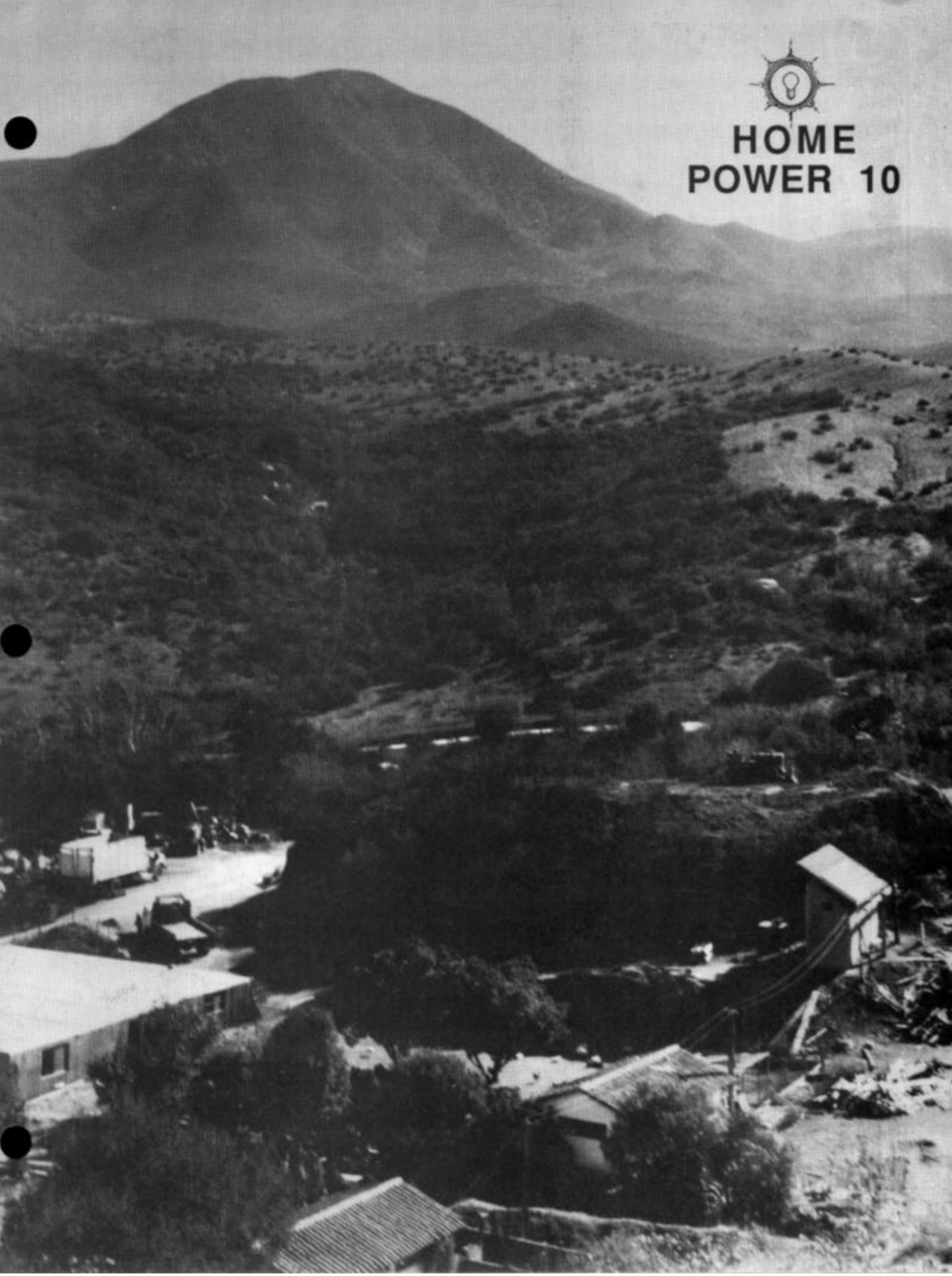

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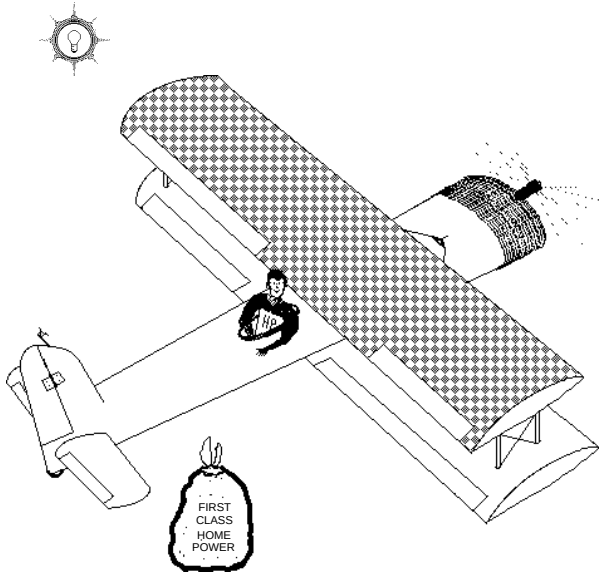

Home Power

People

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Laura Flett
Chris Greacen
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John Millard
Karen Perez
Richard Perez
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Think About It

"There is no such thing as a problem without a gift for you in its hands. You seek problems because you need their gifts."

Richard Bach 1977

Cover

Rancho Chatuco, a solar powered orchard in Baja California. See article on page 5 for all the info.

Photo by Richard Perez

Welcome to Home Power #10

For many of you this will be your first issue of Home Power Magazine. Home Power has been mentioned in several large international publications and the mail is flooding in. If this is your first copy of Home Power, then please take time to subscribe by filling out the Sub Form on page 23. If you don't fill out this form, then you may not receive future issues of HP. The basic subscription is free, all you need is an interest in renewable energy.

We've complied the data all of you have been supplying on the Subs Forms. There are now over 10,000 readers of HP and the collected data about our renewable energy usage is very interesting. See page 25 for a compilation of this data.

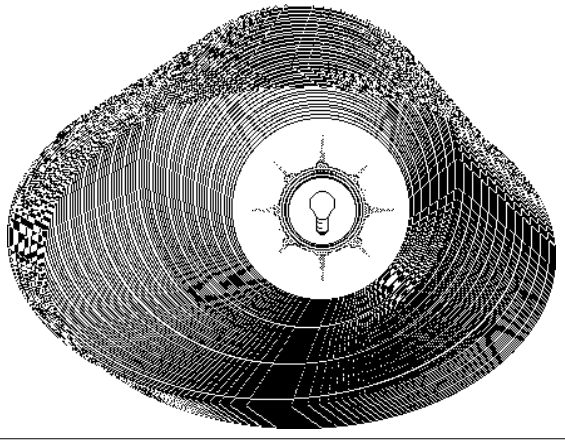
Many thanks to all of you who have sent in $20 and become First Class Home Power Readers. Your support is wonderful and your bucks have enabled us to freely distribute HP#10 to thousands of new readers. Every new reader means another magazine printed and mailed. Frankly, without the support of you First Class types, we'd have problems getting HP to everyone that wants it. So thanks, not only from us, but from all the folks who get HP free. If you want to get HP faster via 1st class US mail and help support this magazine, then see the First Class info on page 45.

As a publication supported basically by advertising, I must harangue you periodically about supporting our advertisers. All we ask is that you give the companies that make Home Power Magazine possible a shot at **your** business. When you buy products or services from a Home Power advertiser, tell them you saw their ad in HP. The renewable energy industry has been very generous in supporting the flow of information through this publication. The companies you see advertised herein deserve your support.

What can you do to help spread the word about renewable energy? Want to help clean up our environment? Well, you've got friends here at HP that share your goals. That's why we power this publication totally with renewable energy and offer it **free** to anyone that'll listen. We know that renewable energy offers us all a future we can live with. Information is the primary obstacle preventing mass implementation of renewable energy sources. The technology is here now and working, many of us are using it to power our homes. Home Power is our attempt to let everyone know what can be done with renewable energy. We need all the help we can get. We can use contributions of information, money, and Macintosh computer equipment. If you can help out, please do.

Thanks for your support!

Richard, Karen & the HP Crew



A Treasure Not Rare

I was tilling the earth
On an old piece of ground
When the tines of my tiller
Made a clink of a sound

So I bent to untangle
Whatever had fouled
Discover the cause
Of that clink in my plow

It was a couple of shoes
No doubt of their source
Two cast-iron clunkers
Left by a horse

"Would the horseshoes be lucky?"
I thought to myself
Or were they forewarning
Of quite something else

It took only a minute
To make up my mind
Decided the fortune
Foretold by my find

The luck's here already
That horse made it sure
Just look at this soil
Dark loam from manure

So when planting a garden
The treasure's not rare
There's wealth in the hay
That's been through the mare.

OOPS

Power House Paul Apologizes

If to err is human, then my article in HP#8 should make me Superhuman. I rewrote it to include newly acquired information on pipe losses that was more thorough and accurate than previous info. What I really liked was how optimistic the new chart was. I am conditioned to use charts giving pipe flow losses in feet and I never noticed this chart was in PSI.

In order for the figures to be in feet you must divide by 0.43 or multiply by 2.3. This causes the figures to more than double. If any readers have already acted on this I am profoundly sorry. Please note the charts are correct and the article is wrong. (If anyone wishes to consult with me directly, note that it costs 5¢ more than domestic mail to post a letter to Canada.) Soon another article on hydro will appear covering turbine types.

Paul Cunningham, Energy Systems & Design, POB 1557, Sussex, N.B., Canada E0E 1P0 • tele: 506-433-3151

God's favorite place on Earth

Richard Perez

Chatuco is a Yaqui indian word meaning "God's favorite place on Earth". This is a saga about solar energy at Chatuco; it is a true story about sunshine, electrons, and some of the brightest folks I've ever met.

System Location

Rancho Chatuco is the home of Victor and Cynthia Rubio. This 325 acre fruit orchard is located in the mountains of Baja California. At 32°N. latitude and an elevation of 800 feet, Rancho Chatuco gets more than its share of sunshine.

System Situation

Rancho Chatuco is amazing in itself. Never mind their new high tech energy system, let's talk trees and dirt for a moment. Victor & Cynthia, with a crew of six, have worked for 18 years and created an organic paradise. They use no commercial fertilizers or pesticides. Manure is used as fertilizer. Under intensive cultivation are oranges, lemons, avocados, apples (a special dry land type developed in Israel), grapefruit and such delicacies as Kiwi fruit. Over 4,000 trees are immaculately kept, many having their own individual drip waterers.

Maybe the best way to show how well these folks understand their environment is by a short story. During the time we were at Rancho Chatuco, the fruit trees were being attacked by snails. Instead of buying poison to kill the snails, Victor and his crew had a better idea. The rancho also supports several hundred geese, turkeys and chickens. Every morning the crew would herd these birds high into the orchards. It would take all day for the birds to travel back to their pens. The birds ate their fill of snails along the way. Not only were the snails being controlled, but the bird's food expenses went down and the orchards were being fertilized by the birds' droppings. Total cost- a few minutes loving labor in the morning. With an attitude like that, we instantly realized that these folks were going to have no problem adjusting to solar electricity.

Rancho Chatuco is located far beyond the local commercial electrical grid. For years the only electricity there was produced by a series of engine/generators. When the generator stopped so did the electricity.

Victor Rubio has been doing his homework. I was amazed at all the thoroughly thumbed renewable energy books in his library. He realized that the time had come to use photovoltaic technology to produce the rancho's power. He started the actual project in the Summer of 1988 with a trip through California, Oregon and Washington. On this journey he stopped and talked with various renewable energy companies. He eventually selected Electron Connection Ltd. to help him with his system. Together we started the process at the beginning- a complete survey and estimate of Rancho Chatuco's electrical requirements.

Electrical Power Requirements

The major 120 vac electrical load is lighting. The over 25 lights in the large ranch house are used extensively. We estimated their consumption at an average of 1,861 Watt-hours per day. While this may seem like a lot of energy just for lighting, please understand that we are looking at a Rancho here. A happy house filled with people, folks who get up before sunrise and need a light to cook breakfast. Other 120 vac appliances used in this system are: radiotelephone, coffee maker, stereo, TV set, vacuum, computer, copier, satellite TV, food processor and a hair dryer. All 120 vac electrical consumption totals out at 3,322 Watt-hours per day, including 10% for inverter inefficiency.

There are only two DC appliances powered directly from the batteries. A Sun Frost RF-16, 16 cubic foot, refrigerator/freezer which consumes 950 Watt-hours per day. A Sun Frost F-10, 10 cubic foot, freezer which consumes 900 Watt-hours per day. These refrigerator/freezers replace two propane powered units which were making the kitchen unbearably hot during the Summer months. DC Consumption totals out at 1,874 Watt-hours per day when the inverter's standby drain of 24 W.-hrs/ day is added in.

The entrance to Rancho Chatuco.
Beyond the entrance are the rancho's shops,
fruit storage buildings and the main hacienda. Photo by Richard Perez

Some of Rancho Chatuco's fruit trees.
The amount of work required by organic farming in this arrid environment is immense.
Most of the trees are serviced by buried water lines. Photo by Richard Perez

Victor and Cynthia Rubio.
Photos by Richard Perez

Total electrical consumption, both 120 vac via inverter and 24 VDC directly from the batteries, is 5,197 Watt-hours per day. All the appliances are graphed, with their estimated average daily power consumption, in Figure 1.

System Components

The components that make up Rancho Chatuco's renewable energy system are the most cost effective types now available. The system is primarily sourced via PV panels, with an occasional assist by the 12kW. diesel engine/generator. Lead-acid batteries store the energy. An inverter converts the DC energy stored in the batteries into 120 vac for consumption by standard appliances. Here's how the system breaks down.

Power Sources- Photovoltaics (PVs) & Engine

Rancho Chatuco uses 20 Kyocera 48 Watt photovoltaic modules to make most of its electricity. These panels were assembled into a 24 VDC array with an output of about 30 Amperes. The array is rated at 960 peak Watts under full sun. We estimate that this array will produce, under the intense Baja California sun, over 5,000 Watt-hours per average day. Victor and Cynthia tell us that it is unusual to have more than three cloudy days in a row at their location.

If the sunshine fails, Rancho Chatuco falls back on its aged 12 kW. diesel generator. The generator still sources the rancho's workshops and industrial strength power tools (they fix everything

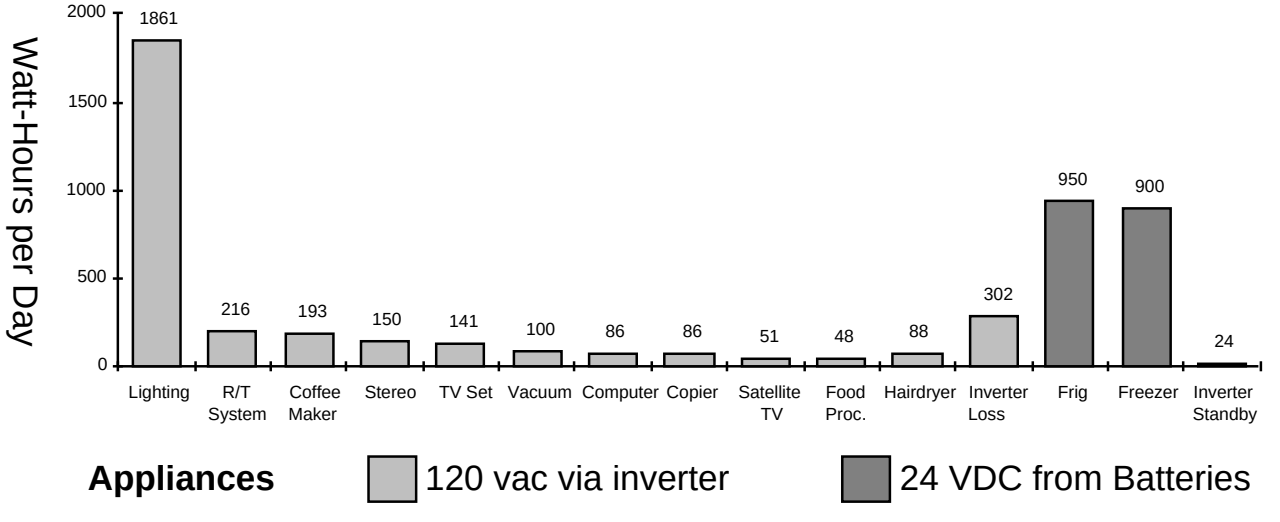


Figure 1- Rancho Chatuco's Estimated Electrical Power Consumption

from pumps to bulldozers on site). This hulk of a unit is located some distance from the rancho's main house where no one has to listen to its considerable racket.

Power Source Control

A Heliotrope CC-60 PWM charge controller is wired in series with the PV array. This unit assures that the batteries store as much of the PVs energy as possible without being overcharged. The Heliotrope controller was equipped with the optional thermostatically controlled fan for those hot Summer days in the Baja. For a complete "Things that Work!" review of this controller and how it works, please see Home Power #8, page 31.

Energy Storage- Batteries

Rancho Chatuco's battery pack is composed of twelve Trojan L-16W lead-acid batteries. The individual batteries, each 6 VDC at 350 Ampere-hours, are assembled into a pack of 24 VDC at 1,050 Ampere-hours. This battery pack is specified so that 20% of its energy is not routinely used. On this basis, the pack contains enough energy to power the system for almost four days.

Energy Conversion- Inverter/Battery Charger

A Trace 2024 Inverter/Battery Charger changes the 24 VDC, produced by the PVs and stored in the batteries, into 120 vac for appliance consumption. This inverter is capable of delivering 2,000 Watts output with surges to around 6,000 Watts. We equipped the inverter with the optional Turbo Fan kit that extends its output by keeping the inverter cool on hot days. Other options installed in this inverter were the battery charger, digital metering package and the remote control. The battery charger deserves special mention.

The Trace inverters are very sophisticated and intelligent electronic devices. The built-in battery charger senses when the generator is operating. It automatically does two things when the generator is running: 1) it stops inverting and starts recharging the batteries, and 2) it switches all loads normally supplied by the inverter to the generator. This battery charger allows the system to use the 120 vac engine/generator to recharge the battery pack when there isn't enough sun to do the job. This charger is capable of putting up to 50 Amperes at 30 VDC into the batteries. The charger is user programmable to fit just about any battery capacity and type. For a "Things that Work!" test of the Trace inverter/charger please see Home Power #8, page 29.

