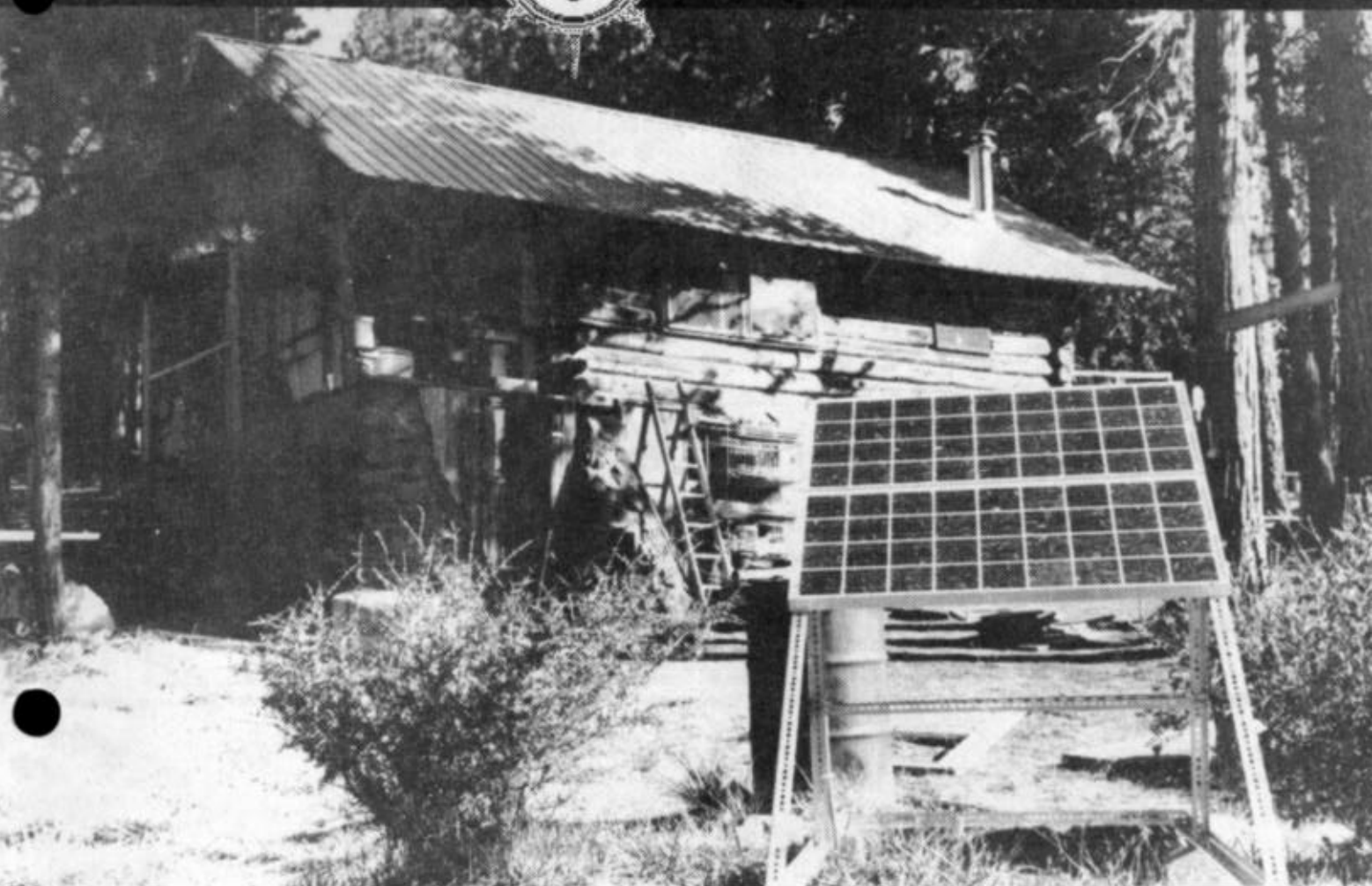
HOME POWER 13



Home Power

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Contents

Access

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Think About It

"In nature there are neither rewards nor punishments - there are consequences."

John Marshal Harlan - 1896.

Cover

Big Uns & Lil Uns. PV systems come in all sizes for all folks! Article on page 5.

Photo by Brian Green & Sonia Cantrell

Welcome to Home Power #13

This 13th issue marks the second anniversary of Home Power Magazine. We want to thank all the folks who make Home Power's continued publication possible. First off comes our advertisers who pay the bill for printing and mailing HP. Without our advertisers there would be no Home Power. Thanks also to everyone who has worked on Home Power-- the contributors of articles, info & money, our printers Valley Web Press in Medford, OR, our Postmaster Elden Cibart in Hornbrook, CA and last but most certainly not least, the thoroughly delirious Home Power Crew who are willing to work their butts off just for the good feelings.

Two years ago we started Home Power Magazine on a dream and a dare. We spent eight months getting enough support to put out the first issue. Many folks and companies donated their mailing lists to enable us to send out about 7,300 copies of Home Power #1. We didn't know what to expect. We'd never met any of you and you didn't know that Home Power was coming. An executive once told me that a "blind" mailing receives less than 2% response. Well, the blind mailing of HP#1 received greater than 53% response. Obviously we had hit some kinda collective nerve and HP was off & running!

Our database has continued to grow and this issue goes out to over 14,000 people under individual mailing labels, with an additional ≈2,400 copies mailed to energy extension services, universities, whole wheatie food co-ops, and anyone else who will read us with both eyes. Home Power has found its way to the most remote locations on this planet. We now have international subscribers on every continent, except Antarctica (and we're workin' on that). The thought of HP helping folks toward energy self-sufficiency makes our day!

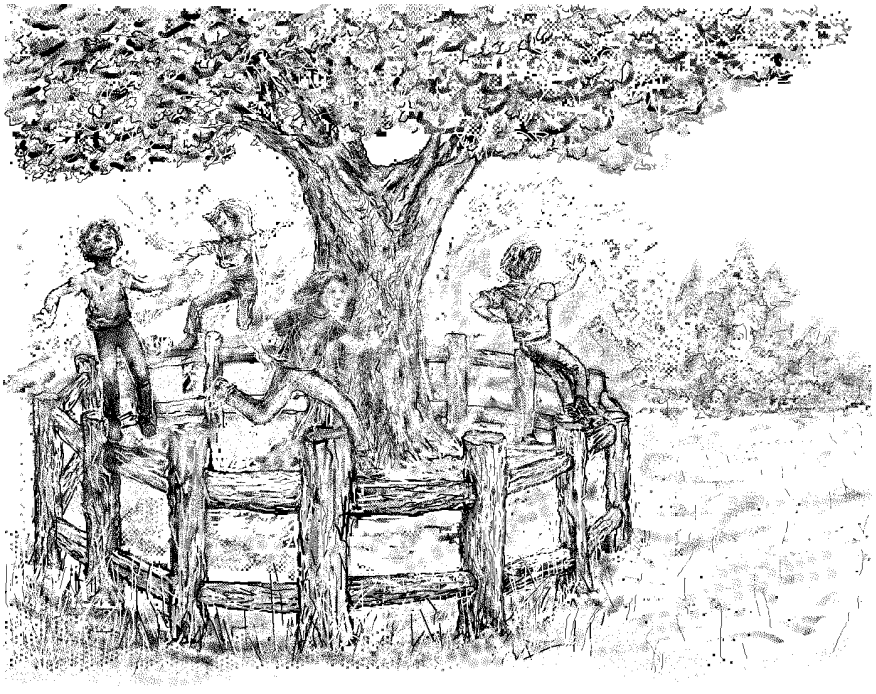
What Home Power shows is our collective concern for our environment, and our use of renewable energies to protect and sustain our planet. While we sort of figured that others shared our concerns, we had no idea that there were sooooo many of you. Or that you were as dedicated as we are to sharing this planet in harmony with all lifeforms. We thank you for your concern and your efforts. Keep it up, it's these energies that can save us all from environmental destruction and make this planet inhabitable into the next century. It's folks like you that keep Home Power up and working. Everytime we feel down, we read your letters and subs forms. The love you send us is magnificent and it keeps us going. Thanks.

the Home Power Crew

Despite Our Tattered Knees

Daniel K. Statnekov

There's an old oak tree where us kids used to play
In the bottom of a pasture that was planted in hay
A red oak it was near eighty feet tall
That stood by itself majestic to all
Limbs like thick arms spread into the sky
Were filled up with leaves where squirrels would hide
And round bout its trunk some farmer had put
A split rail wood fence to protect well its roots
Well, a gang of us boys would climb that there fence
And walk the top rail without human sense
A chasin' each other 'round that big tree
Faster and faster, Abner, Joe, Moe and me



Fearless of fallin' and reckless of heart
Seemed we was practicin' for some circus art
The game got even better when we speeded up the pace
And turned our act of darin' right into a race
"Better not let Moe a catch you" was the motto of the day
Or upside-down and bruised for sure on hard cold ground you'd lay
And Abner's little brother Joe was bigger than the rest
So if he got you by the shirt there wasn't any test
The end of this here enterprize declared right from the start
A heap of us boys on the ground a hollerin' each his part
Till finally we caught our breaths to up and go again
Better times there never was with kith or closest kin
That old oak tree a lookin' down I reckon now with glee
To see us boys a havin' fun despite our tattered knees.

Big Uns & Lil Uns

Richard Perez

One of the greatest advantages to using sunshine to make electricity is freedom-- freedom to live where we want and how we want. All we have to do is lightly tap Mama Nature for a smidgen of her endless energy. Our system's size depends on us, on our needs and desires. If you don't need the power, then you don't have to either produce it or pay for it. Here's an article about a large system that meets large needs and a smaller one that meets smaller needs. Both work and are cost-effective. Both point out the freedom and flexibility built into photovoltaic systems.

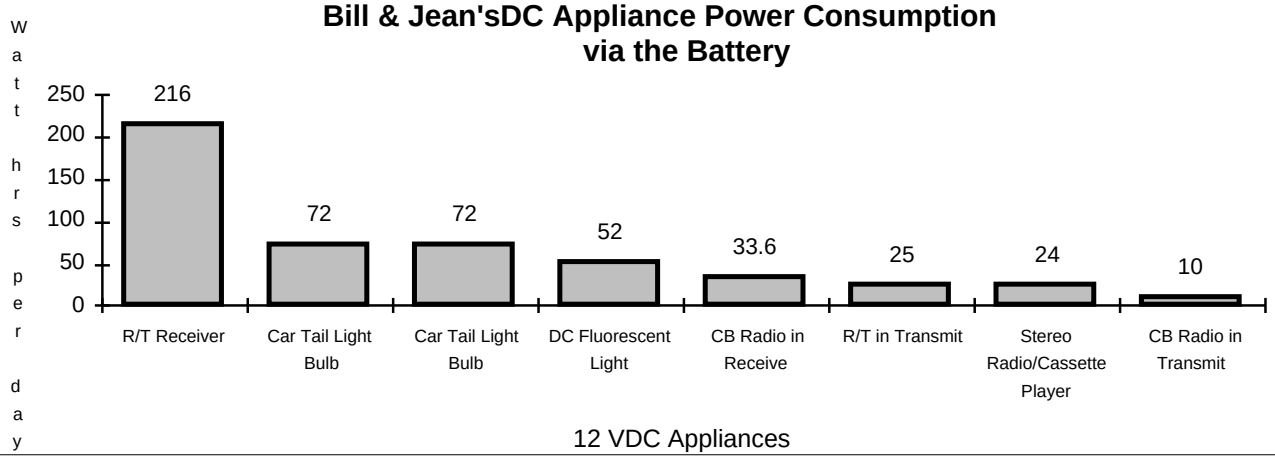
Lil Uns

When Bill and Jean Andrews moved to their mountain home in June of this year, they were ready to leave many conveniences behind. Well, Bill was and Jean remained to be convinced… Bill, a retired logger, and Jean love the peaceful beauty of the high country. At 4,500 feet in the Siskiyou Mountains of southwestern Oregon, their home has a panoramic view of snow-covered Mt. Shasta some 60 miles away. Bill & Jean's home is on a south facing slope surrounded by tall douglas fir and ponderosa pine trees. There's a spring that flows into a small pond in their front yard, home to a least a million frogs and tadpoles.

Their 80 year old log cabin is located about 2.5 airline miles from commercial electricity. The nearest paved highway is over five long, rough, muddy, and deeply rutted miles away. Electrical alternatives, other than running in the commercial grid at $70,600, included an engine/generator and photovoltaics (PVs). They choose to use a stand alone PV system for essential electrical chores like communication and lighting.

Bill & Jean's Electrical Consumption

Every system starts with a thorough survey of the appliances. Bill & Jean's was no exception. They sought help from Electron Connection in specifying and installing their system. In Bill & Jean's case the list of appliances was very short. They only need electricity for two functions, communications and lighting. The chart below details the appliances and their consumption.



Bill and Jean inside their solar-powered log cabin. Photo by Brian Green.

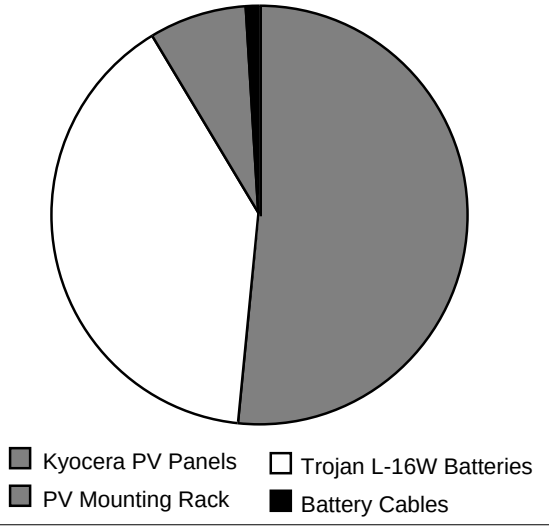
We decided right off to put all the electrical appliances on 12 VDC and not to use an inverter in this system. With such small scale consumption, PVs are easily capable of producing all the energy without the necessity of a back-up engine/generator. Twelve Volt lighting is readily available in either fluorescent or incandescent models. Just about all 2-way radios, either CB or radiotelephone, are available in 12 VDC powered models. Electrical power consumption averages about 500 Watt-hours daily.

Bill & Jean's PV System

This system has only two major components, PV panels and batteries. The PVs produce the power and the batteries store it. Very simple and very direct and very inexpensive. The two Trojan L-16Ws form a battery that will store about 6 sunless days of power for Bill and Jean. Each Kyocera 48 Watt PV panel will produce about 250 Watt-hours per sunny day in this location. There is NO generator in this system, PVs are the ONLY power input. The cost of this system is detailed in the spreadsheet and chart below. Please note that the low cost of this system is due to Bill & Jean's very small electrical consumption. Once again, if you don't consume the energy, then you don't have to generate it, store it or convert it. Stand alone PV system cost is directly proportional to the amount of power required from the system. Note also that Bill & Jean had us install a rack for four PV panels eventhough they now only use two panels. In stand-alone PV systems this is a very good idea. As the system's electrical consumption grows (and it always seems to), then adding more panels is simple and direct.

No.	Item Description	Cost	%
2	Kyocera 48W. Photovoltaic Panels	$712	52%
2	Trojan L-16W Batteries	$550	40%
1	PV Mounting Rack (4 panels)	$100	7%
1	Battery/Inverter Cable	$15	1%
	Total System Cost	$1,377	

Cost Pie for Bill & Jean's System



Big Uns

Jim and Laura Flett moved to the Siskiyou Mountains in 1980. This is the very mountain range that Bill & Jean inhabit, but far enough south to be in California rather than Oregon. Jim is a farrier and Laura is a physical therapist. Both run their own businesses out of their backwoods home. Their 80-acre homestead along Camp Creek is home to Jim, Laura, their two children Saylor and Dana, two horses Shorty and José, and numerous other critters. They moved to the hills for the same reasons most of us have- freedom, a clean unspoiled environment, and some basic peace & quiet.

Jim & Laura's home is located about 2 miles from the nearest commercial electricity. At today's rates, the power company wants about $60,000 to run in the lines. It's easy to see why Jim & Laura decided to make their own power.

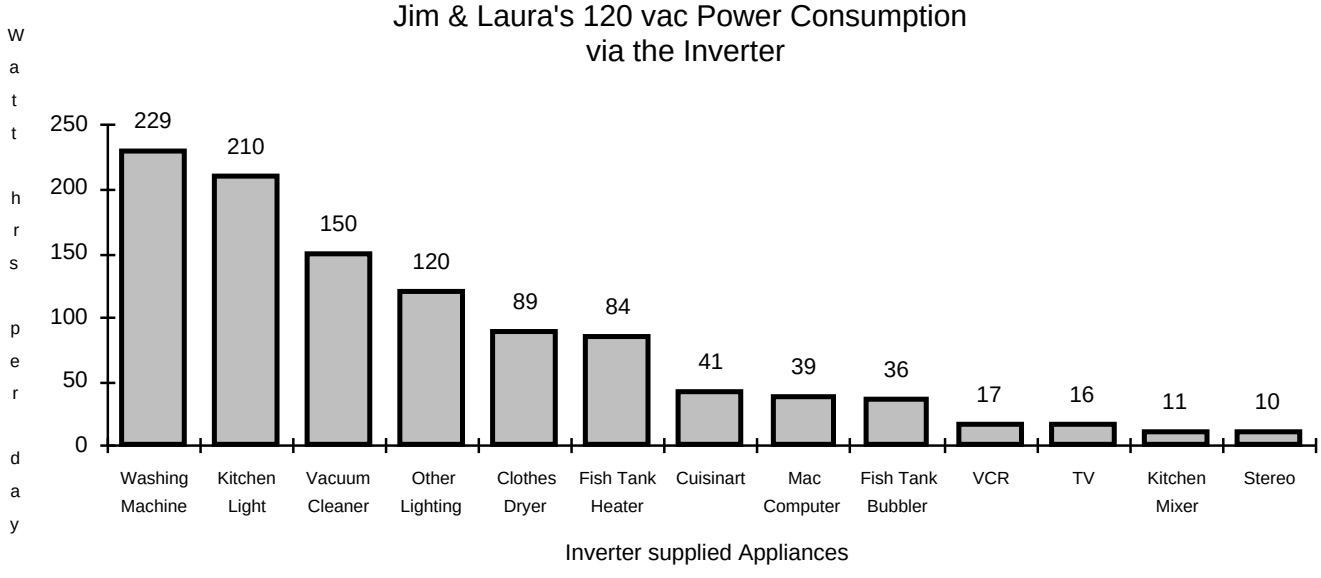
Jim & Laura's Power Consumption

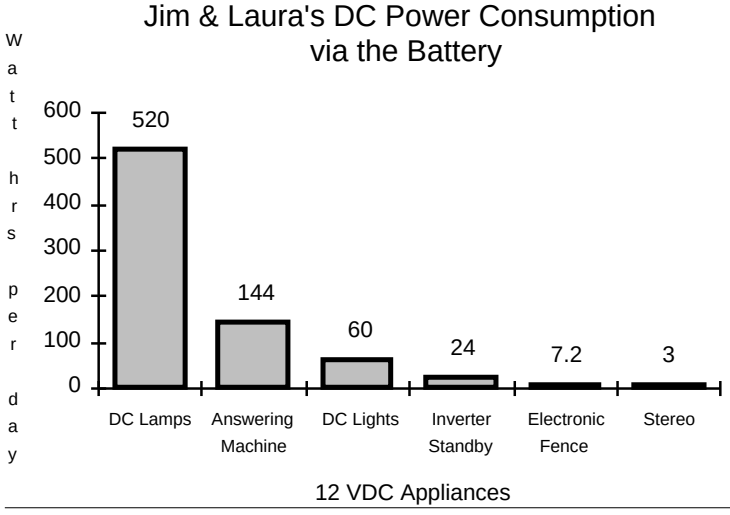
Jim and Laura's home is a large ranch house equipped with the conveniences needed for effective country living. They consume electricity both as 120 vac from their inverter and as 12 VDC directly from the batteries. The chart below details the major consumers of inverter produced 120 vac power. The 12 VDC appliances are powered directly from the batteries and are also detailed in the chart below.

Total power consumption adds up to about 2,000 Watt-hours per day, including inverter inefficiency and several small intermittently used appliances not listed in the charts.

When Jim and Laura first moved to the mountains, their electrical system was much smaller and sourced by a single engine generator. During the eight years before they invested in PVs, an inverter and a much larger battery pack, they learned well the lessons of conservation. Even now, they religiously perform the small tasks that make their system so efficient and effective. Tasks like, turning off lights that are not in use, using efficient lighting and placing it where illumination is needed. While Jim & Laura use their system like veteran energy misers, the visitors to their home are unaware that it's not plugged into the grid. Some visitors leave the house without ever knowing that the electricity they used there was solar produced and battery stored.

