, 33823, 813-965-1865
PARSEC, INC., 5832 PLOVER ROAD, VENICE, FL, 34293, 800-940-0393
LAMOTITE, 2909 EAST 79TH STREET, CLEVELAND, OH, 44104, 216-883-8484
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SIMPLEX PRODUCTS, POB 10, ADRIAN, MI, 49221, 517-263-8881
ALUMAX FOILS, INC., 6100 SOUTH BROADWAY, ST. LOUIS, MO, 63111, 314-481-7000
ENERGY SAVER IMPORTS, INC., 2150 WEST 6TH AVE., UNIT E, BROOMFIELD, CO, 80038, 800-282-3645
ROY & SONS, INC., 1135 EAST WOODLAWN, ONTARIO, CA, 91761, 800-327-6616
R-FAX TECHNOLOGIES, INC., 661 EAST MONTEREY, POMONA, CA, 91767, 714-622-0662
AAE SYSTEMS, INC., 962 C MISSION CENTER CT, SAN DIEGO, CA, 92108, 619-296-0970
INSUL-TRAY, INC., POB 3111, REDMOND, WA, 98073, 206-861-0525

Where can I get radiant barrier materials?

Access

Author: Tom Lane, Energy Conservation Services, 4110-15 SW 34th St., Suite 15, Gainesville, FL 32608

Grounding – How

John Wiles

In the last installment of Code Corner, the "whys" of proper grounding including safety, performance, and legal issues were discussed. Grounding a renewable energy system requires a knowledge of what the codes say, how the system is configured, the internal design of the components, and sometimes the strength of Hercules to bend the conductors and drive the ground rods. Grounding the equipment and the system are two different aspects of grounding which, when integrated, provide for human and equipment safety and higher levels of performance.

The Earth Ground

The National Electrical Code (NEC)® requires that electrical power systems have a good contact with the earth. Some state codes actually require that a measured, low-resistance contact with the earth be obtained. The NEC, however, only requires an 8-foot "manufactured" rod be driven into the ground at no greater than a 45° angle from the vertical. Ground rods are available from electrical supply houses and building supply centers. Suitable alternatives might include a metal well casing, or a concrete-encased, steel building foundation. If solid rock exists near the surface, then it is permissible to bury a grid of copper conductors or pipes in the soil. These should be as deep as possible and cover as wide an area as possible.

In any case, the connection between the grounding cable (usually copper) and the ground rod (steel or copper coated steel) must be welded or made with an approved (UL listed) connector. This will minimize corrosion and mechanical and electrical deterioration of the connection. Drilling and tapping well casings or steel beams may be required.

Grounding Systems

It may be necessary to use more than one ground rod to meet both the requirements of the NEC and the performance and safety requirements of other electrical systems. PV, wind, ham radio, and radio telephone systems may each require separate ground rods. When more than one ground rod is used, it is suggested and the NEC requires that they all be bonded together to form a grounding system. They should be bonded with at least as heavy a cable as is being used to carry current to and from the various pieces of equipment. Better performance will be realized if the largest practical conductors are used. The bonding cables must be connected to the ground rods with separate approved clamps or welding. Only one conductor may be used per clamp.

Equipment Grounding

The exposed metal surfaces of all equipment used in the production and use of electrical power must be grounded. The NEC does not make any exceptions for low-voltage systems, and systems less than fifty volts are specifically addressed. The equipment requiring grounding may range from power sources (metal frames on PV modules and cases on wind and hydro generators) to the appliances that provide useful work (pump housings and the cases on blenders).

While it is possible to run an equipment grounding conductor from the PV module frame, or the wind machine tower to the central ground rod located near the batteries, better lightning and surge protection might dictate a modified approach. If ground rods are placed as near as practical to the lightning-prone metal surfaces (PV array frames and wind machine towers), then lightning induced surges can more easily be bled off to ground. Of course to meet the code, this ground rod must be bonded to the main ground rod. It might be wise to separate the bonding conductor from the current carrying conductors to minimize induced surges (separation allowed in DC systems but not ac systems).

Exposed metal surfaces of switch boxes, fuse holders, charge controllers, inverters, and battery boxes must be connected to the equipment grounding conductor. In the nonstandardized DC world of renewable energy, equipment can be found that does not have a provision to attach the grounding conductor. In these cases, a hole must be drilled, and the paint scraped off to insure a good connection. It is always a good policy to check with the equipment manufacturer to determine where the hole can

be drilled, and if case- and negative-conductor grounding will effect the performance or the warranty.

The size of the equipment grounding conductor should be based on the size of the overcurrent device protecting the conductors between any two pieces of equipment. The NEC gives details in Table 250-95 – for example; a circuit fused at 30 amps would require a number 10 AWG equipment grounding conductor, and a 400-amp fused circuit would require a number 3 AWG equipment ground. If the current carrying conductors are oversized to decrease voltage drop, then the equipment grounding conductor must be increased in size proportionately.

Bare, uninsulated conductors or conductors with green insulation or green markings (number 6 AWG and larger) may be used for the equipment grounding conductors.

The actual connections can be daisy-chained from one piece of equipment to the next and then to the ground rod. They may also be individually connected to a common point, and then to the rod. Separate multiple connections to the ground rod (each with a separate clamp) are allowed. All connections should be inspected periodically (every three months or so) for mechanical and electrical tightness and corrosion.

System Grounding
Grounding one of the current carrying conductors is required if the no-load or open-circuit voltage in the system exceeds 50 volts. Below that voltage, system grounding is optional but reasons for grounding all systems were discussed in HP #27.

The negative conductor is the most commonly grounded conductor in RE systems. If there is a telephone system powered by the RE system, a DC-DC isolator should be used so that the RE system can have a negative ground and the telephone system can have a positive ground.

Contact the Manufacturer
There is not much standardization in RE equipment when it comes to the electrical interface. The manufacturer is the best source of information on equipment connections in a grounded system. Current carrying conductors that are grounded should have white insulation and should be electrically continuous throughout the entire system from power source to load. That generally means no switches, no relays, no fuses, and no internal signal processing in the negative lead (a common problem in charge controllers). A properly designed current-measuring shunt with the same or greater ampacity than the conductor will probably be considered to be the same as a conductor. An electrical inspector expects that all conductors colored white will be at the same potential above ground – that is zero volts. When there are switches, relays, or transistors inside charge controllers in the negative lead, these devices might violate the continuity of the grounded conductor and create an unsafe condition.

One Connection Only
In a grounded system, there can be only one connection between the negative conductor and the ground rod. If there is more than one connection (either intentionally or unintentionally), parallel paths for current flow will exist. Currents will flow in the normal negative conductors and in the uninsulated equipment grounding conductors.

The system grounding conductor between the negative conductor and the ground rod should be as large as the largest current-carrying conductor in the system – even if that happens to be a number 4/0 AWG battery cable.

Article 690 of the NEC requires that the point of connection to the negative conductor be on the PV output circuits, and suggests that a connection closest to the array will minimize surge problems. Following this suggestion would point to the PV Disconnect Switch Enclosure as the logical place to make the connection. On a direct-drive (no batteries) system, this is the ideal place. On a system with batteries and large cables, the negative battery terminal or negative inverter terminal might be a better location since the heavy grounding cable can be connected to the heavy conductor between the battery and the inverter.

If, however, the system uses an inverter which has the case connected to the negative DC input terminal, then the system ground connection must be made at this point. To do otherwise would create the parallel current paths mentioned previously.

Summary
Keep the system safe, meet the code, make the inspector happy. Use an equipment grounding conductor for all exposed metal surfaces. Connect the negative system conductor once to the ground rod. Use a ground rod and the proper clamps.

Access
Author: John Wiles, Southwest Technology Development Institute, POB 30001/Dept 3SOL, Las Cruces, NM 88003 • 505-646-6105.

National Electrical Code (NEC)®, National Fire Protection Association, Batterymarch Park, Quincey, MA 02269.

Home Power's Indigenous Materials Solar Cooker Contest!

Build a Solar Cooker and Win a PV Module!

Contest Prizes

- 1st Prize – a Solarex MSX60 PV Module
- 2nd Prize – a PowerStar 200 Inverter
- 3rd, 4th, and 5th Prizes – your choice of an Osram compact fluorescent light or a Kyocera Jetski PV module

"To give of one's self; to leave the world a bit better, whether by a healthy child, a garden patch, or a redeemed social condition… to know that even one life has breathed easier because you have lived – this is to have succeeded." – *Ralph Waldo Emerson*

You've probably heard the statistics before. The trees are being cut down faster than they are growing. Since 1970, the earth has lost tree cover over an area nearly as large as the United States east of the Mississippi River. In developing countries, finding firewood for the day's cooking fire consumes a large and increasing portion of a family's resources. In most cases the burden is most heavily borne by the women of the family, who spend hours a week gathering fuel from farther and farther away. With the cutting of the trees comes reduced wildlife habitat, topsoil erosion, greater incidence of flood and drought, and increasing global CO_2 levels.

Solar cookers are already successfully providing an alternative to firewood and fossil fuels. Because available materials are limited in developing nations, what is needed is an effective, easily constructed solar cooker made from indigenous materials.

We need to expand the recognition of solar cooking here in the "developed world." Many people in the developing world seek to emulate our "modern" lifestyle. Until now "modern" has meant fast cars, Hollywood dramas, and all-electric kitchens; but it could also mean bicycles, ecologically sane living, and solar cooking.

With this in mind, Home Power announces our Indigenous Materials Solar Cooker Contest.

Goal: To design and build a working solar cooker using materials, skills, and tools readily available in any developing nation of your choice.

Many areas in the world need a new type of solar cooker. Pick an area or country and construct a cooker for that culture. Justify the materials and construction techniques you use. Be creative and inventive! You can use whatever materials you want, but keep in mind that we are judging these cookers on their "buildability." In many places, materials common in the U.S. and Europe are unavailable. We'd like you to use your imagination to design and construct a solar cooker without using high-tech components. Styrofoam, aluminum foil, fiberglass insulation, and plexiglass are high-tech materials. Glass, cardboard, and plywood are medium-tech. With exceptions and local variations, many of these materials are too expensive or not available in many developing nations. Scrap metal (kerosene cans), mud, local insulation (straw, coconut fiber, corn husks...), wire, etc are low-tech materials available anywhere.

Keep the construction of the cooker simple. We will give high scores to designs that use simple fasteners and hardware (like bailing wire), and low scores that require high-tech techniques and hardware (like welding or nuts and bolts). Put yourself high in the Andes, or deep in the jungles of Africa. Use your imagination and can-do spirit!

The Rules of the Contest

❶ First and foremost, your cooker must cook. It must reach at least 250°F (121°C) on a sunny day. Interior volume should be large enough to cook a complete meal for six people.

❷ Design, build, and test your solar cooker. We will accept no designs that have not been actually constructed and tested.

❸ Send the plans for your cooker to Home Power Magazine by 1 July 1992. Plans must include a photograph of your assembled cooker and data on how long it takes your cooker to boil one liter of water, with the water starting at 70°F (21°C).

❹ Designs will be judged on (1) performance – how well it cooks, (2) buildability – use of materials, skills, and tools commonly available in the country of your choice, and (3) ruggedness and beauty of design.

❺ The top five final designs will be built by the Home Power Crew for theSolar Cookoff at SEER '92 (Willits, CA on 8 August 1992). If you are a finalist, we will notify you by mail, and you are invited to bring your cooker to SEER '92. Otherwise we will use the cooker we build from your plans in the Cookoff. All entries will cook the same meal in same amounts during the Cookoff.

❻ Winners will be chosen by the Home Power Solar Cooker Contest Judges at SEER '92 on 8 August 1992. You need not be present to win. Employees of Home Power, Solar Technology Institute, and their relatives are not eligible to enter. All designs become the property of Home Power. The winning design will be featured in an article in Home Power Magazine. Home Power promises all entrants that these designs will only be given away and never used for commercial purposes. This Solar Cooker Contest is for our planet, not for bucks!

OK! ***I'm ready to join the deliriously happy solar cooks. Please enter me in the Solar Cooker Contest. I have read the rules above, and here is my entry.***

*Signature:*_____

Please print:

*Name*_____

*Address*_____

City _____*State*_____*Zip*_____

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*telephone number*_____

Please use the back of this tear-out entry form to tell us more about your entry.
You can enter now and send in your cooker data anytime before 1 July 1992.

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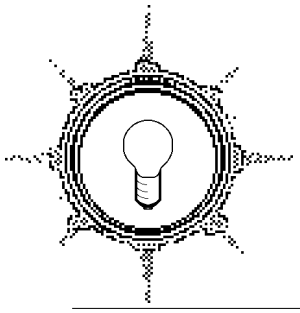

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The following information regarding your usage of alternative energy will help us produce a magazine that better serves your interests. This information will be held confidential. Completion of the rest of this form is not necessary to receive a subscription,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

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

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

☐ **As my only power source**
☐ **As my primary power source**
☐ **As my backup power source**
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I want to use alternative energy in the FUTURE (check one that best applies).

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

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

HP#28

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

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☐	☐	Wind generator	☐	☐	Batteries
☐	☐	Water power generator	☐	☐	Inverter
☐	☐	Battery Charger	☐	☐	Control systems
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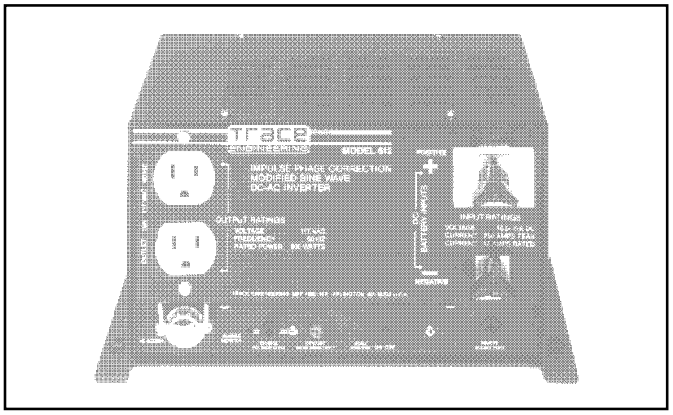
Things that Work!
tested by Home Power



Above: Trace's new 812 Inveter.

Tested by Bob-O Schultze
and Richard Perez

The Trace 700/800 Series Inverters are the kid brothers of the well known and highly respected Trace 2000 Inverters. Due to the availability of more reliable power-handling components, Trace has redesigned and upgraded these machines to deliver more watts out than the earlier 600 Series and they now come in a 24 VDC model also.

Power Inverters
A power inverter takes direct current (DC) electricity and inverts (or switches) it to alternating current (ac). In most home power systems, this means 12 or 24 VDC stored in batteries is changed to 120 or 240 vac standard house power. What we're mainly looking for in a power inverter is efficiency and reliability.

Efficiency is the ratio of output power to input power. An efficiency of 90%, for example, means that 10% of the input power is lost in making the conversion to ac.

Reliability means that the inverter has to work each and every time you use it. It must protect itself and your appliances against "oopsies" like overloading the output, or low input voltage caused by fully discharged batteries.

Packaging and Documentation
If we look at packaging as a means to protect an object while it travels from here to there, the plastic-coated, injected, urethane foam surrounding the 700/800 Series inverters does a dandy job. From an environmental standpoint on the other hand, a maggot wouldn't eat the stuff. 'Nuff said.

Trace owner's manuals are the best in the business. The 25 page 700/800 Series manual is well laid out, easy to read, and contains enough information, graphs, and installation drawings to allow anyone with a nodding acquaintance with electricity to install it safely. A word of warning here. Electricity is wonderful stuff, but it can be dangerous. If you feel that you're out of your depth, get some help from a qualified installer, OK?

The Trace 812SB
Our test inverter had the battery charger (SB) option installed. This is a circuit which turns the inverter into a 25 amp (12 amps in the 724) charger when ac power is fed INTO the inverter from an external source such as a generator. In an RV, for example, this feature allows topping off the trailer batteries when you park in a place where grid power is available.

The charger is a constant current, voltage limited design. It is user adjustable to 14.7 VDC in the 812 and 29.4 VDC in the 724 version. Our test inverter put out 27.0 Amps at 13.9 VDC, slightly better than Trace's specs.

The Controls
In addition to the charger voltage level control, the 700/800 Series features a sleep mode sensitivity adjustment. This circuit allows the inverter to draw very little power when no loads are being run. We measured a 0.025 Amp draw from the batteries in this mode. Not a heck of a lot.

Other controls include an on/off switch and two LED indicator lights. The red LED is the mode monitor which is off when the inverter is off, on when the inverter is on, or blinking when it's in sleep mode. The amber LED

indicates charging when the charger circuit is activated.

Performance

We hooked the Trace 812 up to a 1,500 Ampere-hour, pocket-plate, nickel-cadmium battery. We connected the inverter to this 12 Volt battery with 4/0 AWG cable fed through a 400 Amp Ananda safety switch. We inserted a 500 A., 50 mV. shunt in the negative DC input cable. We measured ac output current with a Fluke 87 digital multimeter (DMM). All measurements were made with Fluke 87 true RMS reading DMMs.

The data speaks very well for itself, well… almost. We used incandescent lamps exclusively for loads to minimize measurement inaccuracies due to reactance. To be completely accurate we should have used RMS reading wattmeters. These little jewels cost about $4,000 each, which explains why we don't have one. Given the switching nature of inverters and the varying voltage and current on the DC input lines, we're likely measuring about 10% lower efficiency than reality at the bottom end of the curve. While we measured an efficiency high of 93.7% and a low of 77.2%, the Trace 812 stayed above 90% from 80 to 450 Watts output. RMS voltage, peak voltage, and frequency remained within accepted variance levels. In fact, the variance was less than you'd find in the average grid-connected home.