System Installation

There is a lot more to a system than a pile of equipment. All these various bits & pieces must be properly assembled into a working system. Details like wire size and

Ramon Andrade, Martin Andrade and John Pryor bolt the PVs to the roof of the PV shed. The PVs were racked in sets of 4 using slotted steel angle stock. The angle holds the PVs off of the roof and promotes cooling and increases hot weather power output. Photo by Richard Perez

A view of the PV shed from a hill to its southest. The crew is busy soldering the PVs feeder wires to the main 00 gauge copper cable bus. All the construction framing came down after the installation was complete. The roof of the Battery House is visible on the left hand side of the photo. The actual distance between the Battery House and the PV Shed is 145 feet. The main hacienda is concealed by the trees at the extreme right of the photo. Photo by Karen Perez

A schematic of Rancho Chatuco's energy system. The left side of this schematic contains the 120 vac equipment and the flow of 120 vacelectricity is indicated by the arrows filled with wavy lines. The right side of the schematic details 24 VDC electrical equipement and the the flow of 24 VDC is indicated by the arrows filled with horizontal straight lines. The schematic is divided into four vertical areas. On the top are the Power Sources making electricity. The next level down is Power Processing and includes the inverter and PV charge controller. Note that the inverter straddles the border bewteen 120 vac and 24 VDC- that's its job, converting one type of electricity into another. The next level down is Power Storage and is accomplished as 24 VDC by batteries. The bottom level is Power Use and details the different types of power consumption.

interconnection are critical. If they are not done right, all the money spent on the hardware is wasted. Victor asked Electron Connection to help his crew install his system. John Pryor, Karen and I went to Baja California to do the job. Before leaving, we corresponded often with Victor and worked out most of the details in advance.

Victor and his crew built a special building with a South facing, 32° sloping, roof. This building was constructed at the best solar site near the house. It receives sunshine all day, the only limits are the distant mountains. While Rancho Chatuco is going to use this building's interior as a tool shed, the real purpose of this building is its South facing roof.

The PVs were racked onto 1.5 inch by 1.5 inch slotted steel angle iron. Each length of angle iron is 6 feet long and a completed rack holds 4 PV panels. See Home Power #2, page 11 for full details on racking and wiring PV panels using this method. Five of these racks were bolted to the roof of the PV shed. We cut up the same steel angle to make feet for the racks. These feet make the racks stand away from the roof by about two inches. This allows air to circulate under and around the PV panels, keeping them cool. The PVs have greater power output and longevity when they are cooler.

The PV array is located about 145 feet from the battery house. In order to efficiently transfer the low voltage DC produced by the PVs to the batteries, we needed special low loss cable. We used 00 gauge copper cable with outdoor insulation. The 290 feet of this cable (two conductors) are capable of moving the 960 Watts produced by the PVs while losing only 20 Watts to resistance within the cable. This 00 gauge copper cable is 97.88% efficient at its job. If you're interested in the tech details of wire specification, see Home Power #2, page 33. Victor's crew already had the cables strung out over their handmade power poles when we arrived. Each conductor is mounted to the pole with its own ceramic standoff. The cables are separated by about two feet.

We wired the individual PV panels up with short lengths of 10 gauge copper wire with soldered #8 ring connectors. These ring connectors were attached inside the panel's junction boxes. Short feeders were wired to each set of two series panels (24 VDC). These short feeders were SOLDERED to the 00 gauge main cables. All low voltage connections, especially those exposed to the weather, must be soldered wherever possible. Mechanical connections are far too temporary and lossy for PV wiring. These 00 gauge cables then ran along the poles and delivered the PV's electrical production to the batteries for storage.

From right to left, John Pryor, Richard Perez and Goyo Villa solder the feeders to the main bus. Photo by Karen Perez.

The battery house is really the center of this installation. It contains the 12 batteries, the inverter and the charge controller. The 00 gauge cables delivering the PVs' energy were connected to the massive power lugs on the PV controller. The controller in turn feeds the battery pack. The inverter was connected to the battery pack via low loss cables with SOLDERED connectors. Mechanical connections don't last long around lead-acid batteries. The battery acid eventually gets inside the connector and the entire cable assembly becomes corroded scrap metal.

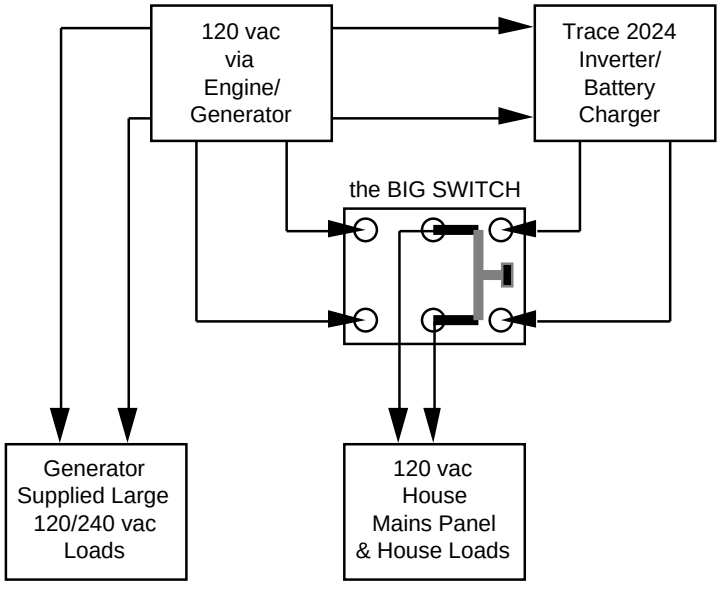
We laid 3 sets of cables over the 112 foot distance between the battery house and the main house. The first set is composed mostly of 00 gauge copper (since we already had the tail end of a roll) with a piece of 6 gauge soldered into the cable set. These low voltage cables deliver 24 VDC to both the Sun Frost refrigerator/freezers in the main house. The second set of cables is 6 gauge copper and carries the inverter's 120 vac output to the house. The third set of cables is 6 gauge copper and delivers the engine/generator's power to the Trace's battery charger.

At the house, both the inverter and the generator are connected to the mains panel via what we call the "Big Switch". This switch is a

Ramon Andrade seeks refuge from the wind to complete his soldering. On this day it was cloudy, cold and too windy to make good solder joints outside. Photo by Richard Perez.

double pole, double throw, knife switch capable of handling 100 Amps at 120 vac in an efficient manner. This switch allows the mains panel to be directly sourced by the generator when the engine is operating or by the inverter if the generator is not operating. This takes the load off of the transfer relay in the Trace (limited to about 3kW.) and makes the full 12 kW. generator power available in the house. The following diagram shows how the Big Switch is wired.

John Pryor and I had alloted 4 days for the installation of Rancho Chatuco's system. Well, we hadn't figured on the folks that worked there. And I mean WORK. Ramon Andrade, Martin Andrade and Goyo Villa were the main workers on this project. Even though they spoke no English and my Spanish has degenerated to ordering dinner, we communicated. After they watched us wire up one set of PV panels, then they correctly did all the rest. Ramon learned to make clean, bright solder joints using a propane torch (if you think this is easy, then give it a try on some 00 gauge cable



sometime). Everyone was curious about the system and wanted to know how everything worked. Fortunately Victor and Cynthia speak better English than I do and were able to translate the technical information. Anyway, instead of 4 days of hard work, this system was installed in 2 & 1/2 days of fiesta.

System Performance

All these components function together as a system. While all PV/Engine systems have basically the same components, they differ greatly in the number and type of components used. It takes experience and knowledge to correctly specify a system so that it meets the electrical needs without overspending. This system works for Victor and Cynthia because it was designed for them. It's as personal as a hand made pair of boots. With this in mind, let's examine how this system performs.

The PV panels produce in excess of 5,000 Watt-hours on an average solar day at Rancho Chatuco. The number of panels, and thereby the quantity of power they make, is specified to almost exactly meet Victor and Cynthia's average daily power consumption. This is the most cost-effective way of using PV supplied energy today. Size the AVERAGE daily production of the PV array to equal the AVERAGE daily power consumption of the system's users. Let the engine/generator pick up the unusual situation of sustained cloudy weather or higher than normal power consumption. If this technique is used, then be sure to do a thorough and accurate estimate of power consumption prior to specifying the system's components. Without a good consumption estimate, you are flying blind.

We estimate that Rancho Chatuco will run their engine/generator about 390 hours per year. Generator operation will mostly occur during the cloudy days of January and February. While the battery pack stores 4 days worth of energy for this system, the almost daily PV input extends their AVERAGE capacity to 13 days. Some generator operation is built into this system. It is far less expensive to occasionally use the generator than it is to oversize the PV array and battery pack to handle the infrequent extended cloudy periods. What we've done with PVs here is push the generator into the background. It's still there, with all its high-powered noise, but now it's only used occasionally. Before PVs, Victor and Cynthia were putting over 2,300 hours per year on their generator. With the PVs making power, the generator will be run about 83% less time. And during these fewer hours, the generator is more fully loaded and more efficient because its power is being stored in batteries for later use.

System Cost

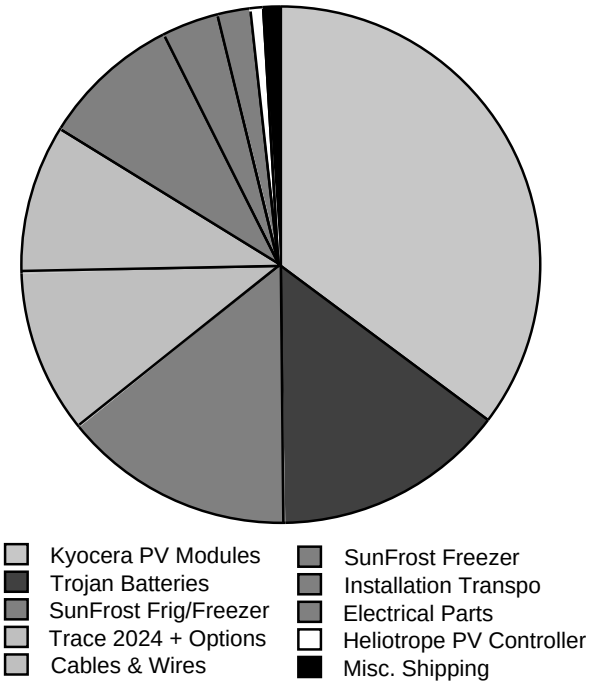
A breakdown of what the components cost is in Table 1. Shipping is included in the cost of the components. Note that the two Sun Frost products are included in the total, eventhough they are appliances and not strictly part of the power system. The category "Cables & Wires" includes ALL wiring and shows that the copper cable used to transfer low voltage is expensive. Also included here are the custom made battery and inverter cables used in this system. Copper prices are rising monthly, so give careful consideration to long wiring runs at low voltages, they can be expensive. The slot titled "Installation Transpo" is the cost of getting John, Karen and I to Baja California and back. Electrical parts includes: the big switch, various electrical boxes, plugs, connectors, the PV rack material, solder, shrinktubing, nuts, bolts, and other small parts.

With the PVs in this system, the bottom line power cost is $0.92 per kiloWatt-hour and the system will cost about $209. per year to operate. Without the PVs, the power cost would be $1.22 per kiloWatt-hour and the system would cost about $1,501. per year to operate. These cost figures are calculated over a ten year basis and include EVERYTHING. By everything, I mean every component, both refrigerator/freezers, each bit of wire, connector, gallon of diesel fuel, and our transportation to install the system. There are no hidden costs here.

Over a 10 year period, this system, with its photovoltaics, will save Rancho Chatuco about $12,920. This is compared to sourcing the

	ITEM	Cost	%
20	Kyocera PV Modules	$7,080.00	35%
12	Trojan Batteries	$2,940.00	15%
1	SunFrost Frig/Freezer	$2,870.00	14%
1	Trace 2024 + All Options	$2,067.35	10%
	Cables & Wires	$1,896.30	9%
1	SunFrost Freezer	$1,723.00	9%
	Installation Transpo	$754.00	4%
	Electrical Parts	$359.58	2%
1	Heliotrope PV Controller	$201.75	1%
	Misc. Shipping	$172.00	1%
	TOTAL	$20,063.98	

Table 1- A spreadsheet breakdown of this system's cost.



Where the Bucks Went.

system with only the generator. After about 6 years of operation, the PV panels will have paid for themselves. And they start making FREE electricity from that time on. How long will the PVs last? Well, no one really knows, but Kyocera warrants them not to lose more than 10% of their output power within 12 years. See the "Thing that STILL Work!" article in this issue for proof of the PVs' longevity.

System Overview

The first morning that the system was operating, Victor was beaming at breakfast. That morning, for the first time at Rancho Chatuco, he had a light over the bathroom sink to shave by. Victor, a sensible man, had never fired up the monster generator just so he could have a light for shaving. Well, this morning he had an illuminated shave while Cynthia cooked fish, rice, beans and eggs for breakfast in a kitchen lit by solar energy. Cynthia was also making plans around her sewing machine, another appliance too small to normally justify starting the generator. The two Sun Frosts were quietly percolating, keeping all the Rancho's homemade food fresh. With or without electricity, the grits at Rancho Chatuco are the best! John and I hardly had time to work between meals.

Solar energy fits right in at Rancho Chatuco. Everything else there is solar powered… If God really does have a favorite place on Earth, then it may just be Rancho Chatuco. Ripe tomatoes volunteer in the orchards, all the animals there are fat and happy, and the folks, well, they beam like sunshine. Nuff said…

The folks at Rancho Chatuco in front of the main hacienda. From left to right, Victor & Cynthia Rubio, Sandra, Richard Perez, Ramon Andrade, Goyo Villa, John Pryor and Martin Andrade. Photo by Karen Perez.

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tele: 707-822-9095

Zomeworks
Corp.
AD

Trace Engineering Ad

Photovoltaics - The alternative to life in a greenhouse

Gary Starr

The summer of '88 brought the worst drought North America has had in 50 years. Crop losses were in the billions. Forest fires blazed throughout the Northwest, the Great Plains and Yellowstone National Park. On the other side of the globe, China was also experiencing horrendous drought and related crop damage conditions. Over a million people were hospitalized, and hundreds of other died from the heat. Was it a mere coincidence? Or a warning: A warning that nature was rebelling?

Until this year scientists have been cautious about attributing rising global temperatures to the greenhouse effect, a predicted warming of the earth caused by pollutants. But this summer a Congressional committee was told by NASA scientist Dr. James E. Hansen that NASA was 99 percent certain the warming trend was not a natural variation, but was caused by a buildup of manmade gasses in the atmosphere. He also pointed out that this decade has seen the four hottest years of the last century and the first five months of 1988 were the warmest on record.

The warming trend appears to be accelerating, and unless we stop it, higher world temperatures by as much as 10 degrees, melting of the polar ice caps, and the rising of the oceans all seem likely in the next century.

The primary culprit appears to be carbon dioxide. Since the industrial revolution an estimated 185 billion tons have been injected into our atmosphere.

The prescription to slow and reverse this dangerous trend is simple, although it is not an easy pill for industrialists to swallow. Slow down the burning of fossil fuels: coal and oil. Scientists and policymakers are investigating plans such as substituting natural gas when possible, since it emits half the carbon dioxide of coal. Stricter emission standards and conservation are also being evaluated. Also the environmentalist's nemesis -- nuclear power -- is back on the table since it produces no carbon dioxide.

However, there is another power source that does not produce carbon dioxide and is renewable: renewable at the beginning of each day, and pollution-free when utilized. This power source is photovoltaics, or solar electricity, the conversion of light into electricity.

You may have heard the myths that photovoltaics are still too expensive, that they're not efficient enough, or that the technology is still 20 years away. Wrong. The technology to build low-cost photovoltaics is no longer on the horizon -- it's here. These solid state devices which change light directly into electricity have the ability to allow significant change to occur. At today's efficiencies a piece of desert land about 2 miles square could host a solar electric generating plant with the power production capacities of a large nuclear or coal plant.

Misinformation combined with corporate greed has held back the full potential of this non-polluting energy source. If the masses could be educated on the true economics of energy, they would realize that reducing our dependency on fossil fuels would not only slow and reverse the greenhouse effect, it could also move us away from the dangerous dependence on foreign oil. The general economy could also benefit from photovoltaics as research has consistently shown that investment in solar technologies results in many more jobs than investments in conventional fossil fuels.

Another obstacle to curbing fossil fuels use is political. Just as poorer countries are becoming industrialized, there is pressure from the rest of the industrialized world to stop the use of these carbon dioxide producing fuels.

It appears that the countries which caused the greenhouse effect now want limits on energy consumption by those struggling to become industrialized. Such limits could cripple the growth of their economics.

Perhaps an equitable solution would be for the wealthy countries to transfer benign technologies such as photovoltaics to poorer countries, free. The motive could be completely self interest. The more the world acts in concert to reduce fossil fuel emission, the less everyone will suffer.

The cost of a major move away from fossil fuels to photovoltaics could be insignificant. A one-time investment of less than $1 billion would allow photovoltaics to become cost effective with nearly all other forms of energy. This figure is less than half of one percent of our current annual defense budget. What better way to feel secure than secure the future of the health of the earth?

Photovoltaics are today a viable, cost effective alternative for many conventional fuel applications. And with the proper backing of governmental agencies and the investment community this benign power source could be competitive with all methods of power generation and save us from the prospect of living in a greenhouse.

Gary Starr is President of Solar Electric Engineering, Inc. and author of "The Solar Electric Book", which is available for $11.95 plus $2.00 shipping and handling (California residents add 6% sales tax) from Solar Electric Engineering, Inc., 175 Cascade Court, Rohnert Park, CA 94928.

PHOTOCOMM
AD
FULL PAGE

A Wind/PV System

John Millard

I have been a renewable energy buff since the 1974 energy crisis. Windmachines for generating electrical power always fascinated me. In 1974, I bought a 200 Watt 12 Volt windcharger and installed it on a 35 foot steel tower. It generated a small amount of power for the house. At the time, I had 5 @ 24V aircraft 35 Ampere-hour batteries (wired in series to produce a pack of ≈130 VDC). The batteries fed a 1kW. rotary converter, 130 VDC in and 120 vac out, which ran the house. The 12V output of the wind charger fed a 12V to 120V, 150 watt Tripplite inverter which in turn fed a rectifier driven by a small auto transformer to boost the voltage up high enough to charge the 130V battery.