Jim & Laura' house is interesting from an electrical standpoint because the home is totally wired for both 12 VDC and 120 vac. Everywhere there is a 120 vac wall receptacle (and there are lots of them because the house is wired to NEC code), there is a 12 VDC outlet. Everywhere there is a permanently mounted 120 vac light, there is also a permanently mounted 12 VDC light. The 12 VDC wiring system was done as follows. Two 0 gauge copper cables





feed DC energy from the battery to a buss in the attic. This buss is made from #2 copper wire and runs about 65 feet along the attic crawl space of this single story ranch type house. Each 12 VDC outlet or light is individually connected to the buss (no daisy-chaining like 120 vac circuits). **All connections to the buss are soldered!**

Jim & Laura's PV/Engine System

First off, this system is very different from Bill and Jean's because it didn't happen all at once or as an integrated unit. It grew gradually over the years with their needs and as the equipment became affordable. As such, Jim & Laura's system contains items like redundant generators that are only very occasionally used now.

The main power source is eight 48 Watt Kyocera PV modules. This photovoltaic array produces about 23 Amperes in full sun, or about 2,000 Watt-hours daily. The PV produced electricity is passed through a Heliotrope CC-60 PWM charge controller (see

Jim & Laura's library and office. Solar energy lilluminates the room and powers the Mac computer & printer.
Photo by Brian Green.

HP#8 for a review of the CC-60) which prevents overcharging the batteries. Power storage is in six Trojan L-16W batteries with a total capacity of 1,050 Ampere-hours at 12 VDC. This storage is sufficient to run the system for over 5 days with no energy input. The L-16Ws are equipped with Hydrocap catalytic converters to reduce gassing into the house and water consumption (see HP#11 for a report on Hydrocaps). This system uses a 1.2 kW. Heart inverter/battery charger to convert the battery stored power into 120 vac for household use.

Two engine/generators are used in this system. The first is a 120/240 vac Honda ES6500 generator. This unit produces 6,500 watts and can both directly source the system and recharge the batteries via the Heart inverter's battery charger. Jim had very good things to say about this two cylinder, overhead valve and cam, water-cooled generator. He's found it to be very quiet, reliable and easy on fuel. The second generator in this system is a Mark VI type 100 Ampere, 12 VDC alternator setup. This powerplant uses a 5hp. Honda OHV single cylinder engine to turn a 100 Ampere Chrysler automotive alternator. The unit is controlled by Electron Connection's Mark VI alternator field controller. See HP#2 for a complete description of the Mark VI system and how to build one. The DC plant was used extensively to recharge the batteries before Jim & Laura installed their PV panels. Since the PVs arrived, both generators are getting a real vacation with only light use on the ES6500 and almost no use on the Mark VI system. Jim uses the ES6500 for large tools and Laura uses it on "cleanup days" when the washing machine, clothes dryer, and vacuum cleaner are all running at once.

The spreadsheet and chart below show the costs of Jim & Laura's system. Please note that this cost breakdown includes **all** the power equipment used in the system. If the system were specified now, then at least one of the generators could be deleted. However, this system grew up before PVs were affordable and hence, extra generators.

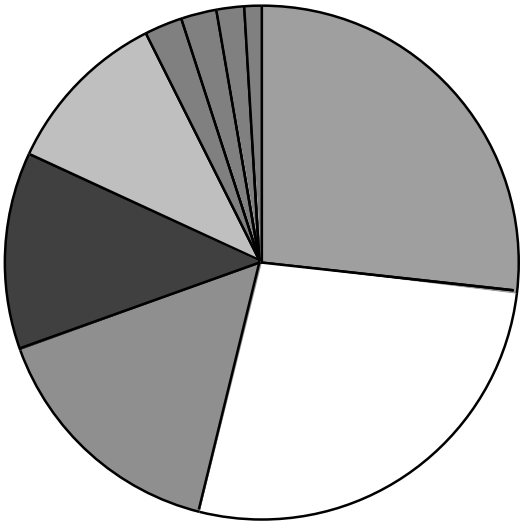
Several other aspects of Jim & Laura's system are interesting although they have nothing to do with electricity. Jim uses a Dempster wind powered jack pump to move water from his deep well to a holding tank behind the house. Jim & Laura's extensive

No.	Item Description	Item Total	%
1	Honda ac Generator	$2,860.00	27%
8	Kyocera PV Panels	$2,848.00	27%
6	Trojan L-16W Batteries	$1,650.00	16%
1	Heart Inverter/Charger	$1,335.00	13%
1	DC Engine/Alternator	$1,100.00	10%
2	PV Mounting Racks	$275.00	3%
1	Heliotrope Controller	$219.75	2%
9	Battery/Inverter Cables	$183.73	2%
18	Hydrocaps	$102.60	1%

Total System Cost $10,574.08

Jim & Laura's living room with Dana lying on the floor enjoying her toes. Photo by Brian Green.

Cost Pie for Jim & Laura's System



- Honda ac Generator
- Kyocera PV Panels
- Trojan L-16W Batteries
- Heart Inverter/Charger
- DC Engine/Alternator
- PV Mounting Racks
- Heliotrope Controller
- Battery/Inverter Cables
- Hydrocaps

vegetable garden is drip watered and micro sprinkled from a gravity flow system sourced by nearby Camp Creek.

Big Uns & Lil Uns

Both the systems described here use PVs for power input and both store power in batteries. The cost and amount of power produced & consumed is different. The Big Un cycles about 2,000 Watt-hours daily and the Lil Un cycles about 500 Watt-hours daily. The higher cost of the larger system is due to its increased flexibility and capabilities. The Big Un uses an inverter (and the increased battery capacity to power it) that allows Jim and Laura essential 120 vac appliances like a computer & printer for their businesses, and appliances for Jim's kitchen wizardry. And other small essentials like a heater and bubbler for the fish tank (while this may not seem essential to some, it certainly does to the fish and 4 year old Saylor Flett who loves them). The Big Un also supports large appliances like a washing machine, gas fired clothes dryer, and a vacuum cleaner. The engine/generators assure that that Jim & Laura won't run out of power during extended cloudy periods or even extended visits from switch-flipping city folks.

And there's good things to say about the Lil Uns too. Small stand alone PV systems are supremely reliable and very cost effective. The Lil Un delivers essential power for lighting and communications that otherwise have to be sourced by a noisy, expensive and unreliable engine/generator. The Lil Un is very reliable because it doesn't depend on complex, expensive electronics like an inverter, but uses power directly from the battery as 12 VDC. Since the only power input is solar, the Lil Un has virtually no maintenance other than occasionally watering the batteries.

Systems

So, ya pays yer money and makes yer choice. The size, complexity and cost of a power system depends on what you require of it. Those with simple low powered requirements can have what they need for very little cost. Those requiring more will have to use larger systems that cost more. But the essential feature here is that you don't have to have any more than you need.

Access

System Owners & Operators
Jim & Laura Flett
19812 Camp Creek, Hornbrook, CA 96044
Bill & Jean Andrews
Randcore Pass, Soda Mtn on Hwy 66., Ashland, OR 97520

System Specifiers, Vendors & Installers
Electron Connection Ltd.
POB 442, Medford, OR 97501 • 916-475-3179

What it's really all about.

Recently arrived Citizen, Dana Flett, doesn't know solar from shinola, but she's living in a better World because her folks give a damn.

Photo by Brian Green.

Carlson Communications

see pg. 49

Energy Depot

Kyocera

Ken Spencer, an ATA student, with a screwdriver in his mouth and energy on his mind. Photo by Michael Ivanovich.

Home Power Generates People Power

at ATA's summer PV for Practitioners Workshop

Michael Ivanovich

Thank you *Home Power* magazine! Over half the PV workshop participants credited HP for informing them of the hands-on course recently held in the Colorado Rockies. Entitled PV for Practitioners (see ad in this issue), the design and installation course drew an exciting and diverse group. PV enthusiasts included five electricians from the Hopi PV Foundation, internationals from Canada, Australia, and Pago Pago American Samoa, and me a solar researcher in an epic quest for hands-on.

Program Summary

PV trainers Steve McCarney, Ken Olson and Johnny Weiss of Appropriate Technology Associates (ATA) taught the intensive one/two week course. Both weeks were **Hot**, here's a quick summary. The first week was classroom, laboratory, design, and demonstration instruction. The second week was hands-on field installation--a water pumping system for ranch livestock and two ultra-remote cross-country cabin lighting systems. (See upcoming HPs for detailed articles on the installations). Participants each received a 300 page practical textbook and a thick notebook stuffed with current product literature and a hard-to-find resource information.

Logistics

Glorious summertime high-country weather allowed folks to experience the joys of mountain living. Many camped cheaply at nearby alpine camp grounds, some enjoyed local bread and breakfast establishments, while elitists motelled-it "downtown" in popular tourist style. Family and friends took advantage of the outdoor recreational opportunities--hiking, fishing, rafting, hot-springing, and playing on the swings in Carbondale Central Park during a class Bar-B-Q. The "classroom" had a rather unique ambiance; it was the community room (and bingo hall) of the local volunteer fire department.

Curriculum

The five-day 8AM to 5PM agenda was originally developed by the instructors as part of the Colorado Mountain College's one year course called Solar Retrofit Program. (This year the course has been renamed the Energy Efficient Building Technology Program). Workshop topics for the first week included: PV applications, basics of solar electricity, PV systems components, solar site analysis, using VOM meters, SAPV installation, example case studies, and system sizing and equipment specifications.

Guest speakers provided a wide variety of industry viewpoints. Manufacturers, hardware suppliers, system designers,researchers and experienced PV homeowners gave individual and unique perspectives. Tours briefly visited John Denver's Windstar Foundation and Amory & Hunter Lovin's Rocky Mountain Institute; both of which are energy and appropriate technology research and demonstration facilities. The class also toured residences, a weather station site, and a commercial greenhouse featuring state-of-the-art passive solar construction. Satisfactory performance on daily quizzes and on a comprehensive final test allowed participants to earn a certificate of completion. We even got to fill out teacher/course evaluations.

Design Philosophy

As practical "nuts and bolts" teachers, ATA instructors believe that PV system designing is both an art and a science. Crunching numbers to five decimals on calculators (preferably PV powered) must be combined with "human engineering" in order to provide a necessary holistic approach. Designers need to remember that people will always be the most critical input--that lifestyle affects system sizing as profoundly as peak sun hours and panel efficiency.

ATA trainers consider themselves "industry tire kickers" because they are independent educators and do not act as salesman for specific manufacturers. They shoot straight but keep the atmosphere from getting too serious--the job gets done, done well, and we all have a good time along the way.

As HP's monthly feature, SYSTEMS, highlights, a good design begins with understanding the load. (LOAD = how much electricity you need!). Thorough load analysis is the foundation of cost effective systems. Attention to detail is important for designers as well as installers. ("Prior proper planning prevents piss-poor production"). They should also provide detailed system documentation (ie., accurate electrical schematics), troubleshooting procedures, and maintenance recommendations.

Why Me

On Monday morning, ATA instructors asked us why we were there. I said after two years of procrastinating, I was at workshop for two reasons: 1) to fill some gaps in my graduate, building energy program, and 2) to get away from the pressures of my thesis and ozone-hole research job (no kidding) by basking in the mountains and sun. Here are reasons from a few other folks.

- to get off the grid
- to bring independent power to my reservation and people

• to recharge my wheelchair's batteries
• to help heal the earth
• to make industry connections and learn more about products
• to learn how to install systems so I can work in the field
• to compliment my wind power expertise
• because Samoa needs a PV powered TV transmitter
• because right now I'm more a roofer than a PV installer, and I want to become more of a PV installer than a roofer.

Here's what ATA did to help us along.

Great Lectures

ATA's preparation and planning resulted in a superb production. Their lectures were comprehensive, well-structured, and well-delivered. Their slide projectors and overhead projectors worked without so much as burning out a light bulb. Their samples of modules, batteries, controllers, inverters, panel mounts, and teaching aids lined almost every inch of available wall space. A king-sized bedsheet-turned-projector screen took up the rest.

Guest Speakers

The guest speakers added a lot to special topics such as lighting, cathodic protection, line conditioning, remote telecommunications, and the newest products. Bernie Haines, developer of the Solar Pathfinder, was there to deliver insights about that device (and equip several students with the Professional model at a bargain rate). Here's a list of the other speakers and their topics.

• RMS Electric: wholistic systems design
• Remote Power: PV systems and products
• Solar Energy Research Institute: solar research update
• Photocomm: latest products
• Guardian Control: Cathodic protection
• Rising Sun Enterprises: energy efficient lighting
• Aspen Ski Hut Caretakers: remote ski huts
• University of Colorado: PV powered weather station network
• American Samoa Energy Office: renewables in Pago Pago
• Hopi Foundation: Hopi PV project
• Heliotrope: latest products
• Medical Benevolence Foundation: energy outreach
• Softech Solar: Canadian amorphous & poly-crystalline panels

Major Tours

The tours were a tremendous "plus" to the program. The Windstar and RMI centers provided some rather unique loads to look at...Windstar is using PV for developing wholistic energy and agricultural research processes in their geodesic BioDome. Mobil recently donated to RMI a 2 kW array of panels (@200 watts EACH) and will soon be selling electricity to the local power utility. Holy Cross, while providing un-interruptible power to their computers, lights, and office equipment (and Amory's "think tank", a solar and wood-fired hot tub.)

Minor Tours

Two other tours brought us to the Planted Earth, a new passive-solar greenhouse with a nearby PV powered teepee (both were Steve McCarney's productions), and a PV powered weather station that I helped design and install a few years ago (see PV International , Oct. 1987) as part of a graduate research project.

At Planted Earth's 6000 sq-ft commercial greenhouse, I got a good look at my first teepee PV system. Debi Tena, an electrician from the Hopi Foundation in Second Mesa, AZ got a kick out of it too. The stand alone system home power-ed several fluorescents lights. The Planted Earth also featured innovative passive solar and greenhouse design features. Steve McCarney unraveled the mysteries behind the main greenhouse's rock/soil/concrete thermal storage, double skin plastic glazing and low profile building design. Planted Earth's gift shop and office featured a selective surface trombe wall and a passive freeze proof batch heater.

At my weather site in Carbondale, I put on my field technician's hat and indoctrinated the other attendees into the world of remote telecommunications and automated weather monitoring. Stand alone data acquisition systems are a natural application for PV and a real convenience for data takers since they don't have to replace batteries or cassette storage tapes.

PV Configuration Laboratories

Being a scientist at heart, the labs were, for me, the best aspect of the first week. On a number of occasions, however, Mother Nature teased and annoyed us playing hide and seek with the sun and by giving us *lightning power* instead of solar power. ATA pleaded guilty to brashness by scheduling the sun to appear in time slots normally occupied by clouds in mid July; they sentenced themselves to not do it again.

We did learn a lot in the labs, like how to: use a Solar Pathfinder, wire modules to batteries, controllers, and inverters, and use the hand tools and testy equipment of the trade. My favorite piece of test equipment was the non-intrusive current transducer (an ammeter that clamps around a conductor and measures current by induction rather than breaking the circuit and wiring an ammeter in series and measuring current directly.)

We wired different stand alone systems and directly coupled systems using a variety of loads. We powered pumps, charged batteries, and observed fluorescent light against incandescent (it was an illuminating experience).

In a controller lab, we wired a heavy duty electric drill to a battery that was at a low state of charge. An LVD controller with a voltmeter and ammeter presided over an experiment to try and discharge the battery until the LVD kicked in to keep it from deep discharging. With anxious eyes, we huddled over the meters as the battery's state of charge sunk with the drill bit. Suddenly, a simultaneous *click* from the LVD and brittle silence from the drill signaled the end to a cool experiment.

An Opportune Installation

After the first week of PV for Practitioners, we had a Saturday and Sunday to ourselves to relax and make ready for the upcoming week of installations. Some people did as they should and disappeared into the wilderness, but eight of us volunteered our Saturday to help Mark McCray of RMS Electric add five panels to a remote homeowner's array.

The Sovonics panels were given to the homeowner after being stashed in a barn for over a year. Mark planned on adding five panels to the existing system and on putting two more on a garage to power a propane generator's controllers. He extended the invitation for volunteers because he knew that several students couldn't stay for the second week and would enjoy participating in the installation. Our contributions included putting up a site-built mounting structure and wiring in the panels for the house's ac/DC system. Thanks Mark--that was fun.

Conclusion

ATA's PV for Practitioners workshop is a winner--it'll make you smart, experienced, and psyched on PV. I recommend that PVer's prepare for it by putting away time and money for both weeks. I'm sure you won't be disappointed--even though it'll cost you some bucks. But like buying energy efficient lights: the cost is up front, but the savings in energy and money is more than worth it.

Rap Up

Special thanks to Jerry and Mia Gamble of Carbondale who let me hole up in their chicken coop so I could write this article; to Colorado College for setting me up with a compete Mac system to keep me company in the coop, and to Johnny Weiss for his inputs and liberal use of his pick-up truck.

Here's a diddy of what's in store for part 2 of this three part series... it's a soul-ful description of the directly coupled SolarJack water pump installation at the Ty-Bar Ranch.

Michael Ivanovich is in the process of starting up Libra Solar, 465 Elmhurst Rd., Utica, NY 13502, • 315-738-0193, while finishing up his graduate engineering thesis. For a laser printer and food, he just began developing data acquisition and processing systems for the Lovins' PV system and for a radon monitoring project in upstate New York.

The Water Pump Rap

Michael Ivanovich

The sun was hot and the mountains high
and the locusts were as nasty as the ground was dry.
But onward we tread with a shake and a rattle
to install a PV pump for a rancher's cattle.
The well went down a hundred-thirty feet deep
but there were no lines for electricity.
So two Arco panels and a SolarJack pump,
directly coupled to the colorado sun,
were bought by the rancher to have his way
and he got a lot of help from ATA.
They set the stage & put the panel post up
but the rest was ours and that was enough.
With smiles and sweat we got **water** flowing
90 gallons an hour with no sign of slowing.
There was a pitless adaptor and an LCB,
plus a Zomeworks tracker
and more, you'll see!

Zomeworks

Lil Otto

A Hard Worker Who Doesn't Drink Very Much…

Richard Perez

Lil Otto opens new vistas in microHydro power. Or rather nanoHydro, for this water powered turbine delivers more electricity from less water than any we've ever seen. Many of us have seasonal streams that run like mad dogs in the winter and dry up in the summer. It's not worth sticking thousands of dollars into a hydro system that only operates ocassionally. At a price less than half of most microHydro turbines, little Otto produces on flows as low as 3.5 gallons per minute or heads as low as 25 feet. Lil Otto is a perfect power supplement for PV systems that also have a small or seasonal hydro source.

Meet Lil Otto

Lil Otto is the brain child of Bob-O Schultze (KG6MM) and Otto Eichenhofer (KB6EJR) of the Lil Otto Hydro Works in California. Lil Otto is a self-contained hydroelectric power generator, complete with output current (Amps) meter. Lil Otto uses a permanent magnet alternator shaft connected to Powerhouse Paul's high tech impulse water wheel. He works on either 12 or 24 VDC systems, and produces up to 4 Amperes of current (that's 24 hours a day, mind you) depending on flow and head. And at a price that's around what a PV panel costs, Lil Otto is very frugal.

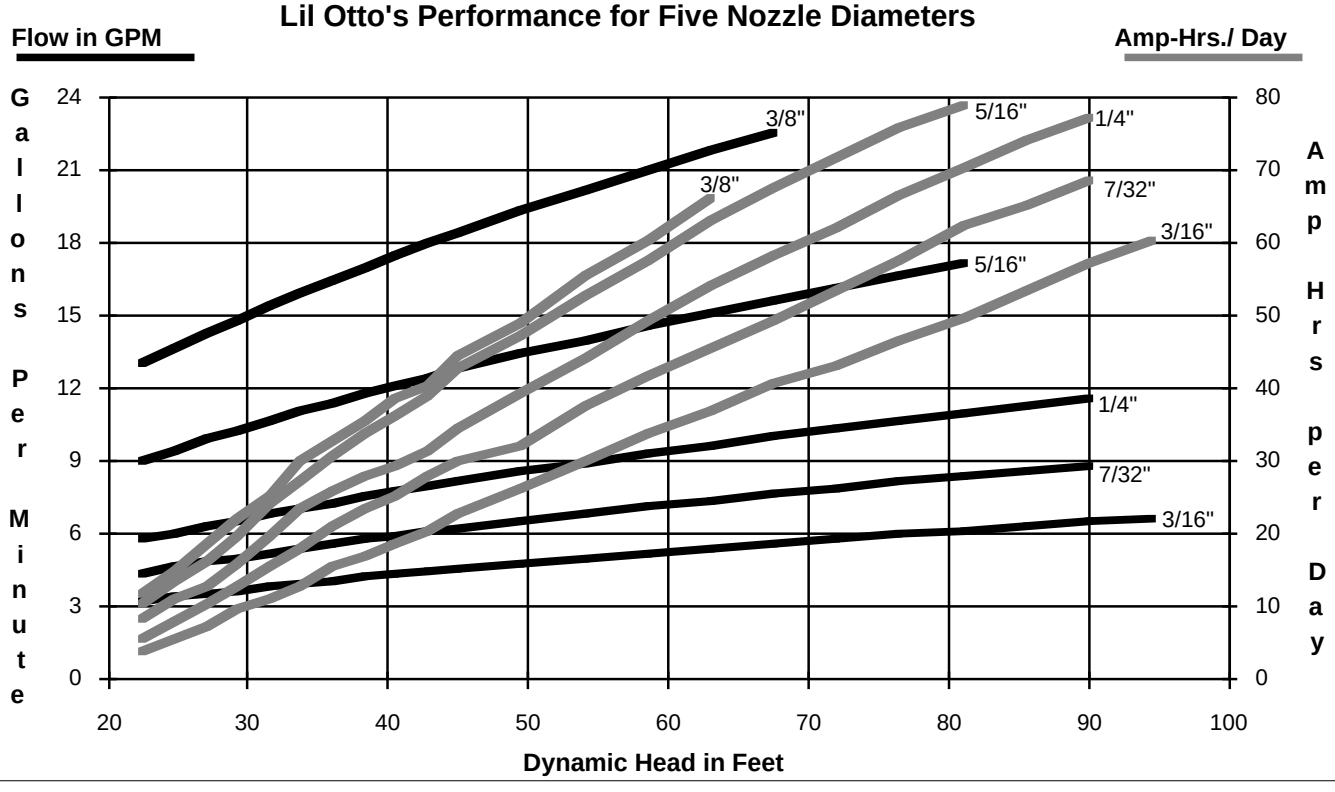
So what's nanoHydro anyway?