TRACE 812SB Inverter Test

INPUT DATA on the 12 Volt DC side			*OUTPUT DATA on the 120 vac side*				*Inverter Efficiency*
Volts DC	*Amps DC*	*Watts DC*	*volts peak*	*volts rms*	*amps rms*	*watts ac*	*%*
14.91	0.02	0.4	0.0	0.0	0.000	0.0	0.0%
15.16	0.29	4.3	0.0	121.6	0.000	0.0	0.0%
13.67	2.30	31.4	164.0	121.3	0.200	24.3	77.2%
13.68	5.20	71.1	162.8	121.0	0.525	63.5	89.3%
13.66	6.80	92.9	162.4	120.9	0.722	87.3	94.0%
13.65	8.10	110.6	161.6	120.8	0.852	102.9	93.1%
13.67	9.90	135.3	161.2	120.8	1.050	126.8	93.7%
13.64	14.80	201.9	159.2	120.4	1.566	188.5	93.4%
13.71	15.40	211.1	160.0	120.5	1.633	196.8	93.2%
13.65	17.35	236.8	158.8	120.3	1.829	220.0	92.9%
13.66	22.40	306.0	158.0	120.1	2.341	281.2	91.9%
13.66	23.70	323.7	156.4	120.0	2.469	296.3	91.5%
13.60	25.70	349.5	156.0	119.8	2.663	319.0	91.3%
13.58	28.90	392.5	154.8	119.6	2.977	356.0	90.7%
13.51	31.00	418.8	153.6	119.4	3.171	378.6	90.4%
13.49	32.40	437.1	152.8	119.3	3.309	394.8	90.3%
13.46	34.50	464.4	151.6	119.1	3.500	416.9	89.8%
13.43	39.90	535.9	150.4	118.9	4.004	476.1	88.8%
13.48	46.70	629.5	147.2	118.6	4.680	555.0	88.2%
13.42	49.70	667.0	147.2	118.4	4.950	586.1	87.9%
13.32	59.50	792.5	142.8	117.9	5.770	680.3	85.8%
13.26	71.10	942.8	138.8	117.5	6.770	795.5	84.4%
13.18	86.30	1137.4	136.4	117.0	7.950	930.2	81.8%

Reliability

As a reliability test, we overloaded the inverter to 930 Watts or 15% above rated output. The inverter powered that load for 18 minutes before shutting itself off. After a short cooling down period, it performed perfectly again. In another reliability test, we hooked the 812 to Home Power's dreaded 1/2 horsepower, split-phase grinder. This appliance has more dead inverters under its belt than any other device we have. While this grinder draws only 5.1 Amps at 120 vac while running, it eats seven times more juice during start-up. The 812 started it every time from a dead stop, even coming out of sleep mode to do it.

Conclusions

For systems with moderate power requirements and short time-period heavy loads, the Trace 812 is a winner. It can get down, grunt, and start loads far in excess of its capacity, yet still provide a good stable waveform for most sensitive electronics. We've saved the best part for last. The price for the 812SB is the same ($650) as the older 612SB that it is replacing! The price of the 812 without the battery charger option is $550.

Access

Manufacturer: Trace Engineering Co., 5916 195th NE, Arlington, WA 98223 • 206-435-8826

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

Things that Work! NRG's Sou'wester and 2100 Totalizer

Things that Work!
tested by Home Power

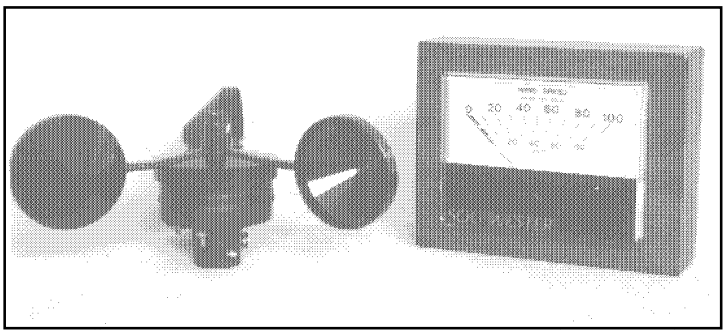
Mick Sagrillo

Inexpensive wind monitoring equipment is getting hard to come by. Last year, NRG Systems introduced two new models to their line of dataloggers: a wind speed indicator and a wind totalizer. We put them both up and let them run over the winter to see what they'd do.

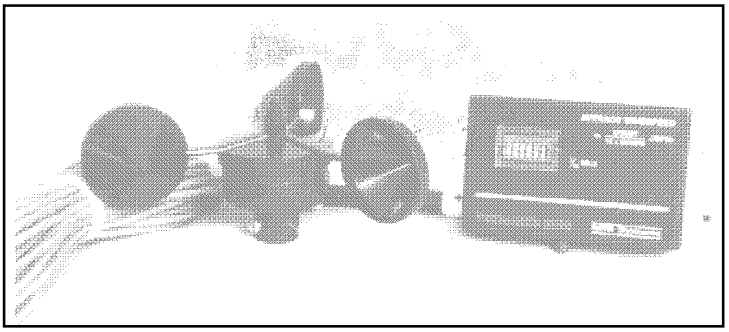
Home Market
Dave Bittersdorf, president of NRG Systems, Inc., explained that, while there are a variety of expensive instruments to monitor the wind potential of a given site, little attention has been paid lately to the home owner. In an attempt to meet the needs of this market, NRG developed the Sou'wester and the 2100 Totalizer.

Both units arrived promptly from UPS, carefully packaged to avoid any shipping damage. Simple-to-follow instructions accompanied each unit.

The Sou'wester
The Sou'wester displays instantaneous wind speed on an analog meter. The unit comes with a Maximum #42 anemometer, a stub mast for the anemometer, and 60 feet of shielded cable. The anemometer should be mounted where it is in the wind: on your wind generator tower, your TV or radio antenna/tower, or on its own dedicated mast or pole. While the unit comes with 60 feet of cable, Bittersdorf told me that the wire run can be as long as 1000 feet, more than adequate for even the farthest installation.



Above: NRG'S Sou'wester Wind Speed Indicator.
Below: NRG's 2100 Wind Totalizer. Photos by Mick Sagrillo



Quality
The anemometer itself has to be the most reliable link in the entire chain. After all, it lives out in the weather and has to make it through whatever Mother Nature decides to throw at it. NRG has opted to use Maximum anemometers because they have a proven track record as THE standard of the industry, a reputation based on their unfailing reliability. The meter is calibrated in both miles per hour and knots, running from 0 to 100 MPH and 0 to 90 knots. Because the anemometer is, in effect, a small generator, it drives the meter. That means that the unit uses no batteries or external power source. In an era of "batteries not included" that's kinda nice!

The 2100 Totalizer
The 2100 Totalizer works on a completely different principle. The totalizer accumulates wind run. In effect, it works similarly to the odometer in your car. The anemometer generates pulses which are counted by the totalizer. The greater the wind speed, the more pulses are generated per unit time. Accumulated pulses are read on the Totalizer's mechanical digital counter. If you know an initial reading and subtract it from a final reading, then divide that number by the hours of running time between the two readings, the answer you get will be the average wind speed for the elapsed time.

The average wind speed for your site can be determined in several ways. You could set the unit up and come back

to it at year's end to figure up the average wind speed. A more accurate average wind speed could be gotten by taking daily or weekly readings. This would be more accurate than the first method because you would know the frequency of your power winds; daily, bi-weekly, weekly. For remote applications, this information is invaluable in determining the battery bank capacity required. Also wind generators do not begin to generate appreciable power at windspeeds under 10 mph. You want to know how much of the time the wind is strong enough to turn the turbine. This data will be lost if your readings are few and far between.

The 2100 Totalizer comes complete with a Maximum #40 anemometer, a stub mast, 60 feet of shielded cable, and a 9 volt battery. Installation is just as easy as with the Sou'wester. The only thing to remember is that, for the most reliable data, the anemometer should be mounted at the hub height of the intended wind generator.

Cost

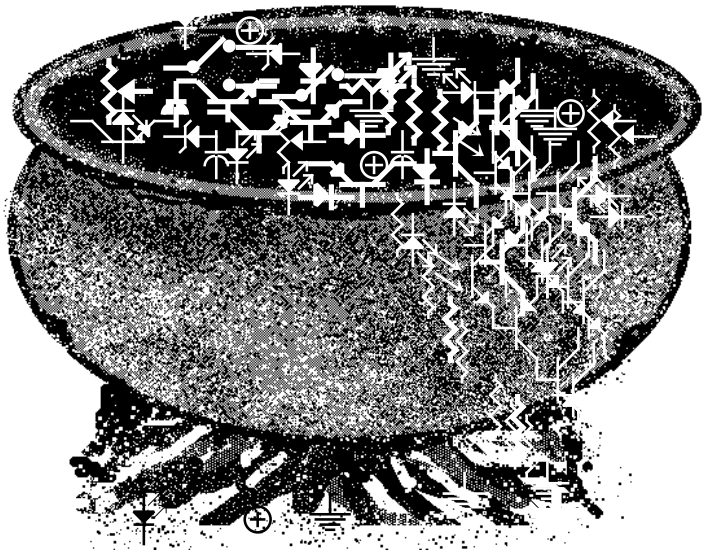
The cost of the 2100 Totalizer is $185 + $5 for UPS charges, anywhere in the lower 48. The Sou'wester sells for $115 + the same UPS charges. If you want both instruments, they can share the same Maximum #42 anemometer (the one that comes with the Sou'wester), and then the Totalizer 2100 sells for only $99 + UPS. Both machines come with a one year warranty. They are available from NRG Systems, Inc., or your favorite wind generator dealer.

Access

Author: Mick Sagrillo continues to search for the Bluebird of happiness at Lake Michigan Wind & Sun, E3971 Bluebird Rd., Forestville, WI 54213 • 414-837-2267

Maker: NRG Systems, Inc., 110 Commerce St., Hinesburg, VT 05461 • 802- 482- 2255

Homebrew



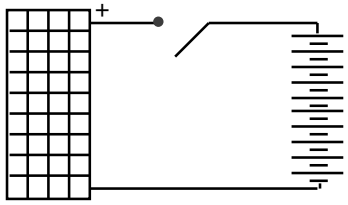
Short Circuit 35 Ampere Regulator

Chris Greacen

Wind, hydro and photovoltaic panels can sometimes produce more electricity than your batteries can handle. Overcharging batteries causes water loss, decreases battery life, and produces potentially explosive hydrogen and oxygen. Without regulation, the system voltage can rise to levels which can fry 12 Volt electronics, including some inverters.

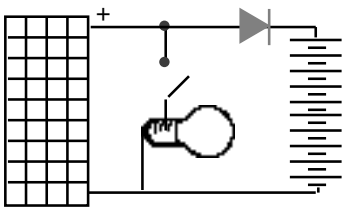
Series and Shunt Regulators

There are two kinds of regulators: series regulators and shunt regulators. Both regulators have a sensing circuit which regulates current flow into batteries when the voltage exceeds a threshold level. Series regulators work by switching off current from the charging source (panels, etc.) when voltage climbs too high. With the charging source disconnected like this the battery voltage sinks to its standing voltage (lower than its voltage under charge). Series regulators are simple, but they have two disadvantages: first, not all power potentially produced by the power source passes through the system. If you monitor the total power put out by your solar panels with an ampere-hour meter, you will see a lower reading when the regulator is "refusing power." More critical, when the load is switched off, generators used in hydro or wind systems can spin too quickly and destroy themselves. This does not apply to solar cells: running them open circuit, or short circuit for that matter, does not hurt them.



series

Shunt regulators work by diverting the current from the charging source into some load other than the battery. In effect they waste electricity, but wasting electricity is much better than overcharging batteries - or frying electronics. Of course if you do have a way to put those electrons to a good use, by all means do it: run that washing machine or that vacuum cleaner, make some toast in the toaster.



shunt

This short circuit regulator is a shunt regulator, but with no load! No bulky, heat producing power resistors are needed. The regulator makes use of the fact that when short circuited, PVs and permanent magnet generators (used in many wind and microhydro turbines) produce a limited amount of current. A short-circuited Kyocera K51 PV panel, for example, is rated at 3.25 Amperes. For comparison, a single 6 V deep cycle battery, when short circuited, produces an unmanageable amount of current (over 6,000 Amps for a few seconds). A power diode between the panel and the battery assures that only the charging source is short circuited and *not the battery!*

How Many PV Panels?

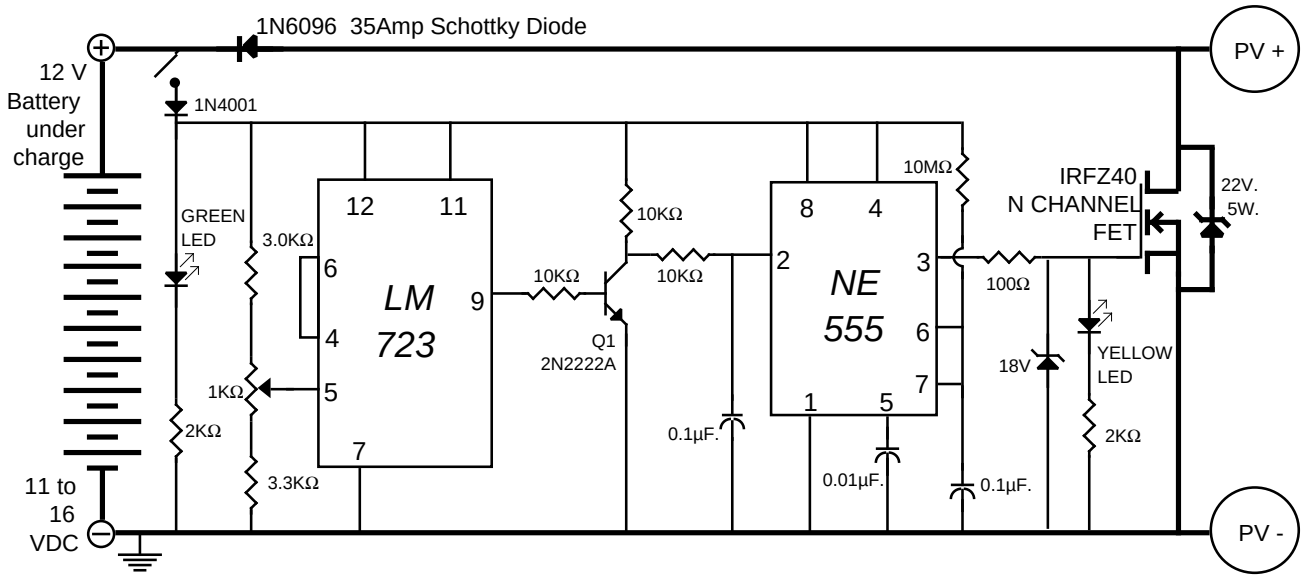
This regulator as designed will handle 35 Amps. Specifying the regulator for PVs is easy: divide 35 Amps by the short circuit current (I_{sc}) of the panel to find the maximum number of panels you can regulate. Actually, under extreme conditions (a cold bright snowy day), a photovoltaic panel will put out as much as 125% of its rated current. If you live where it is ever bright and cold, take this into consideration.

Permanent Magnet Wind and Microhydro Regulation

Specifying this regulator for a micro hydro or a wind turbine driven permanent magnet generator is more difficult. Consider that short circuiting the generator will quickly slow down the turbine, perhaps putting mechanical stress on parts which were not designed to take it. Consult the manufacturer to be sure that short circuit regulation will not harm the machine. Then determine the peak short circuit current by running the

Short Circuit Regulator—

works with PV, Wind, or Hydro Sources up to 35 Amperes



device at normal operating voltage (so it gets up to operating speed), and manually short circuiting it (make sure you don't short-circuit the battery!) Measure peak current and continuous current with a shunt and a recording multimeter. Use this regulator design only if:

- the peak short circuit current does not exceed the maximum drain current (I_{DM}) of the FET you use (160 Amps for the IRFZ40), and
- the continuous short circuit current does not exceed the continuous drain current ($I_{D\ Cont}$) of the FET (51.0 Amps for the IRFZ40).

We tested this regulator on an Energy Systems and Design hydro turbine putting out 2.1 Amperes at 13 VDC, and found that when shorted, the turbine put out as much as 6.8 Amperes for 1 ms.

How it Works

The threshold voltage is determined by the potentiometer on the voltage divider into pin 5 of the 723. When this voltage exceeds the 723's internal reference voltage (pin 6), pin 9 goes high, saturating Q1. The 10kΩ resistor and 0.1µF capacitor assure that the power FET does not make the ON-OFF-ON transition too fast. When the capacitor on pin 2 is discharged to 1/3 Vcc, the 555 is triggered and pin 3 stays high for a time period determined by the resistor to Vcc and capacitor to ground on pins 6 and 7: time ≈ 1.1RC ≈ 1.1 seconds. (Hydro or wind folks, use a 100 KΩ resistor so the permanent magnet motor doesn't lurch). Pin 3 feeds the gate of the FET, protected against over voltage ($V_{gatemax}$= 20 Volts) by an 18 Volt zener. When the gate goes high the FET conducts, short circuiting the PV panel (well, almost: the drain to source resistance is 0.028Ω). Total power dissipation in the IRFZ40 FET for 35 Amps is 34.3 Watts. This isn't much considering you're regulating 8 or 9 panels, but make sure that the FET is well heat sunk. A 5 Watt, 21 Volt zener diode protects against voltage spikes from inductive loads. The two LEDs show what the regulator is doing. The green LED is on whenever power is on. The yellow LED lights under regulation, when the power source is short-circuited.

Construction and Use Information

If you leave out the power diode, or put in it backwards, you will torch the FET in the first millisecond you turn the circuit on, guaranteed.

In the schematic dark lines indicate high current carrying wires. To avoid overheating on these wires use 16 gauge wire or larger. When hooking up your regulator make sure the system's voltage is below 16 VDC since the NE555 is rated at a maximum 16 Volts. The regulator will regulate at voltages from 12.0 to 16.0 Volts.

Access

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

Power FETs and diodes: get the Digi-Key catalog: Digi-Key, 701 Brooks Ave. South P.O. Box 677, Thief River Falls, MN 56701-0677 • 1-800-DIGI-KEY. The IRFZ40 is made by International Rectifier, and costs $4.08 a piece, $34.68 for 10. Schottky Rectifiers: two 16 Amp Schottky diodes in a TO-220 case made by Philips Rectifiers, Digi-Key part PBYR2545CTPH-ND, $3.02 a piece.