Getting Started

The system sounds good, but was very inadequate. It was fine for first few hours, but the energy input to the batteries was extremely low. The windcharger mainly kept wind recording records over the years. I used an old G.E. chart recorder to record the 12V output whenever the wind blew. The tower was too short, the trees are higher than the tower in some directions. But we learn from our mistakes.

System Location

This wind plant attempted to power our summer home in Round Top, upstate New York. We are on three acres of land in the the Catskill Mountains, at 860 feet elevation. Our property is in a resort area with a lot of boarding houses dating back to the 1850's. It's a nice mountain resort with cool summer nights.

Wind Machine & Tower

In 1975, with my father's encouragement, I purchased an Electro Windplant made in Winthur, Switzerland from Real Gas & Electric in California for $3,500. It sat in its crate for 3 years until I completed the 80 foot tower.

The tower is built from eight 9 foot sections of 3"x3"x1/4" angle iron and 2" angle iron. This angle iron came from what was once an 8 foot wall around the roof of "The Valencia", a movie theater in Jamacia, Long Island. After pricing new angle iron, the 45 year old iron and bolts looked very attractive. The district manager was glad to find someone who would dismantle that section for free. With the help of my cousins, Jim Sweeney and Bob, the roof was dismantled and all the angle iron, complete with nuts and bolts, was hauled to upstate New York.

It took three years to build the tower following carefully drawn plans. The whole tower was built on the ground. It was raised with the windplant on it from horizontal to vertical using a hand cranked, 5 ton winch. It took three people two days to raise the tower to the vertical (thanks Frank, Mike and Dan Gilroy). When the tower was finally vertical and the reinforcement bars were in the three holes, the concrete was poured. I used existing large trees, guyed temporarily, to lift the tower. The winch was mounted to the trunk of one large tree. I left the guy cables from the tower to the trees in place for extra security, but after ten years and tremendous winds over the winter, I figured that the tower could support itself as was originally planned. The tower is also anchored in solid rock below the concrete using two rock anchors per hole. The tower was completed in 1978.

In my area the wind usually comes from the northwest or the southwest. The wind machine is producing 6 to 12 kilowatt hours in 24 hours depending on conditions. When the wind is gusty (NW wind) the wind machine is constantly yawing to catch the wind and in the process loses a lot of power. The gentler and more constant wind from the southwest generally produces more power.

Batteries

The battery house, next to the tower, is the size of a one car garage. It was completed in 1980. I built shelves on both sides of the building out of 2x4's and 2x6's. I have two battery banks with 60 cells in each bank. The 2 Volt, lead calcium cells weigh approximately 110 pounds each and are rated at 50 Amps for 8 hours, some are 62.5 Amps for 8 hours. The two battery banks supply about 1200 Amp hours at the 100 hour rate or ≈140 KWH of storage. This supplies 2 weeks of storage using 10 KWH/day.

Photovoltaics & Tracker

In the summer the windplant just sits like a monument, doing nothing, so I decided to try solar. I bought 33 panels @ $200 each from Solarex. They are factory seconds with blemishes, no frames, and no guarantee. All of the panels tested between 2.5 to 2.8 Amps in strong sunlight. Some of the cells were missing their beautiful crystal blue color, but they still produced full current.

I built a wooden frame of 2x4's and household wood molding to frame the 33 panels. The whole frame pivots on a center beam that tilts up. The high end of the frame faces north, the lower end faces south. The frame tilts, like a seesaw, east and west to track the sun. I can also tilt the main beam up (north side) higher using a small hand crank winch and pulley system at the rear of the panels. I adjust the tracker's tilt monthly so the sun hits the panels more directly at 12 Noon. The panels track east to west using a small electric winch and electronic timer which almost precisely keeps the panels in direct sun all day.

The electronic timer operates a relay which closes the circuit to the 1/6hp ac winch motor every 15 minutes for eight seconds. It uses a 555 IC from Radio Shack. It has two adjustments, one for off time and one for on time. Once the two potentiometers are set, it will work reliably for the whole season. In the evening, the panels stop tracking when a mercury switch opens the circuit to the winch motor, just before the panels hit the stops. I then throw a reverse switch to tilt the panels back to the east. The reverse process takes about 3 minutes. The sun hits the panels at about 7 AM. I have calculated that the tracker increases the panels output by 30% in the summer.

In 1986 I added 11 more Solarex seconds to the frame increasing output 25%. The original frame had three "holes", I then added 4 panels to each side of the frame. That gave me 44 panels or 4 sets

John Millard and helper mount the PV panels on the homemade wooden tracker.

John Millard's Mom & Dad standing before the loaded tracker. 44 Solarex PV panels wired to make 10.5 Amperes at130 Volts DC.

A view of John Millard's house and 6kW. Electro Windmachine with 16.4 foot diameter propeller.

of 11 panels in series. Each 11 panels in series produces 130V at 2.5 Amps. The four sets of 11 panels are each connected in parallel to produce 10 Amps at 130V in good summer sun.

Inverters

I had been using a Silicon Control Rectifier (SCR) inverter, but last year I set out to design and build an inverter with improved power handling capability and efficiency. I built a 4.5KW inverter that uses 20 mA. at 130V with no load. It is 97% efficient at 20% load and 94% efficient at full load, which doesn't happen very often. It is a HexFet™ power inverter that's transformerless. I feed the inverter with 130VDC and get squarewave 130vac directly to the load, it's efficient and durable.

Last summer I caused a short circuit on its output, not once but twice. I was cleaning a 32 watt circular kitchen fluorescent light fixture with steel wool. I had removed the fluorescent tube and accidentally touched the socket with the steel wool. I had fireworks with burning steel wool raining on the floor. Good thing I was on a wooden chair. I was careful, but the same thing happened while I was cleaning a second fixture. The inverter didn't fail. The old SCR inverter would have. The inverter and PVs have also survived several thunderstorms with hail as large as 3/4" in diameter. Knock on wood.

Last year I replaced our frost free refrigerator with a manual defrost model, reducing power consumption from 4KWH to 1.8KWH daily. That's a power savings of over 12KWH per week. I have rechanneled the saved energy into a two burner electric stove to supplement our gas range. For two weeks this summer we used the electric stove for all our cooking with no noticeable reduction in battery voltage, besides running everything else in the house (4 electric fans, water pumps, washing machine, toaster, electric tractor, a GE electric riding lawn mower and tractor which uses 6 golfcart batteries) During the summer, when there's company, we need up to 5KWH just to pump water. The rest of the time the pump uses 0.8KWH.

PV Voltage Booster

I made a device this past summer called a maximizer which boosts the voltage output of the solar panels about 15%. It makes use of the solar panels ability to produce higher voltage when they are cool.

Normally the battery voltage is 130V, but with the maximizer I can get 170V from the panels when the temperature is 50°F at practically the same current and drop it down to 130V through a transformer. Of course, you have to change the DC from the panels to ac before you feed the transformer. That extra 40 Volts at 10 Amps is a 400 Watt gain. This extra energy is rectified with a bridge rectifier on the output windings of the step down transformer which changes it back to DC to feed the batteries. It is also an isolation transformer. I have seen an extra couple of Amps going into the batteries.

A second inverter is used to change the DC to ac. I used an isolation transformer and adjustable variac so that I can change the turns ratio to match the best possible voltage the panels put out. It is like tuning in a radio station for the best signal level. I just vary the variac for the highest Amperage reading into the batteries. Then I back off a little to the low Amperage side because I know the panels are warming up if its in the morning. The ratio of the transformer windings is less as the panels heat up. If you go above the high side of the ammeter reading (more turns ratio on the variac) you will soon end up with less output even without the maximizer because the transformer match becomes very poor.

At present, I have to go to the battery house twice a day to reset the variac for maximum match between the PVs and batteries. It would be nice to have an automatic device to keep the match at

maximum at all temperatures throughout the day. Alternative Energy Engineering carries Maximizers, but not at the voltages I'm interested in.

System Instrumentation

I have a large plus and minus Amp meter similar to a car ammeter in the battery house. It has 0 center reading from +70 to -70 Amps. I've seen that meter go over 20 Amps when I have a clear sunny day with a brisk NW wind. That's 10 Amps from the windplant and 10 Amps from the panels. One day last summer the batteries collected 16KWH from the sun and the wind.

The windplant and the PVs can each produce a maximum of about 13KWH in a 24 hour period.

I use two electronic Ampere-hour meters from Natural Power in my system, one measures DC Ampere-hour input to battery and the other the Ampere-hour consumption of the inverter. These Ampere-hour meters tally energy gained or lost per day. A good day in the summer will show approximately 100 Amp-hours input to the battery at 130V. This time of year (Nov. 15, 1988) the solar panels produce about 50 Amp-hours on a good day. The wind plant will produce more energy as we approach the windy season and its output will approach 100 Amp-hours.

I have a small recorder hooked up to an anemometer which measures wind speed calibrated to 50 MPH top scale and 1/8 inch per hour tape speed. One roll of recording paper will last six months. I set this recorder every fall and have winter winter recordings for the past 5 years. The anemometer head is mounted near the wind plant in the tower. The winter wind recordings are very impressive. The wind blows for two weeks straight at times with hardly a break. In fact, the wind blows more days than it doesn't in the winter.

The anemometer is powered by normal utility power over the winter which is at the house and used as backup when my system is off. My system is really not a necessity as I know it is for many other people out there. But since it is already in the house why disconnect it? It's good security if all else fails. Besides it's only $6.00 per month to have the utility there.

I want to thank my mother and father and all people mentioned for their support.

John MIllard, 46-27 157st St, Flushing, NY 11355

Windplant Specifications

Model WV650, 6KW peak output at 130VDC, 16 pole alternator, Double Lundel field rotor.

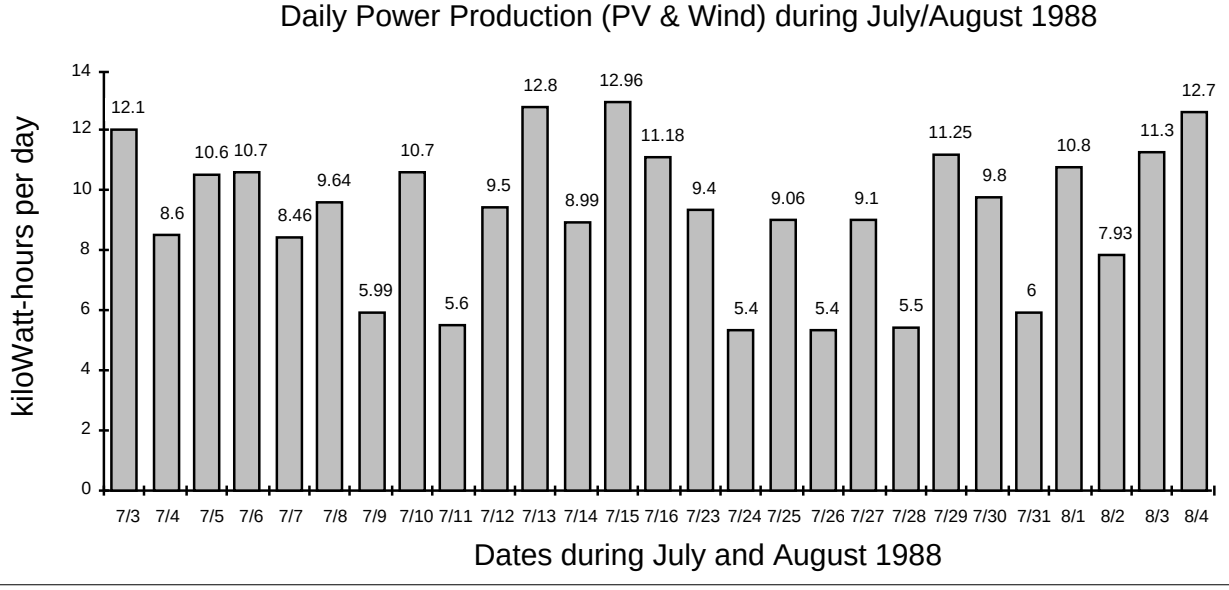
Electro magnetic field shunt fed from a three phase rectifier in head, main three phase output is rectified at base of tower in control box.

Propeller is a three blade spruce wood, 16.4 feet in diameter which automatically feathers in high wind. Maximum prop rpm is 200 stepped to 800 rpm at alternator with 4 to 1 gear box in front of alternator.

The tower is 80 feet tall.

I built an electronic rpm monitor which automatically causes the tail to furl thus shutting down the plant if for any reason it overspeeds. A small winch which operates off a 24 volt tap on the main battery pulls on a 5/16 steel cable which goes up the center of the tower through the turntable at the top and is attached to the tail via a chain.

The windplant is made by Electro GMBC of Winterthur, Switzerland.



Learn Photovoltaic Design & Installation

Johnny Weiss

Register now for an intensive "hands-on" photovoltaic workshop beginning July 10th in Colorado. Entitled "PV Design and Installation for Practitioners", this unique five or ten day program gives participants practical information on solar powered electrical systems.

The Course

Learn to design (1st week) and install (2nd week) stand-alone remote PV systems. The course combines classroom theory and "hands-on" skills training. No prior knowledge of solar or electricity is required.

The first week will focus upon the basics of solar electricity, appropriate applications, system hardware and how to size and specify equipment. Commercially available components will be discussed and evaluated in detail. Teaching is done with full-scale demonstration systems and laboratory exercises are taught with working components. The optional second week is devoted exclusively to "hands-on" installation training. Participants will install working systems on remote sites in the surrounding Colorado Rockies.

Who benefits from this program?

This Workshop/Seminar is for those interested in solar electricity for their own applications or those pursuing a career in PVs. Previous trainees have included licensed electricians, solar technicians, energy efficiency professionals, PV industry trainers, researchers, entrepreneurs, and end users. Everyone from professionals to do-it-yourselfers can learn and benefit from this training. Graduates are employed in PV installation, design, sales, manufacturing, management and training. To date over 400 people have completed this program.

Appropriate Technology Associates

Former Colorado Mountain College (CMC) instructors, Steve McCarney, Ken Olson, and Johnny Weiss are now offering their training program as Appropriate Technology Associates. ATA personnel are professional designers, installers and industrial trainers in the field of renewable energy technologies. Our ATA team has been working together continuously and full-time for the last eight years. We have been involved in such projects as remote power systems, low cost solar food dryers, solar water distillation, award winning passive solar homes, commercial scale greenhouses and construction management of multi-million dollar solar projects. Home Power readers can review the feature article about our program in HP #3.

The Home Power Crew has not been alone in acknowledging the special quality of this training. Solar Age Magazine called this program, "the nation's leading PV Design & Installation course". Mother Earth News wrote that we have, "…the well earned reputation for offering the best nuts & bolts PV instruction course in the country".

In HP #9, instructor Steve McCarney mentioned his recent PV adventures in Chile, Bolivia and Peru. He has been with the World Health Organization and others working with PV powered vaccine refrigeration and water pumping. As this issue of HP goes to press, Steve will be troubleshooting installations in the Carribean Islands.

So come and join us…

We are looking forward to July 10th. This year promises to be the best summer PV workshop yet. If you are serious about learning PV design and installation, make plans to attend. Class size is limited, so register early. The cost per week is $350. This includes our textbook and the Product Literature Supplement Guide. If your registration is postmarked & prepaid by June 15th, then the cost is $300. If you bring a friend and share course materials, then the friend gets a $50. discount. For more information please contact: Appropriate Technology Associates (ATA), 410 Garfield Ave., Carbondale, CO 81623 or call 303-963-2682.

Saving Energy Saves Money

Jonathan Hill

Energy is a unique commodity. Though it has no material form, we can often see it or feel it. It is something we all use every day, and certainly couldn't live without. Energy appears in many forms: heat, light, electrical, chemical, mechanical, nuclear and solar. How we use it and how much we use affects us greatly.

Although vast amounts of energy are consumed in industry, travel and business, this article is mainly concerned with how it is used in our homes. Often the cost of heating fuel and electricity is as large as our mortgage payment. Heating and cooling is by far the greatest of these costs. Hot water heating is next, followed by the cost of operating lighting, electrical appliances and water pumping.

For many years, our country worried little about the cost of home energy. There seemed to be an inexhaustible supply, and it was relatively inexpensive. In the fifties, we were encouraged to buy "all-electric homes" by none other than Ronald Reagan himself, then host of "General Electric Theater." We were assured of "safe, cheap and abundant" supplies of electricity thanks to "the peaceful atom". At our peak of energy use in the seventies, we found that more was not necessarily better, and perhaps using less energy made more sense.

While many consider our high per capita rate of energy use to be necessary to fuel our equally high standard of living, it is interesting to note that in western Europe, where people enjoy a standard of living comparable to ours, they use only half as much energy per person. "Why is this?", you may ask. The answer is simple. Energy costs in Europe have been high for some time, and waste could not be allowed.

Sensible House Design

To live an energy-efficient lifestyle does not mean that one must make sacrifices or do without one's comforts. To the contrary, a home that is properly designed for efficient energy use will be more comfortable year-round, with less over-heating, cold-spots and drafts. If a house is properly oriented to allow for maximum winter sun and summer shade, heating and cooling costs will be reduced drastically. Add to that good insulation, low infiltration (of outside air) & proper window placement, and our job becomes even easier.

Passive Heating and Cooling Aids

Starting with a good house design, there are several things that you can do to save even more money on your heating and cooling bill. Here are a few that require no fuel or electricity and very little maintenance:

1) Solar shade screens- These simple screens fit outside your windows in locations where summer sun and heat enter the house, usually on the southern and western exposures and over skylights. Though they look like ordinary screens, these energy-savers block from 70-90% of the sun's radiation and accompanying heat. They also afford additional privacy by providing an opaque appearance from the outside. Many buildings in our area can go without air conditioning entirely with the use of solar shade screens. Needless to say, the screens cost far less than the conventional cooling equipment that they replace, to say nothing of their complete lack of operating or maintenance costs.

2) Insulated window coverings- It is a common fact that a home's greatest winter heat loss as well as largest summer heat gain is through the windows. This is why areas near windows are often less comfortable. This is especially true in the winter, when window areas are often drafty. Many otherwise well-thought-out homes have rooms that often go unused during periods of the year because they are just not comfortable.