Hydro systems succeed or fail on two site-dependent factors- head and flow. Head is the number of vertical feet of fall in the system expressed in feet. Flow is the quantity of water that the system uses expressed in gallons per minute. Basically in any hydro system we want to see hundreds of feet of fall and thousands of gallons per minute flow. So much for dreaming… Actually most hydro sites have a limited amount of fall and limited quantities of water available for power production via the turbine. MicroHydro means that the site has either very little fall or very small flow, but probably not both. NanoHydro means that the site has either small fall or miniscule water flow, and probably both. The case of nanoHydro is very similar to: "After having done so much with so little, we are now attempting the impossible with nothing." And it works.

Lil Otto's Performance under Pressure

I'm not going to waste space with text about how Lil Otto works, I'm going to give you the straight data and let you make up your own mind. This data was complied by Lil Otto's makers in an actual working system. This chart shows both flow and electrical output against the head of the system for five different diameter nozzles. The vertical axis on the left and the black curves on the chart indicate the amount of water Lil Otto consumes versus the head of the system. The vertical axis on the right and the gray curves indicate Lil Otto's electrical output in Ampere-hours per day versus the head. The horizontal axis at the bottom of the graph indicates the dynamic head of the system. Dynamic head differs slightly from static head (actual physical fall). Dynamic head is always less than the actual physical head because the flow of the water through a pipe involves liquid friction and turbulence that produces some loss.

To put your particular hydro situation into Lil Otto's shoes, use this process. First locate the amount of head you have on the horizontal chart axis. Next locate the amount of flow you have available on the chart's left hand vertical axis. The black curve



below the intersection of these lines is the nozzle size for you. Find the gray curve for that nozzle size and follow it to where it intersects the head you have. Read Lil Otto's output in Amp-hrs. per day on the right hand vertical axis. Seems complicated (and it is), but any hydro power situation is determined by two independent factors: head and flow. And as such, the choices are myriad…

Lil Otto isn't very thirsty…

The really amazing feature is not power output in terms of head, but how little water the turbine consumes to produce this power. This turbine will effectively produce power while consuming as little as 3.3 gallons per minute at dynamic heads as low as 25 feet. Lil Otto really gets to be fun if you feed him about 5 gallons per minute. At 4.4 GPM and a dynamic head of 41 feet (that's with a 3/16" dia. nozzle), the turbine will produce about 19 Ampere-hours per day and that's as much as a PV panel in an all day sun location. With higher heads and flows, Lil Otto can produce up to 80 Ampere-hours per day.

Lil Otto's Physical & Electrical Construction

Lil Otto's outer skin is made from off-the-shelf PVC pipe (7.5" in diameter). He stands 13 inches high. His nozzles are Rain-Bird™ sprinkler nozzles and easily changed in the field in a less than a minute. His permanent magnet alternator is made by Bosch™, and his high-tech water wheel by Powerhouse Paul™. Lil Otto contains a built in blocking diode and an Ampere output meter. This meter is very handy in detecting when leaves or other trash are preventing Lil Otto's from getting the water he needs. He has built-in filtration to keep him from getting loud and obnoxious on your radios or TV. The turbine contains reverse polarity protection, while Lil Otto refuses work if you hook him up backwards, he won't die on you. Lil Otto requires no regulation and has only two wires to connect to your system.

Lil Otto's People

Perhaps one of the most incredible things about Lil Otto is his family. His Pop, Bob-o Schultze, has been living on microHydro for over ten years beside the Salmon River in northern California. Lil Otto turbines are made from electricity produced by Hydro machines. Sort of a clone yourself situation…

Lil Otto's Cost and Warranty

This turbine costs $395. complete with nozzle of your choice and installation/operation manual. Replacement alternators, which are easily user installed, are $45. Lil Otto has a one year warranty against manufacturing and/or electrical defects. Bob-O will help you select the correct nozzle for your site and provide tech support via phone and mail.

Lil Otto's Electric Future

Many of us are now using PVs as our primary power source. The main problem we have are those cloudy, rainy Winter days when the PV array isn't producing. Many of us also have marginal hydro sites, especially during the wet Winter. Up to now, the cost of a microHydro system couldn't be justified against the amount of power it would produce yearly. Lil Otto consumes so little water that marginal hydro sites can now be cost-effectively developed. Not only is the initial cost of the turbine itself low, but since Lil Otto doesn't drink much, the diameter (and cost) of the water pipe feeding him is also small. Lil Otto is a very effective, secondary power source for folks without a lot of water to run through a hydro turbine. He will become a wonderful helper on those cloudy wet days.

Access

Lil Otto Hydro Works!, POB 8, Forks of Salmon, CA 96031, or call 916-462-4740.

Things that Work!

Home Power tests an ED-160 Reconditioned Ni-Cad Storage Battery

Richard Perez

Batteries are really the hearts of our systems. Almost all of the systems that you've been reading about in Home Power use lead-acid cells for power storage. This is not because the lead-acid reaction is the best for our use, but because it is affordable and relatively effective. There are, however, other battery technologies that are **more** effective and efficient at storing energy. Nickel-Cadmium (nicad) is one of these technologies. When Pacific West Supply near Portland, Oregon started offering less expensive, reconditioned nicads with a five year warranty, we couldn't wait to test a set. These nicads are not only amazing, but will revolutionize the way we equip and use our systems. What follows here are the results of over three months of testing of the ED-160 nicads in actual home power type service. If you need info on the nicad cell and how it works, please see HP#12, page 16.

Meet the Edison ED-160 Nickel-Cadmium Cell

The ED-160 is a wet pocket plate nickel-cadmium cell with a capacity of 160 Ampere-hours at a seven hour discharge rate (that's C/7 or 160 A-hr/7 hr.≈ 22.8 Amperes). Each cell is 6.37 inches wide by 18.25 inches tall by 3.37 inches deep and weighs in at 21 pounds. The cells are encased in heavy, transparent plastic making it easy to see their electrolyte level. Since the voltage of the nicad reaction is about 1.22 VDC per cell, it takes ten nicad cells in series to make a 12 Volt battery.

Now, these cells are "reconditioned". This means that the cells have been used for uninterruptible power in railroads, hospitals and airports, etc. nicads in this type of service are routinely replaced whether they are worn out or not. Pacific West Supply reconditions these used cells and resells them at a fraction of their original cost, complete with five year warranty. The fact that these cells are reconditioned means one thing to me. The cells we tested had already been in service and would show any problems likely to occur through use and age.

The Test System

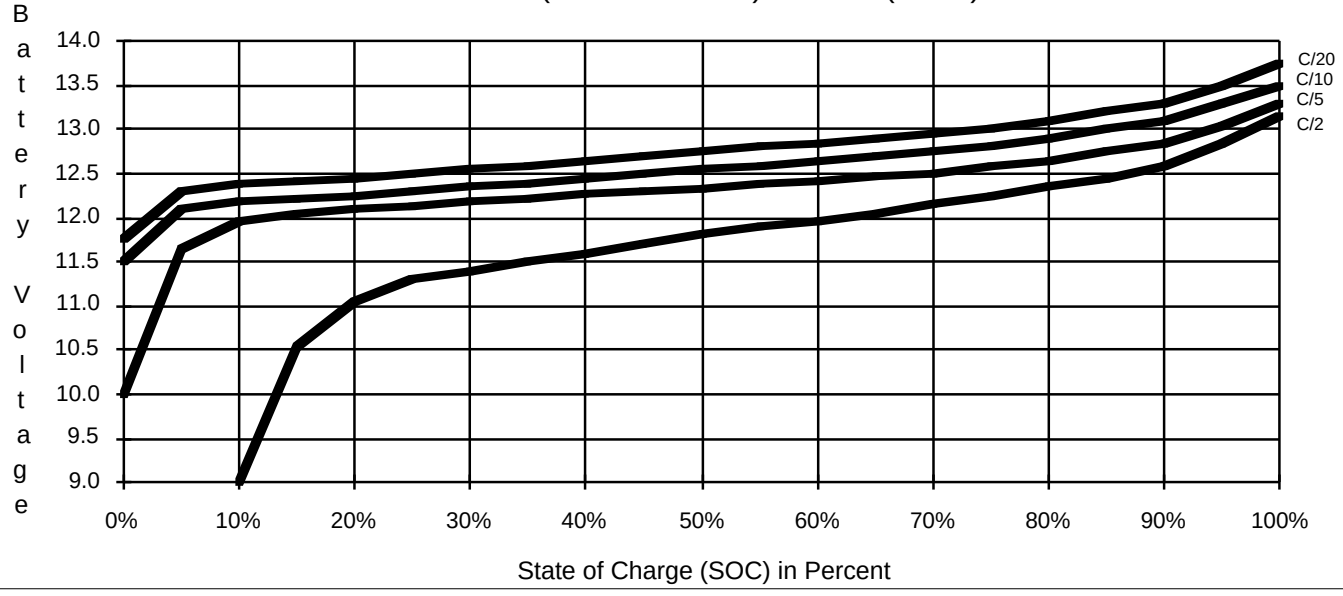
We installed the ten ED-160s right next to our lead-acid pack of 4 Trojan L-16Ws. We recharged the cells and put them in service, all the while measuring & recording the voltage of each individual cell that made up the pack. We transferred ALL the equipment connected to the lead-acid pack to the nicad pack and it became our system's only battery. By all the equipment, I really mean everything electrical: the 2.3kW. Heliotrope PSTT inverter, all of our DC loads, our PV array, and our 12 VDC Mark VI engine/generator. We essentially replaced a lead-acid battery pack of 700 Ampere-hours with a nicad pack of only 160 Ampere-hours. This gave the nicads a real workout!

Life on Nicads

We then proceeded to carry on as normal, using electricity as we always have done. The first thing I noticed was that the nicads had higher voltage under discharge than the lead-acid pack they replaced. We use several 12 VDC lights every evening. The voltage of the lead-acid battery pack would drop to ≈12.5 VDC under the load of these lights. The same lights (about a 5.8 Ampere load) lowered the voltage of the nicad pack to only 13.2 VDC. The lights were the brightest we've ever seen them at night without the engine/generator on line at the time. And this is even more amazing when one considers that the nicad pack has only 1/4th the capacity of the lead-acid pack. The 5.8 Amp load represents only a C/120 discharge rate for the larger lead-acid pack, while the same 5.8 Amp load is a C/28 discharge rate for the nicads. This means that the load is four times greater for the nicads *in relation to their capacity,* and their voltage was still higher!

After several days of using the cells it became apparent that their voltage characteristics were much more suitable for home power service than those of the lead-acid battery. Most PV systems are sized to have between four and seven days storage capacity in their battery. This means that the battery voltage in these systems will stay over 13.0 VDC under normal service. This higher sustained voltage means great performance out of all 12 VDC appliances, including the inverter. The nicads maintained their voltage while being discharged at high rates (>C/10). The operating voltage curves were very flat as described in the chart below.

Discharge Curves for Edison ED-160 Nicad Battery
12 VDC (10 Series Cells) at 77°F. (25°C.)



Recharging the ED-160s

The next question in my mind was how would they charge up? Well, the same style of flat voltage curve holds true for the charge cycle also. The cells seem to sit forever at below 1.45 VDC per cell at a C/10 rate of charge (14.5 VDC for the ten series cell pack) as they are refilling. When they are about 80% full, their voltage jumps to about 1.55 VDC per cell (or 15.5 VDC for the entire pack). The chart below shows the voltage to SOC info for the ED-160s. Considering how most PV systems are designed, the C/40 rate on this curve represents PV type service for the nicad cells. Yes, we will still need a regulator to control the system's voltage. The reason we need this regulator is, however, different. In the lead-acid system we need regulation to prevent overcharging the battery. In the nicad system we need regulation to keep from feeding too much voltage to the inverter and other low voltage appliances. The nicad cells are remarkably immune to damage form overcharging, in fact they actually like it!

However, most of the low voltage gear we use in our system is designed around the lead-acid reaction. Until inverter, appliance and control manufacturers get hip to nicads, we must still use voltage regulation to accommodate their devices. I predict that the first company that markets a 12 Volt inverter that will function at around 17 VDC will sell many inverters to nicad users. The PV panels (36+ series PV cells) we now use are effective at about 16 to 17 VDC and will recharge these nicad cells.

Other Notes on Nicads vs. Lead-Acid Types

As you may have guessed, I'm jazzed by the performance of these nicad cells. When I replace our ancient (over 9 yrs. old) lead-acid pack, it will be with nicads. The performance of the nicad makes it possible for us to use less storage in Ampere-hours and still get greater performance out of the battery. But this is not the entire story…

As lead-acid cells age, their rate of self discharge increases. Self-discharge is energy lost within the battery and is NOT available for our use. A new, deep-cycle (high antimony) lead-acid system starts out self-discharging at about 6% of its capacity per week. As this lead-acid battery ages, this rate increases increase to up to 25% of the battery's capacity per WEEK. The nicad cells start out at about 5% of their capacity per week in self-discharge and stay there forever!

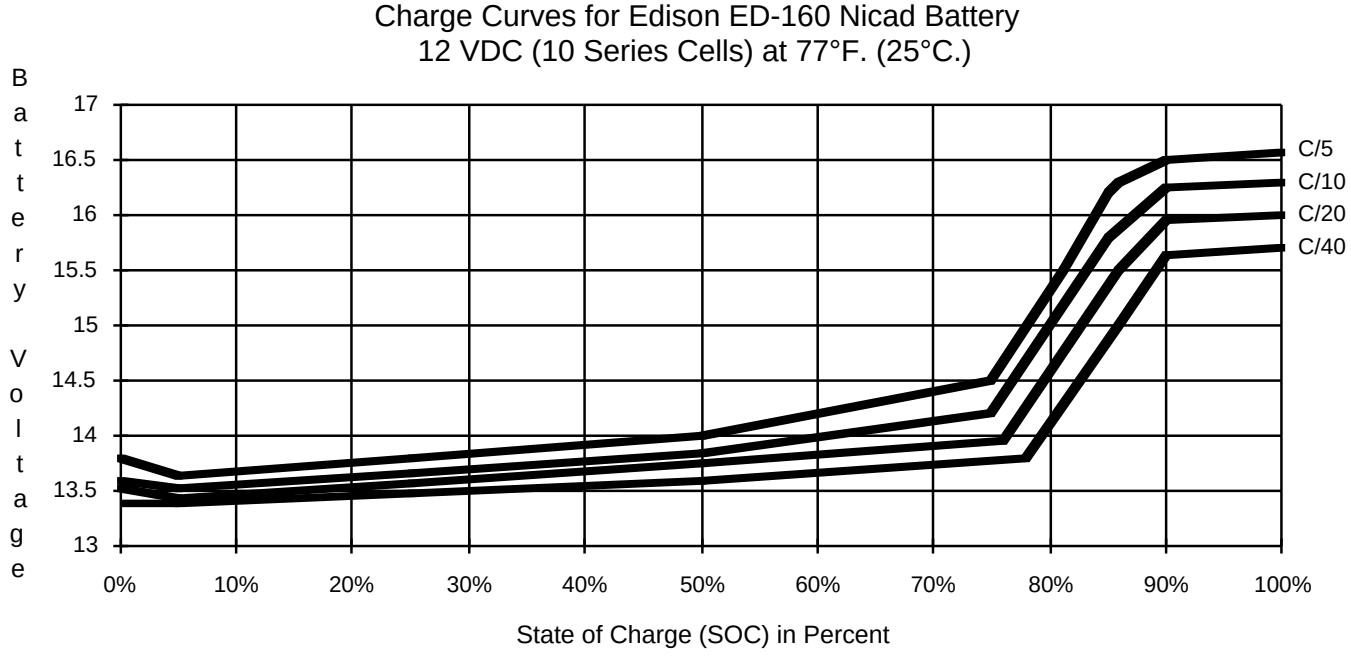
The nicads perform at lower temperatures much better than the lead-acid types. The nicads not only retain most of their effective capacity at low temperatures (≈30°F.)., and are even immune to freezing (which happens at well below zero). While they won't work while frozen, they won't be damaged.

Nicads allow our battery packs to grow! With lead-acid systems, we had to add batteries to our pack within two years of purchasing it new. Lead-acid cells aged far too rapidly for us to mix new batteries with old ones. Nicads, however, don't age appreciably. Their cycle characteristics and internal impediance remaims constant. This means that we can increase our storage capacity whenever we need to and still use our existing nicad batteries. This is an answer to a very non-trivial problem in lead-acid systems. Almost all of us have wanted to expand our storage capacity.

This bring us to a final question. How long do these nicad cells last? How many times can we cycle them? Well, the limiting factor of the nicad's longevity is how we treat them. We determine how long our battery lasts by how we use it. If the nicads are properly sized, recharged and maintained (you still have to add distilled water occasionally), then their life in PV systems is a very long time. The best guesstimate i can make is somewhere between 20 and 50 years.

Nicad Costs

The price of a set of ten reconditioned ED-160 cells is $500., FOB Portland, Oregon. This makes them about about twice as expensive as new lead-acid cells of the same Ampere-hour capacity and voltage. Considering that you can undersize the capacity of a battery by about 20% to 40% due to the increased performance of the nicads, this is a good deal. If you add the increased longevity, expandability, ability to hold the charge, resistance to overcharging, and cold weather performance, then this is an even better deal.



So what's really going on here?

A revolution, that's what. Not a human revolution, but a technical one. We are replacing the very heart of our system--the batteries.

For years ALL the gear we have used, everything from lightbulbs to inverters, has been based on 6 lead-acid cells in series (12 VDC). Now things are changing from 6 lead-acid cells in series to 10 nicad cells in series. It's going to take a while for the industry to catch up…

Access

I'm willing to chew the rag about our nicad experiences. Give me a call at 916-475-3179 and we'll go at it! You can contact Lon Gillas, the fine fellow who recycles these nicads for our use at: Pacific West Supply Co., 5285 S.W. Meadows Rd., Suite 120, Lake Oswego, OR 97035 or call 503-835-1313.

366 Watt Kyocera PV array on homemade single axis tracker and homemade adjustable panel mounts.
Photo by Bob McCormick

A Low Cost Single Axis Manually Operated PV Tracker

Bob McCormick

A PV array with tracking ability will yearly produce about 25% more power than one mounted in a fixed position. A tracker can reduce the number of PV modules required for adequate power production. It should be as maintenance free as possible. A PV tracker should be affordable. Trackers must not operate by any means that may be harmful to humans, animals, or the environment.

Why Tracking is Beneficial

We purchased our first PV modules in November, 1985. They are 8 @ 45.7 Watt Kyocera modules, producing 2.74 amps at optimum insolation levels. They power a 12 volt DC hybrid system with a Trace 2 kW. inverter.

Living in northern British Columbia Canada above the 56° North latitude, means we have a small number of sunlight hours in mid-winter, only about 5 hours per day in December. We live in a valley with hills on the East and West sides. These shorten our sunlight hours by 1 1/2 hours per day during the winter.

We knew that in order to get every Watt our PV array could produce, it must have tracking ability. We also knew that winter tracking adds 10% to 15% (much more in the summer) to the overall power production of the array. This may not sound like much, but it adds about 10 ampere-hours more per sunny winter day. This represents enough power to light a 30 Watt fluorescent fixture for 5 hours. It would run our DC water pump for almost 2 hours.