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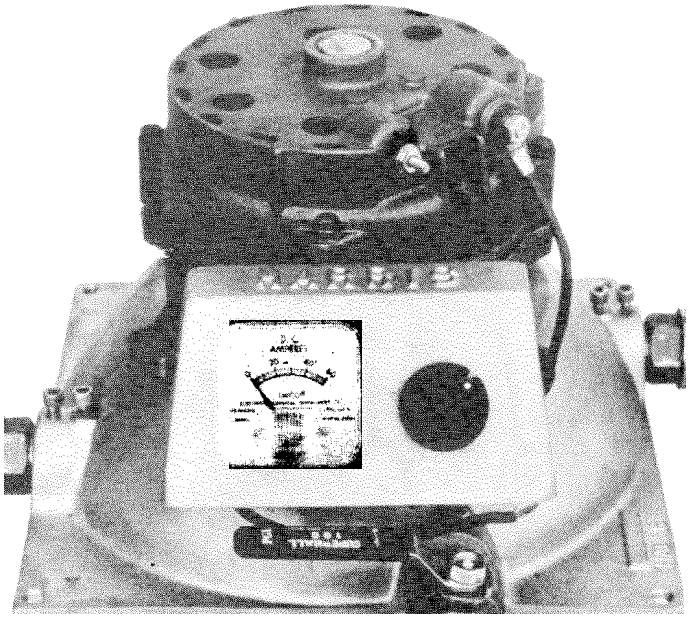

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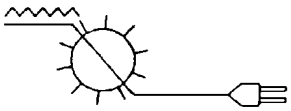

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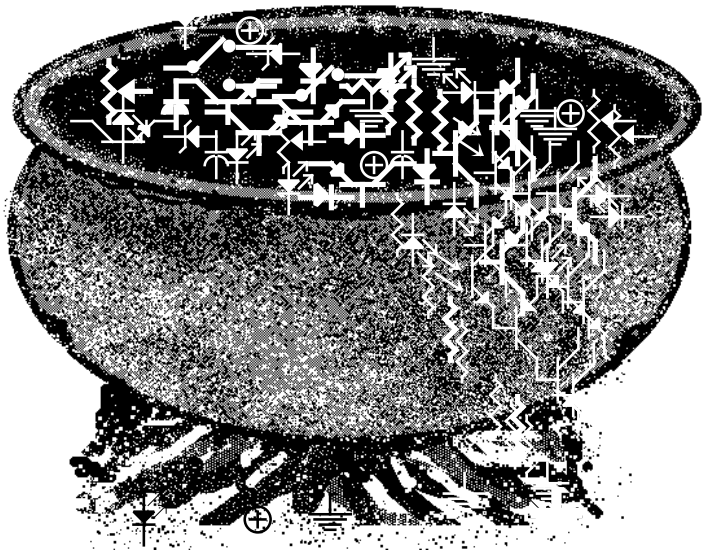


Will The Sun Shine On Your Solar Modules All Winter?

Steve Willey

Most solar module users know that their panels generate electricity only when mounted directly in sunlight. In fact, a shadow on even part of a solar module can stop it from producing power. I have seen solar modules installed by the U. S. Forest Service that were almost completely blocked by trees, because they had considered only the appearance of the building, and neglected practicality.

It seems easy to pick out a good sunny spot for solar modules by just watching shadows outdoors to find a spot that is sunny all day long. But as the seasons change, those shadows become longer or shorter. You don't see the whole picture until you watch for a full season – unless you have a solar siting device.

Winter is the most critical time since the sun is lowest in the sky and shadows are longest. This simple homebrew solar sight shows winter sunshine access at a glance. You stand at the intended PV location and look across the device to see the daily path of the sun in the five winter months, when the sun is lowest in the sky and shadows are longest. Any trees, buildings, or things other than clear sky that are seen to be higher than the edge of the sight will cast a shadow on your spot during those winter months.

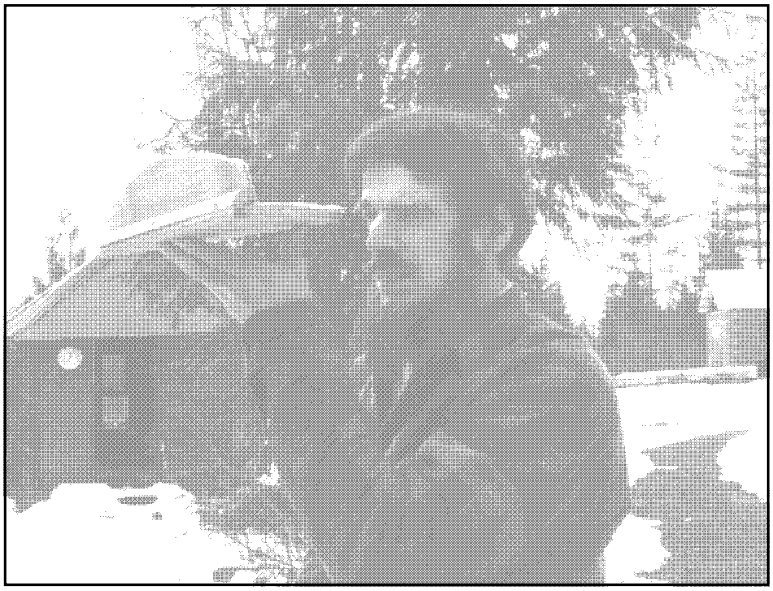
This sight is simple, but accurate enough to do the job. The pattern with this article is shown for one latitude only, but you can build one for other latitudes using Part One dimensions given in the table. The pattern on page 62 is for 46° to 50° latitude (north or south).

Part One Line height for latitudes other than 46°-50°

Angle	45°	30°	15°	0°
Time	8:30 & 3:30	10 & 2	11 & 1	12 Noon
Latitude				
36°	3 1/2"	4 1/4"	4 1/2 "	4 7/8"
40°	2"	3 5/8"	3 3/4"	4"
44°	1 7/8"	2 7/8"	3 1/4"	3 5/8"
56°	5/8"	1"	1 1/2"	2"

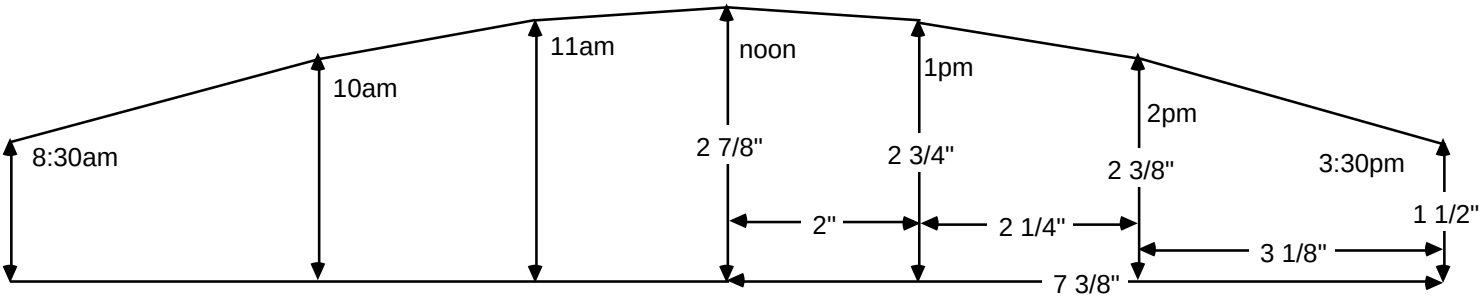
Assembly

The two parts of the solar sight are printed on the next page at half their real size. Cut out pieces of plywood (or cardboard for short term use) to the measurements specified on the pattern (or the table above depending on your latitude). Copy the converging lines onto Part Two and press in a thumbtack where the lines come together to a point for easier visibility. Copy the hours of the day onto Part One. Join Part One at a right angle to Part Two at the dotted line. The joint can be made sturdy by gluing in a piece of quarter-round moulding on the back side (see photo). Elmer's wood glue works great; do not use screws or nails unless they are brass, because they may affect your compass.

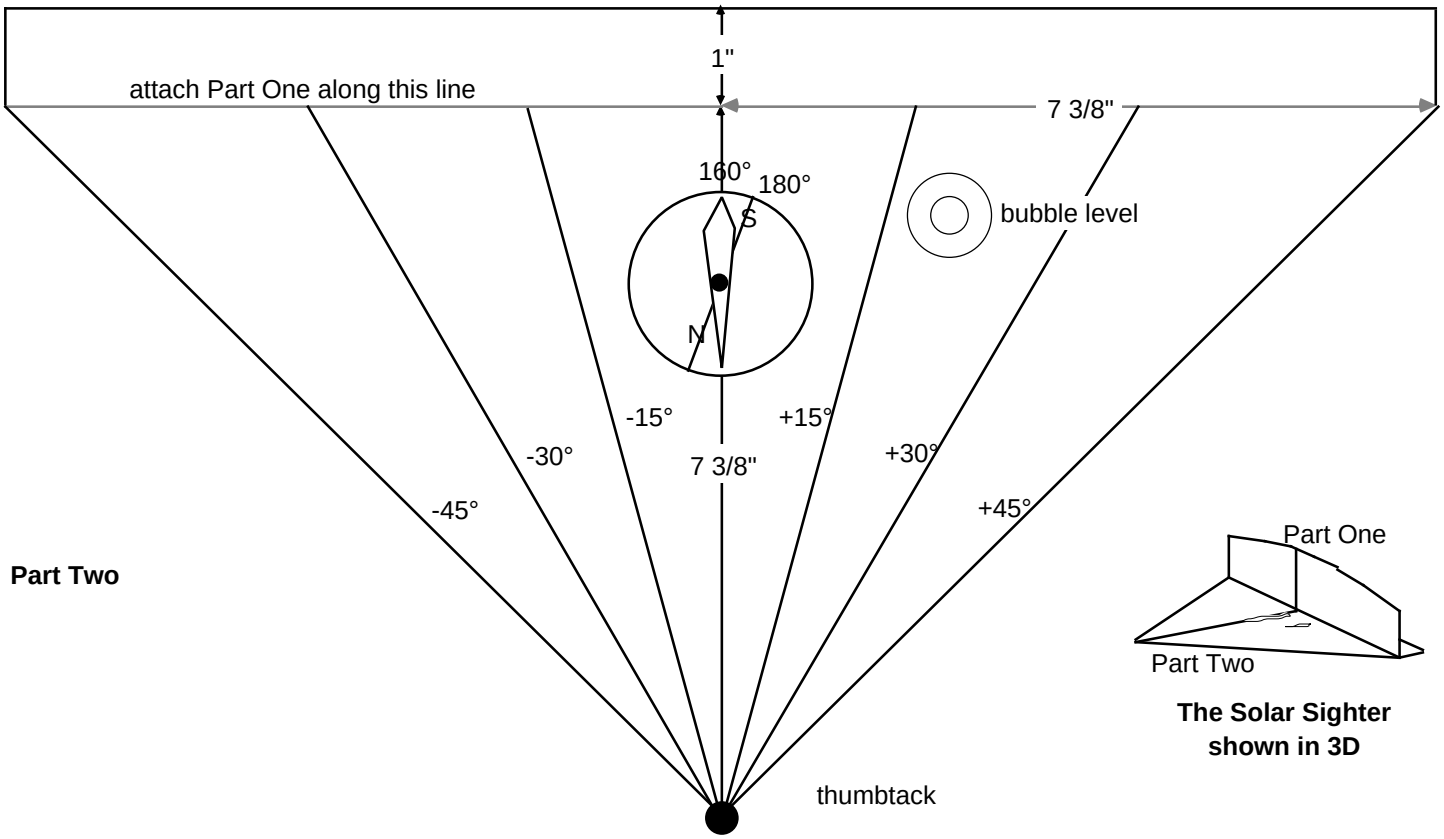


Above: Steve Willey uses his homemade Solar Sight at his home in Sandpoint, Idaho. Photo by Elizabeth Willey

Part One



SOLAR SIGHT PATTERN
shown 50% of real size



Part Two

The Solar Sighter shown in 3D

To align the sight, a compass and a bubble level should be glued on the triangle surface. Round bubble levels are available that mount flat on a horizontal surface and have one bubble that you line up in a central circle for leveling in all directions at once. Look for one in hardware and recreational vehicle stores.

Just about any compass will do, but don't believe the markings on it! True south, or solar south, is the direction of the sun at noon (don't be fooled by Daylight Savings Time). In the northwest U.S. true south is a full 20 degrees left of magnetic south shown on the compass. To point true south, just mount the compass with south mark 20 degrees right of the 0 degree line on the sight as shown on the pattern. Then when you hold the sight so that the needle points to S on the compass, the sight points to the real south. It is just the opposite on the east coast, with true south 20 degrees right from magnetic south. In mid-North America, magnetic south is right on true south. A call to local surveyors will get you the right correction angle for your area.

Using the Solar Site

Hold the sight level, with the 12 noon center line facing

true solar south. Put the head of the thumb tack in front of your eye and gaze up across the top edge of the site. Be sure you are looking right along a straight line starting at the thumb tack and rising to the upper edge of the sight, where the time of day is marked, your eye always level with the thumb tack. What you see just over the edge approximately represents the sun's path in November, December and January, at the time of day shown. Mentally add 1-1/4 inch to the height of the sight to see the sun's path in October and February. Any trees or mountains or buildings that you can see above the curved sight edge will cast a shadow on you in those months. Ideally, you want to see only sky.

Access

Author: Steve Willey, Backwoods Solar Electric Systems, 8530 Rapid Lightning Creek Road, Sandpoint, ID 83864 • 208-263-4290.

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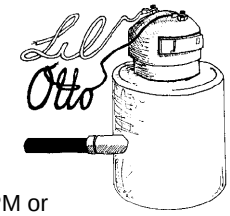

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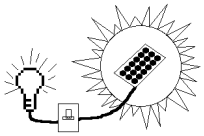


ECS
camera-ready

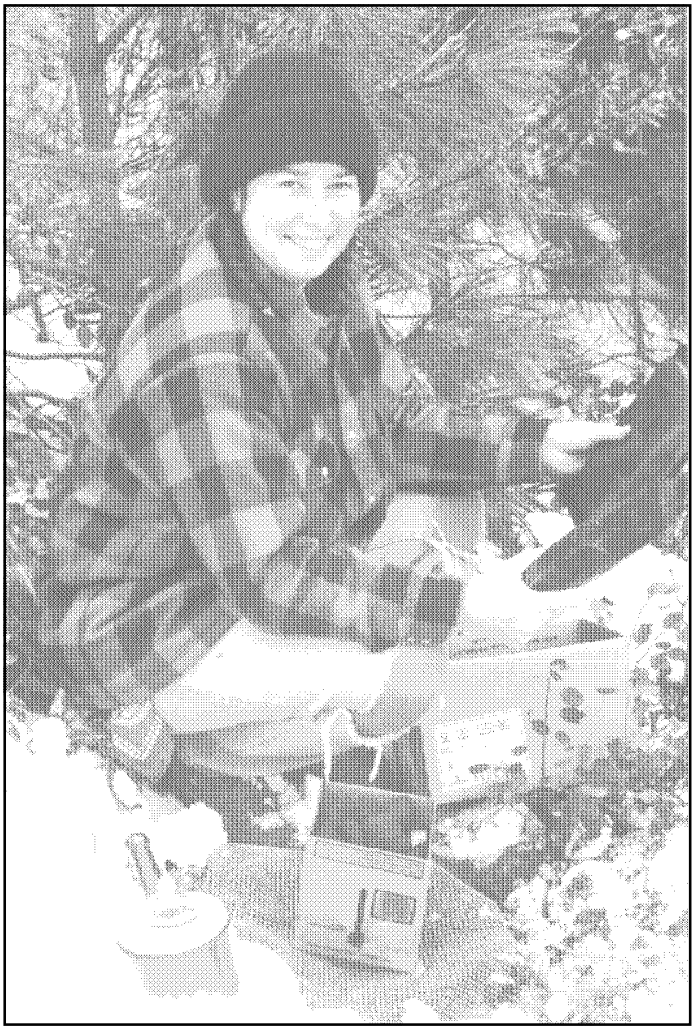
Things that Work!

Things that Work!
tested by Home Power

Camp's Fire™ Bar-B-Que Box

tested by Kathleen Jarschke-Schultze

When we received the Bar-B-Que Box to test, it was too late in the season to use for cookouts at the lake. Another use suggested by the retailer was emergency cooking. Alright then, I could put together an emergency kit for my car, just in case I was trapped in the snow and couldn't keep myself warm with the engine, for fear of asphyxiation. We had some Brown Marys (MREs – Meals Ready to Eat) left over from working forest fires in 1987, so I figured I could set up a fairly good mock emergency test.



Above: Kathleen cooks up a storm with the Bar-B-Que box. Photo by Stan Krute

Packaging

The BBQ Box is tidily encased in clear plastic wrap and measures 6 x 6 x 6 inches. There is cardboard on four sides and it's open on the top. Two sides have vent holes. A third side has a vent hole with a wick poking out. This is taped securely to the side of the box. The box contains no petroleum, but contains mesquite and hickory briquets. The packaging is small and clean, and weighs 2.75 lbs.

Documentation

All the documentation you need is on the box. Since it is sealed in plastic, the instructions will be there when you need them. The BBQ Box is described as a Self-Starting, Complete Bar-B-Que Fire Unit. The instructions are extremely simple. 1. Remove plastic wrap. 2. Place basket in center of grill. 3. Light exposed wick on side of box. 4. Begin cooking when basket burns away and charcoal is hot, about ten minutes. There is also the obligatory warning not to use this product in an unventilated area.

Testing Grounds

We live in the Siskiyou Mountains and must cross a high pass to get to town. I own a 4-wheel drive station wagon which, in the winter, also has studded tires. Still, there have been times when the prospect of getting back home through a blizzard has been dicey, at best. A winter test up on the pass seemed like a good rugged test for this product. If the BBQ box survived this test, then a cookout at the lake would be a picnic.

I assembled a small box of essentials to carry with me in the car. It included three Brown Marys, two clean shop rags, one piece of hardware screen (folded), matches in a waterproof container, one soup spoon, teaspoon and fork, a small saucepan with lid, a folding shovel and a two liter plastic bottle of water. This all fit into a small cardboard box that took up very little space in my car.

Performance

We went up into the snow, where Stan and I gave the Bar-B-Que Box a real workout. By bending the screen flat, then bending the corners down, I was able to make a bed for the box. I cleared a patch of snow with the shovel and set down the screen. After removing the plastic from the BBQ Box, I struck two matches together and lit the fuse. It started right up. In fact, it was like a fuse on a cartoon cannon. It glowed and hissed even after it burned down inside the box.

The instructions said it would take ten minutes for the coals to be ready. Under the test conditions it took 25 minutes for the coals to be ready to cook on. During that time I opened the Brown Mary and ate the freeze-dried peaches and the peanut butter and hardtack. I gave Stan the "cookie, chocolate covered." After depositing the "beef slices in barbeque sauce" into my small sauce pan we waited another ten minutes for the coals to be just right. The fire was quite hot. The pot began boiling in two minutes. If it had been a real emergency fire for heat purposes, I would have kept some briquets out and added them as necessary to keep the heat longer. There were about 40 briquets in the box and that was plenty for any cooking purposes. We each took a bite of the cooked food, for testing purposes, but we gave the lion's share to the dogs.