Attractive, effective insulated window coverings can quickly solve these problems.

3) Radiant shield- This is a new item on the market, and shows tremendous promise in reducing cooling costs. This aluminum-clad material can be applied to new or existing construction. Stapled to the underside of the roof rafters, the radiant shield reflects the sun's heat and keeps it out of the attic, keeping it considerably cooler, resulting in a much lower temperature in the living space. In many dwellings, use of this product can eliminate the need for air conditioning.

Solar Hot Water

After space heating and cooling, the largest user of home energy is usually the hot water heater. Fortunately this energy drain can easily be reduced with only moderate expense. Some people seem to think that solar hot water was a 70's fad, and faded with the times. Not true! Solar hot water was very popular in the Los Angeles area in the early 1900's, and disappeared only when the hot water heater manufacturers gave people free gas and electric hot water heaters in exchange for their "old-fashioned" solar units, assuring a perpetual market for their supplies of then cheap gas and electricity. Well, it may have made sense back then, but one quick glance at our utility bill tells us that we've been had. A family of four often spends $50 per month or more to operate their electric hot water heater. Solar energy is presently making hot water for thousands of people all over the world, many in climates where sunshine is limited. Solar hot water does not have to be complicated or expensive. A moderate investment can save a typical family many thousands in utility costs over the life of a system.

The only type of systems worth cosidering are of the "passive type." This means that there are no pumps, controllers, temperature sensors, solenoid valves or other moving parts to malfunction. Also, no electricity is required for their operation (pv users take note!) When properly sized and installed, passive solar hot water systems can provide most or all of a family's hot water during a large part of the year.

Woodstove Hot Water

If you heat with wood, the perfect compliment to any solar hot water system is a hot water heat exchanger for your woodstove. Easily mounted inside your woodstove's firebox, this simple device extracts a small amount of heat from your stove and uses it to make hot water during the winter months. While this heat exchanger can be used without solar hot water, it really does make sense to use both. Making hot water with both solar and wood

heat, a family can provide as much as 85% of their yearly hot water without their gas or electric hot water heater ever coming on.

Instantaneous/Tankless Water Heaters

Want a quick & inexpensive way to save up to 1/3 or more off your hot water bill? An instantaneous tankless hot water heater could be the answer. Though they do consume fuel, these units are moderately priced, easily installed, and far more efficient than their conventional counterparts. The key to this model's efficiency lies in its tankless design. The burner only comes on when you are actually using hot water, instead of keeping a large tank of water hot 24 hours a day. As a result, these units can pay for themselves in energy savings in as little as two years.

The Energy Efficient Home

The Energy-Efficient Home will be much like your own home, but it will have all of the improvements described above. It isn't likely to cost much more than yours, but it will cost much less to own. Keep in mind that at current trends, utility rates are likely to increase at least ten-fold over the next twenty years! The equipment discussed in this article will pay for itself within a few years. After that, it's all savings. The Energy Efficient Home is the home of the future. But the future starts right now.

Jonathan Hill is a mechanical engineer & for the last 9 years has been proprietor of Integral Energy Systems, 105 Argall Way, Nevada City, CA 95959. Tele: 916-265-8441.

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Home Power

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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 free subscription, but we would greatly appreciate this information so we may better serve you.

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

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

☐ **As my only power source** ☐ **As my primary power source**

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

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

☐ **As my only power source** ☐ **As my primary power source**

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

☐ **Photovoltaic power** ☐ **Water power**

☐ **Wind Power** ☐ **Other** _____

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

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

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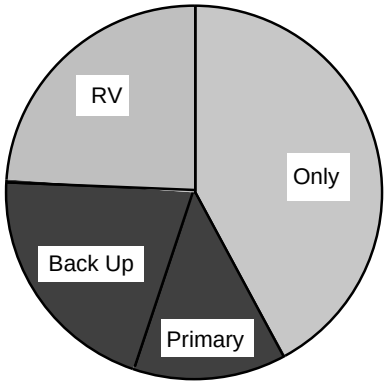
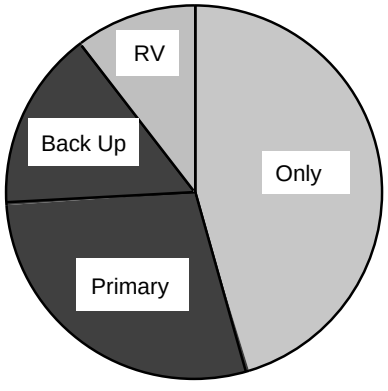
Home Power's Renewable Energy Survey

We've been busy compiling the survey data that comes in with your subscription forms. We thought all of you might be interested in a look at what we're doing with renewable energy, what we're planning on doing, what equipment we now use, and what equipment we are planning on using. We began collecting this data in November of 1987 and here is an update as of 26 March 1989. Feel free to add your data to this survey by using the subs form on page 23.

There are now over 10,000 Home Power readers and 7,528 have responded on the information portion of the subs form. The percentages in the spreadsheet below are computed on the basis of those responding to the survey (7,528 people). Amazing facts: 1) over 39% are now making all, or most, of their electricity, and 2) over 78% want to make all, or most, of their own power in the future. The equipment portion of the survey shows extensive usage of all types of RE equipment and substantial future growth.



Renewable Energy Use – NOW



Renewable Energy Use – FUTURE

Number of Home Power Subscribers	10,106
Number responding to this Survey	7,528

Renewable Energy Usage

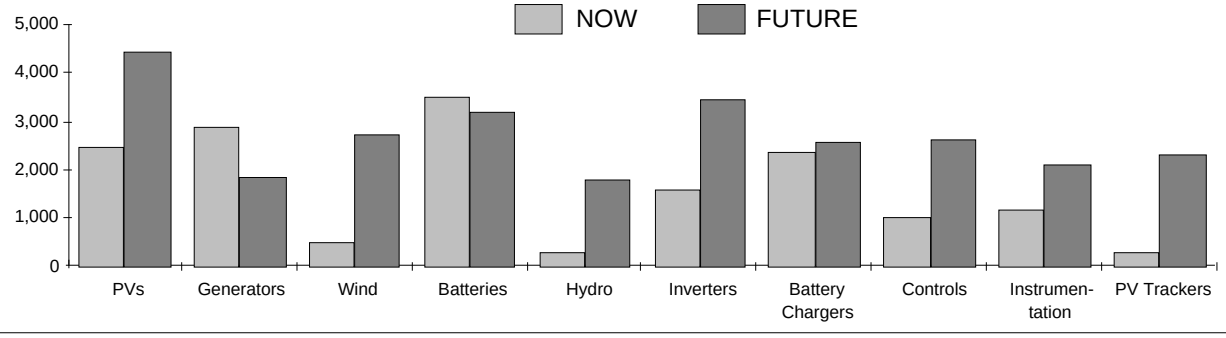
	NOW	%	FUTURE	%
Only	2,269	30.1%	3,622	48.1%
Primary	732	9.7%	2,281	30.3%
Back Up	1,117	14.8%	1,267	16.8%
RV	1,289	17.1%	817	10.9%

Renewable Energy Resource Potential

	NOW	%
Solar	6,480	86.1%
Hydro	2,156	28.6%
Wind	3,897	51.8%

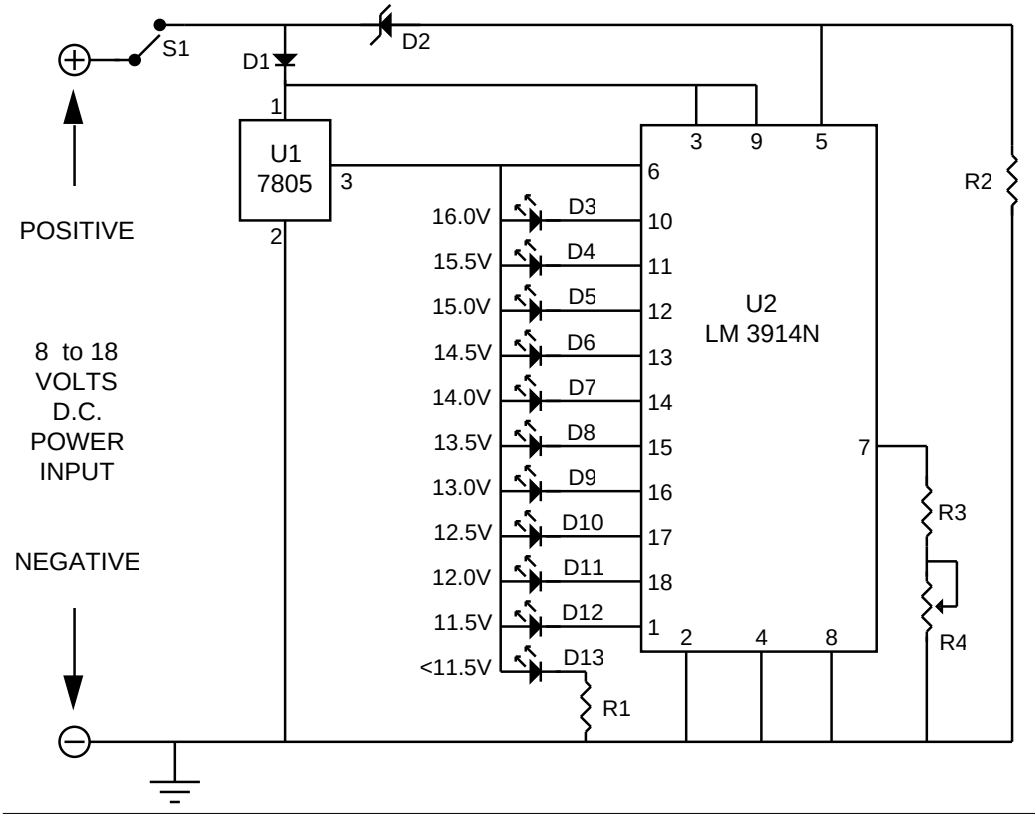
Renewable Energy Equipment Usage

	NOW	%	FUTURE	%
PVs	2,490	33.1%	4,444	59.0%
Generators	2,881	38.3%	1,857	24.7%
Wind	518	6.9%	2,741	36.4%
Batteries	3,526	46.8%	3,192	42.4%
Hydro	299	4.0%	1,809	24.0%
Inverters	1,613	21.4%	3,457	45.9%
Battery Chargers	2,407	32.0%	2,585	34.3%
Controls	1,051	14.0%	2,627	34.9%
Instrumentation	1,184	15.7%	2,141	28.4%
PV Trackers	315	4.2%	2,339	31.1%



12 Volt Lead-Acid Battery "Gas Gauge"

or the "BAT-O-METER"



Parts List

Integrated Circuits

U1- 7805, 5VDC, 1A. Voltage Regulator
U2- LM 3914N, LED Bar/Dot Driver

Diodes

D1- 1N4002, 1 A. Silicon
D2- 1N5241B, 11VDC Zener
D3-Amber LED indicates 16.0 VDC
D4- Amber LED indicates 15.5 VDC
D5- Amber LED indicates 15.0 VDC
D6- Green LED indicates 14.5 VDC
D7- Green LED indicates 14.0 VDC
D8- Green LED indicates 13.5 VDC
D9- Green LED indicates 13.0 VDC
D10- Green LED indicates 12.5 VDC
D11- Green LED indicates 12.0 VDC
D12- Amber LED indicates 11.5 VDC
D13- Red LED indicates <11.5 VDC

Resistors

R1- 390Ω, 1/4W.
R2- 390Ω, 1/2W.
R3- 1.4kΩ, 1/4W.

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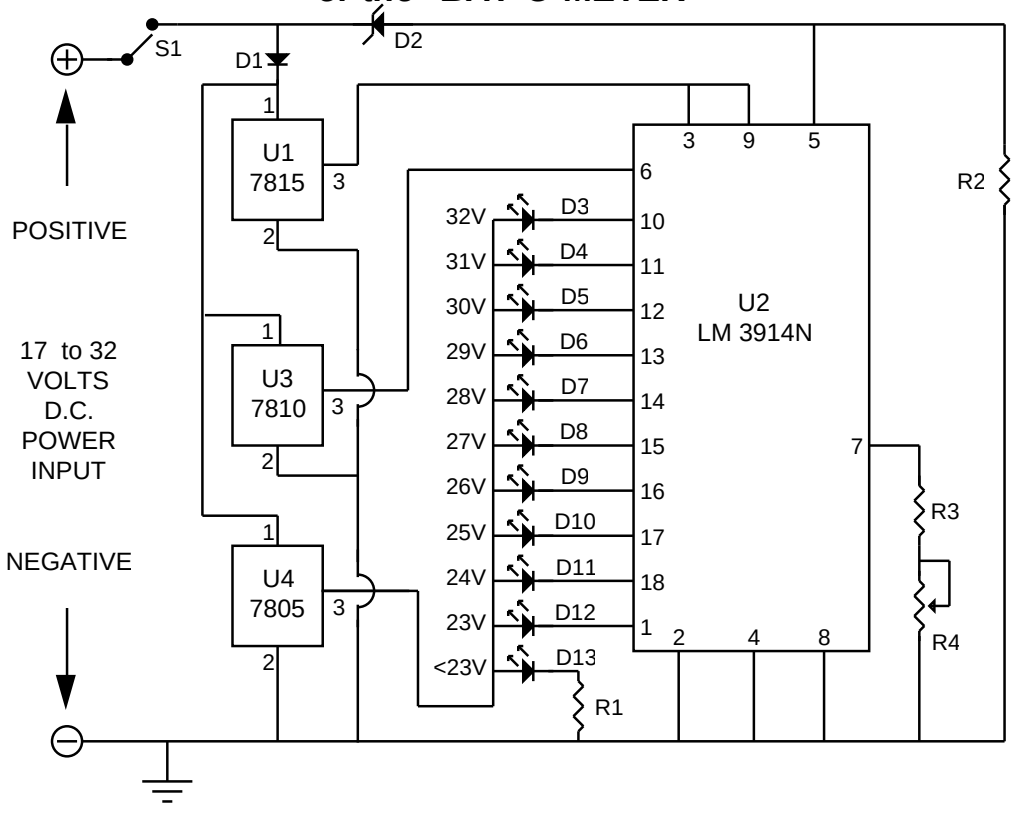
24 Volt Lead-Acid Battery "Gas Gauge"

or the "BAT-O-METER"



Parts List

Integrated Circuits

U1- 7815,15VDC Voltage Regulator
U2- LM 3914N, LED Bar/Dot Driver
U3- 7810, 10VDC Voltage Regulator
U4- 7805, 5VDC Voltage Regulator

Diodes

D1- 1N4004, 1 A. Silicon
D2- 1N5251B, 22 VDC, 1/2 W. Zener
D3-Amber LED indicates 32 VDC
D4- Amber LED indicates 31 VDC
D5- Amber LED indicates 30 VDC
D6- Green LED indicates 29 VDC
D7- Green LED indicates 28 VDC
D8- Green LED indicates 27 VDC
D9- Green LED indicates 26 VDC
D10- Green LED indicates 25 VDC
D11- Green LED indicates 24 VDC
D12- Amber LED indicates 23 VDC
D13- Red LED indicates <23 VDC

Resistors

R1- 390Ω, 1/4W.
R2- 820Ω, 1/2W.
R3- 1.4kΩ, 1/4W.
R4- 10kΩ trimmer potentiometer

Build your own Battery State of Charge Meter

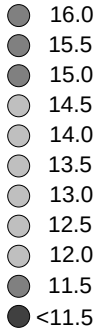
Richard Perez

Here's a simple, home-brew, project that indicates how much energy is remaining in your batteries. It's a "gas gauge" for lead-acid batteries, we call it the "Bat-O-Meter". It is an LED bar graph voltmeter with an expanded scale. It can tell you the state of charge of your batteries from across the room, even in the dark. The Bat-O-Meter is not only very simple to build, but also very inexpensive-less than $10. in parts and about an hour of your time are all that's needed. And, in addition to the 12 Volt model, we've designed a 24 Volt model (we hear you 24 Volters out there).

What is a Bat-O-Meter?

It is a vertical column made up of 11 Light Emitting Diodes (LEDs). It's like a thermometer, the greater number of LEDs that are lit, the higher the column gets, and this indicates higher system voltage and more energy in the battery. Here's the scheme for a 12 Volt system. The bottom red LED indicates battery voltage below 11.5 VDC. The next, amber, LED up the column lights when battery voltage above 11.5 VDC. The next, a green LED, lights up when the voltage is above 12 VDC. And so on in 1/2 Volt increments until the uppermost LED and all the ones under it are lit when the voltage reaches 16 VDC. The scale is setup much the same for 24 VDC systems, except the first LED indicates below 23 VDC, the final LED indicates 32 VDC, and there are 1 Volt increments between the individual LEDs.

The range and spacing of the bar graph is set to function within the voltage range of a lead-acid battery storage system. The battery voltage in a just about exhausted 12 Volt battery is less than 11.5 VDC, so this is the bottom of our scale. When the voltage is above 15 VDC, the battery is full, and almost all the LEDs in the string are lit. Color coding of the LEDs makes it easy to see what happening in the system at a glance.



How the Bat-O-Meter works

Here's some information on how the circuit actually works. Please remember that it is much more difficult to understand how this circuit works than it is to build it. While the understanding is fun and rewarding, you can build this puppy from the schematic and it'll work whether you know how it works or not. Ain't electronics wonderful? So if you're not interested in learning the theory, just skip to the construction part below.

The LM 3914N is an integrated circuit (IC) that contains 10 LED drivers working together across a 10 equal step voltage divider network. The range of this network is set by the voltage fed the upper end of the divider network (pin 6). The voltage of an incoming signal (in our case the battery's voltage) is compared to the voltage across the divider string. The LEDs are lit by comparison of the incoming signal to the various voltages steps across the divider.

Let's start first with the LED called D13 because it is the only LED not controlled the the LM 3914N. The anode of D13 is sourced by the 7805 regulator, just like all the other LEDs. But the cathode of D13 is not controlled by the chip, hence this LED is lit all the time. This is the default LED and it indicates system voltage below 11.5 VDC in a 12 Volt system, or system voltage below 23 VDC in a 24 Volt system. We included this LED because the first LED activated by the LM 3914N is D12, which turns on at 11.5 VDC or above. Well, what about a system with totally depleted batteries. In this case the system voltage will be below 11.5 and we need to indicate that the batteries are empty. Without this default LED the display would be totally dark at voltages below 11.5 VDC (23 VDC in a 24 Volt system). If D13 is the **only** LED lit in the bar graph, then the batteries are empty.