No Passive Tracker

Our home is located at mile 132 on the Alaska Highway in the Pink Mountain area. Winter temperatures often reach -40°F. and lower. Passive tracking devises using solar heat will not operate in these temperatures, no matter how bright the sunlight. This would mean we must use a powered tracker of some kind. I must be motor driven or manually operated.

We wrote to various manufacturers requesting literature and prices for motor driven trackers. We received two answers (a majority never answered at all) and the prices quoted were completely beyond our finances. We would have had to sell the ranch to pay for one.

Necessity is the mother of invention. We put our thinking caps on, and went to work. We'd build our own manually operated tracker.

Scrap Pile Holds The Goods

Almost every farm and ranch in North America has a scrap iron pile. Ours yielded 2 pieces of pipe that looked promising for our needs. We chose one piece of 2 7/8 inch outside diameter pipe which was 7 feet long, and we left it this length. The other piece was 3 1/2 inch OD from which we cut a 16 inch piece. It had an inside diameter of 3 1/8 inch and would slide freely over the 2 7/8 inch pipe. Both pieces had a 3/16 inch wall.

We found a mild steel 3/8 inch plate that measured 40 x 30 inches. It was somewhat bent, but we managed to straighten it sufficiently to meet our needs.

Having an acetylene torch and a portable welder are almost essential where we live. This is 100 miles from the nearest town and 50 miles from the nearest power lines.

We cut one piece 14 x 40 inches from the steel plate, and another smaller piece 14 x14 inches square. We cut the corners off of the 14 x 14 piece at a 45° angle, for which purpose will be explained later. These two pieces would serve as base plates for the array to turn on.

We then cut a hole in the center of the 14 x 14 plate that would allow it to slide over the 2 7/8 inch pipe. We placed the plate 15 inches from one end of the pipe and squared it to the face of the pipe. It was then welded to the pipe on the side of the plate toward the long end.

Next, a hole was cut in the center of the 14 x 40 inch plate that would allow the 3 1/2 inch pipe to slide through. We welded the plate flush with one end of the pipe, squaring it as before, and making the weld on the long pipe side of the plate. The welds were made in this way, so they would be on counter-opposed sides. The two plates would meet exactly together with no gap between, when the 3 1/2 pipe was slid down over the 2 7/8 pipe.

In the center of the 16 inch pipe (length wise) we made a hole slightly larger than the thread diameter of a 3/4 inch bolt nut. A 3/4 inch nut was centered over this hole and welded to the pipe.

We then took a 3/4 x 14 inch bolt, heated it in the center (7 inches from either end) and bent it to an approximate 80° angle. We coated the threads with bearing grease and screwed it into the nut we had welded to the 3 1/2 inch pipe. This bolt would serve as a simple but secure locking pin. By only a slight tightening of the bolt against the inner pipe, it prevents the array from turning in even the strongest wind. Loosening the bolt just a partial turn, would allow the array to be turned with ease.

Cutting the corners from the 14 x 14 inch plate was necessary to allow the bolt a full 360° turn capability. When the plates were in various positions in relation to each other when the array was being turned, the bolt would not make a full circle unless the corners were removed.

The Only Materials Purchased

At this point all we needed to complete the tracker were two pieces

of 4 inch channel iron. Each would be 82 inches long and be bolted across the ends of the 14 x 40 plate. This length was necessary to allow the panel mounting structures for the two sections of the Kyocera array to sit on. Each section sitting tightly against the sides of the 3 1/2 inch pipe. The channel iron pieces were centered, one on each end of the plate and two holes were drilled in each pipe, and the plate. These were 3/8 inch and (2) 3/8 x 2 1/2 inch bolts were used to secure the channel iron to the plate. The two pieces of channel iron were the only materials we had to buy.

For a different make of module, the length of these two pieces of channel iron are all that need be different. To mount a single panel width structure, simply straddle the pipe and make the channel iron pieces slightly longer than the width of the base of the panel mounts.

Ready To Anchor

Add some paint and the tracker is ready to anchor in Mother Earth. Choose a location that has a good solar window and is as close to your controller or batteries as possible. Make a hole in the ground approximately 3 x 3 feet and 3 feet deep. Place the long pipe with the 14 x 14 plate up, into the hole. Use the plate to set a level on and cement the pipe in place, making sure the plate is level. After the cement is properly set, coat the top of the plate and the outside of the pipe above it liberally with grease. Slide the swiveling section, which contains the long plate and channel iron cross pieces, down onto the base. You are now ready to mount the array. We secured the array mounting structures to the channel iron with four 3/8 x 1 inch coated bolts. Two in each base piece of the mounts and in the back pieces of channel iron.

Routing The Power Cable

After the array has been mounted on the tracker, the power cable from the array is run over the front edge of the 14 x 40 inch plate. Leaving 3 to 4 inches of slack in the cable, bring it under the two plates and over to the pipe beneath. Tape or secure the cable to the pipe and then down to the ground. Bury or otherwise protect it. The 3 or 4 inches of slack in the cable, allows the array a tracking arc in excess of 250°.

The cable we used for this section, from the array to the pipe or ground, is No.6 or 8 soft stranded copper, with a butyl rubber coating. This allows flexibility at the most extreme temperatures and hundreds of repeated flexings. After four years this cable has shown no signs of cracking or deterioration.

No Maintenance and Costs To Build

The first of these trackers we built in the winter of 1985 still has the same array on it. The original grease (none has been added) is still there and the array moves as freely and easily as the day it went into service. This tracker does not require Freon to operate, or anything else that may be harmful to the environment. All it requires is a small amount of elbow grease a few times a day. Turning the array to face the sun directly only 2 or 3 times per day, adds considerably to power production. We also adjust the array angle to solar normal periodically throughout the year with the adjustable panel mounts. Our adjustable panel mounting structures are similar to those outlined in HP#2.

We have made a number of these simple trackers for some of our customers over the last four years. We have made them to hold from 2 panels up to 12 and the simplicity of design and ease of use have made them quite acceptable.

If you do not weld or have access to a welder and acetylene torch, you should be able to have this tracker made at your local blacksmith or machine shop. At present prices for materials and labor it should cost less than $200.00 in Canada and about 20% less than this in the United States.

Access

For a detailed plan of this construction, send an SASE to:
Bob McCormick, C/O Northern Alternate Power Systems
PO Box 14
Pink Mountain, BC Canada V0C 2B0

Things that Work!

The PV Powered Econosub Pump by Solarjack

Jonathan Hill

Deep-well water pumping has always been the Achilles heel of the photovoltaic industry. Until now, we advised folks to use a generator and a standard a.c. submersible pump. But with the ECONOSUB SDS series pumps, all that has changed.

The ECONOSUB is a positive displacement, diaphragm-type, submersible pump. It operates on one or two standard size PV panels or a 12 or 24 volt battery bank. With flow rates of up to 2 GPM and lifts up to 230 feet, the ECONOSUB revolutionizes solar pumping. Requiring no batteries or lubrication, if used with a pressure switch and a battery, it can be used as a home pressure system. Test results show 8,000 hours on the diaphragm with no noticeable wear.

The pump is constructed of marine quality bronze and stainless steel. Although it will operate directly from a 12 volt photovoltaic array of as little as 35 watts, the ECONOSUB reaches its maximum output with 2 ARCO Solar M75, 47 watt PV modules (or the equivalent) connected in series. When used in an array-direct configuration, a linear current booster is suggested. I prefer the Sun Selector LCB 3-4-8/T, as it can be adjusted to various PV modules. It also performs well when connected to a 12 or 24 volt battery bank. No LCB is required in when a battery is used. For maximum output, a 24 volt system (or two series PV modules) is recommended.

Here's the kind of performance that you can expect from this unit: With one 47 watt module at open discharge, it delivers 60 gallons per hour. At 225 foot head, the pump delivers 19 GPH. With two 47 watt modules at open discharge, you can get 120 GPH, and at 225 feet, 33 GPH. With a 24 volt battery bank, it will deliver 55 GPH at 225 feet. At 100 feet, it produces 81 GPH on either 2 module array-direct or 24 volt battery operation. Our preliminary testing has shown these figures to be just about right.

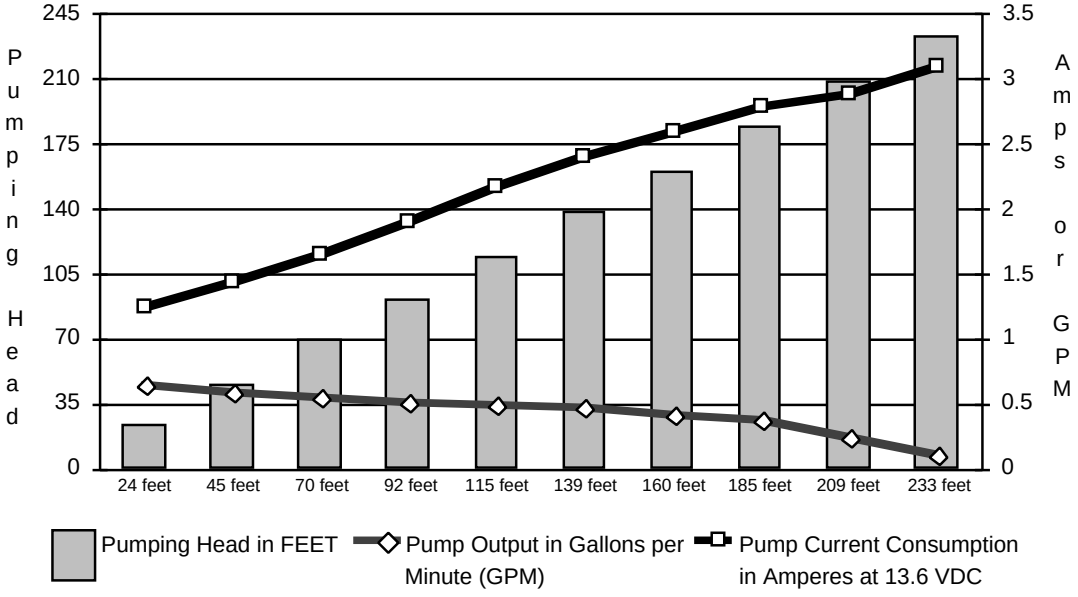
12 VDC

FEET	GPM	AMPS
24	0.65	1.25
45	0.60	1.45
70	0.55	1.65
92	0.52	1.90
115	0.50	2.18
139	0.47	2.40
160	0.42	2.60
185	0.39	2.80
209	0.25	2.90
233	0.12	3.10

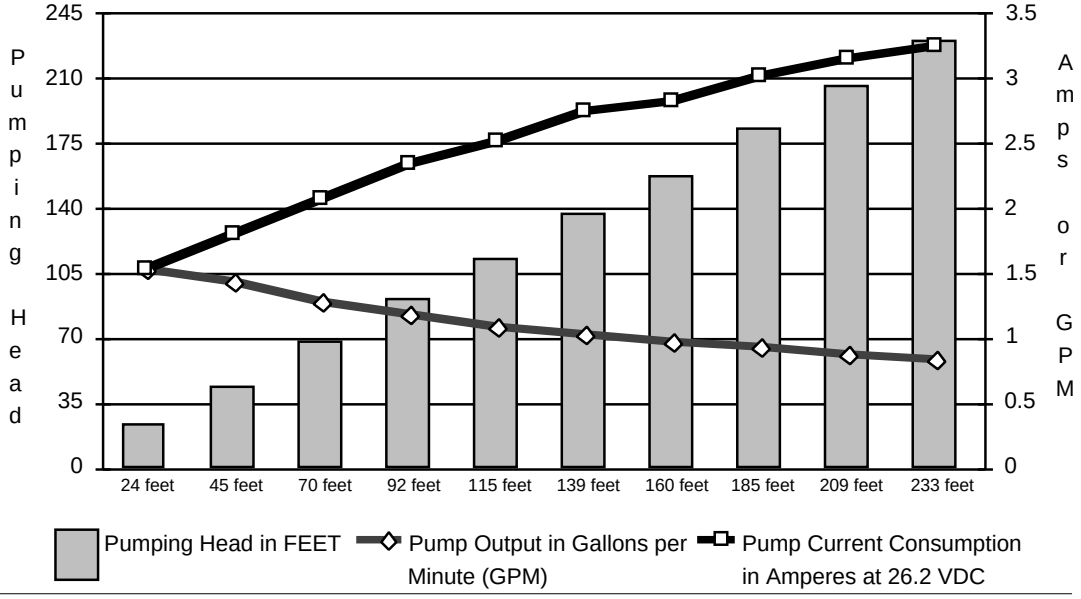
24 VDC

FEET	GPM	AMPS
24	1.55	1.55
45	1.45	1.83
70	1.30	2.11
92	1.20	2.38
115	1.11	2.55
139	1.05	2.78
160	1.00	2.87
185	0.95	3.05
209	0.90	3.19
233	0.85	3.30

SolarJack SDS EconoSub Pump Performance 12VDC



SolarJack SDS EconoSub Pump Performance 24VDC



Another unique feature of this pump is its small size and weight. It is the only pump I've seen that will fit down a four-inch diameter well casing. At a weight of only 14 pounds, installation is quick and easy, even for the first-time user.

In addition to providing water for the PV-powered household, the ECONOSUB works well as a backup for a standard submersible pump used with utility power or a generator. Because of its modest size, it can be installed above the AC pump, with room to spare alongside for the pipe and wire from the lower pump. All that is required here is a small battery bank and a small automatic charger, which keeps the batteries at a constant state of full charge, should the power ever fail. Needless to say, this allows future conversion to PV-power with a minimum of hassle.

In closing, I feel that the ECONOSUB is just about the best (and most affordable) pump of its type currently on the market. At under $800 (less than $1,500 including two 47 watt modules and an LCB), it's a value that's hard to beat. I only wish that they made a larger unit for those of us with lawns!

Access

For the last nine years, Jonathan Hill has been the proprietor of Integral Energy Systems, a full-line dealer in Nevada City, CA. You can reach him at (916) 265-8441.

Energy Fair Update

Richard Perez

The response to the idea of an Energy Fair has been intense. What follows is a summary of the info you've sent in so far and many new ideas. This is what we intend, that the Fair be organized by all interested in participating. For those of you who missed the original Energy Fair proposal, please see HP12, page 27. If you are interested in being actively involved in planning and making this Fair real, then **now** is the time to get in touch with the people and groups listed below. If this is going to happen, then it will be by the work of many. A complete list of activists, with access data, follows this article. Incidentally, I caught so much asparagus over the "People" in the Fair's name, that I cut it out. Guess I'm still stuck in the 60s. I don't care what it's called as long as it happens!

Organization?

Yes. The overwhelming majority say we need some sort of an organization. Non-profit was most popular. Several already existing organizations are willing to take the Fair under their wings.

What goes on?

Seems like just about everything, but heavy on the following: displays & workshops on all phases of renewable energies, solar car rally, music, visiting, solar cooking, camping out, business stalls.

Where

Well, other than everyone wants it close to their home, we can see no major agreement on location. The majority of the folks responding to the survey so far live in California and California was the most chosen location. Sites have been offered in Montana, Tennessee, Kansas, Washington State, Oregon, Arizona, New Mexico and 5 sites in California.

Since everyone wants to travel less than a day to get to the fair, how about a network of simultaneous fairs linked via teleconferencing?

We can link any number of fairs via communications media: ham radio, telephones, computers and, who knows, maybe some satellite transponder time. Teleconferencing works like this: if someone was giving a workshop at one location, folks at another location could not only see and hear what was going on, but they could also ask questions. A two-way video/audio/computer link in real time. Like being in two or more places at once.

Two groups have already made well developed plans for Energy Fairs: 1) the town of Willits, CA and 2) The Farm at Summertown, TN.

The Town of Willits, California

The idea of an Energy Fair has so taken the folks who live in the town of Willits, CA, that City Hall, the Chamber of Commerce, local renewable energy businesses, and many residents are behind the project.

I quote directly from a letter by Phil Jergenson, Fair Sparkplug in Willits:

"Willits, California, Mendocino County, is showing interest in hosting an Alternative Energy Exposition as called for in HP Magazine. Willits has been a solar energy hot spot for years, and we feel that this type of an outdoor event is long overdue.

Our theme will be energy past, present and future. We feel that in order to understand the energy problem we should start with a historical perspective. Our present consumption of energy resources needs to be addressed, and most important, we need to show the world that there are thousands of people who are largely self-sufficient because of these new appropriate technologies.

As we see it now, the event would include outdoor booth spaces for exhibitors, a solar cook off, solar bands and a solar car rally and show.

An excellent site for the event is available next to the county museum on 14 flat acres. The museum is host to the permanent collection of working steam engines assembled by a local group called "Roots of Motive Power" which by itself is an impressive display.

Initial contacts with city hall have been more than positive as well as with the numerous energy companies in the area."

Through our phone conversations with Phil Jergenson and Lynn Kennelly (of the Willits Chamber of Commerce), we have the following info about the Willits site. Camping and RV parking are available near the site, motels and other lodging are also available nearby. The group will allow set up of demonstration systems using all forms of renewable energy and encourages business and educational participation. The town has indoor facilities for educational and telemedia events. The group is planning a solar car rally, featuring operating solar electric vehicles with maybe even a race. Willits is located just about the middle of the West Coast and is easily accessible via all forms of transportation.

Contacts in Willits: The Chamber of Commerce, 15 South Main St., Willits, CA 95490 • 707-459-4113.

The Farm, Summertown, Tennessee.

The Farm is a very successful cooperative community that not only runs their own cottage industries (food, publishing, dye works) but also uses renewable energies to power them. We talked to Mary Ellen Bowen, the Farm's high school director, and the community is very excited about hosting the eastern portion of the Fair.

I quote an excerpt from Albert Bates's letter concerning this:

"The Farm is an intentional community of some 250 people living on 1750 acres in Summertown TN. We have hosted 1000+ visitor conferences…"

The Farm is equipped to handle a Fair physically with extensive outdoor and indoor facilities. The Farm already has renewable energy in daily use. The Farm also operates its own food services, store, telephone system, and emergency medical clinic. They have the communications and computer facilities to teleconference. Camping is available on site and motels are located 15 to 30 minutes away. Summertown is readily accessible via road and about 90 minutes from the Nashville, TN airport. Maybe the thing that impressed me most about the Farm as a site was the enthusiasm of the Farmers. They are intelligent, dedicated folks that are sure to make this event a success.

Contacts: Albert Bates or Mary Ellen Bowen, POB 90, Summertown, TN 38483 • 615-964-3992.

Multiple Simultaneous Fairs?

The idea of driving coast-to-coast to attend a Fair about renewable energies and our environment is fairly absurd. We've been talking for some time about self-sufficiency and on-site energies. Let's apply what we've already learned. The essence here is **communication**. Maybe we can all get together from our individual locales. We've already got both the East and West Coasts represented by The Farm and Willits. Now if we had another equally delirious group somewhere in the middle of America…

When?

The most popular times suggested were between mid-June to the end of August 1990. If we are going to do several Energy Fairs at the same time, then we need to pick a firm date within the next 60 days.

How Long?

Average answer was 5 days, but about 1/3 of the respondents left this box blank. My personal feelings are that with all the activities and seminars proposed, a week would hardly be enough.

The Head Cheese

There have been two volunteers for the tough job of Head Cheese. Bernie Rosen, Ashcreek Rd., Anderson, CA 96007 • 916-365-6780 or 916-378-0101. And John D'Angelo, 0170 Hwy 133, C-2, Carbondale, CO 81623 • 303-963-9632. Call/write these fellows before they call/write you! Get to know them if you're interested in working on the planning phases of the Fair.

We need to elect (or otherwise choose) a, as Steve Baer put it, "benevolent dictator" to ride herd on the entire show. We need to do this within the next 60 days.

Other Remarkable Stuff

Clan Dyken, a solar-powered music band, has volunteered to act as music directors and have offered their PV-powered bus/stage for the fair's use. Contact Gary Dyken, POB 1614, San Andreas, CA 95249 • 209-754-1350 about things musical and entertaining.

Johnny Weiss, Steve McCarney and Ken Olson from ATA, 410 Garfield Ave., Carbondale, CO 81623 • 303-963-2682 will be running a PV seminar (see page 14, this issue) for a week preceding the fair and a week during the fair at Willits. The graduates of the program will spearhead the installation and operation of this fair's power systems.

We need to do the following within the next 60 days:

- •Get a Head Cheese(s).
- •Decide on Fair dates.
- •Define Fair locations.

Communications & Access

The information is flowing far too fast for a set reply form to be of much worth. We don't know enough about this process to formulate the proper questions much less tabulate meaningful answers.

We will continue to act as information clearing house for all Energy Fair data and people. If you have ideas, let us know. If you are interested in organizing, working, and/or just attending, then please send in your name and access data. This will assure that at least we are organized enough to get information to you when you need it.

List of Fair Activists.

This list was regurgitated by the Energy Fair Database. All entries are current and made within the last 60 days. The entries are organized as follows: NAME, STREET, CITY, STATE, ZIP • TELEPHONE(S) • INTEREST. The INTEREST category is organized by: CATEGORY followed by either Org or Part. Org means an interest in organizing that category, while Part indicates interest in participation in that category.