Feasibility

The Bar-B-Que Box costs $3.50 each. It is tidy, compact, and efficient. I like that it doesn't use petroleum products. Quick, easy, inexpensive, and it works. That just about covers all my prerequisites. I like it a lot and look forward to this summer at the lake for some hassle-free cooking.

Access

Author: Kathleen Jarschke-Schultze, c/o Home Power, POB 130, Hornbrook, CA 96044

Bar-B-Que Box Maker: Bob Taylor, 4770 Orseth Rd., Poulsbo, WA 98370 • 206-697-3685

Black Lightning
camera-ready

Energy Comes in Different Flavors

Therese Peffer

To some, energy is measured in BTUs and kilowatt hours. To others, energy is the stuff that allows us to move about in the morning; the food in our bellies refuels us for another day. Energy warms the earth, makes plants grow, lights our lamps, heats our tea. Energy comes from different sources. Here at Home Power, we throw around many descriptions of energy depending on its source. What do the various terms mean?

Alternative Energy

One term is alternative energy. "Alternative to what?", you might ask. We mean alternative to the "norm", the centralized utility-powered grid. In Northern California, Pacific Gas & Electric supplies energy in the form of electricity and natural gas. Electrical energy is usually measured in kilowatt-hours. If you live on the grid, your utility charges you by the kilowatt-hour every month.

Those living off the grid in a recreational vehicle or on a site remote from the power lines are using alternative energy to power lights and heat food. We are our own utility, and generate and store our own watts of electrical power. The sources can be photovoltaic modules, wind generators, water turbines, or diesel or gasoline generators. We use batteries to store this energy for use at other times. Propane or kerosene can be used for cooking or lights. The word alternative doesn't mean settling for second best, it just means we can have electricity off the grid. The generation of energy brings us to another definition: renewable energy.

Non-Renewable versus Renewable Energy

What does it mean for energy to be renewable or nonrenewable? The source of energy can be used up in the process of making energy, never to be used again. This is non-renewable energy; examples are coal, oil, and gasoline. Millions of years ago, organic matter such as algae fossilized under the right conditions to leave pools of oil beneath the earth's surface; the Middle East had more favorable conditions than the U.S.! The oil is pumped from under the ground, refined, and made into various substances. Some are used for energy such as kerosene and propane for lights or cooking stoves, and gasoline for automobiles. These fossil fuels are nonrenewable sources – once the fuel is used up, that's it.

Other centuries-old sources of energy don't get used up and are called renewable energies. The sun, wind, and water are a few examples.

Folks have used the sun to warm their bodies and shelters and wash water for thousands of years. The sun's thermal energy can be used for cooking and heating water, and is exploited in the design of houses for space heating.

The sun can be used for another energy, to generate the flow of electrons or electricity. Photovoltaic cells harness light (photo) to make electric potential (voltaic) form in certain materials. The primary material used in PV cells is silicon, which is made from sand, one of the most abundant materials on earth (see HP #23).

The wind is another source. Wind turbines are used to pump water and to generate electricity.

Flowing water is also a renewable source of energy. Streams and rivers have been used to grind grains for centuries and are still used to transport things and generate electricity.

The sun, wind, and water are renewable sources of energy. The sunshine is not diminished no matter how many solar panels are up. The flow of wind and water is not used up by the turbines. The sun shines, the wind blows, and the water flows and will continue whether or not we tap their energies.

Not all alternative energy is renewable, and vice versa. Many RVers and we folks living in the country use gasoline generators, either full time or as a back-up; this is alternative energy, but not renewable. While many utilities in the U.S. use coal to produce electricity, some use hydroelectric power or wind.

Sustainability

Another word to add to our vocabulary list is sustainable. To sustain is to last, to withstand, and maintain. What is a sustainable energy? Energy that is sustainable is more than just renewable. Sustainable energy does not jeapardize the ecosystems in which it operates.

Sustainable energy use is good for *all* of us. And by all, I mean the air, water, land, plants, humans, and other animals on this earth. There are no easy answers – what some people consider sustainable for them may not be for others. Some examples:

Oil is not renewable and cannot sustain our society. Once oil is burned, that's it. We have only 30 - 60 years of oil reserves at the current rate of use and present efficiencies. Fossil fuels have a bad environmental track record. As with any industry, we must trust the manufacturers to be responsible and not endanger the environment or population. But there is the inevitable oil spill on land or water, and air pollution due to oil fires. Go ask a Minnesotan what a gas-powered speed boat would do to the tranquil Boundary Waters. As for air, any person from Los Angeles could tell you that using gasoline to run our cars contributes to air pollution. Smog is unhealthy to breathe and hides the beautiful San Gabriel mountains. And lately we've been hearing about the greenhouse effect due to carbon dioxide released from burning oil.

Our current lifestyle cannot sustain the use of oil as our primary source of energy. We can conserve more, and drive efficient cars or ride bicycles, busses, or trains – maybe the oil reserves will last into the century after next. So why don't we all drive hydrogen-fueled cars or solar-electric vehicles and conserve more? Oil and gasoline are cheap, thanks to government subsidies, and easy to transport, and gosh, we've been doing it for the last century anyway. But wouldn't it be nice not to import our major source of energy, and not mar the beautiful coast with oil wells?

Another source of energy is wood. Is cutting down trees for wood burning stoves a sustainable activity? Wood is renewable in the sense that trees grow back. Whether it is a sustainable practice depends how the cutting and replanting are managed. If so many trees are cut that the top soil erodes away, sediment clogs the streams, and wildlife disappears, then certainly this is not sustainable. Some wood burning stoves release more pollutants than others. There are other forms of heating, and good design can help conserve. We must also consider that wood has other uses, such as construction, furniture, and paper. Alternatives look promising – most paper used to come from hemp (don't laugh). There are countries now reconsidering this fast growing option to wood pulp.

The next example is large scale hydroelectric such as the Hetch Hetchy hydroelectric dam in northern Yosemite National Park in California. Hetch Hetchy Reservoir supplies the San Francisco area with water and Northern California with electric power. Hydroelectricity is certainly a renewable form of energy as long as the snow and rain continue to fall, but is it a sustainable source of energy? John Muir, a naturalist and "father" of Yosemite, would argue that Hetch Hetchy is not sustainable for environmental and aesthetic reasons. A beautiful valley was covered when the dam was built. Many hydroelectric dams prevent salmon from returning to their spawning ground, and young salmon heading downstream may be killed in the turbines. The salmon have all but disappeared from the Columbia and Snake Rivers in Oregon. Can large scale hydroelectric be a sustainable source of energy? Some argue that it can be sustainable – design stairs for salmon, the energy is worth the cost. Others say it cannot be sustainable.

Photovoltaics are a renewable source of energy, but is it sustainable? Depending on the manufacturer of the PV modules, the process can be benign or harmful to the environment. Some of the materials used are toxic; the same case can be made for batteries. It's our responsibility to buy from responsible manufacturers who treat and recycle the toxic materials.

What flavor is your planet?

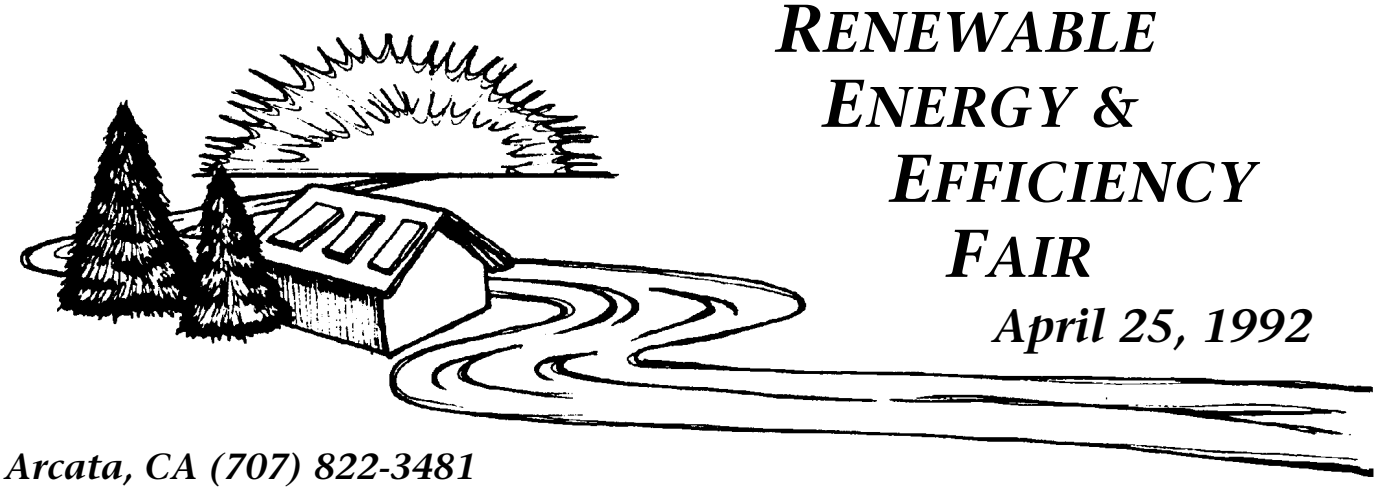
Defining what is sustainable is not easy; sustainable can apply to resources and economics as well as energy. The word reflects a spirit or attitude – we're all in this together! We can maintain our livelihood while respecting the right of other species to coexist.

Sustainable activities endeavor to work with the process of nature and not against it. Obviously people have some impact on the environment, but we have a choice as to whether this impact is a crushing blow or a light step. We've developed land and built buildings, and introduced new plants and animals that affect the land. But there are choices. Buildings can be made with materials native to the land, a material the land can sustain without our great grandchildren noticing its loss. Agriculture can use pesticides or not use pesticides; consumer choice plays a role here. Cars and buildings can be designed to use much less energy. We can produce energy from sources that will be around for generations to come, and not pollute the air, water, and land.

Energy is certainly necessary, but the source – the flavor – is our choice. Some flavors are tasty in terms of the price tag, but don't smell or look so good. What we taste now determines what our great-grandchildren will have – we may need to refine our palate.

Access

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



RENEWABLE ENERGY & EFFICIENCY FAIR

April 25, 1992

Arcata, CA (707) 822-3481

Nestled among the majestic Coastal Redwoods of Northern Califronia, Arcata, in its innovative tradition, will host Humboldt County's first annual

RENEWABLE ENERGY & EFFICIENCY FAIR
on Saturday, April 25 1992.

The event will coincide with a national effort named "Sun Day 1992 – a campaign for a sustainable energy future."

The fair will display renewable energy and energy efficiency applications:

- small hydro power
- solar electricity & water heating
- solar cooking
- active and passive home heating
- efficient lighting & refrigeration
- alcohol & hydrogen fuels
- electric vehicles

  and more!

Workshops will be held on many topics. Music and speakers will be interspersed throughout the day using a solar powered sound system.

The fair site will be at Redwood Community Park, located in the hills above Arcata near Humboldt State University. The park has access to trails among the redwoods, sunny lawns, and a wonderful children's playground. Lots of activities are planned for kids!

Sponsors and Contributors: KATA / KFMI, PG&E, Solutions, Energy & Resource Advocates, Sunfrost, Redwood Alliance, Yakima Products, Fossil Fuels Policy Action Institute, Citizens for Social Responsibility, Campus Center for Appropriate Tech, and the City of Arcata.

We invite you to participate at REEF and join us in a more appropriate energy futur e!

RENEWABLE ENERGY & EFFICIENCY FAIR

P.O. Box 4179, Arcata, CA 95521

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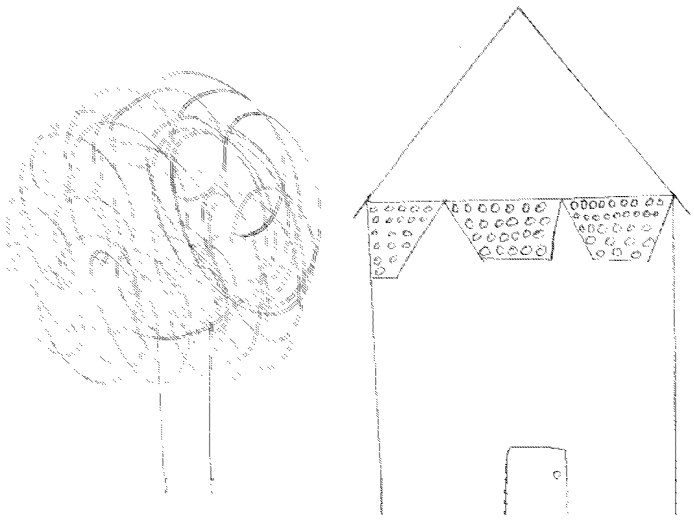
Kids Corner

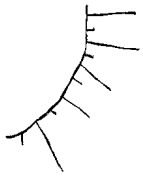


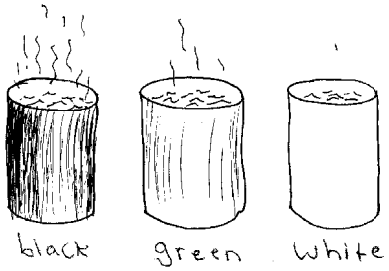
Anthony Mg

Dear home Power

today in our solar power class two new people came with Brad Rose there names are Cary lane + Lisa lane They showed us a solar kit. It was a modle of houses + cows. There were six tiny solar panels on the modle. when the sun shinned on the solar panels it made electricity and a radio would turn on. when you shade the panels the radio would turn off. They also had a Ball that would float to the top of a tube. That also had a solar panel a small one too. when it faced the sun a fan would turn on and that is what made the Ball go to the top.

ALENA





Brad Rose brought a parabolic trough and a thermal syphen system. They both heated water. The Parabolic trough heated water in a hospital. The parabolic system got heated by sunlight hitting the 2 sides And the middle bar got very hot. Some boys spit on their hand and put it on the bar. It made steam.

Christina

Brad Rose came today he brought two guests. there names are Cary And lisa lane. They brought a photovoltaics kit And a blower fan. They also brought 3 cans with water in them. The colors of the cans were black, green, And white. The black can was The hottest. The green can was medium. The white was the coldest. Today was Really fun.

Sincerely yours, Jennife T.

Mr. Rose brought a Parabolic Frough that heated up water with the sun hiting glass and hited a coper pipe that heated water and also brought a thermal syphen system is where is there is a panel and It heats up water also if you put the tank on top of it it will cercleate by its self.

Scott

We want to hear from you kids!! What are you learning about the sun's energy or the environment? Send us your drawings and words, and we'll print as many as we can. Thanks, Penasco, New Mexico Kids! Therese and the rest of the Home Power Kids

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Evening: Greg Brown (Modern Folk)

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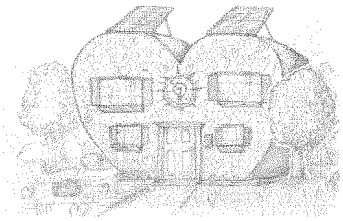
Home & Heart



Kathleen Jarschke-Schultze

One of the best things about writing this column is the readers. I love hearing from people and my readers do respond. There is so much information to share, I love being part of that.

Solar Food Drying

Wow! Did I get response from my request for solar food dryer designs! I got information, plans and designs from six readers. So much that I can't cover it in Home & Heart. To give myself time for assembly and testing and room for details, this subject will be covered in a whole devoted article in the next issue. I really want to thank all who responded. I really appreciate it and my other readers will too.

Growing Great Garlic

That's the name of a book I have just finished reading. It's a great book for anyone who grows garlic for any reason. Once again one of my readers, George Gillies, bless his heart, sent me the access information on Ron Engeland, garlic guru.

Bob-O says it's easy to put too little garlic in a dish and hard to put too much. I cook by that philosophy. I've been growing garlic on a small scale for six years. After reading Ron's book I've realized that I don't know half as much as I thought I did. How did this guy learn so much about garlic? By experience, the best teacher.

You may find it hard to believe a book on garlic can be fascinating, but this is. Ron covers the history of garlic from ancient to present. The types, varieties and sub-species known and grown. He and his wife grow over 200 strains of garlic at Filaree Farm. They are certified organic growers in the state of Washington. He sells seed stock and has a catalog available. But order early, because he always sell out. If you are a gardener at all this book will make you want to grow garlic. Oh, if only I had had this book when I started gardening, years ago. But, I have it now.

Pests and Predators

Spring has come early to the creek this year. I already feel like I am behind in my gardening. I have started some seedlings even though our last frost date is May 15th. I seem to have all the pests that are the hardest to get rid of. Whenever I ask any other gardener about deer, gophers, grasshoppers or earwigs they just shake their heads and say they're sorry. I will be putting up a fence around my garden this year to keep the deer out. I don't know what to do about the gophers. I have heard that turkeys are very good grasshopper controls, but I'm afraid the skunks and coyotes will be good turkey controls.

Also, I was told if I would just roll up newspaper into tubes, then dampen it and set it in the garden in the morning I could empty the tubes of earwigs into a bucket of water with kerosene on the top. Probably soap would work just as well. I am certainly going to try that this year. The earwigs were terrible on my potatoes, last year. Any other organic solutions are very welcome.

Readership

Readership is a vessel that carries me around the world every issue. The letters, phone calls and visits we receive from our readers enrich our lives tremendously. We have subscribers on every continent. Yes, even Palmer Station in Antarctica. Susan Butcher, four time winner of the Iditarod dog sled race, who is one week into this year's race as I write this, is also a reader. Former President Jimmy Carter reads Home Power. People all over the country, all over the world share this with us. We hear bits and pieces of their lives and it is always so interesting.

One of our readers lives on the Snake River in Idaho and gets his mail delivered once a week by boat. Except in winter, when the mail call is sometimes delayed for weeks. Another reader, Jonathon Sutton from New South Wales, Australia was in America so he brought the family by for a visit this fall. Then there are the readers in Willits and Wisconsin who are so inspired they create energy fairs which in turn inspire us. Thank you.

Light Fantastic

Grizzly Bear brought me a gift last time he visited. Actually a couple of things. One was the new Light of America instant-on fluorescent. It is a model #2022 energy saver, 22 watt electronic circleline fixture with a replaceable bulb. What is so nice is that it is instant-on. No more standing there in the doorway waiting while the light flickers until it warms up.