The high end of the voltage divider network is Pin 6 on the LM 3914N, and the low end of the divider chain is pin 4. We are feeding the high end of the divider 5 VDC from the 7805 voltage regulator. The low end of the divider (pin 4) is grounded. Thus we have established 5 VDC across the divider, and the LM 3914N automatically divides this 5 Volts into 10 equal steps, each 0.5 VDC. This establishes the full scale voltage of the meter (all LEDs lit) and the increment between each LED.

The incoming battery voltage (our signal) is too high in voltage to be fed directly to the LM 3914N. We've referenced its voltage divider to 5 VDC and battery voltage is always much greater than this. So we must process the incoming battery voltage signal. We accomplish this by inserting an 11 Volt zener diode in series with the incoming signal. This zener diode (1N5241B) subtracts 11 Volts from the incoming signal. For example, if the battery has a voltage of 12 VDC, then once the zener has processed the incoming signal, its voltage is 1 VDC. This gyration is necessary so that the meter starts reading at 11 Volts and not a lower voltage. This incoming signal processing expands the scale of the resulting bar graph. R2 is a ballast resistor for the zener. It continually draws current through the zener and makes the voltage drop (11 Volts) across the zener more stable.

The resistor network (R3 & R4) from Pin 7 of the LM 3914N to ground determines the brightness of all LEDs except D13. Now LEDs can be power hungry kinda guys. If you turn the brightness control (R4) all the way up, then each LED is consuming 10 milliAmperes of current. With the brightness control all the way down each LED is consuming less than 3 milliAmperes. R4 allows adjustment of the LEDs' brightness, and thereby the overall power consumption of the meter.

The 7805 (U1) is an integrated circuit voltage regulator. You can feed any DC voltage (<35 VDC) into it and it will only output 5 VDC at up to 1 Ampere. We are using it for two purposes in this circuit. First is to establish a stable 5 VDC reference for the voltage divider/ comparator network in the LM 3914N. Second, the 7805 feeds the anodes of the LEDs. While the anodes of the LEDs could be fed directly from ambient voltage, this places a strain on the LM 3914N display driver chip. The LM 3914N controls the amount of current

that flows through the LEDs. If the LEDs are fed more than 8 VDC, then the LM 3914N starts to get hot. The LM 3914N has a total device dissipation of around 600 milliWatts. In order to get the LEDs brightly lit without overheating and ruining the display driver, we fed them a lower voltage. This allows us to run the LEDs at high brightness without french frying the LM 3914N.

Two other parts are worthy of mention. D1 is not strictly necessary, but protects all the electronics if you should hook up the meter backwards (reverse polarity). If the meter is hooked up to the battery backwards, it will not work, BUT it won't be damaged. S1 is a switch. This switch is in the schematic because this meter can consume an appreciable amount of power if you turn the LEDs brightness way up. For example, let's look at the worst case- all LEDs lit and at maximum brightness. In this situation the meter will consume about 130 milliAmperes or 3.12 Ampere-hours in a day. So Switch 1 allows you to shut off the meter if you wish to save power. Use a momentary switch for S1 and the meter will only function when you are depressing its switch. Power consumption of this meter can also be controlled by turning the brightness down on the LEDs. For example, consider 3 LEDs lit and the brightness turned down. In this case the meter consumes less than 20 milliAmperes or about 0.5 Ampere-hours a day.

Notes on the 24 Volt Bat-O-Meter

It's a bit tougher to get the Bat-O-Meter on 24 VDC than onto 12 VDC. We need to add two more voltage regulators (about 75¢ each). The 7815 regulates the overall circuit and protects the LM 3914N from overvoltage. The 7810 establishes a 10 VDC reference for the voltage divider/comparator in the LM 3914N. The 7805 performs the same function in both the 12 and 24 Volt models. Note that there are different resistor values in the 24 Volt model.

Constructing the Bat-O-Meter

The parts can be purchased from your local Radio Shack or from Digi-Key, POB 677, Thief River Falls, MN 56701-0677 • tele: 1-800-344-4539. Digi-Key stocks just about everything electronic and their quality is higher and prices lower than Radio Shack. I based my component cost estimate of $9.58 on the latest Digi-Key catalog.

Use a 2 inch by 3 inch piece of perforated circuit board to construct the Bat-O-Meter. Arrange the LEDs in a vertical column, starting with D13 at the bottom. All parts are mounted on the perfboard and there is no wiring to the enclosure. Use an 18 pin DIP socket for the LM 3914N, don't solder directly to the IC unless you are a good hand with electronics work. It's easy to damage the LM 3914N by overheating it with a soldering iron. Use a heatsink on U1 as it'll warm up under high LED brightness and high system voltage.

How you enclose the meter is up to you. Or even if you put it in an enclosure- I've had one running for years- perfboard nailed to the wall. I liked mounting the finished perfboard, using standoffs, on a piece of oak. Use more standoffs to mount a piece of lucite or plexiglass over the unit- The visible Bat-O-Meter.

You only have to adjust R4 to the brightness you desire, and your Bat-O-Meters functional.

Using the Bat-O-Meter

One factor that will affect the accuracy of the Bat-O-Meter is where the meter is placed in the system. While the meter can be located anywhere on the DC wiring, it will work best if it is directly wired to the batteries or the main battery/bus terminals. If the Bat-O-Meter is located on wiring that is feeding other appliances, then it will indicate the voltage loss in the wiring when these other appliances are working. Since the resolution of this meter is rather coarse (0.5 VDC), losses in wiring won't affect the reading very much unless the appliance is very large or the wiring undersized.

Using the Bat-O-Meter is simple. The more LEDs illuminated, the more power you have. During periods when the batteries are being recharged by whatever source you have available, the bar graph will indicate this by lighting more LEDs. If you turn on an appliance, the system voltage is depressed by this load, the voltage goes down, and so does the number of LEDs lit by the Bat-O-Meter.

The color coding of the LEDs also means something. The bottom red LED indicates that you're out of power, batteries empty. The next LED up is amber and it indicates that you're getting low. The next 5 LEDs are green and mean you have power, the more green LEDs lit, the more power. The amber LEDs at the top of the scale (15, 15.5, & 16 VDC in a 12 Volt system) indicate high voltage and possible failure of regulators or other incoming power control equipment. If you normally run your system at 15 VDC under charge (we do), then change D5 from an amber LED to a green one.

A word of disclaimer. The Bat-O-Meter is designed to be a simple, non-technical, indicator of a battery's state of charge. It doesn't read out in numbers that need to be referred to a graph to give you the info you want. It's made to be simple and easy to read. It is not designed to replace an accurate voltmeter, but as an "at a glance" supplement to the info provided by a digital meter or such like. After living with our Bat-O-Meter for a while, we find that it tells us all we really need to know and in colors no less. Red- out of power, Amber- caution, & Green- go go go…

Fresh Water from the Sea

using solar distillation & PVs for pumping

Horace McCracken

Practically any seacoast and many desert areas can be made inhabitable by using sunshine to pump and purify water. A 10 gallon/day solar still now purifies sea water for drinking, cooking and other household needs for a residence near George Town, Exuma, in the Bahamas. Solar energy does the pumping, purification, and controls seawater feed to the stills.

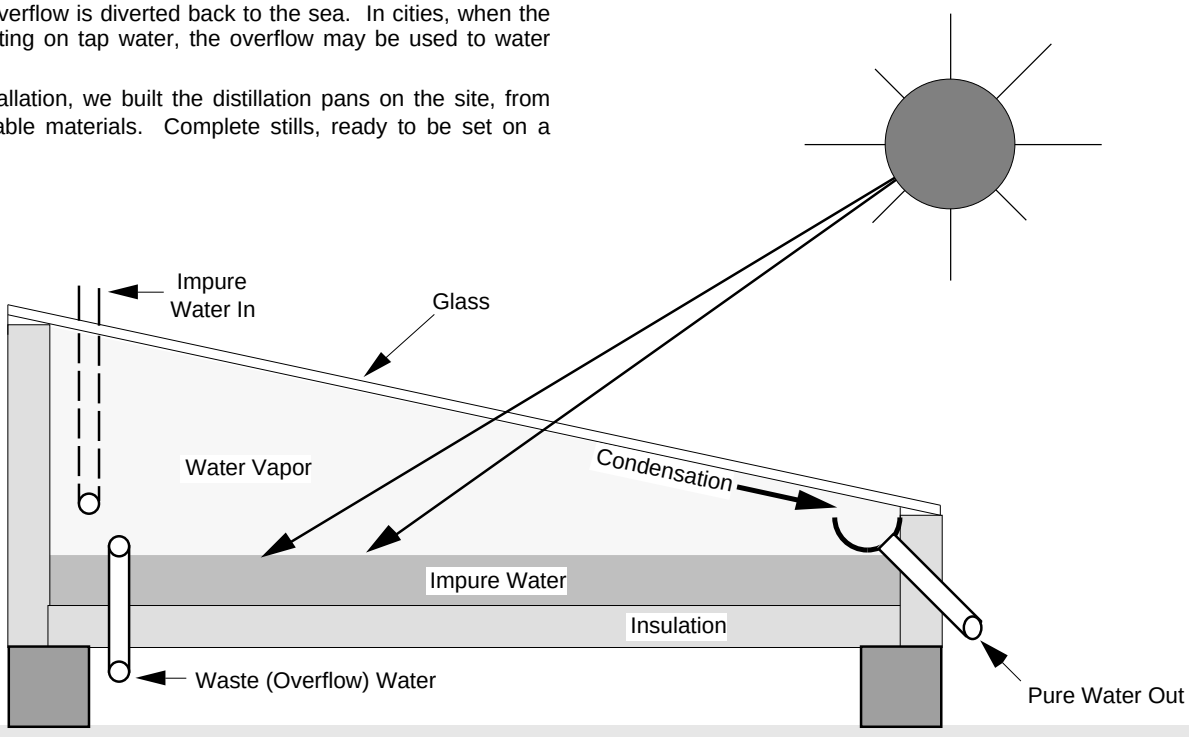
Solar Distillation

This system uses three solar distiller pans 33" wide by 10'3" long. They are insulated, lined with a special corrosion-resistant membrane. The pans contain salt water, about 3/4 of an inch deep. Tempered glass covers are cemented over the pans. Sunlight shines through the glass cover, warming the salt water in the pan. Pure water evaporates, leaving the salts, minerals, fertilizers, etc. in the pan, still dissolved in the brine. In the solar still, the glass cover traps the water vapor which then condenses on the underside of the glass (which is cooled by the outside air). The cover is tilted, so that the condensed water runs into a trough, where it flows into a storage tank. The process is exactly Mother Nature's method of getting fresh water into the clouds from oceans, lakes, swamps, etc. All the water you have ever consumed has already been solar distilled a few thousand times around the hydrologic cycle.

The still is filled once daily, at night or in the morning, with at least twice the amount of water that was distilled the preceding day. There is an overflow fitting at the opposite end, so that the extra water runs out, keeping the salts from building up in the still. In this installation, the overflow from one still feeds the next one and the total amount of feed was set at 40 gallons per night. On this tiny island, the overflow is diverted back to the sea. In cities, when the still is operating on tap water, the overflow may be used to water plants.

For this installation, we built the distillation pans on the site, from locally available materials. Complete stills, ready to be set on a level support, are also available. A photovoltaic panel powers the pump filling the salt water reservoir. The water comes from a well about 10 feet deep in limestone rock. The well's bottom is about a foot below sea level. Some rain water mixes in, but it is mostly sea water, well filtered by the 50' or so of sand between the sea and the well. Good filtration is imperative to keep the pump running dependably. Dropping a hose into the sea with a screen over it is not adequate.

The sea water is pumped up hill via 300 feet of pipe, to a reservoir about 25 feet above sea level. Feeding sea water into the still when the sun is shining would substantially reduce production because the heated water would be flushed from the still, So the PV pumped sea water is held in reserve in a shallow reservoir. A special solar actuated valve (invented and manufactured by McCracken Solar), stays closed all day and then it lets water flow into the stills about an hour after the sun goes down. This slow response time prevents emptying the still when a passing cloud goes by. The reservoir was built with a black impervious membrane liner and a glass cover, so that the stored sea water is also solar



heated during the day, about 60° warmer than the outside air. This pre-heated water also helps evaporation within the still, increasing the day's yield by ≈10%.

All parts of this system, except the working parts of the pump, are designed to last for 20 years. The pump has been chosen for simple, inexpensive, and infrequent maintenance. In this installation, the pump runs for only about an hour a day, so its parts may last for years before replacement.

Solar Still Performance

Operation of the still is totally automatic. It requires no routine maintenance and has no routine operating costs.

The rated production of the still is an estimated annual average and is not exact, as the amount of sunshine can vary widely. These stills produce more in hot climates than in cold ones, more at low latitudes than high, and more in summer than in winter. At the 23° North latitude of the central Bahamas, the estimated average production of this installation in June will be 15 gallons per day, down to about 5 in mid-winter. In higher latitudes, addition of a mirror to the rear of each still increases winter production.

The still also functions in freezing climates. The still itself is entirely unharmed by freezing, any number of times, but exposed water lines must be insulated. The still's production is greatly diminished or ceases in very cold weather, i.e., below freezing during the day. Use a larger distilled water reservoir to store up excess production from summer and fall for winter use.

In addition to leaving salts, minerals, and other dissolved substances behind, the evaporated water also leaves bacteria in the pan. The evaporated water is sterile and does not contain dead bacteria. Fertilizers, pesticides, & other organic materials are largely left behind by this evaporation process. The distilled water produced is of very high quality, normally better than that sold in bottles as distilled water. It routinely tests lower than one part per million total dissolved solids. It is also aerated, as it condenses in the presence of air inside the still, & it tastes delicious.

Solar Still Cost

The cost of a solar distillation system will vary widely, due to size and site-specific circumstances. A residential system, like the one described here, will cost several thousand dollars.

This project was designed and constructed by Horace McCracken, long a pioneer in solar distillation. McCracken Solar Company can be reached at 329 West Carlos, Alturas, CA 96101 or call 916-233-3175.

Things that STILL Work!

Home Power tests an Ancient PV Panel

We've been telling you that photovoltaics last a long time. Well, here's living proof that PVs can handle the LONG haul. This venerable PV panel has been in the sun for more than 10 years and still produces more than its rated output. Amazingly enough these silicon marvels don't seem to wear out.

In the Spring of 1977 the US Energy R&D Administration spent one million dollars on a PV powered irrigation project in Mead, Nebraska. This venture was conducted by Lincoln Labs of MIT and the University of Nebraska-Lincoln. Their goal was to pump over 700,000 gallons of water daily using PV produced electricity. The system employed 100,000 photovoltaic cells costing $22 per Watt in 1977. The resulting array produced 25kW during peak sunlight periods.

Well, the experiment ended after 10 years (successfully, I must say) and the facility was disbanded. The PVs were sold on the surplus market. We couldn't pass up the chance to get one of these working antiques and test it. Was it still working well after 10 years in the Sun? Or had the cells degraded and lost their power producing capacity? Here's the straight story…

The PV Panel

The panel we tested was made by Sensor Technology in Chatsworth, CA in 1977. It is composed of 44 round, 2 inch in diameter, single crystal PV cells. The panel is rated at 8 Watts output. Its part number is 20-10-1452 and its serial number is 3045.

The panel is 11.375 inches wide, by 22.875 inches long, and 1 inch thick. Physically it is unique. The cells lay within an aluminum tray. The cells are electrically isolated from the tray by a nylon wire mesh.

The entire works is potted in silicon RTV compound. This module uses no glass in its face. The aluminum case and the absence of any glass makes this panel very light in weight- an ideal panel for portability. The electrical terminals are ring connector types and located on the back of the panel along with a lug that grounds the panel's case.

How this PV Panel has survived in the Sun

I was amazed that the RTV compound is still in perfect condition after 10 years in the sun. When we got the panel it had a fair amount of dirt and grunge covering its face. A little soap and water cleaned it up. The panel's face, made of special UV transmissive silicon RTV, is still clear and flawless. The panel is still sealed and shows no sign of weather degradation or moisture infiltration.

We used a Fluke 77 Digital Multimeter (DMM) to test the panels electrical operation. We measured the open circuit voltage of the panel at 24.65 VDC. We hooked the panel up to a small lead-acid battery, including a blocking diode. The battery was just about full already and its voltage quickly went to 14.4 VDC. At 14.4 VDC, this panel was delivering 0.76 Amperes to the battery. Since Watts is Volts times Amps, this panel was producing 10.94 Watts (14.4 VDC times 0.76 Amperes equals 10.94 Watts). Not bad for an 8 Watt rated panel that's been working hard for ten years. Not bad at all…

Out to Pasture?

Not hardly. The very thought of a PV panel that's not in the sunshine gives me the shakes. We installed the Sensor Tech panel on our rack and wired it into our system. Here it happily produces electricity right along with our more modern Kyocera polycrystalline PV panels. One big happy solar family. Eventhough this ten year old panel has seen some service, it's still going strong and will charge our batteries for years to come.

Own a working part of Solar History

These government surplus panels are being sold by Solar Electric Engineering, 175 Cascade Court, Rohnert Park, CA 94928 • tele: 707-586-1987 or 1-800-832-1986. The price of a single Sensor Tech panel like the one we tested is $69. Two to three panels cost $65 each, four to nineteen panels $50. each and twenty or more $36. each and that's about $4.50 per rated Watt! Gary Starr, CEO of Solar Electric, tells us these panels are finding new homes

The venerable Sensor Tech PV panel finds new friends. Together they continue to make the electricity that energizes Home Power Magazine.
Photo by Brian Green.

quickly, so if you want your own part of Solar History better hurry.

Conclusion

When someone tells you that PV panels are a lifetime investment, he's telling you the truth. While we can estimate their lifetimes in decades, the proof of the pudding can only be found over time. This particular panel has spent over 10 years working its silicon heart out. And it's still producing more power than its original rating!

Very few things in this Life offer the steadfast reliability and performance of photovoltaics. Lifetimes of energy from the Sun! Use PVs and will them to your children and your children can will them to their children and… *RP*

Yellow Jacket
Solar Ad

Holly Solar

Things that Work!