Chip Mauck Sunweaver Energy Enterprises, 30 Perry Rd, Deerfield, NH, 03037, • 603/463-7857 • CommPart • FirstAidPart • PowerPart • WaterPart •

Keith M Lessor, POB 14 annex, Concord, NH, 03301, • none • FoodPart • SecurityPart •

Jane Dwinell, RD1 Box 37, Irasburg, VT, 05845, • 802/754-8780 • BizOrg•BizPart• FirstAidOrg • FirstAidPart • FoodOrg • FoodPart • FinancialOrg • FinancialPart •

Will Timmons, 90 Colton Ave, Suyville, NY, 11782, • 516/589-7138 • FirstAidPart • CleanUpPart • TranspoPart • PowerPart • SitingPart • WaterPart •

Michael Benedetto, Rt17 E Hillsboro, Camden, NY, 13316, • none • CommPart • WasteReCyclePart • PowerOrg • WaterPart •

Chris Nenrath, RT1 Box 123 A, Richville, NY, 13681, • 315/347-2427 • WasteReCyclePart •

Robert N Jones Frontier Central Schools, S 4432 Bay Vire Rd, Hamburg, NY, 14075, • 716/649-6001 ext 315 • BizPart• CommPart • SecurityPart • TranspoPart • PublicityPart •

Howard Weinblatt Howlin Marsh Co, 2684 Kenyonville Rd, Albion, NY, 14411, • 716/589-5371 • BizPart• PublicityPart •

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Brian Gilfeather, POB 656, Horsham, PA, 19044, • 215/443-6356 • FirstAidOrg • FirstAidPart •

Eric Reisfeld, 9905 Lorain Ave, Silver Springs, MD, 20901, • 301/593-0958 • BizPart• PublicityOrg •

Albert Nunez SKS Inc, 8 Sherman Ave, Takoma Park, MD, 20912, • 301/270-8959 work 301/270-0313 home • PublicityOrg • SitingOrg •

Rob Conrad, RT 6, Box 204, Abingdon, VA, 24210, • •

George Peroni Hydrocap Corp, 975 NW 9th St, Miami, FL, 33150, • 305/696-2504 • BizPart• FirstAidPart •

The Farm / Albert Bates, 156 Drake Ln/POB 90, Summertown, TN, 38483, • 615/964-3992 • CommPart • FirstAidPart • FoodPart • CleanUpPart • SecurityPart • TranspoPart • SanitationPart • WasteReCyclePart • PowerPart • SitingOrg •

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Terry Kok Earth-Base Projex Incorp, POB 1328, Bloomington, IN, 47402, • 812/336-5334 •

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Johnny Weiss / ATA, 410 Garfield Ave., Carbondale, CO, 81623, • 303-963-2682 • PowerOrg • PowerPart •

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Mr Patrick Strange, 11208 Towner NE #3, Albuquerque, NM, 87112, • 505/291-8358 • CommPart • CleanUpPart • SecurityPart • WasteReCyclePart • SitingPart • WaterPart •

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Ms Lindy, 17240 Encino Dr, Lake Elsimore, CA, 92330, • 714/678-2717 •

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Michael Bach, 1609 Molitor RD, Belmont, CA, 94002, • 415/592-2710 (H) 415/592-1221 EX2653 (W) • CommPart • FirstAidPart • FinancialPart •

Delbert Drew Duncan, 678 Swanton Rd, Davenport, CA, 95017, • 408/423-0621 • BizOrg• SecurityOrg •

Bill & Katcha Sanderson, 20295 Panoche Rd, Paicines, CA, 95043, • 408/628-3362 • FoodPart • SitingPart •

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Dona & Morris Ridgeway, 100 Santa's Village Rd, Scotts Valley, CA, 95066, • 408/438-1600 mess • FinancialPart • PublicityPart •

Joe Biondo, 19355 El Cerro Way, Watsonville, CA, 95076, • 408/726-1830 • PublicityPart •

Gary Dyken, Clan Dyken Forward Productions, POB 1614, San Andreas, CA, 95249, • 209-754-1350 •

Phil Jergensen, 271 Franklin, Willits, CA, 95429, • 707-459-5513 • SitingOrg •

Larry, Box 296, Ukiah, CA, 95482, • 707/463-0326 •

J Filarski, POB 440, Willits, CA, 95490, • 707/459-4241 • CleanUpPart • SecurityPart • WasteReCyclePart • PowerPart • SitingPart •

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Bruce Rawles, Box 1284, Rough & Ready, CA, 95975, • 916/478-3260 work 916/432 1403 home (preferred) • CommPart • FundRaisingPart • PublicityPart • SitingPart •

Bernie Rosen, Ashcreek Rd, Anderson, CA, 96007, • 916/365-6780 916/378-0101 • BizPart• FoodOrg • FoodPart • FundRaisingPart • CleanUpOrg • SitingOrg •

Benny Austin, POB 100, Greenview, CA, 96037, • 916/468-2434 or 916/468-2409 • CleanUpPart • TranspoPart •

Richard & Karen Perez, POB 130, Hornbrook, CA, 96044, • 916-475-3179 • BizPart• CommPart • FundRaisingPart • CleanUpPart • PublicityOrg • PowerPart • SitingOrg •

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Michael W Davis, POB 174, South Beach, OR, 97366, • 503/867-3011 day 503/563-3371 nite •

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James Betteridge c/o Betteridge Engineering, Mattis Rd, Fort Rock, OR, 97735, • 503/576-2249 •

Bert Mehling, 8832 Rathbun Rd SE, Yelm, WA, 98597, • 206/458-5943 • BizPart• CleanUpPart • WasteReCyclePart • SitingPart •

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New News From SERI's Science & Technology In Review

Imagine a technology that can directly convert atmospheric carbon dioxide to commercially valuable fuel and chemicals. A process that turns municipal solid waste into ethanol, a clean burning liquid fuel. How about high efficiency PV's or insulation with an R-value of 150? These are all things that the Solar Energy Research Institute are working on right now.

Good News For PVs

"Photovoltaics are sometimes seen as a futuristic approach," says Jack Stone, director of SERI's Solar Electric Research Division. "Nothing could be further from the facts."

In 1988, US manufactures sold enough PVs to provide more than 11 megawatts of electricity, at annualized energy costs of about 25¢/kWh.

A SERI-patented cascade PV cell has achieved 25% efficiency, the highest ever recorded. In cost-shared research, ARCO Solar recently attained a record 11.1% efficiency with a one square foot, copper indium diselenide (CIS) cell. ARCO also developed a low-cost, large manufacturing process for CIS products. With continued successes such as these, the cost of PV-generated energy may reach 12¢/kWh by the mid-1990's and 6¢/kWh by the year 2000.

Wind Energy

Wind Energy Technology is advancing rapidly. In less than 10 years, the total US installed capacity has grown from virtually zero to about 1500 Mega Watts. That's the equivalent of a typical nuclear power plant or two coal fired plants. The electricity produced by these systems, located primarily in California and Hawaii, totals almost 6 billion kWh, displacing about 11 billion barrels of oil and avoiding more than 1 million tons of carbon emissions.

Wind turbines do have reliability problems though. SERI researchers in conjunction with companies such as SeaWest Energy Group are working on specially shaped, strong, lightweight blades that would work at moderate winds.

In The Works

SERI researchers are working on a patented vacuum window with an R-value of 12, about three times the insulating value of conventional double pane windows. Another SERI invention uses a window that uses electrochromic coatings to automatically control the heat and light entering through windows by changing opacity.

Chlorofluorocarbons (CFCs) are a potent atmospheric pollutant with the ability to aggravate global warming as well as deplete the Earth's protective ozone layer. This threat has sparked an international effort to ban CFCs, which are used as the working fluids in air conditioners and refrigerators, as a propellant in aerosols and as foam-blown agents in producing plastic foam and insulation.

SERI researchers have invented a unique vacuum insulation, devoid of CFCs, that may revolutionize the appliance industry. The concept uses a sealed vacuum between two metal panels to create an R-value of 150 per inch of thickness - as much as 20 times the insulating value of conventional foams now used in refrigerators and freezers, it could reduce appliance energy use and also reduce CFC emissions in the US by 50% or more. SERI is also developing chemical methods of destroying CFCs.

Well, I've just run out of room to say more about the incredible things under way at SERI. More next time! How about solar thermal to destroy certain hazardous wastes.

Karen Perez

Wire Sizing and Voltage Drop in Low Voltage Power Systems

Part 1

John Davey and Windy Dankoff

Properly sized wire can make the difference between inadequate and full charging of your energy system, between dim and bright lights, and between feeble and full blast performance of your tools and appliances. Even wiring that is slightly undersized can cheat you out of a major portion of your system's energy.

Designers of low voltage systems are often confused by the implications of voltage drop and wire size. In conventional home electrical systems (120/240 volts ac), wire is sized according to its safe amperage carrying capacity know as "ampacity". The overriding concern here is fire safety. However in low voltage (12/24/48 volts DC) systems, sizing for larger wire is usually necessary to minimize power loss due to voltage drop before increased wire size is required for amperage safety.

Typically, low voltage systems are seen in Alternative Energy (AE) home systems and Recreational Vehicle (RV) systems. The heart of these systems is DC power, because DC electrical power can be stored in batteries. With photovoltaic systems, the electrical power produced is also DC. DC systems are primarily low voltage because most of the DC lights and appliances have traditionally been built for the vehicular market, which is typically 12 or 24 volts. There is also increased fire danger with high voltage DC because of the high potential for arcing in switches and in poor electrical connections. DC at high voltage also has high shock hazard (more than at equivalent ac voltages).

Voltage Drop

Voltage Drop is caused by a conductor's electrical resistance (Ohms) and may be calculated according to Ohm's Law--

(1) Voltage Drop (Volts) = Electrical Resistance (Ohms) X Current (Amps)

Power Loss is calculated by--

(2) Power Loss (Watts) = Voltage Drop (Volts) X Current(Amps)

By substituting the Voltage Drop Equivalence from equation (1) into equation (2), we find--

Power Loss (Watts) = Ohms X $Amps^2$

If we have a 12V system with a 100 ft. wire run of 12 gauge wire (0.33 Ohms) and a 72 watt load, there will be a 6 amp current (Amps = Watts/Volts) and a power loss of 12 watts (0.33 Ohms X 6 $Amps^2$). If we converted this system to 24V, we would have a current of 3 amps and a power loss of 3 watts. The implication here is that by DOUBLING the system voltage, power loss is reduced by a FACTOR OF FOUR. Or for no increase in power loss, we can use ONE FOURTH the wire size by doubling the voltage. This is why the trend in AE full home systems with DC circuits is towards 24V instead 12V systems. It is also why it is important to reduce the current by using efficient loads and putting fewer loads on the same circuit. Likewise, reducing wire resistance by using large wire and shorter wire runs is important. All of these are particularly critical with AE systems, where cost per kilowatt of electrical power may be several times that of "Grid" supplied electrical power.

Wire Size Chart

Because of the significance of voltage drop in low voltage electrical systems, we have developed an easy-to-use wire sizing chart. Most such charts published assume a 2% or 5% voltage drop for 12 and 24 volt systems and result in pages of numbers. This new chart works for any voltage and accommodates your choice of percentage voltage drop. You'll find it the handiest chart available. The chart applies to typical DC circuits and to simple ac circuits (refer to footnote on Wire Size Chart).

We recommend sizing for a 2-3% voltage drop where efficiency is important. We shall discuss this as it applies to specific loads in greater detail in Part II of the article.

ac/DC Wire Size Chart

❶ Calculate Voltage Drop Index (VDI)

$$VDI = \frac{AMPS \times VOLTS}{\%\ VOLT\ DROP \times VOLTAGE}$$

where:
AMPS= Watts/Volts
FEET=One-way Wire distance
% VOLTAGE DROP= Percentage you are willing to accept (e.g. use 2 for 2%)
VOLTAGE=Line voltage

❷ Calculate Voltage Drop Index (VDI)

a. Compare the "calculated VDI" with the VDI values for the American Wire Gauge (AWG) sizes in the chart to determine the appropriate wire size.
b. Amperage must not exceed the indicated fire hazard AMPACITY for the wire gauge (set by the National Electric Code).

Wire Size	Copper Wire		Aluminum Wire	
AWG	VDI	Ampacity	VDI	Ampacity
OOOO	99	260	62	205
OOO	78	225	49	175
OO	62	195	39	150
O	49	170	31	135
2	31	130	20	100
4	20	95	12	75
6	12	75	•	•
8	8	55	•	•
10	5	30	•	•
12	3	20	•	•
14	2	15	•	•
16	1	•	•	•

Information applies to DC circuits and ac circuits where Power Factor =1.0 and line reactance is negligible.

For 2-wire circuits. For more complex circuits, refer to an electrical engineering handbook.

We recommend sizing for a 2% to 3% voltage drop where efficiency is important.

Sizing Example

We have a 12 volt system with a total one-way wire run of 40 ft. servicing three 13 watt fluorescent lights and one 20 watt quartz halogen light. Sizing for a 2% voltage drop, what wire size is needed for this circuit?

$$\text{AMPS} = \frac{\text{TOTAL WATTS ALL LOADS}}{\text{VOLTS}}$$

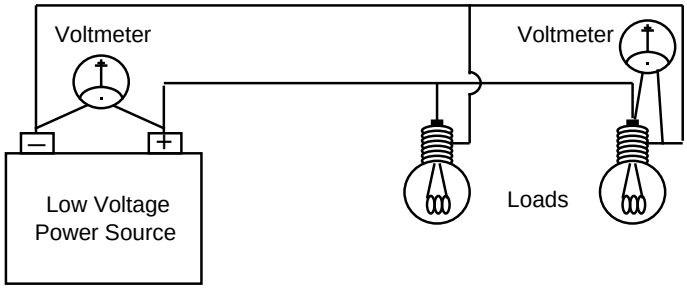
$$= \frac{3 \text{ X } 13 + 20}{12} = 4.9$$

$$\text{VDI} = \frac{4.9 \text{ X } 40}{2 \text{ X } 12} = 8.2$$

The "calculated VDI" 8.2 is between VDI values 8 and 12 on the Chart. This calls for #8 gauge wire (#12 gauge wire could be used in a 24V system). Since the "calculated VDI" is not much greater than 8, we may consider sizing-down and accepting a slightly greater voltage drop. This would be sensible because #8 gauge wire is expensive and difficult to work with. Or we might consider putting these loads on two circuits--compare wire and labor costs. If on the average only one of the fluorescents and the quartz halogen are on at the same time, we could size for this load, being sure not to exceed the wire ampacity for the total of all loads. In this case #12 gauge wire would be adequate. This is an example of some of the considerations and tradeoffs that will be discussed in Part II of the article.

Determining Voltage Drop In Existing Circuits

You may wish to know how efficient an already existing circuit is in terms of voltage drop. There is an easy way to measure this. With a "multi-tester" or voltmeter, measure the "source voltage" for the circuit and the "load Voltage" at the end of the line, then compare the difference. Do this while the circuit is powered and all the loads are on:



Now calculate the % voltage drop for the circuit by--

$$\%\ \text{VOLTAGE DROP} = \frac{\text{SOURCE VOLTAGE - LOAD VOLTAGE X 100}}{\text{SOURCE VOLTAGE}}$$

where:

$$\text{AMPS} = \frac{\text{TOTAL WATTS ALL LOADS}}{\text{VOLTS}}$$

FEET= One-way length of the circuit

VDI= VDI value from Wire Size Chart for the gauge of wire in the circuit

This method will total ALL voltage drops in the circuit caused by wire, connections, and switches. Because the amperage is diminished beyond each load in the circuit, the true % voltage drop will be somewhat less than is calculated in the above equation.

An easy way to calculate the wire voltage drop WITHOUT any measurements, if you have the information needed about the circuit, is to solve for % Voltage Drop using the VDI equation--

$$\%\ \text{VOLTAGE DROP} = \frac{\text{AMPS X FEET}}{\text{VDI X VOLTAGE}}$$

Look for Part II of the article in the next issue dealing with: PRACTICAL APPLICATIONS OF VOLTAGE DROP AND WIRE SIZE.

NERD'S CORNER

Wire Size Chart Derivation

Voltage drop is caused by the electrical resistance (Ohms) of a conductor. This in turn is determined by resistance of the conductor material and the cross sectional area and length of the conductor. The nominal resistance for copper wire is 10.7 Ohms (17.0 Ohms for aluminum wire) per foot of wire one circular mil in cross sectional area. Therefore the resistance of a copper wire run may be determined by--

$$R\ (\text{copper wire}) = \frac{10.7 \text{ X Length of the wire in Feet}}{\text{cross sectional area in circular mils}} \quad (a)$$

From Ohm's Law, the voltage drop in a conductor is E = I X R. Upon substituting equation (a) for R, the voltage drop in a circuit may be calculated by--

$$E = \frac{10.7 \text{ X Current in Amps X 2 X Oneway Wire Feet}}{\text{cross sectional area in circular mils}} \quad (b)$$

Percent voltage drop can be calculated by--

$$\%\ \text{Voltage Drop} = \frac{10.7 \text{ X Current X 2 X Wire Feet X 100}}{\text{cross sectional area in circular mils X voltage}} \quad (c)$$

By rearranging this equation we can calculate the appropriate wire size (circular mils) for a given % voltage drop and current--

$$\text{c-mils} = \frac{10.7 \text{ X Current X 2 X Wire Feet X 100}}{\%\ \text{Voltage Drop X Voltage}} \quad (d)$$

This equation may be reduced to--

$$\text{c-mils} = \frac{2140 \text{ X Current X Wire Feet}}{\%\ \text{Voltage Drop X Voltage}} \quad (e)$$

We use the American Wire Gauge (AWG) system which has 40 gauges ranging from the largest gauge 0000 (0.4600 in. diameter) to the smallest #36 (0.005 in. diameter). The ratio of any gauge diameter to the diameter of the next smallest gauge is--

$$\sqrt[39]{\frac{0.4600}{0.0050}} = 1.1229322$$

Using this relationship we can calculate the diameter (inches) of every gauge.

The cross sectional area of the gauges in circular mils is calculated by--

$$\text{c-mils} = (1000 \text{ X wire diameter in inches})^2$$

Now, recalling the equation--

$$\text{c-mils} = \frac{2140 \text{ X Current X Wire Feet}}{\%\ \text{Voltage Drop X Voltage}}$$

and rearranging it we obtain--

c-mils = Current X One way wire length in feet
2140 % Voltage Drop X Voltage

If we solve c-mils/2140 for each gauge we come up with a value, which we shall denote the Voltage Drop Index (VDI), for each gauge.

Now, to size wire for a particular circuit, we calculate VDI for this circuit using--

VDI = Current X One way wire length in feet
% Voltage Drop X Voltage

and compare this "calculated VDI" to the VDI's for the standard gauges in the Chart and come up with the appropriate wire gauge for the acceptable % voltage drop.

END OF DERIVATION

Access

Dr. John Davey is a biology/ecology professor and jack-of-all-trades at Flowlight Solar Power. He is a graduate of the Colorado Mountain College Solar/PV program.

Windy Dankoff is owner of Flowlight Solar Power. Flowlight supplies remote home PV systems and manufactures "Flowlight Solar Pumps". Windy began working with wind generators in 1975 and PV in 1979. He has contributed 12 articles to Home Power since issue #2.

Controlling Hydroelectric Systems

Bob-O Schultze KG6MM

I've been living on and with Microhydro for over ten years. I realize that I'm damn lucky to be among the fortunate few to have the natural resources to do it. I define Microhydro as the ability to generate 3 or more amps @12VDC or better per hour continuously **and** year-round. Less output than that falls into the "Nanohydro" category. Many homesites have Nanohydro capability and don't even realize it, but that's another article entirely.

The 3 amp cutoff isn't arbitrary. Less than that you're **usually** better off with a permanent magnet type of hydroplant which uses none of the generator output to energize its field; hence, what you produce you get. Above 3 amps output, you're starting to fight the limits of residual magnetism and are probably better off with an alternator or induction motor system. At this point, I can visualize dyed-in-the-wool hydromanics everywhere unsheathing their pens, ready to do battle. Whoa! There are some very notable and good exceptions to the rule, but geez, ya gotta start somewhere! In my opinion and experience, the alternator gets the overall nod for Microhydro for most systems. It's flexible in both voltage and amperage output to cover a vast amount of situations, cheap and readily available to replace and, as a rule, the user or a local tech can do the job.

Field or Load Control?

Most Microhydro users have the ability to generate more juice than they use. Ain't it great? Well yes, but whaddya do with the extra? It boils down to either you dump the excess energy somewhere or don't produce it in the first place.