Another neat thing he brought that goes with the circular light is a "Light Diffuser." It is made by Lights of America too. Called an instant light fixture, it comes with a mounting kit. It fits right on the circular bulb and looks just like a regular ceiling fixture cover. That's right, my dining room doesn't look like a shop anymore, with bare bulbs

hanging out. The Diffuser only cost $6.95 and it looks great. When we tested it with Bob-O's light meter there was essentially no difference in the amount of available light. I am getting more as soon as I find out where to get them. Our Wal-Mart has the Instant-On LOAs, but not the Diffusers. Check your hardware stores.

Thermomax

We finally got our Thermomax solar hot water heating system on line. It looks like something right out of the future, and it is. It works real well here, even in winter. It is an evacuated tube design that is manufactured in Northern Ireland. They are used quite a bit in England where the sun does not necessarily shine a lot. The neat thing is that it will work on hazy days or even days when the clouds pass in front of the sun a lot. Solar heated hot water is very hot. I have been thinking about getting a sign for above my kitchen sink. "Caution – Solar Heated Water – May exceed temperatures of 150°F." Really. I used to wash my hands and just turn the hot water on because it would take a while to heat up and I could just finish with hot. Now I have to turn on the cold water too because the hot water tap heats up so fast and to such a high degree. The washing machine loves it though. Showers are more enjoyable too, just knowing that it is solar heated water.

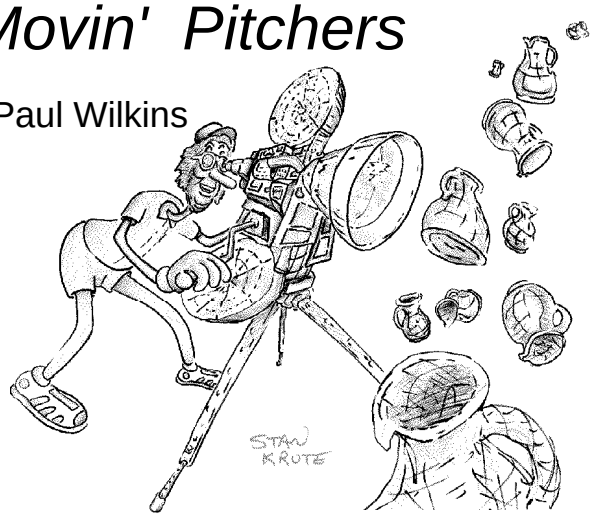
Access

Garlic Stuff: Growing Great Garlic - $12.95 + $2 S&H WA res. add tax. US funds only. Garlic Catalog & Research Journal - $3 from: Filaree Productions, Route 1, Box 162, Okanogan, WA 98840 • 509-422-6940

Author: Kathleen Jarschke-Schultze writes, reads, and weeds at her home on the creek c/o Home Power, POB 130, Hornbrook, CA 96044 • 916-475-3401

Movin' Pitchers

Paul Wilkins



Siemens Video

Siemens Solar Industries' *World Of Solar Electricity* is a nifty propaganda video for PV, with good music and graphics. It starts with materials, goes to Africa to show water pumping for irrigation and a local telling Aid organizations: "Give us solar pumps, not diesel."

Next we briefly see vaccine refrigerators, lighting systems, and cathodic protection for pipe lines. This is followed by several communications systems in South America and the U.S., and navigation systems from buoys to light houses in Sweden. Next we get module testing, and how Siemens exceeds the Jet Propulsion Laboratories (JPL) standards and UL testing.

Gene Hitney of Hitney Solar Products takes us on a tour of a remote home in central Arizona. It is a 48 volt system with a 5kw inverter. The house has all the features of a 20th century home. The lighting is 48 volt and the rest of the equipment is 120, right down to the evaporative cooler! I have known Gene for a few years, he has consistently designed and installed excellent systems.

There is a custom subdivision in Carlsbad, California, near San Diego. It was built few years ago with 1 KW grid connected arrays on each roof. According to the video these homes are saving 25% to 35% on utility bills in an area with some of the highest rates in the U.S.

John Long built a 24 home subdivision near Phoenix with a 200 KW array to power the whole place. The homes are rammed earth (not mentioned in the video), and very energy efficient. If the owners are reasonable power users they can come away at the end of the year with a $00 utility bill. All excess power from the array is sold to the utility. John Long is planning a PV-powered *town* north of Phoenix.

The video makes the questionable claim that Siemens built the LUGO, Carrizo, and SMUD utility scale PV systems. LUGO powers 300 to 400 homes, while Carrizo's 6 megawatts powers 2000 homes. The fact is ARCO Solar built LUGO and Carrizo. Siemens declined to buy these plants when it bought ARCO a couple of years ago. Another fact is that the utility companies involved don't want to pay a price that gives the new owners of LUGO and Carrizo a reasonable profit on their investment. So Carrizo Solar is selling the modules (16-2000's, M51's, and the famous Quad-Lams) from these former utility stations to dealers and distributors.

The last segment is on thin films for PV and their PV-powered yard lighting. The fact is, so far, thin films have not made a dent in retail PV. In a telephone call, Siemens informed me that in recent versions of the video the thin film section has been edited out. They are not working on thin films any longer.

If Siemens would edit the audio about Carrizo and LUGO... Other than this, I recommend this tape for teachers and others interested in PV. The music is nice, the production values are good and the explanations on how systems work is very clear.

SunAmp Video

SunAmp Power Co's *Solar Power And You* is a 15 minute video that shows the basics of how systems work then goes on a world tour of applications from navigation to refrigeration, hospitals to homes. I like it. It is educational, showing that PV is here now and affordable. It is partially a SunAmp ad, but what company would make an expensive production and not plug themselves? The dealer price is $14.95 and list price is $18.95.

Basic Stuff

If you are interested in learning about video production equipment, from VHS to 8mm, cameras to editing, go to your local magazine store and get *Videomaker* magazine. It has always had things of interest to me: practical how to information, evaluations of equipment, Q&A, and lots of advertising.

Solar Powered Video?

Sure. I have been using two methods that work: a Sovonics (now United Solar Systems) fold up module that puts out about 5 Watts, and takes 5 or 6 hours to fill my 2 Ampere-hour battery. The fast way is to use the tuner that came with my recorder (I still use a camera and separate recorder) and a 100 watt Statpower inverter off my house or RV batteries.

Format

You can go nuts here. VHS is the most common. S-VHS

is an expensive higher quality picture variation. If you want to do good quality video, S-VHS has the best resolution and lots of good editing and post production equipment. It is sometimes referred to as "industrial equipment." VHS-C format is for small cameras that do not record as long on standard play and have an adaptor so they can be used in standard VHS machines. 8mm and HI-8 take great pictures, but you cannot edit their sound in their native format without changing the video or vice versa. This has to do with the audio signal being mixed with the video signal and recorded on the same tracks as the video.

More and more HI-8 equipment is becoming available, Sony just introduced an editing machine; others are making or working on editors, titlers, etc. I would have a hard time at the present deciding between S-VHS and HI-8. Budget and camera size would be my deciding factors. If I could have both I would.

Another small detail: cameras that you hold in front of your face, all small formats, tend to wobble around more than full sized cameras that you can rest on your shoulder. Smooth motion is valuable. Use a fluid head tripod that has leveling bubbles to make your setup quick and accurate. Even being 5 degrees off will drive your audience to distraction. Fluid head tripods let your camera move smoothly in all directions. When you are looking at tripods check the knobs that lock the head in place. Does the camera move when you lock or unlock them? Look at another tripod!

Generations

First generation is what you shoot. Second generation is what all your 1st generation gets edited into, and 3rd is what you copy from 2nd to send to your friends. And herein lies the rub. Each time you copy you lose quality, regardless of format. This is an excellent reason to script your shooting and make your first generation as perfect as possible.

Well, I have learned a few things in the last few years:

- Three generations maximum using VHS
- Copies from long play or super long play don't look very good, even 2nd generation
- Use a tripod as much as possible, don't rush things
- If you have access to a community college that has video training, sign up, it can give you access to editing facilities.
- If you can afford S-VHS do it. The resolution is better and so are copies. You can do your work in S-VHS, then make copies on standard VHS.
- Use quality brand name tapes. Cheap, house brand tapes have a reputation for not looking good, and shedding material onto your player's heads and screwing them up.
- Read, talk to other video users, and read some more.

Many towns have commercial editing facilities that rent editing suites by the hour. If you know how to use their equipment, they charge one price; if they train you it is another price. They usually have the latest technology in editors, sound equipment, titling and special effects. After you do your shoot, you can rent time and make good copies. The advice and instruction are well worth the money spent. One editing suite can cost $15K to $30K in equipment. If the price to rent it seems high, that's why.

Access

Author: Paul Wilkins, 2303 Cedros Circle, Santa Fe, NM 87505 • 505-473-1067.

Siemens Solar, POB 6032, Camarillo, CA 93010

Sun Amp Power Co., 1902 N.Country Club Lane, Scottsdale, AZ 85201 • 800-677-6527

Videomaker, POB 558, Mt. Morris, IL 61054. $22.50 for 12 issues. Editorial and letters go to 290 Airpark Blvd, Chico, CA 95926

The Hydroponic Hot House: Low-Cost High-Yield Greenhouse Gardening

by James B. DeKorne

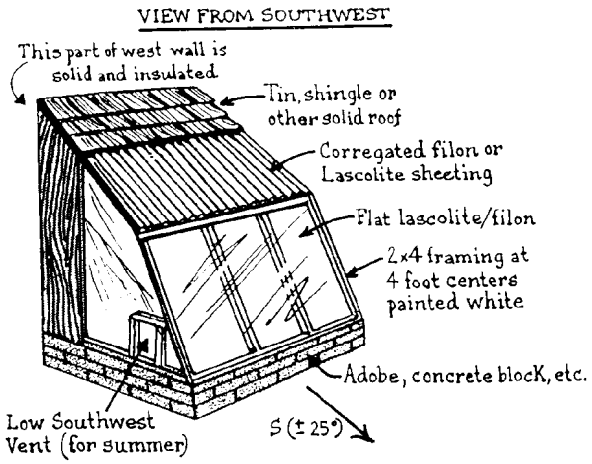
Reviewed by Chris Greacen

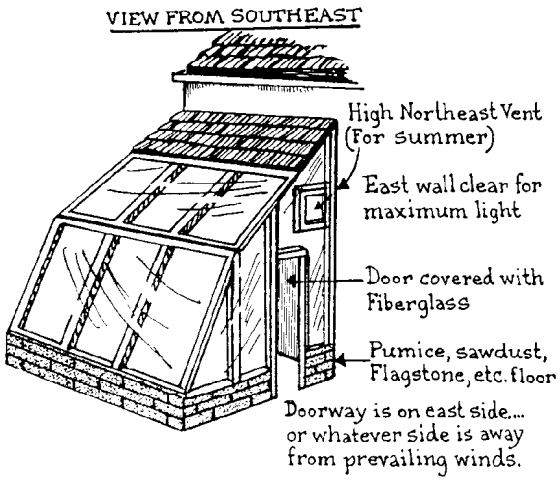
In 1975 James B. DeKorne wrote *The Survival Greenhouse* to advertise greenhouse gardening as a way of providing all of a family's food needs. He was aiming for a greenhouse which would produce vegetables and fish year round, using only organic materials generated on site, and energy from the sun and a small windmill. The quest turned out to be unrealistic.

In the "Author's Confession and Introduction" in this latest book, *The Hydroponic Hot House* (©1992 Loompanics Press), DeKorne writes, "Much of the stuff appearing in the back-to-the-land publications from that era converted unproven hypotheses into proven facts. I am not proud to admit I am responsible for my own share of it... This publication is a description of my on-going experience with those original concepts and an attempt to put them into some realistic perspective."

The result is a down-to-earth book of greenhouse design and techniques which evolved from 20 years and a succession of greenhouses at his New Mexico homesite. The design he was eventually most happy with was an attached greenhouse, providing heating for his home, while the home provided CO_2 for the plants.

Especially strong is a section on hydroponic gardening (growing plants without soil), which DeKorne finds the most successful for growing lots of vegetables in a small space. His low-tech hydroponic approach is automated, using water pumps powered by a small photovoltaic array. The book also covers greenhouse temperature control, greenhouse management (when to plant and when to pull out the plants), and pest control. There is an interesting portion on the response of plants to temperature, photoperiod, and CO_2 (DeKorne had excellent results with Club Soda carbonated water).





If you're new to greenhouses you'll find this 181 page book informative and easy to read. If you're a greenhouse veteran, this book is still likely to pay for itself a few times over in pointing you towards realistic possibilities and away from dead ends in greenhouse work.

Access

The Hydroponic Hot House: Low-Cost High Yield Greenhouse Gardening by James B. DeKorne (ISBN# 1-55950-079-4) is available for $20.95 (which includes postage) from Loompanics Unlimited, POB 1197, Port Townsend, WA 98368 • 206-385-5087.

H A P P E N I N G S

NATIONAL

Sun Day 1992 – Public Citizen and nearly 200 citizen groups (including Midwest RE Assoc., Great Lakes RE Assoc., Redwood Alliance, & just about every RE Assoc. and environmental group you can think of), businesses (including Jordon College, Snowbelt Solar, Lake MI Wind & Sun, Integral Energy, Solsource, & Home Power), government officials and others announced plans to sponsor SUN DAY 1992: A Campaign for a Sustainable Energy Future. SUN DAY advocates a national energy policy that, at a minimum, reduces the total energy use by 10 percent and triples the current contribution of renewable energy (RE) technologies by the year 2010. It will include at least one national day (Earth Day – April 22, 1992). The focus of SUN DAY 1992's sponsors will be developing local and state-level coalitions to advocate for policies supportive of SUN DAY 1992's goals. Participating organizations will provide information, encourage model programs, lobby for RE friendly legislation, hold conferences, and distribute information to grammar schools, high schools, and colleges. For more information and to find out how you can help contact: Public Citizen, attn. SUN DAY 1992, 215 Pennsylvania Ave SE, Washington, DC 20003 • 202-546-4996

The Union of Concerned Scientists (UCS) has announced a year-long campaign to change the public perception of solar power, wind power, and other renewable energy sources. UCS will help interested people to plan and carry out educational activities and political actions that promote greater use of renewable energy. Although the public likes the idea of using renewable energy most people, including industry leaders, utility planners, and government officials, think of renewables as futuristic, backyard novelties. In actuality, RE technologies could provide a much greater share of the nation's energy supply. However, current energy policies have prevented renewables from penetrating energy markets in a significant way.

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

For more information, contact the UCS, 26 Church St., Cambridge, MA 02238 • 717-547-5552

American Tour de Sol, Albany NY, Hartford CT, Boston MA The automobiles of the future are coming! They are clean, quiet, and they never stop for gas. Over 40 cars, powered by the sun, will race from Albany NY to Boston MA May 18-23, in the 1992 American Tour de Sol, the solar and electric car championship. There will be ten free educational displays of these innovative non-polluting cars along the route. For information about the display nearest you, contact the Northeast Sustainable Energy Association (NESEA), 23 Ames St, Greenfield MA 01301 • 413-774-6051

Electric Vehicle Safety Survey: In order to establish meaningful standards, the Electric Vehicle Industry Association is seeking data on the safety of EVs already in actual use. Anyone who has had any experience with EV accidents is invited to share their information. The survey takes 10 minutes to complete. Final data will be made available for publication. To participate, contact Shari Prange, Electro Automotive, POB 1113, Felton, CA 95018-1113 • 408-429-1989

Renewable Energies/Conservation Directory will be a listing of folks who have implemented conservation and renewables in their homes, and are willing to share their stories with others and at the same time help answer individual questions. Categories: 1) USERS: those employing a particular technology; 2) Providers: businesses who deal in renewables/conservation. Providers will be charged $25 to defray the cost of the directory; 3) Networkers: users or aspiring users interested in getting together to knock a few ideas around; 4) Homegrowns: those who are using a renewable system that they have built from scratch; 5) Owner-installed: those who purchased a system but installed it themselves; 6) Educators: those who know enough about a topic that they are willing to share their knowledge in a lecture, slide presentation, or forum with school or community groups (this is a most needed category!). If you're interested, send your name and address (phone optional) and category (s) to Julie Weier, Midwest Renewable Energy Association, P.O. Box 249, 116 Cross St., Amherst, WI 54406 • 715-824-5166

Elfin Permaculture is holding a number of workshops ranging from one day to three weeks in locations around the U.S. and Canada. Contact Cynthia Hemenway, 7781 Lenox Ave., Jacsonville, FL 32221

ARIZONA

Second Annual Solar & Electric 500, Friday April 24 through Sunday April 26 at the Phoenix International Raceway. Featured in the event are a solar car race

(three days, 100 miles a day), an electric stock car race, an electric hybrid race (auxiliary internal combustion engines allowed), and an open competition. The race is sponsored by the Arizona Public Service Company, the US Department of Energy, the Arizona Department of Commerce Energy Office, the Arizona Department of Transportation, and the Edison Electric Institute, to showcase renewable non-polluting transportation. Tickets can be purchased at Dillard's Box Office (1-800-638-4253). For more information contact the Solar & Electric Racing Association 11811 N. Tatum Blvd., Suite 3031, Phoenix, AZ 85028-1621 • 602-953-6672.

BRITISH COLUMBIA

Low Impact Living Systems: Examine practical appropriate technology with Bob McCormic, Bunky Hall, & Ralph Keller from May 25-30. The workshop includes assembling a home photovoltaic system, constructing a passive solar water heater, and a look at functioning microhydro projects. $630 includes tuition, vegetarian and seafood meals, and dormitory accommodation. Hollyhock Farm, Box 127 Manson's Landing, Cortes Island, B.C. Canada V0P 1K0 • 604-935-6465

CALIFORNIA

Renewable Energy & Efficiency Fair, Saturday April 25 at Arcata's Redwood Community Park. Held in conjunction with SUN DAY '92 (see above), the fair will be a regional gathering to see micro hydro, wind, and PV systems; solar ovens, solar hot water, electric vehicles, etc. There will be workshops on renewable energy, local music on a PV powered sound system, and a keynote address by Richard Perez of Home Power. Contact us at PO Box 4179 Arcata, CA 95521 • 707-822-3481

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

Solar Energy Symposium April 18 and 19, 1992, sponsored by College of the Desert. The event will feature solar and electric car displays as well as electric vehicle components, the latest energy conservation and renewable energy technologies, and more. Please join us and accept our invitation to be part of the solution to our energy dilemma. For more info contact George Smith Jr. at 619-346-8041 FAX# 619-341-8678, College of the Desert, 43-500 Monterey Ave. Palm Desert, CA 92260

North San Francisco Bay Chapter of the Electric Auto Assoc. (EAA) holds meetings on the third Saturday of each month at the Citibank conference room in Novato, CA. For information on the EAA and the chapter nearest you send an SASE to 1249 Lane St, Belmont, CA 94002, or call 415-591-6698 (9 to 5 on weekdays).