Home Power tests an energy saving 120 vac outlet cover

Sometimes a product is so simple, so obvious, that we look at it and wonder why we hadn't thought of it. Well, We Care, Inc.'s "CareCover" is such a product. It all started with a letter from Home Power reader Sheryl Salasky in Trapper Creek, Alaska.

Hello Home Power Folks,

I've just received a wonderful little item in the mail. I'm highly impressed and thought y'all might be interested to know of it. It's an energy efficient, child resistant outlet cover called CARECOVER, put out by We Care, Inc. of Pierre, South Dakota.

I wrote them for price & info and they sent me the real thing. I'm not a parent but I am an energy hoarding hound. This little item seems to be saving me cords of winter burned birch for all the drafts it eliminates through the cover plate holes. Even safety plugs didn't stop the cold air infiltration the way these covers do.

The CareCover costs around $3. each. Enclosed is some of the info they sent me. I wrote & told them about you guys- yenta that I am!

Again thanks for all your fine efforts so that I and others can continue to learn about and implement home power.

with warmth…

Sheryl Salasky

POB 13322

Trapper Creek, AK 99683

About three weeks after Sheryl's letter, we got a sample CARECOVER in the mail from the folks that make them. It is a cover which replaces the standard covers used over 120 vac duplex receptacles. The CARECOVER uses an enclosed spring loaded slide cover to close the receptacles holes when they're not in use. The CARECOVER also uses a closed cell foam gasket that seals the cover to the wall.

Installation is very simple, all you need is a screwdriver and less than a minute of time. Remove the old cover over an outlet, and replace it with the CARECOVER. The actual plug-in receptacle, connected to the wiring, remains the same, only the cover is changed. This means no actual electrical work is required, only a moment of screwdriver time. The CARECOVER effectively seals the receptacle against children and air infiltration.

Operation of the CARECOVER is also simple. Only one hand is needed. As the plug is inserted in the socket, slight sideways pressure to the right moves the slide covering the recepticle's holes and the plug slides home.

The CARECOVER is well made of heavy plastic and looks like it will last. It is designed with enough size to accept heavy industrial plugs, night lights, and just about anything that will fit into a standard ac outlet. It is available in three colors, white, ivory and black.

The CARECOVER has received energy saving awards from the US Dept. of Energy and from the State of South Dakota. According to the manufacturer, "over 50,000 CARECOVERs are currently being used in homes, day-care centers, hospitals and schools." We, at Home Power, think it is a great product. It's simple to install and use. And it protects children at the same time it saves energy by reducing air infiltration. And the price is right. It's a "Thing that Works!".

Contact We Care, Inc, POB 873, Pierre, SD 57501 or call 605-224-5304 for further information.

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the Wizard Speaks…

More on Entropy

In the last issue I discussed entropy in terms of information and energy. Through an analogy with Special Relatively, I theorized that increasing the spacial order of a system increases its temporal order. Thus, its energy potential is also increased.

Does a way exist to increase temporal order directly? Heisenberg's Uncertainty Principle states that if the time interval is short enough, then the energy transitions that take place during this interval are indeterminate and may violate conservation laws. Our view of the Universe is limited by our perception of events in time. If the period of time is sufficiently short, then we cannot be sure of what is happening.

If a system can produce energy transitions within an ultra-short time interval, then the possibility exists for free energy during this interval. Free energy may lurk in the cracks between our perceptual intervals. In order to use this energy, a collection and storage system must only receive energy from the ultra-short system. This second system may be a one-way, inductive field system with internal dynamic equilibrium.

The increased energy potential of the second system results in a higher degree of spacial order for that system. The second system occupies a new, higher level of dynamic equilibrium.

The Universe surrounds us. Our knowledge of it is determined by the limits of our perception. We really have no idea what's going on in the cracks between our Worlds.

On May 22/ 23, Flowlight Solar Power and Sun Selector will present a seminar in Santa Cruz, NM to explain & demonstrate photovoltaic water pumping equipment for livestock watering, small-scale irrigation and domestic water supply.

Windy Dankoff will present a session on "System Design" encompassing both deep and shallow pumping systems. Featured will be a demonstration of two workings systems on site. Joseph Bobier will present "Electrical Interfacing", highlighting Linear Current Booster (LCB) installation, adjustment and performance. His hands-on presentation will cover the broad line of LCB products and control systems.

This seminar is for all who will be selling, servicing and/or using PV water pumping systems. The workshop will be at Flowlight's facility located near Espanola, NM, 70 mi. North of Albuquerque, NM. Motels are available nearby.
Fee: $50.
Contact: Robert Bobier, Sun Selector • 304-485-6303
or Windy Dankoff, Flowlight Solar Power • 505-753-9699

CQ HOME POWER HAMS

KE5HV • KG6MM • N6HWY

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7.230 MHz on Sundays at 1330 Pacific, Central & Eastern.
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14.290 MHz Sunday at 1900 UTC.

Novices

7.110 MHz on Wednesdays and Saturdays at 0500 UTC.

Letters to Home Power
we print 'em unedited.

First an apology to Kevin Crawford for leaving out an important line from his letter in HP9, pgs. 39 & 40. SORRY! In the last paragraph, 5th line, the sentence should read "Instead of the relay turning the battery charger on and off it can be used to divert the current to a second set of batteries or other load when the first set is fully charged." KP

Solar Cooking goes International

I am a visiting student from West Africa (Mali) currently studying at the University of California, Davis. I just came from the "You can make a difference conference in land deforestation and environmental strategies" at Stanford University. It's there I found out about you. My country has a big problem with deforestation and using the firewood is a disaster in my country. I will be very glad to take Solar Cooker home and make a national demonstration. I'll stay in touch. Thank You, Ba Mahamadou Nassirou

Deforestation is a international problem. Every living tree that disappears is one less oxygen producer for our biosphere. If the tree is burned, then the situation is even worse because of the carbon dioxide produced. Solar cooking uses free energy and is without pollution. RP

Movin' to the Country with HP

Friends: A year and a half ago we were living in an apartment in downtown Indianapolis and I had never heard the term, "Home Power". One year ago we bought 24 acres of farmland in northern Indiana and a friend who must have been guided by an angel gave me a subscription form for "Home Power" magazine. Nine months ago the local "public service" company told us it would cost $5,000 to get electricity back our 1000' lane. We now live with a stand-alone wind generator system. "Home Power" magazine came at exactly the right time for us: we bought our wind generator, batteries, inverter, and some fluorescent lights all from advertisers in HP, and following the product recommendations of your writers. Many Thanks, Rich Myer, Millersburg, IN

Glad to help out. There are many folks that could benefit from renewable energy products, if only they knew what can be done. That's what Home Power is all about. RP

DC Stereo?

I just received my first issue of HP (#9) and enjoyed it greatly. It gave me encouragement to see that my long-time dreams of clean energy self-sufficiency are indeed possible and even to a greater degree of comfort than I had imagined.

I found the article on lead acid batteries very informative and that on lighting. The article on Roger & Ana's system gave me more of an idea of what kind of system I would need for my own purposes than I've gotten elsewhere. Everything else I've read previously left me with the feeling I might never figure it out. Not knowing yet what has appeared in past issues (I'll be ordering back issues soon) I can't say for sure what ought to appear in the future. I'd like to know more about voltage controllers & types of things that can run best on DC - music is important to me so I'd like to know what decent quality DC sound system alternatives exist. I would like to know more about determining energy needs to have a better idea what to shoot for, is there any likelihood of someone coming up with a small DC chest freezer?

My own use of IC transportation is small, so hybrid-configured electric vehicles isn't all that important to me personally, though I'm sure it could (should) be to many others (let's hope).

Thanks, Randy Davis-Paraniuk, Louisville, KY

P.S. Don't go to color pictures - the pigments are poison & not worth the compromise, I worked for a pigment producer and quit on moral beliefs. The stuff ought to be outlawed.

Well, HP is still B&W and likely to stay that way. We figure it's much more important to get the word out to thousands of new readers, rather than pleasing the already convinced with color pictures. With regards to DC Stereo- look into the higher quality automotive rigs. If they are used with normal house sized speakers, they sound great and are very efficient. We use a Mitsubishi auto component (circa 1978) setup, Pioneer, and Nakamichi also work well. See the Sun Frost ad in this issue for a source of DC freezers (12 or 24 Volt). RP

Addicted?

Dear Friends,

I find myself at a loss for words to praise your fine publication! I was fortunate that a friend put me on your list, and I have been reading from issue one. Unfortunately, I seem to have loaned out many of them, so I am enclosing funds for a complete set of back issues. I'm happy to see more information appearing regarding direct use of alternative sources. I added a solar greenhouse to my home about 5 years ago, and it adds heat, light, and space with no use of electrons. I am employed as an electrician and electronic technician, but I see electricity as our greatest achievement, as well as a major pitfall. This is because people have no sense of where electricity comes from, or what it takes to make it. We turn up the thermostat, and the house gets warmer, but we see no signs of pollution or environmental damage. The problem isn't so much that alternative electrical sources are too expensive, but that conventional sources are too cheap. The modern world has an addiction, and the pusher is just around the corner! Very shortly we will have to decide to curb the addiction or we will be led down the road to nuclear power. The energy czars are already touting it as environmentally sound because it doesn't add carbon or sulphur dioxide to the atmosphere. The only long term solutions lie in conservation, direct use, and alternative sources. Thank you for helping us in this direction.

Here are addresses for three sources other readers may be able to use. H & R Corp., 401 East Eire Ave., Philadelphia, PA 19134-1184; Burdens Surplus, 1015 West "O" St., Box 82209, Lincoln, NE, 68501-2209; Fair Radio Sales, 1016 East Eureka St., Box 1105, Lima, OH 45802.

Perhaps they would like to advertise with you. Keep up the good work! RMS Electric, Ron Peterson, RD1, Cattaraugus, NY 14719

Thanks for the flowers, Ron. Conservation offers everyone, grid connected or not, immediate relief. It's real easy, just turn it off if you're not using it. Sounds simple and it is. Amazingly enough, it can reduce America's home energy consumption by half (and the associated environmental and financial bills). So turn if off! RP

Hydro, PVs & Solar Pathfinder™

Dear Richard and Home Power Staff,

A little get acquainted talk before I get to the heart of my letter. My name is Romain Cooper and I talked to Richard once over the phone about a used inverter and then about AE, the magazine etc.

I live near Takilma, OR with 3 other families on a semi-remote, 200 acre piece of land. We inhabitants did without electricity for many years for the usual reasons: We didn't want to support those "coal burning, river damming, nuke-reacting" utilities, we wanted to remain somewhat self reliant and the price tag of a grid hookup was prohibitive.

9 years ago we first discovered hydro-generated electricity. Our initial installations were the simplest imaginable. Wheels from pulleys and stainless steel dessert spoons, surplus permanent magnet alternators, and Sears deep cycle 12V batteries. A voltmeter and switch to prevent back cycling rounded out the system. Two irrigation lines served as penstocks. They both had

about 100' of head and were of 2.5" or 3" PVC.

About 4 years ago we upgraded our "electric company". A new penstock was installed to provide irrigation for the 2.5 garden/orchard, to supply domestic water to 3 residences, and to supply electricity to the 3 residences and to misc. shops and work places. The pipeline is 2000' of 6" PVC, mostly buried, with 200' of drop. The system was designed to eventually produce straight ac current during winter flows, hence the 6" pipe. The present system utilizes a 4 jet Harris pelton wheel (4.5"D), a Ford heavy duty truck alternator, 8 Trojan L-16 batteries (wired in series and parallel to store 1400 AH *(700AH? RP)* at 24V) and a Heart 24V, 2400W inverter. Jonny Klien, neighbor and friend, built for us a voltage regulator that measures battery voltage and relays a dummy load. (This is the JK who is a Takilma ham operator.)

This system is removed from the residences that it services by 200 yards from the nearest residence to 600 yards to the farthest. The trenches that hold the AL transmission cables also hold the water pipes for the domestic water and cables for phone service.

Another system, for a single residence, utilizes the 3" PVC, 110' head irrigation system that was designed to water a 4 acre meadow. It operates on a single jet Harris pelton identical to the other system's with a home-made housing, a surplus permanent magnet alternator, (2) 6V deep cycle forklift batteries wired in series for 12V and a Trace 2000W 12V inverter.

The systems have performed well for several years. We run the usual devices: lights, audio (with inverter noise), juicers, blenders, and such, washing machines, power tools. Been running my IBM clone AT on the Heart inverter heavy for over a year with no problems. Though the alternator of the 3 family system can run 60 amps (for how long?), we get what we need for 3 households with 10 amps worth (25-27V) and still trip the shunt load daily. 24 gal./min. gives the 10 amps. The single residence system delivers 10 amps at 13-14V.

For us, the catcher is summer time. From July into October we can use hydro only sporadically. Our stream flows are very low and use most of our hydro-power to push irrigation sprinklers rather than generate electricity.

Last summer we increased our PV generating capacity of (4) 44W Kyocera panels with 10 bargain 36W Solavolt panels. We put the panels on a beam framework and used wooden mounts modeled after the metal ones described in issue 2. The wiring to the power/battery/inverter shed and components were sized to a 30 amp (at 24V) load to allow for expansion of the array.

Unfortunately, the solar site chosen has only fair solar potential. Analysis showed it cheaper to purchase additional panels at reduced output due to shading than to purchase and install wire and components to bring the 24V current to the batteries and inverter from a sunnier location.

Which finally brings me to the heart of the letter. Evaluating various sites for their PV outputs proved to be a lot of work and guess work. A few months later, while monitoring streams for the US Forest Service, I used a tool that seemed ideal for evaluating the solar capabilities of a site. The device is called a Solar Pathfinder™ and it is manufactured by Solar Pathways, Inc. of Glenwood Springs, Colorado.

The pathfinder looks somewhat like an R2D2 robot. The Forest Service uses it to determine the amount of sun striking a stream at a particular place (which strongly influences stream water temperatures). The device is easy to use and portable. It measures, in one fast reading, the hours of sun hitting a site for the entire year. The reading can be taken anytime of day or year in clear or cloudy weather.

A transparent, parabolic mirror shows reflections of all shade producing features including horizons, trees, and buildings. Below the domed mirror, a sky chart tailored to the site's latitude shows, through the year, the sun's projected path. Different charts can show hours of sun light per day, sunrise and sunset times, solar collector outputs in BTU's,W-h/day from PVs for any time of year.

Is this a well know alternative energy tool? Are there other similar products? The price is a bit much for an individual. It seems reasonably enough priced for AE consultants, installers, or for groups of people to chip in and share. I briefly talked (phone call) to Bernie?, the inventor. He was friendly and accessible.

Seemed like a tool that Home Power might be interested in so I'm sending you the literature. I don't think the hand held version would be as accurate or easy to use but it may have some advantages other than lower price. Some type of case (though we didn't have one) is advisable to protect the plastic doomed lens.

Of course, I very much appreciate the magazine. It is entertaining (to an AE buff), informative and best of all, useful. I hope you can keep up the good work. If any of you are in our area, please visit. Romain Cooper, Cave Junction, OR

The Solar Pathfinder™ not only works well, but is becoming a standard in the industry. It takes the guesswork out of determining solar insolation in sites with trees, hills, buildings, or other obstructions. The Solar Pathfinder™ is well built and worth what they charge. On your Hydro setup, your solution of PVs is ideal. Wet or dry, you've still got power. RP

Permanent Magnet Motors & the Free Lunch

Home Power, I have read every issue word to word, except issue #1. I've learned much valuable information and I read all the advertisements, I think we all do. Keep the good work up, we need you out here.

In your #6 issue on page 45 you stated that an inventor (Harold R Johnson) was issued a patent for a "Permanent Magnet Motor" and you gave the patent number. Well, I have obtained a copy of the patent and I find the principle he worked out for making a motor that operates just from magnets and a few other items very interesting. The issued patent gives many details and drawings of its construction. The principle seems almost simple enough to work. There is a good possibility that it could be able to power an alternator etc. Maybe there is a "Free Lunch" or what I like to say, "Power for Thought". I don't think the oil companies want to hear about it though! Maybe you could forward this to your readers. I am willing to send anyone a copy of the patent for $2.00 (the cost to photocopy all the pages) and an SASE #10 envelope for a neater delivery. This is cheaper than the patent office charges for copies and I'll send it much faster than they will. Us AE folks are the only ones that could make "Power for Thought" come to life.

Anyway, I'm looking forward to all your future issues. If you ever could find the time, maybe you can print up a few thousand copies of issue #1 again. I need it to complete my new collection. Thanks "Home Power". Tom K., POB 1173, Tempe, AZ 85280

As much as we'd like to reprint HP1, we are trucking on with new info. It's a matter of time & money. We are considering collecting the first dozen or so issues of HP into a hardbound book. Many folks, energy extension services, and educational institutions have written in asking for an indexed, durable, collected by subject, book of the material in HP. We are considering giving it a try. How about it HP readers, any interest in such a book? RP

DC Fluorescents

Hi there, Hey I want to thank you for sending me Home Power since issue one. I thrill to my toes when it shows up in my po box. I have a small addendum to Windy Dankoff's light bulb article. I went to visit Iota Engineering, (1301 Wielding Rd., Tucson, AZ 85706, 802-294-3294) last summer to pick up some 12 volt fluorescent ballasts and some bulbs and they turned me on to some interesting stuff. In standard PL double and quadruple plug in lights there are a couple of pieces put in which only relate to their function with 120 vac power. One is a small 1/2 inch glass bulb

and the other is a solid small tube. I don't know what it is or does except that it works in tandem with a small bulb. The bulb is the thing that makes your PL flicker when you turn it on. I guess it also is that which prevents the bulb from turning on with less than 12 1/2 volts coming to it. Well, if you cut the bottom piece off the base and clip these two pieces off, the bulb turns right on without any flicker whatsoever and it turns on with voltages of much less than 12 1/2. I have had mine working with less than 10 volts and after they are turned on they maintain their brightness regardless of decreasing current *(voltage RP)*. This is in contrast to the incandescent and quartz halogens which go dimmer as the current *(voltage RP*) goes down. I am currently buying PL's at a light bulb specialty shop in Austin for $5.25 for the double tube 13, 9, 7, and 5 watt and $9.50 for the quad tube. So I would like to tender a suggestion that all you PL buyers out there explore your local light bulb specialty shops in lieu of solar shops, nothing personal you solar guys. Oh yeah, back to Iota, they sell an Edison base bulb for $8.00-$9.00 and when they put it together they take out those two pieces I spoke about above. And I've been told by John at Real Goods that Solar Electric Specialties, (POB 537, Willits, CA 95490, 707-459-9496) have conversion kits for natural gas to propane but I have never corroborated that statement. Once again, thanx for all of your networking and information gathering for those of us out here who are going alternative.