Load Control

All load controllers that I've seen work the same way. They sense a preset battery voltage level and turn on a transistor or a relay to use the power elsewhere, usually to a resistive load used to heat either air or water. The problem is that it takes a heap o'amps at 12VDC to heat any significant amount of air or water. If you got'em, fine. If you ain't, why bother? Besides that, you have to size your shunt load to be capable of handling your hydroplant's maximum output. If you nozzle down for summer flow as most folks do, and use the same shunt, your controller has to work **overtime** switching on and off. And if, God forbid, the controller **or** the shunt fails for whatever reason, (they're machines, ain't they?) the full, unregulated, output of the hydroplant mainlines directly into your already full batteries. Boil, boil, bubble, and trouble!

Field Controller

For my money, this is where it's at for 3 good reasons. 1-By reducing the load on the alternator when the batteries are full, it runs cooler and lasts longer. Yes, I've heard the argument that the fluctuation in RPM as the alternator loads and unloads is more conductive to wear on bearings, etc. than one run at a constant load, but I ain't going for it. Picture that same alternator in your Chevy going down the road, stopping for a red light, zooming down the freeway, naw, I ain't buying it. Cooler=longer life period. 2-If you have a good field controller, such as Electron Connection's Mark VI, it will Pulse Width Modulate the last 10-15% of charge. Yum, Yum said the batteries. The PWM feature plus ease of adjusting the voltage preset for summer to winter temperature conditions, equalizing, etc., is the real beauty of the Mark VI. 3-If your field controller should fail, (Alas, the common feature of machines, of whatever description, is that sooner or later the buggers break) the alternator output just quits. No fun, but it won't ruin your batteries or 12 VDC appliances, either.

The Mark VI

Why not use an ordinary automotive voltage regulator? Good question! In 99% of hydro situations it won't work and here's why. Nearly all 12VDC alternators are designed to provide between 50 and 100 amps depending on type, brand, application, etc. The old style Delcotron used in most Microhydro set-ups will produce 50-55 amps at 5000 RPM. Getting an alternator to spin that fast under no load is one thing, maintaining that speed under a 50 amp load is another! In a vehicle, it's no great shakes. If it needs a couple or three extra horsepower to do it, it just grabs 'em off the engine and no one even notices unless you happen to be at idle when you can hear the engine RPM pull down a hair. In this case, the automotive type voltage regulator just throws a couple of amps at the field, the alternator grabs what RPM it can get from the engine and honks on. In a hydro situation, on the other hand, you have a very limited (usually) amount of torque and RPM provided by the velocity and volume of water hitting your water wheel. If you attempt to load it past that limited amount, RPM falls and output drops dramatically. Since the automotive regulator only knows to pour the coals to the field and let the engine pick up the slack, it blows it.

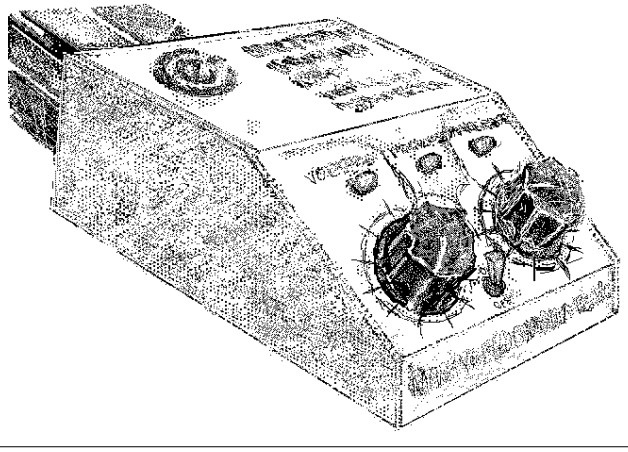
The Mark VI is a two-stage, all electronic, electronic device (no relays!). The first stage uses an adjustable, PWM to control the output amperage of the alternator. This allows you to adjust the load on the hydroplant's alternator to compensate for the limited torque/RPM situation. You can only get what the water is capable of giving you and no more. The second stage monitors system voltage and reduces the alternator's output should the voltage exceeds a preset, adjustable limit. Neat, huh?

I've been using the Mark VI on my old "Water Watts" hydrocharger for well over a year now and I love it. No more buying gallons of distilled battery water by the 6-pack, no worry, set it and forget it. I've installed two other Mark VIs on Harris Hydro systems to the complete satisfaction of the owners and just recently put together and installed a 24 volt model that's riding herd on a set-up that's producing 35 amps! Can you imagine 35 amps at 24VDC, 24hrs a day year'round? Tough break, huh?

Access

The Mark VI Field Controller is available thru Electron Connection, Ltd. POB 442, Medford, OR 97501 • 916-475-3179. Complete, tested Mk.VI is $155.ppd. Kits are available for the do-it-yourselfer from $15 to $105.ppd. 24 volt models slightly higher. See HP#2 for a complete description of the Mark VI including build your own instructions complete with schematic.

Bob-O Schultze is the owner/operator of the Lil Otto Hydro Works,



Things that Work!

Home Power tests the Heliotrope CC-20 PV Charge Controller

Richard Perez

A photovoltaic charge controller keeps the PV array from overcharging the battery. Sounds simple enough, but over the years many, many electronic solutions have been designed for controlling the PVs output. Some worked, and some didn't. Some lasted and some failed within hours of installation. This one works and lasts. The Heliotrope CC-20 is a series type PV controller that will handle arrays of up to 20 Amperes and in either 12 or 24 VDC systems. The CC-20 uses a very effective method of controlling the array while also maintaining the highest possible state of charge in the battery.

How the C-20 PV Controller Works

There are two basic types of PV controllers: series and shunt. They both perform the same function: voltage regulation of the system to prevent overcharging the batteries. A series controller essentially disconnects the PVs from the battery when they are full. A shunt regulator adds an electrical load to the system and the additional consumption of the shunt load keeps the system's voltage within limits.

The CC-20 is a series type regulator. It pulse width modulates (PWMs) a metallic oxide semiconductor (MOS) field effect transistor (FET) ON and OFF in response to the battery's voltage. If the battery isn't full, then the CC-20 passes all the PV array's power to the battery. When the battery gets full, the CC-20 rapidly turns the MOS FET on and off (many times per second) to maintain the battery at the fullest state of charge possible. Relay type controllers, however, totally disconnect the array from the battery. This is not only less effective in maintaining the battery, but also wastes already paid-for, pollution-free solar energy.

The PWM scheme that Heliotrope uses in their controllers pulses the array to maintain a constant system voltage. Net result is a fuller, better maintained battery and less wasted energy from the PV array. The use of a MOS FET instead of a relay enormously increases the reliability of the controller. Relays are very failure prone since they use moving parts and mechanical electrical contacts. Transistors on the other hand have no moving parts and all the connections are soldered.

Installing the CC-20

The unit arrived in good shape and was ruggedly packaged. The documentation was adequate to program and install the CC-20. We put this test CC-20 in series between a PV array of 4 Kyocera J48 modules (producing ≈12 Amperes at 12 VDC) and a set of 4 Trojan L-16W batteries (storing ≈700 Ampere-hours at 12 VDC). The CC-20 is user programmable for system voltage (we choose 12VDC) and state of charge voltage regulation point. We choose 15.0 VDC as the PWM voltage level of the controller. This voltage level is user adjusted on a set of small switches. You can set the unit as low as 13.2 VDC (26.4 for 24 VDC systems) and as high as 15.0 VDC (30.0 for 24 VDC systems).

CC-20 Performance

We've had this regulator in line now for about four months and it works great. Some of the features we like are its built-in LED bargraph metering for both system voltage and PV array current output. These two bargraphs can be read from across the room and tell all you need to know to run the system. The ammeter was somewhat generous and read high. Heliotrope has informed us that the metering circuit has been fixed and is now accurate. The system voltmeter was checked against a Fluke 77 DMM and proved accurate.

The controller also has several other features. There are three status LED lights on its front. One lights when the PV array is producing electricity. Another indicates that the batteries are fully charged and that the controller is regulating (a good time to vacuum the floors). The third indicator informs the user if the regulator has shut itself off because of overtemperature. Rather than french fry its MOS FET into destruction, the CC-20 will shut off the FET if its temperature gets too high. The CC-20 is also protected against reverse polarity hook-up. There is a front panel switch that selects one of two battery packs (great for RVs).

CC-20 Cost and Conclusions

The CC-20 costs around $180., complete with LED bar graph metering. This controller offers excellent value for its cost. It is effective, easy to install, user programmable, virtually indestructible, and best of all it treats the batteries right. We highly recommend it to any PV system user with an array of 20 Amps or less. For bigger systems, Heliotrope uses the same PWM scheme in controllers up to a whopping 120 Amperes and that at either 12 or 24 VDC. The Heliotrope PWM Controllers work better than any other PV regulation device we've ever used (and there have been more than a few that were "Things that DON'T Work!").

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the Wizard Speaks…

Biomagnetics

It has been known for quite a while that E-M (electro-magnetic) fields can affect biological mechanisms & controls. This is not surprising since living things have developed against an environmental background of naturally occurring E-M fields. There exists today a danger of EM pollution that may approach in severity that of other more well publicized types of environmental pollution. Statistical studies have shown that high current ac and very high current DC produced fields have a significant effect on certain cancer rates. Even low current ac produced fields have shown brain chemistry and immune system effects in animal studies.

The most pronounced effects have been shown to occur in the band of frequencies known as the ELF band. These are frequencies between 1 and 100 cycles per second. Effects have been noticed at very low power levels within this band, even when higher carrier frequencies are modulated at ELF frequencies. This is not surprising since this band contains most of the frequencies of naturally occurring EM radiation. Many effects have been shown to occur in narrow frequency and power bands, within the ELF region, which correspond to brain wave or bio-rhythm frequencies. These are also effected by the Earth's local magnetic field.

One of the more frightening studies showed that a 60Hz EM field (either actual or modulated on a higher frequency) caused suppression of the ability of T-lymphocyte cells from mice to kill cancer and possibly other types of diseases. Somewhat smaller suppression occurred at other frequencies. Effects were also found in human tonsil lymphocytes. Thus 60 cycle fields may promote the formation of cancer and other diseases through depressing the ability of the immune system to combat them. Other chemical links to cancer have also been shown to be promoted by short exposures to 60 cycle fields. The strength of these fields are typically of the magnitude of those present near high voltage lines all around the world.

Man-made sources of ELF EM radiation abound in our world. In view of the above and other findings too numerous to list we must begin to think about phasing out large 60 cycle ac usage, going instead to direct DC utilization wherever possible.

OOPS!

IN HP12, I got Solar Box Cookers International address & phone number wrong. Their correct address & phone number is:

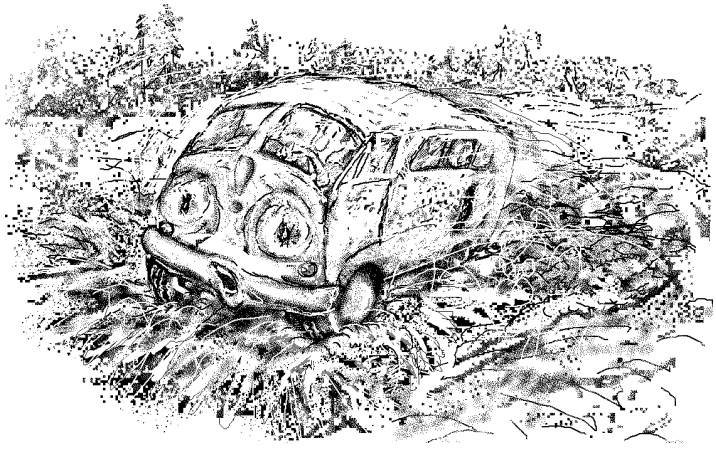
Solar Box Cookers International
1724 11th St.
Sacramento, CA 95814
916-444-6616

By the way, pasteurizing water is possible in a solar box cooker now. KP

SunAmp Power Co.

Echo Energy Products

muddy roads



Flat Diving

Stan Krute

Guess What
Surprise ha ha it was February and my woodpile puny. There's an emergency firewood cutting place nearby. It has scattered small groves of fire-killed standing hard dead oak. This oak burns hot and clean. The limbs are small, so little splitting's needed. The location is of interest.

Lake Adobe
It's a flat-topped basin of adobe sprinkled with and sitting on volcanic rock. Elevation's 4,000 feet. There are higher points on two sides.

In summer even the rutted unrocked roads are dry and hard. In the winter wet season the water table oozes to the surface. Wet adobe is hard and rough when frozen, bottomless and slick when not.

During cold wet periods it's best to drive when the sun isn't around. After sunrise things move toward muck. By late mid-morning it's best to be parked somewhere solid.

My Attorney Appears
One overcast February afternoon John Pryor came by. "Let's go get some wood,", he said. It seemed a plausible idea despite the time of day. We had been having some cold nights. So John went in his four-wheel-drive Toyota truck and I followed in my rear-wheel-chained Volkswagen van.

Climb Up And Jump Off
I live below the flat area. We drove on up. We followed a rocked road. After a mile we turned onto a rutted unrocked subsidiary road. Snow and ice filled the ruts. It looked passable to optimists.

Sprong Ka Bong
Within fifty yards, John was taking evasive maneuvers. The van and I were following. We were pushing accelerators, working out steering wheels. I got the familiar sickening slow-down-into-stuck feeling. I pushed the pedal. The van groaned, hopped, swerve-zoomed free. I aimed for some frozen ground. Ice cracked and broke. The van sank. More pedal pumping and wheel wrestling. The van hopped and bounded. Ever see a headlighted full-moon jack rabbit dance ? A final lurch, then the van sank beyond its axles. Buried.

A Recurrent Desire
I usually wish for a small journey back a minute or two in time after one of these sorts of avoidable-via-common-sense events.

Next Day
The next morning John and I went out before sunrise. We started to dig the van out. We used a four-wheel-drive truck, cable, rope, come-alongs, chain, shovels, a pick, breaker bars, and a floor jack.

By ten AM we'd managed to pull the rear end out. We quit for the day.

Day Three
We started before sunrise again. Richard Perez and his four-wheel-drive truck joined us. We decided to pull the van back to a nearby relatively solid high point. From there we'd launch her back out the way she'd come in, which was the shortest path to rocked road. By ten AM the front end was free and the van was on the high spot.

Day Four
I started the van. Tried to drive her off. The rear wheels dug into the ground. We dug them out and put boards under them. Tried driving again. Dug in again. Hmmm. Moved the van and tried again. Dug in. Hmmm....

Cold And Round
Maybe the front wheels were frozen. We jacked up the front end. Yep, locked solid. Richard went and got a propane torch. I lay down and warmed the wheel drums. We banged on them. Muddy water dripped out. We yanked. The wheels cracked free. We kept rotating and warming them until things felt thorough.

Exeunt
Though it was getting late in the morning, I wanted to drive out. I examined the road. What the heck. I revved the van, then launched her off the high spot. Swerving and accelerating we weaved through the way in, and bounced up onto the rocked road. Ah. Phew.

CQ
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KE5HV • KG6MM • N6HWY • KB6HLR

Regional Home Power Nets

(local times indicate local nets)

7.230 MHz on Sundays at 1330 Pacific, Central & Eastern.

3.900 MHz on Wednesday at 2000 Pacific & Eastern time.

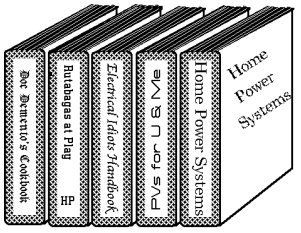
14.290 MHz Sunday at 1900 UTC.

Novices

Wednesdays at 0300 UTC-

7.107 to 7.110 MHz. Listen for Dave KB6HLR

7.110 MHz on Wednesdays and Saturdays at 0500 UTC.



Book

A lot of folks have been asking for good books for their shelf. For the coming long winter nights, here's a few good ones to keep those sunny dreams happening.

The New Solar Electric Home by Joel Davidson. This 416 pg. book covers everything from how PV cells work to wiring and everything in between. Full of photos, diagrams, charts, tables, formulas, case studies and worksheets. Useful info for everyone from the novice to the experienced. Available from aatec Publications, POB 7119, Ann Arbor, MI 48107, 313-995-1470, $18.95 + shipping.

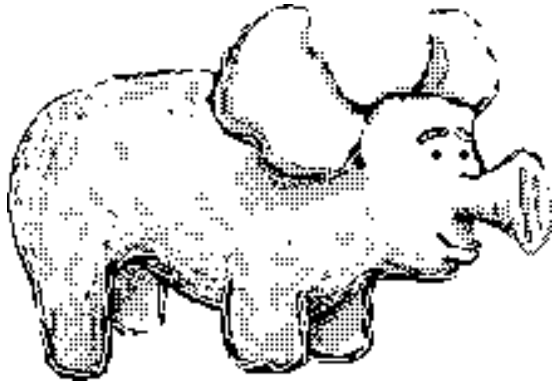
The Solar Electric Independent Home Book by Fowler Solar Electric Inc. is written specifically for the PV home owner or the potential PV home owner. It is meant to be a book that will educate and thus spread the use of PV. Covers all phases from sizing to maintenance. A greatly expanded, improved version of Solar Electricity for the Remote Site Home. This 184 pgs., 50 CAD diagrams, 25 photos, perfect bound paperback sells for $15.95 plus $2 UPS shipping (dealer discounts available) and is available from Fowler Solar Electric, POB 435, Worthington, MA 01098, 413-238-5974.

Photovoltaics: A manual of design and installation for practitioners covers the design, specification, and installation of photovoltaic power systems from A to Z. It was written by three of the foremost PV practitioner/educators in the world. This is the text book for their PV course and reads as such. If you can't make it to their course here's the next best thing. Approx. 300 pgs. with lots of maps, charts, tables and graphs. $35 postpaid anywhere in the world, available from Appropriate Technology Assoc., 410 Garfield Ave, Carbondale, CO 81623, 303-963-2682.

Here's just a few more in case you have a fast digester!

Practical Photovoltaics: second edition by Dr Richard J. Komp, 196pp, $16.95, aatec Publication (see above).

Keeping Your Cool: Do It Yourself Alternatives in Refrigeration by Michael Hackleman, Earthmind Publications, POB 743, Mariposa, CA 95338.



SWRES Research

The Southwest Region Experiment Station (SWRES) is a photovoltaic engineering research facility operated by the Southwest Technology Development Institute at New Mexico State University in Las Cruces, New Mexico. The SWRES operates and monitors 10-12 grid-connected and stand-alone PV systems ranging in power from 200 watts to about 5Kw. The facility, under contract to the Department of Energy, monitors six additional systems via telephone-modems throughout the US. Numerous large (2 megawatt) and small (500 watt) systems are tested on an annual basis to determine long term performance. In the last nine years, over 200,000 PV modules have been tested including single crystal, polycrystalline, and amorphous modules. Engineers at SWRES design and build special purpose PV power systems for government and commercial customers. They are currently finishing eleven PV systems that will fly on high altitude research balloons.

The purpose of this newsletter is to disseminate information that would be of interest to the small scale user of photovoltaics. Primary areas to be covered will be: Lessons learned on proper installation techniques for maximum longevity. PV and the National Electric Code-1990 has some new requirements. Sources for some hard-to-find components like approved module interconnect wire. Here are some examples of what you can expect.

Single crystal silicon and polycrystalline silicon modules when used in residential, low voltage (less than 48 volts) systems are extremely reliable and have a less than two in ten thousand failure rate. Life expectancy may exceed 25 years. New production amorphous silicon modules may prove equally reliable, but only time will tell. Wiring and balance of system components are far more prone to failure and careful attention to details in this area is necessary.

The 1990 National Electric Code will require that PV systems mounted on the roofs of dwellings have a Ground Fault Detector and Interrupter to minimize the hazards of fire due to ground faults in the array. At the present time, no device exists to accomplish this function, but SWRES is working on a design which may eventually be produced by industry.

Need approved, single-conductor, stranded, 10 gauge wire for module interconnects? The NEC says use UF cable identified as Sunlight resistant, but nobody makes it anymore and the SWRES experience is that UF insulation isn't tough enough to stand up to daily exposure in direct sunlight. A better solution is to use USE XLP or XLPE which most inspectors know is sunlight resistant and a more durable wire than UF. Here are some sources for 500 foot or larger quantities;

Drew Epstein, Anixter Wire, Albuquerque, NM
1-800-432-6622 or

Bill Gaal, Paige Electric, Union, NJ
1-800-327-2443

These distributors can supply this wire in spools with a card stating the wire is rated as sunlight resistant by Underwriters Laboratories. The price of copper varies from day to day, but expect to pay over $100 for 500 feet. For smaller quantities, contact Photron Power Systems in Willits, CA at 707-459-3211.

More next issue from John Wiles, SWRES 505-646-6105

HAPPENINGS

SUNAMP POWER CO. will hold a two day PV Seminar on Nov. 10 and 11 1989. This seminar is designed for everyone from professionals to do-it-yourselfers. Some of the topics will be: Introduction to PV hardware, demonstrations, of systems, instrumentation, information access, system design, and marketing.

Cost of the seminar is $145 which includes two lunches, refreshments, syllabus & classroom materials. For more info contact Steve Bass, SunAmp, POB 6346, Scottsdale, AZ 85261, 602-951-0699.