AlTranEx'92 Sept. 9-13, at the Santa Monica Civic Auditorium, will feature an electric vehicle endurance competition, exhibits of electric cars, natural gas, alternative fuel-flexible, solar, hybrids, conversions & human-powered vehicles; photovoltaic & energy efficient products, and environmental organizations. The Expo is being held in association with Alternative Transportation News, Energy West Publishers, & Greenbrokers. For more info contact Greenbrokers, 279 S Beverly Dr, Ste 369, Beverly Hills, CA 90212 • 310-285-0093

Arroyo Seco Earth Festival Saturday, April 18. The festival will have 15 "villages" of exhibits with themes such as energy, water, transportation, food and agriculture, Native Americans, and bicycling. An Earth Parade kicks off the event. 15,000 attended last year. Call 818-577-9033

Workshops at Sun Mountain Research Center SUNDAY APRIL 19, free tours of SMRC's PV system and solar efficient building will be conducted beginning at 10am. An open discussion of future energy options will follow at 1pm. Light refreshments will be served. SUNDAY, MAY 3, All day PV workshop for those seriously considering a PV system. We'll tour the center's PV system and then go into details of designing a system. Covered will be: load analysis and lifestyle, efficient appliances, pv array sizing, batteries, inverters, system monitoring, wiring requirements and safety..Group limited to 15. Dress comfortably, and bring a lunch. Cost $35 individual or $45 couple. Starts 10am ending at 5pm. Sun Mountain is located in Tollhouse, CA, near Fresno. Contact Don at Offline 209-877-7080

COLORADO

Solar Home Workshops will be held at the Solar Technology Institute (STI). These workshops are for owner builders and persons seeking careers as solar professionals.

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

For a detailed description of the SOLAR HOME PROGRAM WORKSHOPS, costs and scholarship

information; write STI, P.O. Box 1115, Carbondale, CO 81623-1115 • 303-963-0715

FLORIDA

The American Solar Energy Society (ASES) has issued a call for papers for SOLAR 92: The National Solar Energy Conference, Cocoa Beach, Florida on June 13-18, 1992. The conference is the 21st ASES Annual Conference and includes the 17th National Passive Solar Conference. Papers are solicited which detail current work in the field of solar energy conversion and utilization. Contact: ASES, 2400 Central Ave., Ste G-1, Boulder, CO 80301 • 303-443-3130, FAX 303-443-3212

SunDay Challenge AE Vehicle Rally on June 14, 1992 sponsored by the Florida Solar Energy Center (FSEC) in conjunction with the 21th American Solar Energy Society Annual Conference, in Cocoa Beach, FL. The rally will include commuter and solar/electric vehicles. For more info contact FSEC.(see below).

FSEC Photovoltaic System Design Workshop May 12-14, Sept. 15-17, Dec. 9-11, 1992 at the Florida Solar Energy Center (FSEC), 300 State Road 401, Cape Canaveral, FL 32920. The registration fee is $300; target audience: solar industry, engineers, government agency reps and interested individuals. Call JoAnn Stirling at 407-783-0300, ext. 116.

The Florida House Foundation is building two model homes using passive solar architecture, energy/water efficient appliances, solar electricity, hot water, and edible landscaping. Contact The Florida House Foundation, POB 21583 Sarasota, FL 34276 • 813-924-6833

IDAHO

Backwoods Solar will be holding two one day workshops on photovoltaic equipment and installation, June 27 and Sept. 5, 1992 (both are Saturdays). Each workshop is limited to ten people. The cost is $40.00 per person, non-refundable pre-paid, which includes lunch and a text book ($30 per person if 2 people share the text book). For more information contact: Steve or Elizabeth Willey, Backwoods Solar Electric Systems, 8530-HP, Rapid Lightning Creek Rd., Sandpoint, ID 83864 • 208-263-4290

INDIANA

3rd Annual Planet Fest '92, July 10 - 12, in Bloomington Workshops and booths on a veritable plethora of sustainable lifestyle topics, solar powered performance stage.Send a SASE to PF'92 c/o EBPX, PO Box 1328, Bloomington, Indiana 47402-1328

MAINE

Hands-On Workshops will include: solar air heating, solar water heating, solar cookers and ovens, solar electric home, passive architecture, greenhouses and sun spaces, and the immensely popular photovoltaics workshop. The fee for each of these workshops is $25.00, which includes lunch. For information on sites and dates contact Richard Komp, Maine Solar Energy Association, RFD Box 751, Addison, ME 04606 • 207-497-2204

MASSACHUSETTS

Solar and Electric Vehicle Symposium (S/EV'92) Boston, October 1992, sponsored by the Northeast Sustainable Energy Association (NESEA). This will be a forum for advancing the electric vehicle market, infrastructure and technology. Interested parties include NESCAUM, Electric Edison Institute, the DOE, GM, Ford, and Unique mobility. Call 413-774-6051

Solar Electric Inc. Workshop, June 6 and Sept 12, in Worthington. $35 per person/ $45 per couple, see NEW HAMPSHIRE entry for details

MICHIGAN

Earth Day Kalamazoo Goes Solar Sunday afternoon, April 26, Bronson Park. The celebration will include environmental displays, energy saving/making devices, and entertainment on a solar powered stage. For more info contact Earth Day Kalamazoo, 420 S. Burdick St., Kalamazoo, MI 49007 • 616-342-7328

MINNESOTA

Minneapolis Environment Expo 92, April 23-26, International Market Square, Minneapolis, Minnesota. Two exhibitions: Commercial-Industrial (Apr 23-24) and Public-Consumer (Apr 25-26). Four conferences: (A) Buildings, Environment and Energy, (B) Waste Reduction and Management, (C) Regional Air and Water Issue, (D) Environmental Marketing. Followed by 'Earthforum' (April 25-26) with exhibits, speakers, and films. Keynote speaker, Christopher Flavin of World Watch Institute. Call 612-379-3889.

NEW HAMPSHIRE

Free Solar Electric Inc. Workshop, April 11, 1992. Jeffrey Fowler, author of the "The Solar Electric Independent Home Book" and his wife Lea will hold a free workshop on solar electricity. Lecture and slides presenting remote homes using solar electricity will be from 9:30 AM to 12:30 PM. Lunch (BYO), product display and questions from 12:30 PM to 3:00 PM at The Harris Center, Hancock, NH 03449 (20 miles NE of Keene, NH) For more information call 413-238-5974 or 603-525-3394

NEW YORK

3rd Annual Cortland County Energy Fair July 11-12 at the Cortland County Fair grounds. Events include

workshops, vendors and exhibitors, live music, home tours, a parade, and mountain bike rodeo. Contact Paul Yaman, P.O. Box 306, Cortland, NY 13045

Solar Electric Inc. Workshop, June 20, in Plattsburgh (W. Chazy). $35 per person/ $45 per couple, see NEW HAMPSHIRE entry for details

VERMONT

Sunnyside Solar Workshops one day workshops on photovoltaic home electric systems: 1992 dates include: April 11, May 9, June 6, July 11, August 1, Sept. 19, Oct. 3, & Oct. 24. The workshops are limited to 8 persons, fee $95/person. $35 advance registration required. For more info contact: Sunnyside Solar, RD4 Box 808, Green River Rd., Brattleboro, VT 05301 • 802-257-1482

Vermont Solar Electric Systems will be conducting a four week class entitled "Solar Electricity for the Home" through the University of Vermont's Church St. Center for Continuing Education. The class includes 8 hours of instruction and a tour of a PV powered home. The class begins Thurs. May 1 and costs $84. For more info, contact VSES, 69 Thibault Pkwy., Burlington, VT 05401 • 802-863-1202

WISCONSIN

Solstice Celebration of Sun Power The 3rd annual Midwest Renewable Energy Fair (MREF) is June 19-21, 1992 at Amherst, Wisconsin. The Energy Fair introduces the public to a wide spectrum of renewable energy technologies and their contemporary applications. MREF is accepting workshop proposals. Please include a brief description and outline with your proposal.

the Wizard Speaks…

Alternating Field Permanent Magnets

By breaking down magnetic domains into smaller regions it may be possible to bring about the micro-engineering of magnetic substances. By producing the proper dynamic equilibrium, permanent magnets might someday be produced with alternating fields. If this becomes a reality, an energy source could be created which would last as long as the substance continues to generate the alternating magnetic field.

One possible way for this feat to be accomplished is to first create a holographic, high-energy, electromagnetic standing-wave blueprint of the necessary structural configuration. This field image could then be applied to various substances so that they align internally in the proper dynamic configuration. When the external field is removed the substances would remain in proper dynamic equilibrium to generate alternating magnetic fields.

Possibilities abound! Let your imagination create your future! Follow the child within!

Ozonal Notes

The North American Weasel

It is difficult to recognize the rare, but not rare enough, North American Weasel. This sly animal hides his true self among the ranks of hard-working, honest animals.

I am constantly on the lookout for the Weasel. We carefully check out each and every display advertiser. Every so often one sneaks by us and finds refuge in our pages.

We are interested in the performance of the businesses advertising in Home Power. We do our level best to make sure that the products and/or services provided by a business are as advertised. If any of you have business problems with a Home Power advertiser, please let Karen or me know.

We are a growing industry with new startup companies appearing daily. We want renewable energy to grow as quickly as possible. We can't wait for years for a company to establish its reputation. We just have to look the human in the eye and decide if he's Weasel or Wizard. Sometimes we goof.

Every story has at least two sides. I remember a phone call from a distraut inverter buyer. His inverter blew up and its maker wouldn't give warranty replacement. After a little discussion, it became apparant that the fellow had mounted the inverter outside. Under his roof's drip line. And when it started raining, the inverter filled with water, and it blew up.

Please take this message as it is intended. Help us monitor the businesses in the RE industry. In our experiences over the last twenty years, you won't find a more honest and hard-working group in any other industry.

Don't let a Weasel steal the light and the future from the Wizards who are working so hard to make it real.

Richard Perez

muddy roads

Halloween – Up the Creek

or Pinheads Put Out a Fire

Eleanor Frances Stranger

It was going to be a quiet Halloween this year. Last year José, Ralph, and I dressed up and visited all our neighbors. We had the distinction of being the first Trick-or-Treaters to ever knock on few of the local remote homes. Our hosts were amused and found treats for us even though they were unprepared. The treats ranged from cookies to scotch whiskey. We had a good time that night.

This year, though, we had planned nothing special. That evening, José had just finished taking a shower. Our friend, Moose, was getting ready to shower (we have one of the few working showers in the neighborhood). We were all having a cup of tea, waiting for the water to heat up again. The phone rang and José started talking to someone about a hydro unit, while still in his bathrobe.

Suddenly we get a call over the 2 meter ham radio. It was an emergency call. The kind we all dread. It was Jane. There was interference on the frequency. All we could make out was that there was fire somewhere. It took two tries to find out the fire was at a close Ralph's place. Jane had already notified the local fire department, the State Dept. of Forestry (SDF).

José hung up the phone and raced into his clothes. Moose ran to our truck and warmed it up. I put on shoes, tied my hair back, and grabbed every fire extinguisher we had. José jumped in the truck to drive, Moose and I jumped in the back, standing up, holding on to the pipe rack. As we neared the barn, José jumped out and ran ahead to open the gate. Moose and I ran to the garden shed and grabbed two shovels, a pick, and McLeod. By the time we got back to the truck, José was jumping into the seat and heading out, fast.

We sped along the rutted, muddy road. I hung on hard and kept my knees bent. We searched for some sign of the fire when we neared the house . We couldn't see anything. It all looked just the same as it always did. Then beyond the house and through the trees, we saw the column of white. We grabbed all the tools and extinguishers and ran towards the smoke.

It was the outhouse. The two-holer was spewing thick white smoke and glowed a hellish red inside. Ralph was sawing down the tree limbs that hung over the outhouse. I used the McLeod and cleared the debris from the sides of the building. Moose and José started digging and shoveling dirt into the outhouse hole. That didn't seem to faze it. They used up one whole extinguisher firing it down into the hole. The smoke hadn't lessened. Ralph started carrying five gallon jugs of water from his house. Nothing seemed to faze it. José scraped the side of the building and uncovered the fire as it consumed the underflooring. Another fire extinguisher was used there to no avail. Finally, José took the pick and opened a large hole in the middle of the floor. More dirt and water was thrown down the hole. The fire began to abate.

I was sent back to the house to call off the SDF fire fighters. Since they are our closest fire protection, we always call them first, before we call our neighbors for help. However, they were already on their way and couldn't be turned back. I went across the creek to the main road to wait for the trucks. I wanted to turn them back before they got really stuck in the mud further on. The first vehicle to show up was our local rescue squad. They drove all the way to the outhouse. After having determined that no one was hurt, they had to back up to leave.

Meanwhile on the main road, a SDF pickup arrived. He wanted to go ahead so I directed him to the ford in the creek. Then a big firetruck tanker drove up. I told him he better just turn around there cause there was nowhere to turn that baby around anywhere further on. The next one along was the incident commander. He just parked in the field. I brought him across the creek to talk with Ralph.

The fire had started because Ralph had cleaned out his woodstove and threw the hot ashes down the outhouse hole. I guess they burned buffalo chips for a reason.

I was in the local Post Office a couple of days later when an acquaintance came in. "Sorry to hear about your outhouse," he said. When I inquired how he had heard, I found out the call went out over the police/fire radio. I

explained it wasn't our outhouse at all, but our Ralph's. In November, José got a call from a customer who lives across the county. "Sorry to hear about your outhouse burning down," he said.

I guess we'll never live it down.

Access
Author: Eleanor Frances Stranger, c/o Home Power, POB 130, Hornbrook, CA 96044

Editor's note: the names and places in this article have been changed to protect the guilty from embarrassment. Richard

Letters to Home Power

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

NREL Physicist speaks

Dear Richard, I saw a copy of your Dec.-Jan. issue over the weekend. I can understand the frustration that was evident in your opening remarks. There is nowhere near the level of support for research aimed at the wide scale implementation of existing hardware for residential use that would be evident in a rational energy policy. I'd like you and your readers to know that the researchers at the National Renewable Energy Laboratory (NREL) respect the work that you in the private sector have done in attempting to put this elegant form of energy production into practical use.

However, speaking as a member of the five person group at NREL that was responsible for the development of the 32% efficient tandem PV cell (which no one can afford), I'd like to explain the rational that went into the creation of such a device. First, as a true believer in the merits of PV generated power, I can't help but think that any project that demonstrates the potential of the technology and stimulates the interest of the average citizen is beneficial to everyone involved in photovoltaics. If you're concerned that it represents a poor use of resources, let me assure you that this project was not funded by the DOE and the cost to the taxpayers way truly miniscule. Most of the work was done after hours by myself and my colleague Mark Wanlass. The device in question is a concentrator version of a cell we are working on for space applications.

As you know, the economics of concentrator devices is very different than that of flat plate devices. For a concentrator cell, high efficiency is a requirement because the major cost is in the module and tracking system. Our ultimate goal is to develop the ability to grow these single crystal III-V compounds on inexpensive Si or Ge substrates. If we can accomplish this task, these devices will be immediately useful for utility scale power generation. I realize that one of the primary attractions to PV for you and your readers is the ability to get off the grid. While I wholeheartedly endorse the concept, the fact of the matter is that the majority of American citizens lack the initiative required by such a course of action. If we are successful in getting major U.S. utilities to generate significant fractions of their energy with PV, the net effect

is the same as if that fraction of the utility's customers had stand alone systems (except they're still stuck with the bill).

There are several companies that are producing concentrator systems for stand alone applications. If we can come up with a 30% efficient concentrator cell grown on a cheap substrate, I'm confident that someone will find a use for it. Perhaps some of your readers would see an advantage to cutting the size of their arrays in half. I think it's important to realize that we're all in this together. The work that you and your readers are doing is vitally important. You are demonstrating to the skeptic that this is a technology that deserves to be put into use immediately. I would only hope that you of all people would be aware of the need to seek to improve the technology and support research that pursues that goal. Yours, James S. Ward, Staff Scientist NREL Branch 4130, 1617 Cole Boulevard, Golden, CO 80401-3393

Bravo Mr. Ward! Clearly some research is effective on the home sized scale; and some, like growing III-V cells on silicon substrates, is only possible in a research laboratory. The success of these Home Power systems rests, in large part, on breakthroughs by semiconductor physicists like yourself – from PV cells themselves to the FETs which process this power. We applaud your work and the work of your colleagues on terrestrial solar systems at NREL. I especially applaud the fact that your concentrator PV project was done after hours, with funding for space cells. Isn't this indicative of how sick the R&D funding priorities have become? Chris and Richard

200W Continuous

Get 200 watts continuous out of a PowerStar 200! Bolt two heatsinks onto the SIDES of inverter, use some silicone grease where they contact the sides. DON'T go drilling holes into the inverter case or you might stab a component. Just tighten the screws to clamp it like a sandwich. Take a small 12 VDC "muffin" fan and mount it so it blows air through both sides of the heatsink. I mounted it in a small aluminum box with grilles on both ends, and also installed two switches – one for inverter, and one for the fan. (I only use the fan when I draw over 100 watts) also I put a 30 Amp fuse in the line and ran #6 copper for primary leads.

For 2 years I used this inverter to power my 27" color TV (165 watts) and VCR (35W). Three other PowerStars are beefed up like this and operating perfectly at homes in the area where I installed "starter systems", operating the whole house's lighting using compact fluorescents. Do not attempt to exceed 200 watts continuous. If you live in a fringe area, you will get interference on channels 2-6 and FM. Strong signals – good VHF-FM antenna and pre-amp booster will take care of it. I have not found anything to filter the RFI. By the way, I have found the RFI much worse using the Statpower 250, especially on FM.

Not all PowerStar 200 inverters are created equal! The units I ordered from J.C. Whitney are made in Scotland. All of the large transistors were mounted to the internal heatsink in these units. A unit ordered from a major solar catalog was made in Taiwan. Only a FEW of the transistors were mounted to the heatsink. Otherwise they were completely identical. The key to extending the life of semiconductors is to keep them cool!