Be well & take care, Motorcycle Michael, Elgin, TX 78621

Thanks for the PL info, Michael. Many Home Power readers are using these lamps, being able to operate them at lower battery states of charge (voltage) is a real plus. RP

Dear People,

Several weeks ago, I received word from a high tech "headhunter", that Texas Instruments was looking for someone to help manage Texas Instrument's entrance into the PV marketplace. Since I am an unemployed engineer, I busied myself with a letter explaining my view of how a company might go about entering this market. This article is a slightly altered version of that letter. I am sending it as repayment for the inspiration Home Power has provided me. It's important for me to know there are people like you folks out there.

The headhunter suggested that I might hope to find a position which would lead to a strategic planning or product development position at Texas Instruments. At first I was skeptical as my experience in corporate America has not suggested that the business environment can nurture the planning for engineering choices which would lead to long term success in this and related fields. This, and the battle which any company will inevitably experience with utility and energy companys (should they succeed in posing a real threat to the current energy infrastructure), combined with my own frustrations as an inventor in unfunded renewable energy technologies fostered procrastination ***and*** considerable thought about the real challenges and opportunities in this field. This is a path with fantastic opportunity but it is also littered with land mines.

Any enterprise that wants to successfully implement PV technology should think of itself as an implementor of **customized intelligent energy systems**. Photovoltaics should be thought of as an important component in this corporate mission.

An implementing engineer in the field, would have an array of electronic and nonelectronic technology which would fascillitate appropriate solutions to the always unique situations in the field. The engineering thrust of of a company that wants to dominate in the field of intelligent energy systems should be **ease of energy control system customization**.

Why is ease of energy control system customization the most important engineering goal? The reason is that independent, small scale energy production systems must maximize their energy production using the peculiarities of the local environment to successfully compete with other systems. Why bother to invest in alternate equipment unless their are peculiar circumstances like an abundance of sunlight or a strong steady wind or stream on someone's property or a combined heating and electrical requirement (which makes cogeneration attractive)? In every site I have dealt with, it is the completely unique aspects of energy flows at the site together with the customer's needs, which determine which system is economically viable. There always seems to be a way to make "alternate energy" systems pay for themselves, but the solutions are always custom. This empirical fact has a basis in a more general principle which is amply demonstrated by biological life.

The biosphere is driven by the exchange of solar energy which provides free energy for dissipative structures. Given any net flow of energy, (available free energy), there are inumerable dissipative regenerative structures which can form "in the wake". The primary difference between a barren earth surface and one teaming with biological life, is the **information** implicit in the dissipative structures of cells, organs, and organisms. These organisms together produce novel energy vorteces which provide new niches which encourage new adaptive mechanisms and new organisms. At every point, greater complexity and information gets encoded in genes. But within all this complexity, there are some biological mechanisms which seem to be used repeatedly. Photosynthesis is an obvious example. The thermodynamic heat engine which drives sap around in trees and all stemmed plants is another. Eating photosynthesizers is a successful strategy which we, along with other animals have employed in this complex web of dissipative biological structures.

Choosing a financially viable small scale energy system, whether it is a wind powered electrical generation, a PV powered satellite in orbit, a cogenerator system for a hospital or whatever, is like a plant or animal finding a successful niche. There does not exist a best system or even a handful of right systems since every situation is unique! And it is precisely this uniqueness which gives these systems the economic edge over large centralized power distribution systems. This fact suggests exactly why customizable electronic control technology holds immense promise for this field.

A successful product in this field is like the successful mutation which produced red chlorophyll or the first stemmed plant. The industry wants to invent or discern which systems are going to have wide applicability and then provide tools to implementors who can take advantage of the peculiarities of a particular installation.

Any electronics firm with a large collection of proprietary analog and digital chips is in a fantastic position to flourish in this field because flexible electronic control technology together with power MOSFETs provide an implementation flexibility which compares with the control flexibility in the biological world. DNA/RNA nucleus control structures and enzymatic cellular metabolism is to biology as processors, control codes, interface circuitry, and power transistors promise to be for the manmade environment. Both activities can coordinate and capitalize on innumerable dissipative vortices and bring life and complexity to comparatively lifeless free energy potential.

Market forces encourage companies to discern those electronic control structures in the analog and digital world which are most generally applicable. Power transistors have changed the design balance in energy management so that it is frequently sensible to do everything electronically rather then using hydraulic systems or electromechanical control systems. This is revolutionary for small scale energy systems as it makes the goal of implementing appropriately customized solutions so much easier. The important work which remains is to discern or invent the devices which will be most widely used.

Small scale local energy systems have some inherent advantages over the 120vac grid. Free from the grid, better approaches to power distribution can be employed which can reduce wiring costs, facilitate installation, and increase safety. As an example, one could combine power lines and control channels on twisted pairs to both drive and communicate with appliances. For this purpose, a chip containing a good PWM driving a small high frequency inductor for transformation to DC together with a special modem to decode signals on the twisted pair is a candidate for the small power "circulation system". (Biological systems frequently combine energy and information in the same "transmission line".) Use of high frequency ac allows high energy transport over thin wire at low voltage.

The folks at Backwood Solar Electric Systems, tell me that starting roughly in the fall of 1987, business started to boom. The sales are mostly in the northwestern portions of North America to people who live too far from power lines to economically connect to the grid. (Bear with me, if this is not news to "Home Power" readers, it is to an easterner like me.) There are huge untapped markets in small cogeneration systems and inexpensive devices enabling people to sell electricity back to the utilities.

The high price of the technology used to pump energy from small producers, back into the grid is an obstacle which could be overcome. While I cannot provide completely convincing proof of this assertion, it is my believe that the technology could be redesigned and sold profitably at less then one fourth the current cost. Whether this is true or not, the legal obstacles are more expensive then the technological obstacles today.

In the Carter Administration, legislation was passed which required Utilities to buy power back from small producers. On paper, utilities are generally, owned by the communities they serve. Unsurprisingly, the legal roadblocks for anyone who actually tries to take advantage of this law are considerable. This means that advancing into this (potentially huge) market would require a lobbying effort in Washington. A group who attempts the lobbying effort, (with a demonstrably profitable technology in hand), would find considerable support from environmentalists and beleagured congressmen who (if they have not recieved too much PAC money from utility companies), would love to assist in something which could help reduce the trade deficit and the greenhouse effect.

It is easy to sell PVs to aerospace firms who have the engineering skill and funding to implement solar systems on satellites. A PV producing company does not have to do anything other then produce a quality component. Selling this same technology to Baja or Alaskan homesteaders with very low technological sophistication is more challenging since the burden of simplified implementation rests with the seller. Even if the Alaskan wants the same net energy output from his system as the Baja resident, two entirely different systems are going to have to be implemented.

I reemphasize that the appropriate way to look at an industry that wants to sell PVs, is for them to see themselves as manufacturers of easily customized energy control systems. While the sale of PVs may compose a large portion of the profit, the sales will not be there unless they are easily implemented in a unique fashion in every situation. PVs, in fact, may not be very useful in many independent energy production sites and the most profitable focus is the more general problem of customized local energy production control technology.

About a year and a half ago, a large chunk of the population realized they could leave civilization without much cost or without becoming uncivilized or isolated. Periodicals (like "Home Power") reminds me of the literature produced in the seventies by the "techs" interested in microcomputers. I expect the industry of independent power production to do much the same thing that the microcomputer industry did in the seventies. For a new industry to start, there has to already exist a community of enthusiasts. In the seventies, there was this collection of young electronics and programming freaks who built the industry. There is easily as large a community of energy system tinkerers today. In seven to ten years, there will be standards which will dominate the field just as MSDOS and the MacOS dominate microcomputers today. Nobody knew microcomputers would be so important, the "techs" simply knew they wanted a computer. Similarly, today I doubt many know that independent power systems may become hugely important; but lots of people know that it would be nice to live in greater harmony with the environment, preferably on some remote peak without being isolated or uncomfortable....

Today the guy who dreams such dreams thinks of a generator and photovoltaics. In fact, these two components are in most modern small power installation I have seen. Even a well planned installation requires more attention then most Americans would like to provide, and there is considerable room for improvement in control integration of these components. Energy conservation is valuable not only as an economy and an environmental good, but as a means to avoid hauling fuel to remote sites. The lack of system integration is the primary cause of failure and frustration. The technology Texas Instrument is developing for the automotive industry has wide applicability in this field, but it will require some modification. (Modification for increased modular flexibility.)

The steps and engineering requirements to make independent, local power generation into a mass industry are these:

(1) Familiarity with photoelectrics and their production.

(2) Familiarity with the electronic control of heat engines, cogenerations devices, water and wind systems, etc.

(3) Review of TI's technology for automotive applications.

(4) Review of the proposed specs and standards for "smart houses".

(5) Synthesis of the reviews in steps (3) and (4) with the technologies in (1) and (2) to produce a map for the appropriate transfers and modifications of existing (mostly automotive) electronics and recommendation of appropriate systems for small energy production system design and implementation methodology.

(6) Design and manufacture of modular electronic components which implement the findings in (5).

(7) System documentation in the form of an "Idiot's Guide to Independent Power Systems".

This is a big job which would take several years to perform well. If I don't get a job with Texas Instruments, there is really nothing which prevents a determined individual from doing this on their own.

Some of the technological preferences I have mentioned here run counter to the articles I have read in Home Power. The preference of Home Power readers for 12VDC is determined by the availability of inexpensive storage batterys at this voltage; I think there are better local power distribution possibilities for an energy independent site. Readers interested in exactly why I think high frequency (>20KHz), low voltage ac, is a better distribution technique then then 12VDC should write me.

If Home Power is interested, I could write an article explaining this in detail; it is rather technical. This debate is about a century old now. I would have sided with Tesla who is responsible for the 120vac standard. The folks at Home Power are the voice of Edison...

To me, the process of evolving technology is more fun then actual products and so I welcome sound arguments.

John Bergamini
191 Academy Street, Wilkes-Barre, PA 18702

We'll take you up on the offer of an article. We too are into the evolution of technology. I've been in the RE business for over ten

years now and each system we spec and install isstill unique. I'll agree with Steve Willey of Backwoods Solar, most of these systems are going in because the power company wanted too much to run in the lines. Five years ago, we figured you had to be over 4 miles from commercial power to make RE cost competitive. Now this distance has shrunk to 1/2 mile. A combination of factors is pushing RE into the average down-town home. Factors like the rising cost of commercial power, the environmental consequences of making that power, and the decreasing cost of RE equipment.RP

Q&A

We try our best to answer all your questions. Please remember that we are limited by our own experiences. If we don't have the direct personal experience to answer your question, we won't. We'll print the question anyway and hope that a Home Power Reader will have the experience to answer it. So this column is not only for questions , but also for answers from readers. Thanks for your patience-- Richard

Recycling Batteries

We received a very nice letter from Debbie White, Recycling Program Coordinator for Environmental Pacific Corp. at 5285 SW Meadows Rd. Ste 120, Lake Oswego, OR 97035 • tele: 503-226-7331.

Ms. White informed us that her company recycles batteries. They do not use landfills or hazardous waste dumping. They provide safe shipping containers (you pay for the shipping to Amity, OR). Environmental Pacific Corp. pays for the batteries on a debit and credit system.

For example, silver oxide or mercury type button cells would give you a credit, while other types could produce a debit.

Anyway, they are the folks to contact if you would like to recycle dead batteries. KP

Gas Refrigeration

I want to offer Nash Williams some information. In HP#9 he asked about converting a gas refrigerator from natural gas to propane. All that is necessary is to change the orifice in the burner to one with the proper size hole (smaller if my memory is correct). This is done frequently with gas cooking stoves. It's quite likely that he can find a stove repairman in his area that will have the orifice he needs. It's a small piece of bronze not much larger than a shirt button and probably costs less than a dollar. Wilbur Loyet, Olmsted, IL

Wincharger Mods

Dear Home Power Crew: I know you hear it alot, but one more time doesn't hurt. Keep up the good work.

Here is an answer to a question in the last issue. Kevin Crawford wrote in wanting to eliminate a Wincharger type airbrake governor for his homebuilt wind generator. A way to do this is to offset the prop axis 3 to 8 inches to one side of the vertical axis. The tail will need a pivot point and a spring to keep it straight back. In higher winds, the increased thrust on the prop will pivot the prop out of the wind due to the offset and the tail will fold almost parallel to the prop. Some trial and error time will be needed to get the right offset and spring tension for the tail.

Giving up the Wincharger governor will cause a vibration problem when the wind plant changes direction. A 3 or 4 blade prop will eliminate this problem but if you want to keep the simple 2 blade prop, you might mount some weights perpendicular to the prop to act as a flyweight as the Wincharger governor does. Be sure to mount the weights out at least 2 feet from the hub. Steve Hicks, Mountain Pass Wind Co., 711 North C St., Livingston, MT 59047

I'll second Steve's recommendation about balance around the Wincharger's hub. If everything is not in rotational harmony, then you're going to eat bearings like peanuts. RP

DC Fluorescents & Servel Reefer Stuff

Dear Home Power,

Here are some answers to questions from HP9 and some of my recent experiences.

The Elusive IOTA Ballast (Harold May): Iota Engineering Co. is at 4700 S. Park St.#8, Tucson, AZ 85714, 602-294-3292. They give significant discounts and prefer to sell through dealers, the one

I know being Mendocino Power Co., 3001 S. State St., Ukiah, CA 95482, 707-468-9963. I have three Iotas in daily use and am much impressed.

The Desperate Need For, and Lack of, Battery Recycling (Don Seeberger): The Winter 1988-89 Earth Island Journal (V4, #1, Pg. 17, from 300 Broadway, Suite 28, San Francisco, CA 94133) covers the well-documented environmental effects of "disposable" batteries. Except for the tiny mercury and silver oxide buttons, which are valuable enough to make recycling economical, it sounds like the best you can do is throw dead batteries in a "hazardous waste landfill". New York City, San Francisco, Springfield, MO, and New Hampshire/Vermont will at least help you do this.

The Barefoot Guide to Servel Conversion (Nash Williams): Servels regulate their temperature by clicking between high and low flame. The low flame has to be big enough that it doesn't get blown out by slamming doors or basking animals. The high flame has to be small enough that your milk and veggies don't freeze. There is some difference in heating value between natural gas and propane, but the main difference is in the traditional delivery pressures. My Servel has been unused in the barn for six years since I installed PV's (anyone need a Servel?) but if I remember right propane regulators usually come at 11 (is it pounds or inches?) and city gas is often around 6 (whatevers). If you have access to an expert they will change the orifice (the "nozzle" which determines how easily the gas can escape into the burner) to a smaller one, to compensate for the higher pressure of propane. If not, hook the Servel to its own propane regulator, remove the cap at the top of the regulator, and unscrew the slotted adjusting screw underneath (many turns!) until your flame stays lit and doesn't freeze what shouldn't be frozen. In either case, adjust the air supply to the burner until you get the classic blue flame. On mine, you rotate the whole burner tube (the "candle" shape under the actual flame). Be warned that it is too hot to touch with bare fingers and too fragile to touch with pliers - try heavy gloves, and freeing it up and studying its operation before you light it! When you first light a Servel, you may see only high flame for a day or so, and feel little cooling for hours. Not to worry - my theory is that the reaction doesn't begin to take place until the hot side of the plumbing reaches some essential temperature, and the flame is not nearly big enough to heat it quickly. Once the guts of the machine are good and hot, it can start working on cooling down the box. The majority of the energy input seems to go toward keeping the guts hot and the reaction available - my Servel, which lived outdoors, used nearly as much fuel in winter as in summer!

The Low-Pressure Guide to Palomas (Timothy Traquair): The newer Palomas, in order to keep from burning themselves out by running when there is no water inside the tubing, need to see a certain pressure drop between their inlet and outlet ports. They don't care at all what the absolute pressure is, only that there is significant difference. Just like with electricity, pressure drop (voltage) is equal to flow rate (current) times resistance. If almost all your resistance is at the end of the line (a low-flow showerhead, for instance), almost all your pressure drop is found there, too. And very little of it is found across the resistance of the Palmoas tubing, where it is needed to cut the thing on! If you remove the showerhead and let the water fall out of the pipe freely, then the resistance of the internal tubing becomes proportionally much more important, and the heater may come on. The resistance of the internal tubing is also variable - with the temperature knob! When you turn it to hot, it cuts down the flow rate (increases the resistance) through the tubing. With about 5 pounds of pressure and an old-fashioned gusher showerhead, I keep mine operating from medium through hot, but if I turned it to cool it shut down. Another temporary system which was much beloved, even with its quirks, while I was building a real house to hang my solar hot water system on.

The Fire Line on Projection Bulbs (W.E.S.): You get a bright, white light by upping the voltage across an incandescent lamp - which ups the temperature and stress on the filament. Projection bulbs take this to the max, running so close to the edge that their rated life may be 5% or less of an ordinary 120V lamp. Unfortunately for themselves, incandescent lamps tend toward self-destruction; the hotter they get the lower their resistance becomes and the more power they accept (power = current squared times resistance). Luckily for you, Kodak provided a fuse which interrupts this process before the much more expensive bulb vaporizes. What I've seen over and over is the projector switched on as the first load on an engine generator, causing it to over-rev for a minute as it picks up the load, and taking out the bulb before the show even starts. My answer is an adjustable autotransformer "Variac", with which you can bring the voltage up slowly from zero to the brightness you need. Running on your inverter it may buzz ominously, but should not be harmed (DON'T try to use the common wall-switch sized dimmer unless you want to hear a truly frightening buzz!). Knowing when you have it set correctly is almost impossible, because no meter I've ever seen will measure the output of an inverter usefully. Set it so the projector is not quite as bright as it is without the autotransformer; or maybe you could measure the brightness of the screen at a fixed distance (with your light meter!) while running on someone's mains power, and then reproduce that at home with the inverter power and autotransformer... If you don't have a Variac in your junkbox, Fair Radio Sales (Box 1105, Lima, OH 45802) lists a 3A model for $18.00.