ALCYONE LIGHT CENTRE will hold a two section program covering Energy - Passive (section 1, Nov.5-10) & Active Systems (section 2, Nov. 10-12). Section 1 will cover land planning, building design & construction, & passive energy. Section 2 will cover solar hot water and greenhouse aquaculture.

The cost of section 2 is $120 ($180 couples), 2 days. Section 1 $250 ($375 couples), 5 days. For the full 7 day program the cost is $300 ($450 couples). For more info contact: Alcyone Light Centre, 1965 Hilt Rd, Hornbrook, CA 96044, 916-475-3310

Letters to Home Power

We Print 'em Unedited.

Freedom

Dear Home Power,

I have read about every Mother Earth News there was but my dream to be self-reliant, power wise never came about.

Now less than a year on *Home Power* and I'm Free. I did not trust the system, but did not want to go back to the stone age either. We severed the utility companies umbilical cord and bills in May of this year.

Thank you for helping the poor boys dream come true. We enclosed a photo of the utility pulling out. Thanks to your fine work.

Thank you so much, Bill, Laurie, Tabitha, Desiree, Amanda, Betsy, & ?(past due) Mielke, Ogdensburg, WI.

We like this picture. RP &SK

Another Opinion

Dear Editor,

Joel Davidson's question, "What's wrong with PV?" compels me to respond. As the "solar guy" at a major industrial distributor near the oil patch and a veteran of Jimmy Carter's TVA sponsored, residential, utility financed solar project, it is easy to for me to empathize with Joel's wistfulness. However, to reply to the question "What's wrong with PV?", I have to say loudly, "NOTHING"!

There is another question that has been asked frequently that may hit closer to home for a lot of people who would like to see PV become widespread and have a big effect in reducing the contamination of the water and air covered skin of the big rock we call earth. The question is, "How come PV's are not big business in the USA?" I think the answer is that, practically speaking, PV just isn't a big enough benefit to a big enough group people. I also think the solution to this stumbling block to widespread PV use is right on our doorstep. Let me explain.

Most of us in the USA buy considerable electricity to keep the inside climate of our homes and workplaces similar to that of Northern Europe in summer. For most of us during North America's summer that means lots of air conditioning. One way to use PV to help reduce this major electric load is to mate a PV array with a DC motor driven, variable speed heat pump. Since the appropriate electronics to intergrate the DC array with the ac power lines are already in the pump, the high cost of an inverter is avoided. Also avoided is the hassle of interfacing with a utility and the problem of jeopardizing utility workers safety when maintaining power lines. The cost of storing the PV gathered cool is much less than electric storage. Thermal mass is much cheaper than batteries. There are at least two major US heat pump makers using DC motors. There do not seem to be any technical problems in the way.

The whole stumbling block to this PV concept and any other PV concept moving forward is the unfair way in which non-renewable energy is subsidized and promoted and the woeful ignorance of the few urban pioneers that are willing to actually lose money to demonstrate the renewable technology that they support. We must not allow these folks to be victimized by unscrupulous and incompetent solar companies.

Sooner or later, PV and other renewables will receive their just place in our energy mix. Thanks to all the brainstormers working to make the day sooner instead of later.

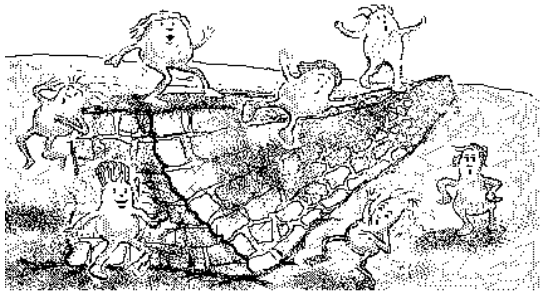
Sincerely, Mark Wiener, Carrollton, TX

Better Batteries?

Dear Perez People and others,

Again, thanks for the wonderful job you are doing with *Home Power*. A tremendous magazine for information & philosophies (although some writers may be a bit different). But this is truly the personification of FREE speech which is on of the major TENETS this country was founded upon. So much of the press is either prostituted by advertising monies and/or are controlled by political pressures etc., etc.

Thanks for staying as pure as a publication as I have seen in a long time. Some of the information from writers especially is a bit



off the wall. But again "God Bless" it in spirit (renewable energy) and again Personification of "Free Speech".

Well, with that over with a few things I want to state.

A) All the discussion about cold fusion and superconductivity. Even in reference to this topic in *Home Power*, authors fail to mention factors such as... cold fusion only is an augmenter/booster

of DC input. A DC power source is necessary. Superconductivity is only a transmission and storage media.

What we are failing to mention is where is the initial generation. PV from the sun is Pure generation of power. All the other things that have been getting so much press are only as good as the generator.

B) In reference to Nicads for rechargeable batteries, they have been the standard but involve the major toxic waste cadmium & have a memory problem. Also pricing has gone up of late. More important, there is a rechargeable battery that is better, the Ovonic nickel-hydride battery of the Harding Think Tank. Please see attached literature which I have enclosed. Lastly we will probably be advertising in your great magazine in the near future.

Thanks for your time, Nicholas Pietrangelo, Pres. Power By Sun, Sec. Harding Think Tank, 633 Washington, Grand Haven, MI 49417

Low Flush

Dear Home Power,

Enclosed is a donation meant to show our appreciation for your wonderful magazine. Even *National Geographic* takes 2nd seat to *Home Power* in our house.

A note of interest for those folks looking for low flush toilets - Eljer, an American Company, makes a 1 gallon flush toilet called Ultra-One/G.

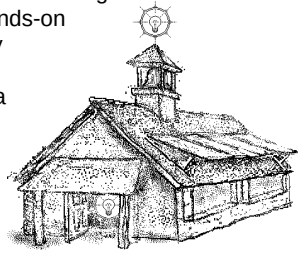
A unit that I, (as a remodeler) have installed in several homes, with no complaints from customers.

Since the unit is made by a well known plumbing fixture manufacturer, it is often available through local plumbing supply houses, and sells for around $170.00. Thanks again for everything.

Sincerely, Doug Porter, Fordland, MO

Solar Cookin'

I teach 5th grade in the sunbelt. I need to bring the technological applications to the hands-on level that 10 year olds need. So I really appreciated #12's article on solar box cookers. We've been wanting to build a solar cooker for a long time, but were afraid of burning down the school. Thanks!



I already receive *Home Power* at home - seems like it should be in schools. Kids need to learn that solar, wind, & other power sources are not merely the domain of NASA & the government on a hugh scale; individuals are potent enough to tap these resources on a small scale too!

Lois Brill, Tomasita Elementary, Albuquerque, NM

African Energy

Dear Folks at Home Power,

My wife and I are volunteers doing veterinary development with the Society of International Missionaries (SIM) in a remote part of SW Ethiopia. Our home is now powered by six Arco M-55 modules, enough for lights, music, communications radio and SunFrost refrigerator. We have lotsa sunlight and practically no other energy source out here!

Thanks for the excellent work you're doing on the magazine. I have learned a lot from the experiences of others reported in HP, and it has filled a multitude of ignorance gaps. We had to plunge in to solar electricity--then learn about it! We bake in a solar oven (the nomads are astounded), and we dehydrate our extra food in a solar dehydrator-- for preservation. We hope to change from gas to solar water pumping from the well, and install a solar water heater quite soon.

Challenging all these solar projects based only on what I could find to read--I still had/have plenty of questions. Your magazine has provided some long-sought answers. Thanks very much.

Enclosed is our check for back issues #2, 3, 4, 5 and 6. They should be mailed to the address in your computer--not to us directly unless costs cover overseas postage. My folks forward them to us. Please keep up the good work.

Sincerely, Fred Van Gorkom, DVM, Addis Ababa, Ethiopia, East Africa

An Engine Story

Dear HP,

In response to M Riener's letter in HP12.

About 1 year ago I bought a used China Diesel engine, model X195DN, with a 12.5Kw Winco generator. The unit had not been used for a couple of years and the oil had not been drained. This (unknown to me) had caused the brass screen on the pick-up of the oil pump to disintegrate because of condensation and acid build-up in the old oil.

After I had run the engine a few hours, the pieces of screen plugged the oil line and the engine seized. That was when I wondered if I would have a problem getting parts. I completely disassembled the engine to see what I would need to rebuild it.

I called China Diesel Imports (17549 Lyons Valley Rd, Jamul, CA 92035, 619/669-1995) and talked to Hardy Day the owner of China Diesel Imports and also to his mechanic Joe.

They were able to fill my order for all the parts I needed which consisted of crankshaft, rod & main bearings, exhaust valve, gaskets, and questions.

A couple of months ago the original starter began to have problems. I took it to a local starter repair shop and it was going to cost a bundle to have it rebuilt. So I called China Diesel Imports and they had a bracket that would allow me to use a 5.7 liter GM Diesel starter. This saved me some money and also starts the engine quicker than the original starter.

I have also replaced the injector nozzle, which they have in stock.

As you can see, so far I have not had any problems getting the parts I need, and they ship them as soon as they get the order.

The only "horror" story I have is that the oil should have been drained from this engine before it was stored.

A couple of minutes of effort on someone's part would have saved me a good deal of time and money.

HP, I enjoy the articles in your magazine which are interesting and informative. Also it is probably one of the few magazines where everyone also reads the advertisements. Keep up the good work.

Sincerely, Gordon Gronewold, Tonasket, WA

Dear Person,

I recently received six back issues in the mail and promptly read them all, cover to cover, in one sitting. Now I would like to order issues 2, 3, 4, and 5, to complete my collection.

Now some comments and questions:

1. I urge the readers to make use of solar water heaters (in place of gas and wood) wherever possible to minimize environmental impact. Why burn things to make hot water when the sun does it so well. This year I installed a Solahart unit that works great and cost only $156.00 after the Oregon tax credit.

water heater $1195.00, fittings etc. $48.00, minus $1087.00 State tax credit = $156.00.

2. I want to put in a good word for Bobier Electronics and their NDR-30 charge controller. I suggest a place in the "Things That Work" column. Have you seen their technical comparison document #1126B? Their warranty? Quite impressive! I use one,

and it works!

3. Can anyone there tell me how to build a circuit to make 9vac 60Hz from 120VDC? My old Commodore 64 requires this to run the timing part of the interface chips. I know how to make 5VDC and 9VDC that runs the rest of the machine.

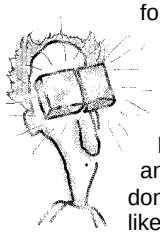
4. I would like to see more build it yourself type articles for the tinkers out there. For instance a schematic for a good 12V fluorescent light ballast. You've been doing a good job in this area so far. Keep it up.

5. The peoples energy fair is a good idea and if I can be of help in any way here in Central Oregon, I'll be glad to donate some time.

Sincerely, Quintin Myers, Bend, OR

Dear HP,

I'm a new reader, as green as they come on getting "wattage in my cottage". Plan to build a tiny house within the next two years, so I'm beginning now to explore the literature--and must say that HP hits the spot better than most. I read your letters first and generally find them the most involving and interesting--then one or two articles such as "Simple Designs for Efficient, Low Cost and Reliable Systems", by Steve Willey, will ring a bell. On that particular article, the way Steve explains why a $35 fluorescent lamp is better than a $300 added panel is so nicely put that it gives me enthusiasm to go deeper into the whole field. BUT then he follows on with advice to wire for ac and DC both--



and I get an attack of the MEGO Syndrome-- "My Eyes Glaze Over"! I'm at the stage of knowing, in a general way, that it's better to be a net producer than a net consumer, beyond that I'm at the very beginning. I want to hear that I need to wire for ac and DC, but I also have to deal with the fact that I don't know anything about even the most basic stuff--like what IS electricity, how does it work, what controls and directs it, etc.? So to reply to Dr. Bill's query in the letters column, YES to more info for those of us "low in electronic know how, trying to get up to speed". YES also to Jeff Damm's request to "see some actual home-grown systems", especially those of people like myself who had to make their start with no electrical savoir-faire, confronting in dumb stupefaction a great idea that seems overpopulated with neat products and diverse applications!

About the direction of the magazine as a whole-- you're doing great. Articles that respond directly to reader's queries appear in the same issue, which means that there's healthy ferment going on. I agree with those who don't want to see you go upscale, downtown, and get slick. The mindset of our culture is tremendously powerful, and it's easy to get sucked right back in to where you were before you started. Stay alert! It seems to me that you should stay with the nuts-and-bolts of independent power production, letting the other critical issues such as gardening, lifestyle, politics be your SUPPORTING arguments. We live in a time when so many different big issues are truly important, that if you treated them all as they deserve to be treated in each issue, you'd be printing something about the size of the Manhattan Yellow Pages. Don't underestimate the great impact you're making by sticking to this one issue and doing it as well as you are. What this magazine/movement is REALLY about (as you know) is taking power (electrical and political) out of the hands of the money-grubbers, mystifiers and slave-drivers, and getting it into the hands of EVERYBODY. It seems like this should present enough of a challenge to those who really want to change the world... not that the other issues are not just as important, because they are--and blessings on your favorite cause.

Ideas on the People's Energy Fair: YES, the fair requires and organization, and you ought to hire a full-time director/coordinator/administrator NOW. You don't have to pay them a lot, even a couple of hundred dollars a month would do. The right kind of person will be into it for the free phone, contacts, challenge and fun anyway, not for the bucks. DEFINITELY set it up as a separate non-profit. I had experience in the early '80s starting a soup kitchen and we tried to do it under the umbrella of a sister organization. It's not worth the energy having to run everything through two staffs and two boards, even given good cooperation (which we had). The time/money investment to set up a small non-profit is small for those who know how. Start it as your own baby and my experience says you'll be much happier. LOCATION? I vote east of the Mississippi, because: 1-more population; 2-better chance of major media coverage (like it or not, the decisions and energy for this come from the east coast) 3-there may be a better chance to make the environmental case in a way that counts (acid rain is more of an Eastern problem) 4-would give the largely Western-based alternative energy crowd a chance to mix 'n' mingle with the more staid Easterners (we need it and you do, too). TIME: definitely August 1990. August is traditionally the slowest month for news, when media is willing to look around for "alternative" stories. ACTIVITIES: Include "the basics", so as to pull into your orbit as many as possible. I think the fair will suffer if you end up just preaching to the already converted. Reach out to Joe Six-Pack America! I think there's still a lot of idealism out there, but people have been burned pretty badly by recent culture and history-- so they want to see the nut-and-bolts demonstrations along with the "Better World Through Cheap Energy" type slogans. We have to give the fair-goers two big, and equally important messages-- there is Hope, and there is a Realistic Method. BUSINESS INVOLVEMENT? They've gotta be there! I don't want to buy a concept, I want to buy a panel! I want to get off the grid and I want to do it in reality. This requires the hardware and technical expertise that the business people have. Why not get those who are there to make a profit, also run critical parts of the fair as a cost of doing business? For example, get some of those who handle toilets to throw in on the sanitation end of things. And sell the toilets after the fair is over at a reduced price to people like me who would consider it a historic kick to get one of the VERY TOILETS that were used at the first P.E.F.! What a story for the grandchildren... FINAL POINT: be sure to locate on an active bus line with a good station to handle the flow. Amtrak accessibility not a bad idea, either.

Rob Conrad, Abingdon, VA

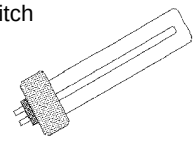
Dear Home Power,

I'd like to share something which seems a small point. The PL series of lights has been a positive boost for solar power in my neighborhood. One stumbling block for them is they are awkward. I wish everyone to know that the ballast can be located three to four feet from the bulb. (Does anyone know the maximum?)

My latest conversion to PL lighting is an articulated, spring jointed, study lamp. My procedure was as follows.

1) remove the bulb sock assembly and switch

2) plug the existing lamp wire into the PL socket



3) use small nuts & bolts to mount the PL socket to the lamp

4) cut the wires to the study lamp at about desk level

5) mount the ballast and a switch near the base of the lamp.

The result of this simple retrofit is a very nice lighting system suitable for the home desk or professional drafting.

NOTE: To make the mounting look like it came from the factory, glue the nuts to the PL socket with miracle glue, so the screw heads aim down and into the light area. This suggestion is for

people with bulky fingers. By the way, as long as I'm boosting PL lights. The PL-5 makes a great area light which will keep friends safe on rough ground for at least 75 feet from your front door, maybe even 100.

Sincerely, Garrett Connelly, Environmental Economics, 300 W. Mountain Dr., Santa Barbara, 93103

Dear Home "Power"

Saw in your "Letters To Home Power" your comment on "Food Generation" & possible column on same.

Home Power is already well into helping us become self-sufficient & "Food Generation" is part of our needs.

Some basic info on hydroponics. There are basically 2 approaches

1. HIGH TECH. - w/pumps, heaters, chemical nutrients

2. SOFT TECH. - w/no pumps, & very limited chemical inputs

1st High Tech. sources of info.

1. Hydroponic Society of America, PO Box 6067, Concord, CA 94524 - Journal & book lists $25.00/yr

2. "The 21st Century Gardener Journal" Growers Press, Inc., POB 189, Princeton, BC, Canada V0X 1W0, $20/yr, sample Free? This is the best journal I'm aware of with lots of equipment sources, books, etc.

SOURCES OF EQUIPMENT & SUPPLIES

Western Water Farms, 1244 Seymour St, Vancouver BC, Canada V6B 3N9, Ph. 1-604-682-6636

Crop King Inc., POB 310-CG, Media, OH 44258, Catalog Free.

Aquaculture, 700 W 1st St, Tempe, AZ 85281, Ph. 602-966-6429, 1-800-633-2137, catalog Free.

I'm more interested in soft-tech hydroponics. Sometimes called passive water hydroponics. It is much easier, & cheaper to set up the system, & the system is a more easily adaptable to "organic" type growth. Some info on these systems is available from: "Echo Development Notes", RR2 Box 852, North Ft Myers FL, 33903, $10/yr and New Alchemy Institute, 237 Hatchville Rd, E Falmouth, MA 02356

Hydroponics systems can be used in your Home or in a greenhouse.

Simple, cheap, small, greenhouses are available from: Shelter Systems, POB 67, Aptos, CA 95001, catalog $1.00.

Materials & info on very cheap, rugged, do-it-yourself greenhouses are available from, Northern Greenhouse Sales, Box 42, Neche, ND 28265, Ph. 204-327-5540.

For food growing with high nutritional value & with least impact on the environment please consider, these groups for information.

Dan Carlson, Scientific Enterprises, Inc., 708 119th Ln NE, Blaine, MN 55434, Ph. 612-757-8274 (on use of sound & foliate feeding of plants).

Don Weaver, POB 1961, Burlingame, CA 94010 or Soltice, 201 E Main St Ste. H, Charlotteville, VA 22901 (for info on soil remineralization with ground rock).

The Permaculturae Activists, POB 101, Davis, CA 95617 (for info on a wide range of important growing info).

If "Home Power" or others want more details on this sort of information & "underground greenhouses" for use in cold climates or underground houses for do-it-yourselfers & other appropriate technology subjects - Let me know.

Best to you all, Jan, San Luis Obispo,CA

Hi Folks,

I, along with everybody else it seems, am excited with your magazine, and very much appreciate what you are doing. There is a lot of potential growing out of your efforts which I believe will be of benefit to many many people.

Enclosed is a check for $14.00. Please send me one copy each of issues 2, 3, 4, 5, 6, 7, and 8.

Something has begun to concern me these last few months as I have avidly read through your last four issues of Home Power (through 12). As a way of giving my perspective I will say that I am a licensed builder here in California, with over 25 years experience in the construction field. I began my career as an electrician, and branched out some 10 to 15 years ago. I also have some minor experience with electronics bases upon a stint in the Navy many years ago. In regards to solar energy and ecological concerns my primary interest has been in the area of passive solar solutions having to do with the design and construction of dwellings that are long lasting and require low maintenance. My desire has been to combine evolved technologies and natural materials to promote minimal consumption, balance, light, and groundedness, as well as esthetics and ecological harmony. Again, it has been a joy to discover Home Power.

In any case, the concern that has come up for me (which could possibly be answered in one of your back issues?) is that I have seen no discussion regarding the costs, both in terms of actual energy as well as the ecological impact, of the manufacturing (and disposal?) of PVs, storage batteries, and the myriad other things associated with the systems of energy generation/retrieval, storage, and utilization, that are discussed in Home Power. Living near what is commonly called Silicon Valley I have become very much aware of the impact the manufacturing of computers (such as the one I am using here) is making upon our environment. I also wonder how the amount of energy that goes into the manufacture of a PV panel and it's support structure (including such things as the mining of it's materials, transportation, and disposal...) compares with the amount of energy it is expected to generate over it's lifetime... and how that ratio might be affected by other cost factors in the system as a whole.

I am bringing up questions I have no answers to, but I do believe these questions might concern others besides myself. Perhaps there are those amongst your readers who have information that could answer some of these concerns?