I also wanted to pass along my experience with Osram 15 watt Reflectors compact fluorescents used on PowerStar 200 and Statpower 250. There has been several sudden deaths of these lamps, one of them was mine and only had a few hours on it. The reflector lamps seem to run a little hotter in these units. I have had no problem with the standard EL Osram lamps. There has been no problem whatsoever using the Osram Reflectors on my Trace 2236 or my ancient Dynamote MB-36-3000, which collects a lot of dust lately.

Aluminum heatsinks and silicone grease can be found at Radio Shack or at surplus outlets. Backwoods Solar has a muffin fan that's reasonable.

The best VHF-FM antenna I have found is made by Winegard: antenna model CS-5100 Booster Model CP-3800. The booster mounts on the antenna. Also the power supply to the booster can be 12 VDC, just cut out the transformer. The shield of the coax is positive. Winegard Inc., 3000 Kirkwood St., Burlington, IA 52601. Kim Brettingen, Box 533, Finland, MN 55603

Kim – All genuine PowerStar inverters are made in Scotland and have been for some time. Some of the earlier ones were made in Hong Kong, but never in Taiwan. What you have there is a clone ripoff. There have been some reports of these clones lately, so buyer beware! Wonder if you're dealing with an authorized PowerStar dealer? Call PowerStar at 408-973-8502. While there's no reason that your extra heatsinks and fan idea shouldn't work to increase the continuous wattage output, you can't expect PowerStar to stand behind it if you blow it up. Anyone doing this mod should figure that they're on their own. I assume that your 30A fuse is at the battery source and is there primarily to protect your #6 leads. Otherwise, it's kinda redundant as there is an input fuse built into the unit.

The Osram Reflectors run somewhat hotter even on grid

power, but yours is the first I've heard of that went blooey on a POW-200. I'll look into that. Thanks for the tip on the antenna boosters. Bob-O

Solar DHW permits

Dear Home Power: I read with interest, the article titled "Things to Know Before Buying Solar DHW" by Steve Shewmake (Feb./ March 1992). The article is well written and very informative, however, one important area was left out, and that is Building Department regulations.

Currently in Sacramento County, a building permit is required when installing a solar system. The reason a permit is required is to protect the consumer from such things as cross-connection (contamination of potable water systems) structural failures, and electrical hazards.

While most contractors that I dealt with are reputable and professional, there are a few out there who give all the others a bad name. A good contractor will readily furnish his license number and references.

When you apply for a permit, some of the information you will need is: job address, owner's name, contractor's name, contractor's address, contractor's license number, proof of workmen's compensation insurance, type of system, structural engineering (as needed), proof that all components are listed and approved, a sketch showing location of all system components and the size of structural members supporting them and type of roof covering.

As with any project, always check with your local jurisdiction. Thank you. Barry Hutchens, Supervising Building Inspector, County of Sacramento Department of Public Works, Building Inspection Field Office, 4101 Branch Center Road, Sacramento, CA 95827

Thanks for the advice. Building to code, even in remote sites where inspectors don't frequent, is an excellent idea, and will save money, worry, and headaches in the long run. As these systems move from the backyard do-it-yourselfers into the market place of installing professionals, we respect the need for permits and inspections. Although none of us like the paperwork, these measures are the only way to ensure safe, reliable technology. – Chris

The Sacramento Municipal Utility District (SMUD) has a solar domestic hot water rebate program to encourage SMUD customers with electrically heated water to install DHW systems. Call 916-782-4332 or write CAL SEIA, 801 Riverside Ave. Suite 201, Roseville, CA 95678. If your utility does not have such a rebate program, call 'em up and bug them until they do. And as the tax season approaches us, Oregon has tax credits for renewable energy systems, does YOUR STATE?? Therese

Nameless Dread

Shame on you for advocating use of Halon fire extinguishers – (HP F/M P 69) – they put out the ozone as well and there's no excuse for using them in this application and Halon hopefully soon will be outlawed. Good old CO_2 is heavy but cheap and effective – works fine in refrigerators too. No Name, Postmark GMF Denver, CO 802XX

You are entirely correct and I apologise for recommending a Halon extinguisher. In fact, the extinguisher on our wall is a First Alert model FE2A10 that uses monamonium phosphate; this extinguisher uses no halogens, and is refillable instead of disposable. Cost is about thirty bucks. Richard.

RV System

Dear Home Power Magazine; I have been an avid reader of your magazine since discovering it a while back. I can now hardly wait for the next issue to arrive, and when it does, it is quickly and thoroughly digested.

As I ain't as young as I used to be I am thinking about retiring to my RV full time and want to experiment with solar power as my total electrical supply. I wish to make contact with other Home Power readers who are full time RV'ers and 100% off the grid. I am especially interested in anyone who has designed PV mounting structures suitable for use on travel trailers or anyone having ideas on the problems of managing large battery packs in confined space and with the severe weight limits that go along with RV living...

My electrical system is stock RV with a few added options such as heavier wiring, fans, TV, bed warmer, quartz lights and a short wave receiver. The wife, KB4OYY, and I are both amateur radio operators and as such, several ham radios will be included. I have studied the power requirements of our equipment and our life style and think a system consisting of 15-18 amps of PVs, a Heliotrope CC-20 Charge Control, a Cruising Equipment Amp-Hour + meter and 440 AH of golf cart batteries would be sufficient. Later we plan to add a PowerStar 1300 watt inverter to enable the use of a microwave oven.

Jim Phyper's Hydronic Heating System, as described in issue 26 of Home Power, has already given me other ideas for projects to add to the system. Any help or experiences other RV'ers could share with us would be appreciated.

Also your feature, "Kid's Corner" is a great idea, Solar Works, Brad Rose and Home Power are to be

commended for the efforts to expose our young to the wonders of Home Power Production. I am enclosing $20 for two more years of Home Power for the students at Penasco Elementary School, I also would like to challenge other readers to do the same for their local school library. This information should be available for all interested persons, especially our youth. Keep up the good work, Tom Blanchard, WA4UPO, 12051 Hwy 73 E., Mount Pleasant, NC 28124 • 704-436-9589

Tom-It sounds like you've done your homework with the RV system you describe. The CC-20, CE A/hr+, and UPG 1300 are excellent choices for an RV. You might look into the Trojan T-125s for your batteries. I've heard of good success with them in a mobile situation. Echolite racks might be a good choice if you've got a flat roof. The fastilt models come up and lock down flat with a couple of thumbscrews. An ideal setup would have easily removable frames and polarized, waterproof module connectors. With a heavy "extension cord", you would be able to park the RV in the shade and the PVs in the sun for an extended stay. I haven't seen anything "off the shelf" like that yet. -Bob-O KG6MM

Hello Tom– YOU'RE the one that deserves the flowers for your generous donation to the Penasco School Kids! Mrs. Compton says the kids get more and more excited with each session. It would be great if all youth had the opportunity to learn about solar energy, etc. – they are the future! We have many readers who donate subs to their local library, but few for schools (so far!) Thanks, Therese

Grid Weaning

Great Magazine! Having just recently joined the ranks of solar power fanatics I'm still in the information gathering phase which I suspect will never truly end but hopefully this year will go a long way towards telling me what I need to know. Currently I have a 1 kW system with 7 Hoxan 4810 new panels and 2 Arco M51 used panels. A PowerStar 1300 provides AC power to my primitive load distribution system which I plan to upgrade when my friendly electrician returns from a 3 month job out of state. For instrumentation I have a BCM-12 digital voltage meter from the SunAmp Power Company and an Amp Hour meter from the Cruising Equipment Company.

While the articles on Nicads are great and I will probably switch to them before my current Lead-Acid cells expire in 5+ years, keep providing information about Lead-Acid set-ups. Many folks just starting can't afford ideal batteries at first and information on how to get the most life from what you can afford is important.

At present I have 10 220-Amp-hr 6Volt golf cart batteries wired for a 12volt system at 1100 Amp-Hrs battery. With more ideas than budget, I'm spending a lot of time reading and dreaming. Over the next 3-5 years the system will be upgraded to a 5-10kwhr a day system, relegating the utility feeds to an emergency backup system. Most of the batteries in the house have been switched to nicads which now get charged by the sun. Thanks for the article in HP#4 warning about fake D cells. It turns out that Everyready sells such things without providing info on them showing their ratings. While their lower sized one seems fine, I found an alternate vendor that clearly labels the cell capacity for a comparable price, so I will probably just switch and write a nasty letter to Eveready and the store where I bought them explaining the importance of the product. Maybe they will change their ways but I don't count on it, so let the buyer beware.

Unlike many Home Power readers, or at least the ones reviewed in the systems sections, I have ready access to the grid with the lines less than 500 feet from the house and my utility bills are ridiculously low, less than $100 gas and electric a mont. But we all know the meter doesn't reflect the true cost of letting big companies provide us with power. At present the bulk of my energy budget goes to exterior lighting at night. While I would love to preserve the sanctity of the night as one reader suggested, in an urban environment night lights are a fact of life if you wish to deter impulse criminals. While working to cleanup the neighborhood it is nice to have lights that don't contribute to the local smog and CO_2 problems and yes, they are high efficiency models (Fluorescent and Quartz Halogen bulbs) about 80 Watts worth. The TV and refrigerator are my next projects to switch over as soon as I get a few more panels. Over the past several months I have been able to shave about 10 kwhrs a month from my grid usage with a combination of more PV and conservation. By the end of the year I will be below 100 kwhrs a month from the grid. When I chose to replace my current Fridge/Freezer, which was bought just before the Solar bug bit, with a SunFrost unit and converting the washer/dryer to more efficient motors I should have the excess capacity to start looking at converting my old VW to electric.

In February I'm going to attend an overpriced government conference, Soltec '92, just because it's local and should provide some useful info. In July I'm planning on attending the Solar Technology Institute's advanced PV for Remote Homes class. Signed up for their family membership and depending on how it's set up may chip in $15 more to upgrade my Home Power subscription to first class, but

will have to wait and see how they are coordinating the subscriptions with you folks.

Sometime this next year I will be adding solar to heat our water but currently I'm just looking to see what's out there. One thing I have noticed is all the units use electricity as a backup. Why no gas fired units? Probably I will put in a system with no backup, just a 120-gallon storage tank, and installing some of the inline on-demand tankless water heaters to make it hotter if necessary.

Also inclosed is a copy of the reader survey from HP#27, my 1st issue to warrant a mailing label. To add an additional option I would be willing to pay $20-$30 for B&W reprint of the original masters of issues 1-10 if it were offered. In the survey you don't make it clear what dollar amounts by each format choice mean. Are they your costs or approximate costs to the purchaser. Assuming your costs I'd say $30-$50 is what I'd pay. If just estimates I'd drop to $20-$35.

Just got my copy of the 1990 Alternative Energy Source Book from the folks at Real Goods and recognize many articles as reprints from Home Power. I was especially pleased to find an article from Richard with Lead-Acid charge/discharge curves. Good luck to all and keep up the good work.

P.S. On page 28 of HP#27 the picture was printed upside down so left and right are reversed. Oops. Don't let it bother you too much most people will spot it and occasional slips like that remind us we're human and to watch out for Murphy. Michael Kline, 2932 Hyder SE, Albuquerque, NM 87106 • 505-277-8148-Work, Internet mail - mikep@triton.unm.edu, bitnet mail - mike@unm

An easy way to tell if you're getting burned on the "C cell in a D cell" package scam is by weight. Heft the 2 D cell package in one hand and a 2 C cell package in the other. The D cells should be noticeably heavier. If not, the fix is in. Bob-O

Hi, Michael. We too noticed that DHW heat exchanger tanks are only fitted with electric power for backup, not propane. Consider using the less efficient tube-in-tube heat exchanger to interface with the propane hot water heater/tank. Be sure to insulate the exchanger/pipes well, and use a circulating pump on the exchanger/propane heater loop. The Thermomax setup in Bob-O's home uses this technique to interface solar heated water with a propane fired backup. Richard

Hello, Michael– Thanks for returning your survey (there's still time for those of you who have not!!) The prices are guestimates of cost to you, the reader. The next issue of HP will have the findings from the survey. We noticed the reversed photo, too; the printer was a little rushed last issue. Ah well...Therese

High Lifter Pump Data

Dear HP: As the author of the "Things that Work" article on High Lifter pumps (HP#23), I'd like to respond to the letter from Dave Luckenbach as published in HP #26. Dave's letter put into question the efficiency of the High Lifter as opposed to ram pumps.

First of all, there was an error in the way I described my test site. I stated that 6 gpm flowed through my supply pipe to the High Lifter, and Dave's efficiency calculations were based on that amount being used by the pump. Actually, at that time, 6 gpm was flowing into my settling tank from my spring but only a small portion of that was needed to supply the High Lifter. Further development to improve the cleanliness of my spring water reduced the flow to under 2 gpm, still more than enough to feed the High Lifter.

I went back and did some more measurements to come up with an efficiency figure for the pump, which ended up being 78.6%. First I shut off the supply to the pump and carefully measured the total flow from my source tank, then I restarted the pump and measured the unused overflow from the tank. Subtracting, I deduced that the pump was using 1.19 gpm as its supply. Next, I measured the pump output at my storage tank above my house to be 0.154 gpm. I then calculated pump efficiency according to Dave's method: 1.19 gpm x 26 ft. head = 30.94 gallon feet of water per minute used; 0.154 gpm x 158 ft. delivery height = 24.33 gallon feet per minute of water pumped. Therefore, 24.33 / 30.94 = 78.6% efficient.

Second, based on my experience to date, the High Lifter pump appears more suitable than ram pumps in low flow situations. The pump I used previous to the High Lifter was a Davey ram. This pump needed the entire 6 gpm my spring originally put out, and still would pump less than 175 gallons per day or 0.122 gpm. Admittedly this pump's impetus valve was very worn from years of debris flowing through it, and not a fair representation of a new ram pump. In recent months I have been testing a new, commercially available ram pump installed according to manufacturer's instructions, and have not been able to make it run on less than 2 gpm. I have not, however, given up on its potential for applications similar to mine. As I continue to experiment with non-electric pumps, I'll keep you posted on positive results.

My conclusion is that a ram pump is likely to be as or more efficient in higher flow situations, but the High Lifter

appears to be more appropriate for those of us with low flow situations and debris-free water supplies. Michael Welch, c/o Redwood Alliance, PO Box 293, Arcata, CA 95521 • 707 - 822 - 7884

Hydromaniac

Dear friends; I haven't even finished reading your magazine and I'm already subscribing. I am enthused to read about different aspects of hydro usage as I am a hydromaniac. In the 5 years that I have been using our hydro, I have come from "So what is an amp?" to redesigning our entire system with my partner. I've had many challenges such as chipping ice out of a frozen hydro at minus 30°F every day for a week and yearly, climbing into and cleaning out a 4' deep, 3' wide well casings full of silt and debris. Being a conservationist, I decided to use an existing system which was anything but optimum. Thanks to my partner and Steve Willey (Backwoods Solar), my spirit endured and our power grew. Your magazine is inspiring as well as informative to a lay person as myself. For me, being self-reliant and respectful of Earth means using her resources efficiently and purposefully. I would like to see articles about the spirit that drives us to be inventive, visionary and enduring in our goals of living harmoniously with Nature. Abundantly, Noreen Wenborne, 9465 Rapid Lightning Rd., Sandpoint, ID 83864

I have admiration for you, Noreen. You have obviously grown in the last 5 years. In response to your comment about the spirit of RE users I think you will be interested in the following letter. - Kathleen

IEAN

Dear Home Power Editor: Please allow me to introduce myself. My name is Carolyn Erler. I am director of Independent Environmental Artists Network, a new organization dedicated to people who work with environmental elements as art, and who primarily do this on their own time, i.e., most are not actively seeking publication of their works, but are in need of correspondents for feedback. As for our members, a willingness to communicate, an enthusiasm for pooling ideas and sharing experience, is the only requirement for involvement. We are people – artists, though representing a rich diversity of professional backgrounds – who are not only exploring the boundaries of what constitutes an art form, but are also striving to assume a broader role in regards to the whole of nature.

Being that the term "environmental art" seems to mean so much to so many these days, it would no doubt be helpful to you if I specified the kind of creative worker IEAN is seeking – although, please, what is mentioned below should be taken merely as a set of focal points.

• Home-made passive energy installations: appliances, dwellings, related creative conceptualizations. • Creative stonemasonry. • Micro/macro organic and-or "found" architecture. • Original thoughtwork regarding that which may, in an enlarged sense, be seen as aspects of an overarching, autopoetic Geo-art. Some examples: rock metamorphism, the carbon cycle, petroleum formation, chemosynthesis, space lattices, symbiotic alliances, microbial mats, dissipative structures, bioluminous cells – the universe is the limit! We seek active, enthusiastic correspondence among workers in these general fields. The working goal of Independent Environmental Artists Network is for it to evolve into an art itself. This means an on-line art composed of creative workers communicating, resonating, breaking out of old patterns of competition and silence.

While searching for various avenues through which possible contacts might be found for IEAN, I was made aware, through the Planetary Association for Clean Energy, Inc., of Home Power magazine. As a service both to myself and to those associated with IEAN, I was wondering if you might be able to send us any material (resource/address lists, sample issues, etc.) which could prove beneficial to this community of creative workers. Also, if you happen to know of someone among your friends and associates who is working in one of the above-mentioned areas, please urge them to write me at the address below.

Thank you for your time, and for whatever you might be able to send our way. Sincerely, Carolyn Erler, Director, Independent Environmental Artists Network, POB 396, Rochester, New York 14603

Consider the word spread, Carolyn. - Kathleen

Working System

Having installed and maintained a stand alone system here for 3 years, I am glad for any opportunity to share what I have learned with others interested in home power. You can give my name, address and number to anyone in this area wanting to see home power. An electric vehicle has to come next!

You serve as a guide and mentor for me as for so many others. Each issue an inspiration - when HP comes in the mail becomes for me a moment of rededication to earthkeeping. Thanks, Rich Meyer, 13416 CR 44, Millersburg, IN 46543 • 219-642-3963

Thank you, Rich. Here is the name, address, and number for interested parties near you. - Kathleen

Grid Interface

Howdy Friends; I have read almost every issue of Home Power, there is no magazine I enjoy more, as the ragged edges of my abused copies attest. Your policy of reporting on real systems and applications, and hands-on tests cannot be beat. I'm sure that there are many people who read the magazine that live in grid wired homes and feel twinges of guilt. I'm one of those. I dream one day of moving into a remote AE-only home. However, for the time being, that is out of the question. Since the house is already wired, there is no cost savings in not having the grid strung to your house to offset the high cost of even a modest AE system. Another oft mentioned solution for people like me is a utility intertie (sellback) system. Even with the savings on a battery bank those systems are perhaps only economically reasonable with a huge wind generator; they are also very expensive.