The Ultimate Backwoods Mac Printer: I just spent two weeks thoroughly testing the GCC Write Move, a 3 pound, 192 dot-per-inch, ink jet portable printer. It uses the software GCC developed for their PLP "Personal Laser Printer", and Bitstream outline fonts which exactly duplicate the PostScipt fonts in the Laserwriter NT (X), letting you proof laser output with exact line endings and page layouts. (Except, of course, that you can't feed it PostScript programs, or Illustrator documents, and it doesn't know anything at all about "fractional widths".) (And not all of the TNX font set is available yet....) Any output in the Mac's internal QuickDraw format can be previewed on the screen and printed at full resolution, no"jaggies", at any point size your program will allow, and can even be reduced down to 50% or enlarged up to 200%! The output is rich, dark black right out to the last drop in the (easily replaceable, HP compatible) ink cartridge. It is sharper on special ink jet paper, but to my eye, and especially for proofing, looks acceptable on regular tractor feed paper. The Write Move prints "high quality" faster than an Imagewriter in "best" mode, but it takes a few seconds to a minute to prepare the page before printing starts. You can select its internal kerning and track kerning which will respace the characters within a line but leave the total line length unchanged (and equal to the Laserwriter's line length). There is also a draft mode which is about as fast as the Imagewriter II's draft mode, but instead of psychotically spaced-out words, the Write Move draft mode is a single pass version of the high resolution print - quite nice looking and easy to read. The hardware is really a Diconix (Kodak) 150, with GCC-designed ROM's inside. It comes with cable, power adaptor, fonts, driver program, print spooler program, batch printing utility, paper, and ink cartridge - everything but batteries included. No Kidding, you can put five C nicads inside the print platen(!) and print for over half an hour per charge! And the charger is built in! Needless to say, power consumption is all but insignificant, and the noise level is a new low which makes the Laserwriter seem offensive. I have only one reservation, which is that there seems to be no way to use the Write Move with any computer other than a Mac (like the laptop with which it would be

so handy), or with a Mac program which assumes a "dumb" printer - like TMON (series nerding only...), OverVue (designed in the days of the 128K Mac), or the thing you wrote in BASIC which uses Aout or Bout. Oh, yes, if you use the spooler program, you must dis-install it and restart your Mac before you can use that serial port for anything else - or a crash is guaranteed! For around $500., at M.A.C. in Berkeley, CA the Write Move makes an Imagewriter seem quite dull.

The Solar Flue in Operation: One of the fantasies included in my energy-independent home is a solar flue - a 4" deep by 42" wide by 24' high-glass-front black box up the south side. When the lid opens on a sunny day, natural convection draws the hot air in the top of the "greenhouse" collector down through the center of a concrete block thermal mass and then through a 20' concrete labyrinth under the house, before exhausting it above the roof peak. Incoming replacement air can come into the greenhouse, or from a floor-level vent on the cool and forested north side of the house (it hasn't ever been hot enough here to consider artificial cooling). The airflow is not rapid, but like PV's it is persistent, and I can measure about eighteen degrees of heat loss between the top of the greenhouse and the end of the labyrinth. If I just wanted to move air instead of fighting gravity pulling hot air down a cold tunnel, I'm sure I could have quite a draft going! The bug in this project has been materials - the flue is sheetrock taped and painted black, and the sun has cracked the tape off and is about to go through the paper to the already crumbling gypsum. Anyone have a (hopefully natural) better idea short of sheet metal?

The Declining PV Output Mystery Solved: For about a year it had seemed there was never enough power, but with all my panels wired together it was hard to tell if there was a real problem or not. Finally I rewired everything so that I could easily measure the contribution of individual panels during operation, and found one-third of them fade out to zero after an hour or so of charging. I sent two back to the factory, and they repaired them. Turned out there is one non-redundant solder connection to the back of a cell in each panel, and it was failing once it was hot. The catch is that disconnecting a panel and putting an ammeter across it would "shock" the connection back into operation, sometimes for another hour or so! And a voltmeter would always read correctly, because it draws almost no current. Anyway, a few minutes with a razor knife, soldering iron, and silicone seal, and I'm back to full power.

Hope these reports help someone else along the road to energy independence!

Loren Amelang, Box 24, Philo, CA 95466

Loren's letter arrived printed on the Write Move printer. We're impressed. The resolution is good- just shy of laser quality. It also uses about 1/5th power of the watt hungry laser. RP

Servel Info

Hello Home Power,

Excellent magazine, it gets me "fully charged" whenever it arrives. We've lived since 1976 without grid power and now power a family of six with a combination of propane, gasoline and photovoltaics.

Don't sell the Servel's short. Remember these units are 40 and more years old and still percolating. If kept clean and well tuned they can be acceptably efficient, without ozone eating chloroflourcarbons. A mostly legible copy of a Servel service manuel is available from Earthmind, 4844 Hirsch Rd., Mariposa, CA 95338. For Nash William's Servel Question, only the diecast aluminum or steel body burner can use LP gas. The orifice can be changed, Earthmind can lead you to one, or a handy appliance person can adopt one, maximum hourly BTU's range from 1800 to 3800, depending on the model. The thermostat has to be adjusted with a manometer. All models take up to 10.2 inches water column maximum flame, minimums range from .4 to 1.7.

To Timothy Traquair's Paloma water heater question, our experience with gravity water is avoid any uphill runs with your pipes. Any trapped air will greatly diminish flow and pressure. Your plumbing should be able to drain itself dry. And keep the largest diameter pipe you can. Volume can offset some pressure losses.

An idea to anyone with kids, most slot cars/train sets operate on 12 to 18 VDC and will work off your battery bank. Be sure to fuse it, 3 amps or less. Something I'd like to see in Home Power is some schematics for adapting cordless hand tools to charge off alternative power.

Thanks, Bell-Dereske, RR1, Box 660, Branch, MI 49402

24 Volt Stuff?

Hi!

There are many 12VDC products, but where are the 24VDC?

Can you or your readers tell me any sources? 24 volt lighting of all kinds, motors, fans, anything.

Thanks, Nancy Dooley, Gakona, AK 99586

The only reason that there are lots of 12 VDC products is automobiles. Try surplus houses, like Fair Radio Sales (address above), for military (24 Volt) bulbs and motors. How about 24 Volters, where do you get your DC appliances? RP

Dear Home Power People,

On a recent visit to a Radio Shack store, I noticed their 12VDC nickel-cadmium battery charger on sale ($8) and bought one, thinking this was an easy way to start using nicads on my PV system. The accompanying literature states the charger draw, 280-285 mA for 4 D cells (the charger itself rates the output as 150 mA max.).

When I got home, I re-read HP#4 re: nicads and discovered your warning about factory made (120vac) recharges. Does your warning apply to the 12VDC model?

If the 12VDC charger is OK, can I use it for extra capacity nicads?

Kal Winer, Burkettville, ME

P.S. David Doty (HP#7 Q&A) suggested Sears carries a 14" color TV that would run on 12VDC. The Sears catalog DID list such a TV but it's a catalog misprint and runs on 120vac only.

The Radio Shack 12 Volt Nicad recharger uses resistors to limit the recharging current (that why it's only 8 bucks). As such, its performance will depend greatly on your system's voltage when you are recharging the nicads. If your system voltage is low (under 12 VDC), then the charger will take more time to fill the cells. If the system voltage is higher, like 14+ VDC when the PVs or whatever are producing, then the charger will refill the nicads more quickly and at a higher recharging current rate. This charger suffers from the same problems as the 120 vac powered models. It's designed to be inexpensive, and not to take optimum care of your expensive nicads. This means it is unadjustable, and uses DC to recharge the nicads instead of pulses. If you are using constant current sources to recharge nicads, it's best to give them a slight overcharge to insure that they are fully recharged. An extra hour or two on the recharge does the cells no harm. See HP4 for a tech discussion of nicad recharging. No problem with using this 12 VDC recharger on extra capacity nicads, simply recharge them for a longer period of time. I watch my nicads and call them full after their voltage has reached between 1.45 and 1.60 VDC under a C/10 rate of recharge. The final "full" voltage of a nicad cell will vary from type to type and manufacturer to manufacturer. Watch yours cycle with a voltmeter and you'll quickly discover the exact voltage when they are full. RP

Golf Cart vs. Deep Cycle Batteries

Dear Home Power, Love your magazine, it has really helped me learn electricity.

If you have time to write or even if you want to print this in your Q & A's, could you please answer this question. It has been recommended to me to buy either Trojan L16W's (six of them) or 8

(220 amp golf cart deep-cycle batteries), for my photovoltaic system. The price of the golf cart batteries are slightly less than half the price of the Trojan L16W's but according to this person they have half the life of the Trojan L16W's. I am sort of low on cash and I thought the golf cart batteries would work fine for the next few years till I get more cash. I know absolutely nothing about golf cart batteries. Are they any good or am I buying junk? I am going to buy a Trace 2012 inverter, with battery charger, etc. and have 8 ARCO 47 watt (M75) panels. If you think buying golf cart batteries is a mistake, please let me know.

Aloha, Nick, Kealakekua, HI

Golf cart batteries will not last as long as the L-16Ws. Over a ten year period, the initially more expensive L-16W will be about 40% cheaper to buy and operate. The person mentioned informed you correctly, the golf cart batteries can be expected to last about 1/2 as long as the more rugged L–16Ws. It's a matter of bucks up front vs. long term costs. And I'm afraid that the decision is still yours. RP

Wire Loss & Voltage Boosting

Dear Home Power, Thanks so much for the inspiring publication!

My husband, Tom and I have been experimenting with solar power for several years. Initially in our homemade camper - running lights, radio-cassette player, 5" color TV and a fan from a battery charged by rooftop solar panels.

We are now in the process of buying land and building a small cottage, which will be electrically solar powered (as funds become free to invest in upgrading and expanding our system). We are choosing to do this because of our commitment to, and enthusiasm for SOLAR POWER, rather than for financial reasons. Since hooking up to the utility company, in our location would be easy and relatively very cheap! Out panels are located about 100' from a commercial powerline and Tom jokes that we'll be able to tell the power company to, "Kiss Our Amps". Anyway, HOME POWER is making it much easier for us to materialize our dream - in numerous ways,

But -- We need shade in our Southern Illinois summers and wanted to live amongst our deciduous hardwoods with a small southern clearing for a little sun loving garden and some winter sun for our home. So, our best spot for our solar array is now 600 feet round trip and we must fight line loss.

Tom, has gotten an idea from an ad in HP for a line current booster. He's wondering if this "black box" could handle 350 watts worth of photovoltaic power, if the panels were wired for 60-72 volts. Or, if there are any other such devices on the market that would, and are affordable (Key). We are trying to weigh the cost of 0000 copper wire against other possibilities - perhaps #6 wire and the right "black box". We plan to use 12 or 24 volts in our home. Does anybody have any insights into this long line endeavor?

Also, does anyone have any info on a very efficient woodburning, hot water heater? I read of one in a letter in HP4 and tried to contact the writer, but haven't received a response. This one was a Mexican "Calentadora", reputed to heat 30 gallons in 15 minutes, with a handful of kindling. This would be very practical for us. Where might we acquire one?

There was a letter in Q & A HP#9 about disposing /recycling spent batteries, that didn't answer the question. What to do with our deep cycle lead acid batteries when they inevitably die? We know the lead can be recycled through scrap yards. Is there any way of neutralizing the electrolyte?

Also, I hope and assume that as you improve and expand HP, you will maintain some simplicity, so that they remain recyclable or biodegradable. Though most of us are building HOME POWER libraries, (or passing them on), it seems important to have the option to recycle them, into updated info on newspaper or back to the Earth - if need be. But I'm sure you guys have already thought of that.

Lastly - I once, 16 years or so ago, read that Solarex had converted a complete factory, which produced solar panels, to SOLAR POWER. I have since heard no news of this. But feel that if it continues to be successful (as I hope) this is IMPORTANT NEWS! People sometimes suggest that so much energy is used in the production of solar panels, that this might offset energy gains. I don't think there is much basis for this question anyway, but a solar powered factory would make that a non-question, as well as show how solar power can be applied to factory needs. Has anyone got an update on Solarex's solar factory?

Again thanks so much for HOME POWER!

Patricia Ganyard, Tom Owens, Pomona, IL 62975

P.S. Enclosed is our donation/subscription

Tom's idea will work, he's talking about an inverter basically. Invert the PVs DC power into ac and then step it up in voltage through a transformer, and then transform it back down in voltage and rectify for battery recharging. This solution is complex and inefficient because of all the hardware in line (each component is <100% efficient). Low voltage electricity has always been a problem to move around. The line losses are great and copper prices keep rising. Consider placing the inverter and batteries out with the PVs and running 120 vac to power the entire house. I know that you are thinking 12 or 24 VDC usage in the house, but in your situation the most efficient and least expensive solution is as I've suggested. In days past, we used to steer folks away from inverter only operation. But today's power inverters are so efficient and reliable that we install many successful systems where all the usage is 120 vac.

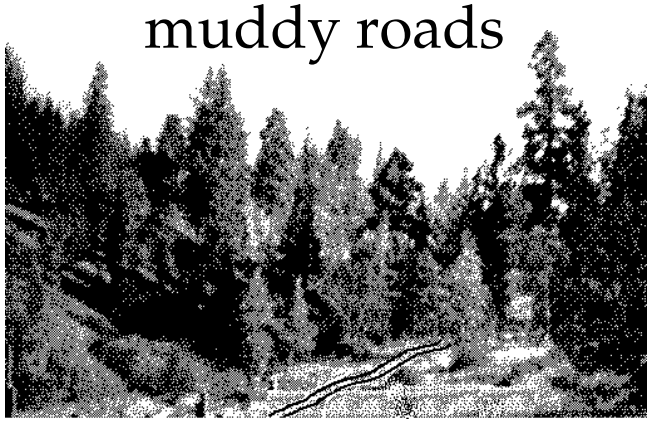
I've no info on the Calentadora, but I'd like to have one myself. How about it, readers & RE dealers, where can we buy wood fired hot water heaters?

The sulphuric acid electrolyte used in lead-acid batteries can be neutralized with ordinary baking soda (sodium bicarbonate) and water. Simply add baking soda and water until the fizzing stops. The products of this neutralization process are relatively benign - carbon dioxide, sodium sulphate and water.

In the past, it took more energy to make a PV panel than the panel would produce in its lifetime. Well, this is NOT true anymore. Modern PV panels produce more electricity, last longer, and are more efficiently made. When you put a PV panel in the sun, you are doing your bit for the Free Lunch. Solarex is only one of several companies using PVs to make PVs. Sort of a "pull yourself up by your own bootstraps" proposition. We totally approve.

Some companies carry PVs even further. For example, the folks at Kyocera practice what they preach. Kyocera has set up a 50kW PV system on the roof of their facility in San Diego. This system produces about 8,000,000 Watt-Hours of electricity in a month. The panels are wired up for 480 VDC which is fed into an Omnion 50,000 watt inverter producing 480 vac, 3 phase power, for Kyocera's use. And now here's the icing on the cake, when Kyocera is not using all that power, it's sold to the public utility for public use. So if you're using power in San Diego, a part of it is from sunshine, whether you've got PVs on your roof or not. This system is one of the largest, privately-funded commercial PV installations in the western US. John Pryor, Karen and I had a tour of this system when we were in San Diego recently. We just drooled, 912 of Kyocera's hot-rod, 59 Watt panels flexing their silicon muscles in San Diego's intense sunshine. What a sight! RP

muddy roads



Laura Flett

Eight years ago my husband Jim and I first moved onto our "raw" land. We started out in a 28 foot trailer with no running water or power. One convenience that I will never again take lightly is the privilege of hot running water.

For the first year or two it was sponge baths from water hauled out of the creek in buckets. Then we made a funky but amazingly cherished hot shower. *A very "modern" improvement.* It consisted of a hot water tank that had a flue up the center of it. With about 30 to 45 minutes of fire tending, one had a full tank of scalding hot water out under the stars. A hose ran across the garden from our buried siphon line from the creek. A junction allowed some of the cold creek water to enter the bottom of the tank forcing the hot water out the top. The remainder of the creek water came directly out of the shower head mounted to the side of a shed. This allowed for the perfect mix of hot & cold and thus the perfect shower, well usually.

One Thanksgiving, when my mother-in-law and relatives were visiting, I was bragging about our wonderful hot shower and offering it to everyone. It *was* rather cold outside but I assured them that once under the hot stream, all else would be forgotten. Surprisingly I had no takers. Finally the water was ready and I slipped out of the trailer with my towel around my naked body and my thongs on my feet. Shivering as I dropped my towel, I turned on the shower. NOTHING HAPPENED! I felt the tank and the water was steaming hot. Why wouldn't it come out? I soon realized that the hose leading to the tank from the garden had frozen up.

I couldn't face Jim's relatives with no shower after my big build up. I knew it hadn't been frozen for long. I dashed madly about the garden in nothing but thongs & goosebumps. I strategically lifted the hose and smashed it up and down on the ground like a whip vertically, laterally, circularly to break the ice into particles. *Finally,* I heard a trickle coming from the shower. I got my shower. I entered the trailer later--clean, warm? and without having lost face. With my hot shower I also got an enduring memory of "alternative energy" at work.

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POSITION AVAILABLE: PV and alternative energy sales/marketing assistant with solar wholesale company in Honolulu, Hawaii. Must have experience with system design and component specification. Computer experience preferred. Call Will at Inter-Island Solar Supply for information and application. 808-523-0711.

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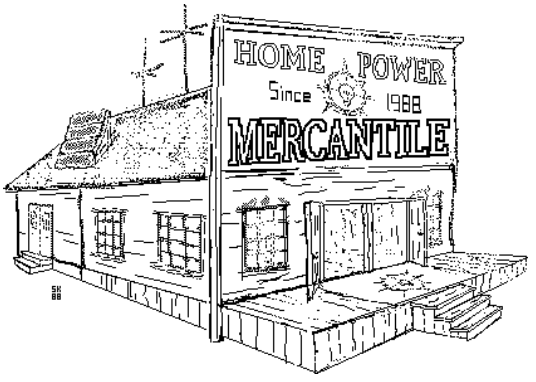

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