It seems to me there is a utility interface solution that makes sense for prewired or easily grid-connected houses. Such systems would use almost all the components of a totally AE system, but would need the addition of some kind of switching system. With proper conservation a normal house could install a modest AE system (which could be acquired in stages) and only have to resort to the grid during periods of heavy load or lack of wind and sun. The system would need some kind of automatic transfer switch that senses when the load is greater than the battery can supply. I'm sure there must be some such controller in existence. I believe running grid power into an inverter with a battery charger option may accomplish this, but I don't recall seeing it mentioned in any article. I would enjoy an article in HP on what is needed for this type of system and how it is set up. I would also love to hear from anyone who uses or has installed such a system. Sincerely, Mark Hart, RR3, Box 167, Battle Lake, MN 56515 • 218-583-2480

Hi, Mark. See Q&A in this issue for information about utility intertie systems. The time is coming, more quickly than we imagine, when home power producers will make much of this nation's power. The grid will be our battery, the sun will be our source. Richard

Home Power Politics

Dear Home Power: I have enjoyed your magazine for some time now, but I was a little sorry to see "Power Struggle" by Kris Holstrom in your iss #27 (Feb/Mar 92). I would hate to see your wonderful magazine politicized. Politics can so easily muddy the clear beauty of Home Power and those who describe their conquests either alone or in groups living without grid power. By their nature, most could be described as individualistic, either scorning or managing without one of society's major products, grid power.

Kris Holstrom's description of Hastings Mesa is at once wonderful and horrific. Beauty, independence, individuals and groups conquering isolation from grid power, but then the age old question – how to keep out "others" and encroaching urbanization raises its ugly head.

I do not live in Coosada because I crave big city lights, but because I enjoy the individualism, quiet, and freedom to do my own thing. I do not look with favor upon the encroaching urban sprawl from Montgomery, but I am part of it as Kris Holstrom is part of Telluride's. We are just the leading edges. We are not in the wilderness.

If the grid comes to Hastings Mesa, no one will be forced onto it, but individual economic decisions would make it likely that many will choose that route. I do not enjoy a group of self-anointed property owners making decisions for other property owners. Some property owners, even with home power, may enjoy the rise in property values. Some will decry the lost natural setting. In either case, this is one area from which I would like to see Home Power steer clear, lest it risk being swallowed by those with a politically correct view, rather than being enjoyed by all of us with a passion for home power. Sincerely, Daniel Gubin, POB 10, Coosada, AL 36020 • 205-285-7486

Daniel, I appreciate your point of view, just as I appreciate Kris's. Raises in property taxes, power lines and stray voltage are valid concerns. Politics will always be interwoven into home power production. In many cases it is small Davids battling the large Goliaths of population and power grids. We cannot escape the politics, but we can remain informed as to how they affect home power producers. Read on... - Kathleen

Micro-problem

A copy of this letter was FAXed to Home Power.

Dear Governor Roberts: For purposes of identification, I am a physician, a legal resident of California but a property owner in the Siskiyou National Forest below Grants Pass in Oregon. The purpose of this letter is to address two comments to your office, one negative and one positive in content.

I philosophically and practically share the growing concern relevant to energy conservation and the necessity to develop and employ existent alternative energy resources such as sun, wind and water. In order to modify and reverse the "greenhouse effect" producing a distinct global warming trend, the use of fossil and other

non-renewable fuels needs to be reduced or curtailed. In a practical attempt to eliminate the use of a propane burning electric light plant, I have already instituted: A) The installation of photo-voltaic panels for electrical energy production. B) I have initiated the system design and state application for a MICROHYDRO-ELECTRIC GENERATOR to be installed on my rural property. Both of these installations, in tandem would virtually eliminate the need for the operation of a propane fueled electric generating plant. Instead of encouraging and facilitating my energy resource conversion to this alternative energy format, especially in respect to the microhydro-electric generator, the state of Oregon mandates a license fee of $1,000.00. This $1,000.00 represents the license necessary to install an object which is approximately one foot high and approximately one-half foot in diameter, which in reality represents an automotive alternator with a water driven wheel attached so that it produces electricity. I must at least communicate my protest at this levy. I understand the tax credit benefit of this installation to state residents. Nonetheless it seems this approach seems to be amicable to an interest beyond simple dollars and cents and amicable to a more global or generic planetary interest. Perhaps you, with your busy schedule, will agree and at least have some staff designate examine this policy and problem.

Please understand that this letter is in no manner or form a criticism of the state personnel responsible for the administration of these regulations. In a positive way I must commend the water master staff, especially the hydroelectric division at Salem, Oregon. Personally, I have found their accessibility, professionalism and personal assistance recently rendered to my person a refreshing experience. In my opinion they represent a group that is a credit to your state government.

I thank you for your attention and assistance with the above matter. Respectfully submitted, J. Robert Egan, M.D., Ste. 807 1441 Avocado Ave., Newport Beach, CA, 92600 • 714-644-1051

Robert- While I agree with you that a $1000 licensing fee for micro-hydro is ridiculous and should be lessened, I don't have a "in principle" problem with a small fee. Here's why. The potential for riparian stream damage can be great even with small water diversions. It depends on the flow of the creek, the season, the volume of the diversion, and what lives in the creek. In an ideal world, that small fee would go to pay for someone's time to help and encourage you to enjoy your hydrosystem with the least environmental impact. I realize that I'm in fantasy la-la land here, given bureaucracies and bureaucrats, but it's something to shoot for. Bob-O

AM Antenna

Dear Home Power: Please renew my subscription. Sure like your magazine. For People who live beyond the range of FM radio and have to rely on AM radio 153 feet of antenna wire is just the right length for the 1000 KHZ of AM radio. This includes running into the house to the radio. Any length up to 153 feet (not more) will help if you are crammed for room. Cheap electric fence wire will work fine. If you're getting pretty good AM now, but hate that inverter hum, this antenna will bring in the stations strong enough to over ride the inverter hum. However, you will hear the hum when you tune the dial between stations. If anyone builds an antenna like this also make a ground deep into the earth, 3 or 4 feet and build jacks to plug into the radio or into the ground when there's lightning present. If your a DC purest and have no inverter hum this antenna will bring in stations you wouldn't believe. Be sure to insulate the poles or trees or what ever you hang the wire on. Plastic water pipe will work fine for that. Donovan McDonald, HC61 - Box 18, Winslow, AZ 86047

DOG-GONE-IT

Amelia Airedale is checking her mailing label. Have you checked yours?

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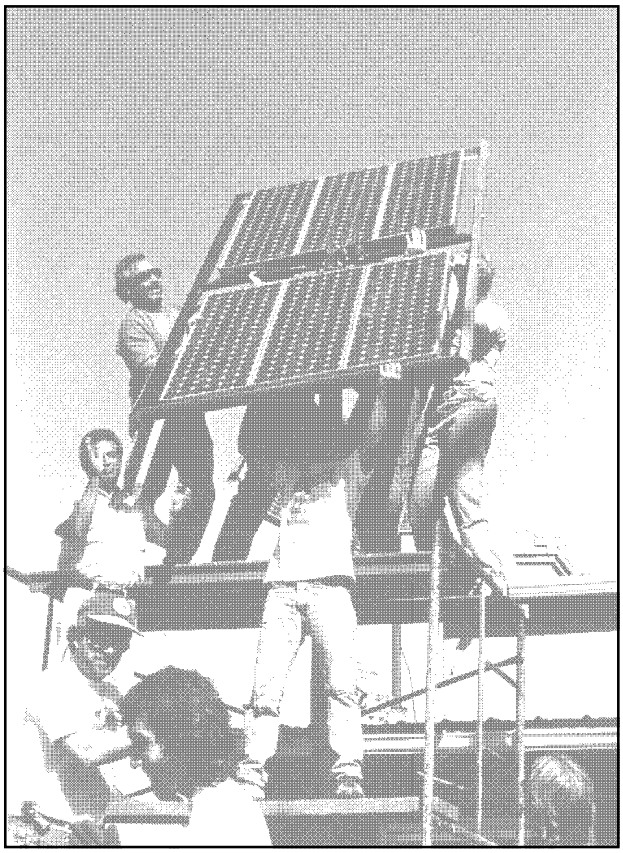

WORKSHOP SCHEDULE

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

Tuition: $350 per week. Discounts for full-time participants and those attending multiple workshops.

For more information, contact:

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Q&A

Charge Ahead

Since I am a new subscriber, I'm not sure if you've already talked about this or not... But here goes, I'm living in a trailer that is powered by two Solarex MSX 64 watt modules, a Bobier 8 Amp controller (with a bypass toggle switch), Equus digital volt meter and two 135 Amp/hr group 27 12 volt deep cycle batteries. My question is – can I use a high voltage (16.0 V)35 Amp Todd battery charger in conjunction with my 650W generator, to charge up my batteries fast? My understanding is that if I monitor the voltmeter and wait for the system to reach its terminal voltage and shut down, then it will not harm the batteries and will also save gas and time because the 16.0 volt charger does not have the same tendency to taper off, when the battery approaches full charge, as do the lower voltage chargers... Please elucidate. Sincerely, Kathy Compagno, POB 903, Redway, CA 95560

Hi, Kathy. You can use the Todd charger. In fact, its design is best suited for operation from your small generator. If you monitor the voltage as you mentioned, then no harm will come if you shut off the charger at around 14.5 to 15.0 VDC depending on battery temperature. You will get the fastest recharge possible and thereby reduce your generator's operating time. However, if you space out the charger and let it "cook" the batteries at over 15 VDC, then you can damage 12 Volt appliances that may be on line during the recharge period. While lead-acid cells love a good equalizing charge (and this can go up to over 16 VDC at a C/20 charge rate if the cells are cold), they don't like chronic overcharging at high current rates. The 35 Amp Todd will put over a C/10 rate into your particular battery. This is OK for a fast recharge, but when the battery is almost full (state of charge greater than 85%), this rate is too high. For equalization and/or recharging above 15 VDC consider a C/20 rate to be the maximum. Richard

Grid Use

How about using the "grid" as a battery? Sell power to the grid during week days, when not at home, so no AC or heating. At nights and weekends, buy it back. Power companies currently see residential customers as a burden and businesses as their most profitable arena. This would turn the tables and make residential customers a "source" instead of a "sink" and create an atmosphere of cooperation where energy efficiency becomes a plus in their corporate reports. John and Pam MacDonald, RR1 Box 133 CC Connor Sta. Rd., Finchville, KY 40022

You bet! Actually the US Federal Government passed a law known as the Public Utilities Regulatory Policies Act of 1979 (PURPA, for short). This act states that public utilities must buy power from individuals if the power comes from a renewable source of energy. The government says the utility must buy our RE sourced power, but it doesn't say that the utility has to make this deal easy or profitable for us. For example, the utility is required to pay you only its "avoided generating cost" for the power you sell them. This means between 1.5¢ to 3.5¢ per kWh. The hook-up and licensing procedure commonly takes several years and at least one hundred pounds of paperwork.

In spite of these warts, more and more folks are putting renewable energy back into the utility grid. The current best prospects for a PURPA system are sourced by hydro, the bigger the better. Also large wind systems. Right now, PV electricity is too expensive to sell back to the power companies and still make a profit. If the price of PV modules can come down in price by a factor of three, then we are looking at America's favorite form of roofing. PV-based PURPA systems will be as common as lawns. Richard

Retirement

Dear Home Power; My seven year old 980 amp-hr lead-acid battery bank is clearly showing its age. Can you offer a rule of thumb to help decide when to replace old batteries? Any discussion and description you could give concerning the heartbreak of aging batteries would be welcome. Keep up the good work! Dan Reeve, RFD2 Box 347, Belfast, ME 04915

Well, Dan, deciding when the ole' batts are done is hard. In my case, I've ridden them until I had an out-and-out cell failure (either open or short), then the decision is obvious. If the battery is still working, then an ampere-hour meter. like the new Cruising Equip. models, will give you an idea of the efficiency of the aged cells. This is really the main issue in battery replacement. New cells are around 85% efficient. As deep cycle, lead-acid cells age, their self-discharge rate increases radically from about 5% self-discharge per week when new, to over 25% per week when old. If you battery is not storing enough power to get you through the dark days of winter, then it's time for a replacement. The common band-aid used on aging

batteries is running the generator for frequent recharges. In our experience, this wastes gas, does the batteries no good, and wears out the generator to boot. Seven years is about the age when most lead-acid batteries begin to show diminished capacity, increased self-discharge, and decreased efficiency. Richard

DC to DC

Dear Home Power Crew; As a family living completely off the grid we have always looked forward to your excellent magazine.

Also, we have a technical problem that we hope you can be of some help with.

Our 6 Arco 40-watt modules have to be located about 400 ft. from our house due to exposure. Obviously we need to wire our panels in series in order to transmit the power that far. Question; How do we transform high voltage DC to low voltage DC (12-15 V)? We are having a very hard time answering this question and would much appreciate your help as we are tired of moving our batteries back and forth in the wheel barrow! Thank you for your time and trouble and for your excellent magazine! Bill C. Gomes, 5184 Sauk Valley Rd., Concrete, WA 98237 • 206-853-7553

Hello, Bill. There are several ways of running the PV array at higher voltages than the battery. You have discovered one obvious reason– voltage loss. You can use a Bobier LCB20 in conjunction with a Bobier ECM-1, see HP#25, page 16 for a technical article describing this type of system. Or you can use a variety of switching power supplies as described in this issue, page 34. And there are more "switchers", called Maximum Power Point Trackers (MPPTs) on the horizon. It is going to be very common to use higher voltage arrays with longer wire runs. Ain't technology wonderful? Richard

Earth Tube

Dear Home Power; I'm interested in an "earth tube" or a "cool tube" to help regulate the temperature of my home. If you or any of your readers have information about them, please write Jim Rosen, Rt 5, Box 494, Malvern, AR 72104, or call 501-623-2050. I will be happy to pay for the call.

Hello, Jim, it sounds like you are talking about a ground coupled heat pump. These devices work like a regular heat pump, but instead of using ambient air, they draw either heat or cold from the earth. The ground coupling pipes can be buried horizontally at a depth of ten to fifteen feet. Or the pipes can be vertical and sunk down a drilled "well." Since the interior temperature of the ground is constant at around 55° F, the ground coupled heat pump has access to heat in the winter and cold in the summer. Other "passive" schemes such as heat pipes and phase change materials are also used to couple a home thermally to the ground. I have no hard data on the more exotic schemes, but I do know that the ground coupled heat pumps work well in very severe climates. Richard

Big & Little

I would like to find out how to hook up multiple size battery groups to be all charged at the same time – it seems the smaller unit charges up way faster than the larger unit. Mr. & Mrs. J.W. Sebranke, 4305 212th S.E., Bothell, WA 98021

Charging dissimilar cells is alway very vague. As you have discovered, the smaller capacity cells fill first and then the larger ones. In general, this does the cells no harm. It does, however, overcharge the smaller cells if they are routinely cycled with larger capacity cells. If you are doing this, then make sure that the system has tight voltage regulation to prevent overcharging. See my article on Battery diagnostics, page 36 in this issue for particular voltage regulation points for lead-acid and nicad cells. Richard

Natural Gas Vehicles

Dear HP; Recently I wrote you concerning literature on methane generation and natural gas vehicles. I have a correction to make about the American Gas Association's 'Natural Gas Vehicle' newsletter. The newsletter is available free to local or state government agencies or local school districts. Requests for subscriptions must come from the agency or school. Write: A.G.A. Membership Services, 1515 Wilson Blvd., Arlington, VA 22209 • 703-841-8400

I hope you are able to provide this information to your readers. Thank you. Sincerely, L. J. Aurbach, 2811 McGill Terr. NW, Washington, DC 20008

Stirling Opportunities

I am interested in methane generation and other bio-mass fuels. I'd like to connect with any local people who'd be interested in a methane project. Also, if anyone's interested in Stirling Cycle engines or refrigerators, I have worked in the field and I'd be glad to share my experience with local folks. Kelpie Wilson, POB 1444, Cave Junction, OR 97523

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Useful info – Do you mind?
On issues of things now past
Is this issue to be your last?

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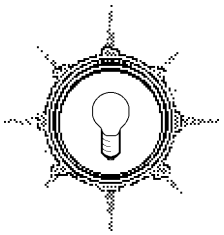
Thomas Lipton - 1870.



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NEW HOXAN SOLAR MODULES Customer canceled after deposit. You save 30%. 16 Hoxan 48 watt modules, Trace 2524 SB Turbo, Controller, Metering and Pole Mounts. (805) 373-9433

12/24v SUBMERSIBLE PUMP - Photocomm with LCB. Brand new (I have a 2 inch well) $500 FL 904-375-0406 eve.

DIESEL ENGINES--4HP and up, from $350 3KW Diesel Gen. set $795 * I.P.S. 3070 Kenneth St., Santa Clara, CA 95054 PH# 408/988-1672 * FX# 408/988-6071

USED SOLAR SYSTEM-8 ARCO M55s, 55 watts ea.; 8 module Zomeworks tracker; 10 2V CD batteries, 800AH; meter system, 30A Controller, PowerStar 1300 W Inverter-Sell All $3000. 2 gas refrigerators - $300 & $250. Trace 2024 SB-$900. Jeff Smurzynski, 619-868-4802.

The cover tells a long fine tale
Of issues now and issues pale
A small white tag there does decry
How many more you have to fly.

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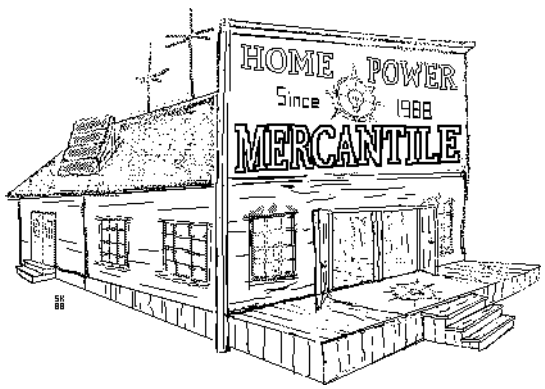

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