Sincerely, Gila Builders, John Fridinger, PO Box 8260, Santa Cruz, CA 95061, (408) 423-5349, Lic#554346

Editors et. al;

Am glad I found your publication. My family and I are operating our home in southwestern Colorado on "Home Power". I am always looking for ideas and sources of various equipment etc. I look forward to your upcoming issues. Keep up the good work -- good articles on home built stuff and "how-to" articles always needed.

Further, as a Junior High science teacher in Farmington , New Mexico, many of your articles will be important contributions to my physical science classes. The need for informative articles written for the lay person is being met with your publication. Good job. I would appreciate a subscription for my science department at school as well. Do you object to my using (photocopying classroom copies) of some appropriate articles for courses. The graphs and discussions are good examples of "real life" applications of Physical Science. Graph interpretation skills are an important part of my curriculum and I can use many you publish. I would like to use some of your material in my class. Thanks for an interesting publication.

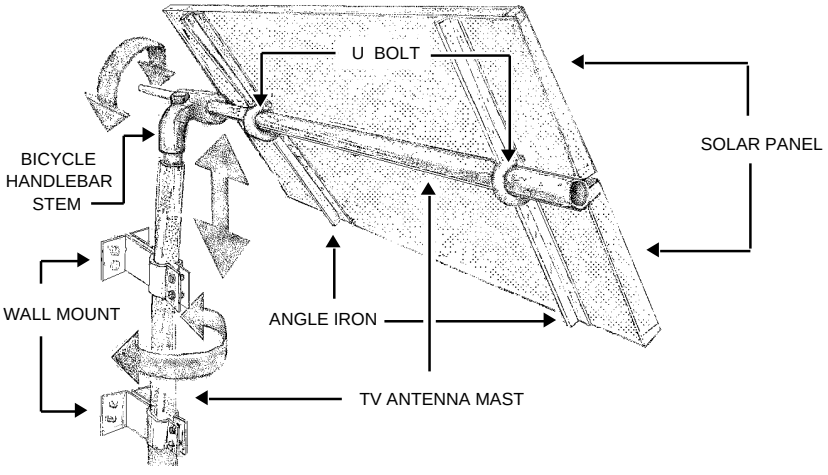
David D Hanna, Science Dept., Tibbetts Junior High School, 312 E Apache St., Farmington, NM 87501

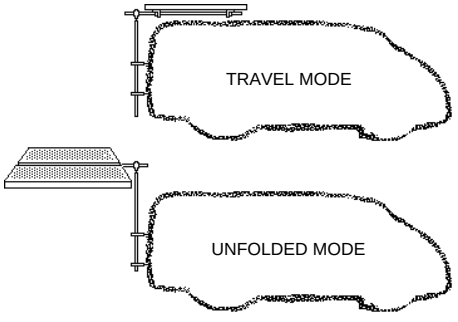
Thanks again, I look forward to your next issue.

Hello,

Thanks to Home Power for all the information. I live in a small motorhome equipped with two Arco M-75 panels. I made a very

simple adjustable rack for the panels using two TV antenna mast poles. They are joined perpendicular with a bicycle handle bar stem. The panels are bolted to two straight angle iron pieces and U bolt directly to the horizontal mast. The vertical mast is supported by two TV type wall mounts. The whole thing can be raised up or down, circle 360°, and the panels themselves can be changed from vertical to horizontal angles. It all folds down so the panels are flat on my roof in a safe position for traveling. All the hardware for the rack was purchased at Radio Shack and a hardware store for around $20; the handle Bar stem being salvaged.





I'd also like to mention that the Radio Shack 12V amplified TV antenna is small but pulls in signals great. It draws only 100ma. Recently I bought a 13 inch color TV which I am powering with a 100 watt Statpower inverter. The inverter causes some speckled horizontal bands which move up the TV screen. They are slightly distracting to see. These do not occur when the VCR is playing a tape so I assume it is RF interference. Is there any way to stop this interference?

I'm happy to share any information on my systems with anyone who needs help.

Thanks, Larry Kapp, POB 151, Gays Mills, WI 54631

P.S. I built the expanded scale voltmeter and after some minor problems (I didn't know what I was doing) I've got it working!

This publication is right up my alley! I was thankful for the article on page 38 (HP10) on DC fluorescents! I use PL type lights & love the watt savings but don't like the flicker & when voltage is low they're terrible. But after the simple modification described by Motorcycle Mike, it's like a new house! THANK YOU. EVERYONE in the nation should be using these lights & getting Home POwer mag. Keep up the good work. I have 1/2K of PV - Zomeworks hot water & heating w/ wood stove coil backup - Family of 3.

Robert Bailar, Tijeras, NM

Home Power has been a deep source of hope for me, without it I am not sure I would have had the courage to sell everything, bring that truck up the Rockies at 10mph and look for land. Now if the contract will go through... Seriously my former electric company was economically involved with Shorcham Nuke. It was a great source of spiritual distress. My only suggestion is : A column for people like me, who want to build an appropriate tech. home. If I could find others to break up a larger parcel, land would be more affordable. Thank you, Deborah Marchand, POB 881719, Steamboat, CO 80488

Dear Editor, RE: June/July 1989 -- "Passive Solar Hot Water" by Kathleen Jaraschke-Schultze.

I think that "Passive Solar Hot Water" is a very well written article about a simple design for a thermal siphon collector. I have experimented a little with solar siphons, and I would like to suggest some minor additions or changes in their system.

One of the problems with thermosyphons is that 'thermal layering' sometimes occurs in the tank ie. the water in the very top of the tank gets too hot and prevents the system from siphoning further. This might be the reason that they only get 10 gallons of hot water out of a 30 or 40 gallon tank.

First, to possibly avoid thermal layering in the tank sometimes you can mount the tank on its side or at an angle instead of upright. This allows for a larger mixing area inside the tank. If you are using an old water for a tank then you arrange it so the drain valve becomes your cold inlet to your siphon and, hopefully, you will have a hot outlet far enough up on the tank to take advantage of the most volume.

Secondly, I suggest mounting or positioning the siphon such that the top of the pyramid is <u>below</u> the lowest part of the tank. This insures that it will always get the coldest water to heat and that it will then siphon to the top of the tank.

Finally, to avoid having to shut off the siphon manually at night they could install a check valve, a one-way valve, between the siphon and the tank so that it will not 'reverse' siphon at night. Also, I assume that they have their tank insulated so that it doesn't become a thermal radiator at night.

Plumbing the system to switch from a solar siphon to an in-the-wood stove siphon can be easily done with the tank mounted high enough so it will work both ways and the addition of a couple more valves. The pyramid siphon could even have a drain cock on its low end and then they may not even have to disconnect a hose in the winter. It's a nice design, and pyramids are supposed to be magical, too! Best Wishes, Jay Lensch, Hornbrook, CA

Dear Home Power, Count two big votes for the People's Energy Phair (PEP)! It's time to spread the news that we can live comfortably and sustainably within our daily income of solar energy. We're glad to see the proposed restriction on automobiles from the fair site. Along this line, we suggest the site be accessible by public transit, eg. bus or train. We live on a sailboat, so it would be nice also if we could get there by wind power.

We want to thank Real Goods for their prompt response to a recent order. We've been enjoying cold drinks from our new PV-powered refrigerator and clean clothes from a 12VDC washing machine. Home Power enriches our lives. Keep up the good work.

Phairly, Larry & Marge Warmberg-Welling, Nahcotta, WA

Folks, Great mag love it etc. etc. I have something to share that I haven't read about anywhere else. I have a minimal 12V PV system in my ongoing Forever owner built home, a lifetime, never ending project. I have to pump or carry water up a 40' hill. To flush a conventional toilet takes a lot of water (heavy). Low flush toilets

carry a premium price tag. I went to an RV salvage yard in the big city & got an old porcelain RV potty with a foot lever operated flapper valve. Uses *miniscule* amounts of water to flush. Of course it's not to code but it is a simple switcheroo. I think many times re: PV systems the point is lost to downscale energy demands rather than upgrade the PV systems. Thanks, Chuck Kondas, Breckenridge, CO

Everything is good, any questions I need answered, all I have to do is be patient and wait for the next issue. Would like to see more info on proper cleaning of batteries and connections. Also would like to talk to other alternative energy users in my area.
Thanks, Guy Stephenson Jr., RT86, Wilmington, NY 12997

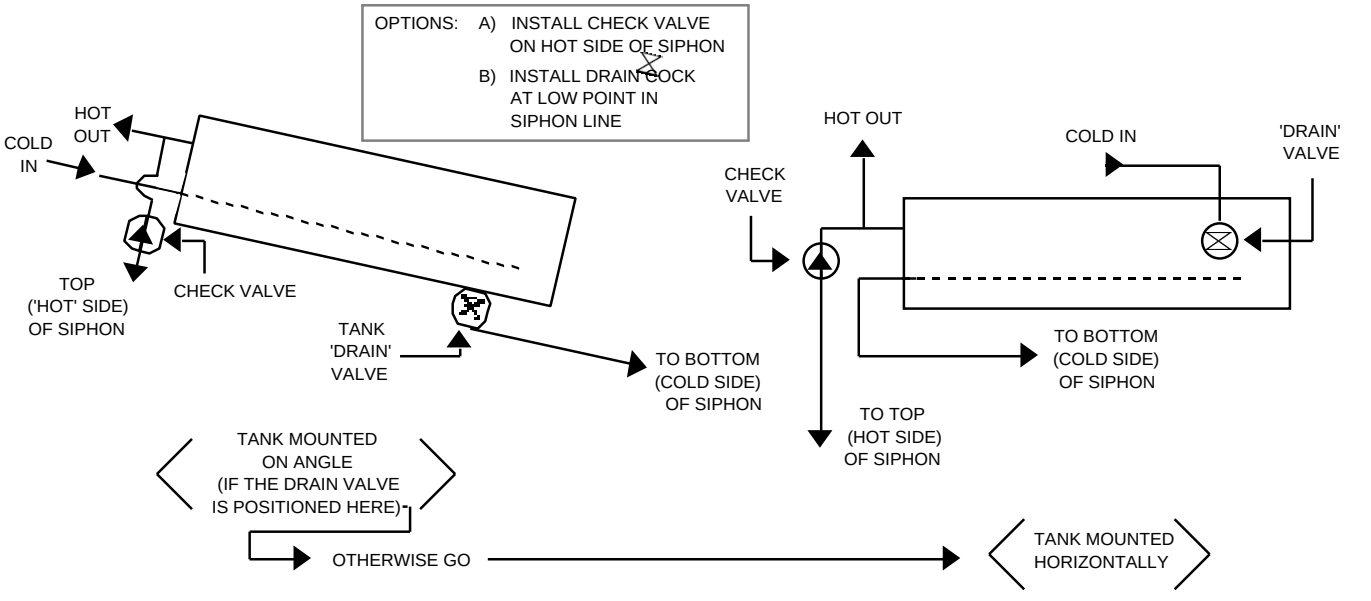
After hauling water for 10 years.....due to "Flowlight" (Santa Cruz, NM) I am about to have "running water" (HOT TOO.....indoors).... Can't wait for the first bubble bath!!!
Chris Spanovich, Chimato, NM

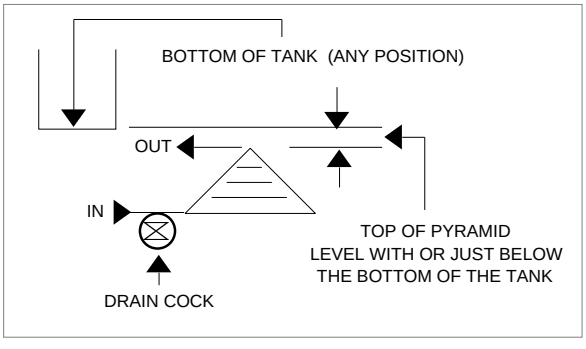
Dear Home Power folks,
I can't begin to tell you how inspiring it's been to read your magazine. The useful and sensible information comes at just the right time for me as I finally move onto the land and create a sustainable lifestyle.
Your high level of integrity comes shining through the pages. It brought tears to my eyes. It can be a struggle to maintain high ideals as you get larger and more recognized. Look at what happened to Mother Earth News. But the high place you guys are obviously coming from gives me great hope. It'll be interesting following your development as well as continuing to receive this important information. Enclosed is $14.00 for back issues #2-8.
You are being a great service to the present. Thank you very much. Sincerely, Fred Mignone, Floyd, VA

Your magazine is the best. I read a book and other articles on home power and felt completely overwhelmed. Then I ordered HP back issues. Now I feel psyched to be going off the grid instead of terrified. Bill St. Cyr, Cabot, VT

Yours is a magazine put out by "Real People" who care. I like everything about it! A free subscription magazine of this caliber is impossible - how do you do it? You are obviously putting much out more than you are getting and the only way you can do that is love.
My wife & I are two school teachers that have just retired and are moving to the foothill country of Grass Valley, CA, where we intend to experiment with different forms of alternative energy. You will be hearing more from us. In the meantime, you are appreciated.
John and Shirley Randall

DIAGRAM OF TANK POSITIONS AND SIPHON PLACEMENT





NOTES:

(1) KEEP SIPHON AS CLOSE TO THE TANK AS POSSIBLE

(2) IF DRAIN VALVE IS TOO HIGH ON TANK IN HORIZONTAL POSITION - HOT WATER QUANTITY MIGHT BE LIMITED

(3) PLUMB SIPHON HOT SIDE SO TANK IS HIGHEST POINT

Q&A

RTV

In reference to E.S. Spiak's letter asking for silicone RTV, GE makes one which I believe is #555 (their code), and Dow Corning makes one called Silastic E RTV. Both are two part mixes, and cost from $12-15 per 1.1 pound kit. They can usually be located at places selling rubber products (raw materials), plastic raw materials, sometimes large electrical supply houses, or sometimes large crafts or jewelry supply houses, as they are used for making molds. Or you can write Dow Corning at Midland, MI 48640 and ask them where the nearest supplier is, or order it from them. The material is easy to mix and use, but has a shelf life of 6 months to one year. Each company makes a line of silicone rubbers, for different applications, so you might want to look at the entire product line before you choose one of the above, as it is primarily for molding.

Sincerely, Rives McDow, Leicester, NC.

Stoking Up Calentadors

Dear Friends at Home Power:

This is in reply to Clyde Gress and others who wrote letters regarding wood-burning water heaters in issue #12.

In 1979 I founded Appropriate Technology Importers, Inc. for the purpose of importing wood-burning water heaters ("Calentadors") from Mexico. It was a good idea that over time evolved into a not-so-good- idea. My only ambition was to support myself and family with a reasonable income while providing a valuable product at a fair price. However, Mexico's runaway inflation soon made each shipment cost more than the previous one, and it became extremely difficult for me to maintain stable prices from month to month. Finally it reached the point where I couldn't earn a living without pricing the product higher than I felt was reasonable. These were great little heaters, but by the time we got them trucked from Mexico City, through customs, into a warehouse, and finally shipped to their destination, the price was more than most people wanted to pay. I sold the company in 1981 to New Atlantis Enterprises, who are now also out of business. The last contact I had with I was told that wood burning water heaters are not even being made for the Mexican market any more. (This may only apply to the Magamex brand that we were importing, although the last time I was in Juarez I couldn't find calentadors of any brand for sale in the hardware stores.) Don't take this as the final word, however. If you visit any border city in Mexico check the hardware stores outside the tourist zone. Ask for a "calentador de agua para lena." ("Wood-burning water heater.") Be cautious about purchasing "a no-name" brand made in someone's backyard: These are fairly common, but they are often more folk art than useable water heater. Your next choice may be to make one by welding a fire box to the bottom of an old gas water heater. This isn't hard to do, and they work quite well. **Always install a Temperature and Pressure relief valve on the heater** -- these are available for about $10.00 in any hardware or building supply store. I am willing to answer brief questions on this subject only if you send an SASE.

Sincerely Yours, James B. DeKorne, POB 145, El Rito, NM 87530

Answering Machines Revisited

Dear HP,

I read with interest Joseph Berube's letter (HP12) regarding problems with DC powered telephone answering machines.

Our machine is a Radio Shack TAD-252, combined phone and answering machine, which is equipped with a 12 volt input (DC) and sold with a transformer for 110 vac use.

However, when we use this machine on our 12 volt battery system, there is a strong hum on the phone whenever the answerer is plugged in. Sometimes incoming calls are accepted by the machine and then immediately cut off.

We have found that disconnecting the entire battery system from its ground somewhat alleviates the problem. It has been suggested to us that the problem lies in the "interface" of the phone with its combined answering circuits, and that the ac transformer normally would also act as a noise filter.

Can anyone help us solve this problem? Is there a way we can filter or isolate the noise while using DC power? Like Mr. Berube, we would be greatly indebted!

On another tack, your fine magazine demonstrates the "power" of "home" publishing. Perhaps an article on how you do it would lend power to others fighting for social change from their homes.

And for anyone who is interested, I'd like to tell the world that our ancient, $40, Servel gas refrigerator just keeps on running and running without the slightest problem. In ten years all we've done is replace the door gasket. Things that work!

Yours, Peter Ladd, RFD#2, Warner, NH, 03278

Peter: I had the same problem with our R/T system. Everything functioned fine until I added an answering machine (Panasonic KX-T1427) and then nothing worked. No phone (incoming or outgoing) no answering machine, no nada. The problem was that the answering machine had a different idea of what ground potential was than did the rest of the equipment. I solved the problem with a completely isolated battery/PV microsystem to power just the answering machine. Another solution is to use a DC to DC switching power supply to give isolation. These supplies are about $50 and will TOTALLY isolate any DC gear with ground contention or noise problems. Give the folks at Carlson Communications a call (advertisers in this issue), they have the DC/DC converters. RP

Wind Equalizer

Dear HP,

I want you to know what a great magazine you folks have! I always look forward to your magazine in the mail, and it's nice to hear about people who also believe we can all share in making our world more clean and healthy, or just plain ol' beat the big guys at their own game.

I originally started out with a Jacobs 32 volt wind plant, but found out that 32 volt appliances are virtually impossible to locate, so I converted the system to 24 volt. The wind plant would begin charging the batteries in a very light wind, but now I have found out that 24 volt appliances are still more scarce and more expensive than their 12 volt counterparts. I like the higher voltage overall, and I'm not willing to give it up without a fight - everything draws less current and uses much smaller wire. I refuse to use those heat generating, current guzzling linear voltage regulators. Have you heard anything about the Vanner voltmaster equalizer for keeping batteries equalized during discharge and recharge? How efficient is it? Does it work well or is it little more than caca? If you folks don't know, please print my name and address, so that someone out there might let me know that has one of those.

I would also be interested in building something to do the job. I tried to build a switched capacitor voltage divider using 140,000uf capacitors, oscillator, and some transistors But I can't get any better than 50% efficiency out of it - maybe from improper transistor selection or something. Maybe there are some tinkerers out there like myself who could give me some ideas on this problem. I have access to any discrete component, and I use mostly 4000 series CMOS IC's.

Thanks again for such a great magazine and keep up the good work!

Steve Robertson, 204 Sasser, Clovis, NM 88101

Steve: I've no personal experience with the Vanner Voltmaster. I know that Windy Dankoff of Flowlight Solar Power (see ad this issue) has done some work with the Voltmaster. Give him a try. The Voltmaster is really a switching power supply and high efficiency for these types of units is now around 80% to 90%. RP

Swimming Anyone

Hi Folks;

Great job you're doing with the magazine. I've got a question for you and your readers.

What are the various options for running swimming pool equipment (i.e. filters, pumps, etc.) on a 12VDC system? We have used a 12' diameter above ground pool for the last 2 summers without a filtering system and would like to get a larger above ground pool next year (15' x18' x 34") but it will definitely need to be filtered.

Aside from using a generator to run the 120vac equipment that comes with the pool, what 12 VDC equipment could be substituted? I'd like to hear from anyone who has tried various other ways to accomplish this.

Thanks, Margaret Waters, Rt2 Box 48, Twin City, GA 30471

How about it readers? Anyone using a low voltage PV system to circulate and filter a swimming pool? RP

PVs, Power & Pollution

Dear Home Power,

As one who has depended on photovoltaics for electricity for the last 7 years, I certainly appreciate the miracle of producing electricity from sunlight. Part of me feels self righteous about living with a "renewable" energy source that is not spewing out CO_2 or nuclear waste. But another part of me realizes that the mining of materials and manufacturer of the panels is not a totally benign practice.

I would be curious if you have the following information?

1) What is the energy input per 50 watt panel for mining and transportation of raw materials?

2) What is the input per 50 watt panel for manufacture of cells and panel components (especially if there is plastic or aluminum in the frame)?

3) What pollutants and/or toxic wastes are associated with mining of the raw materials and manufacture of PV cells and panels?

4) What is the expected net energy of a 50 watt panel over, let us say, one 20 year period, assuming 4, 5, or 6 average hours of full sunlight a day?

5) What is the net energy of the system when one factors in batteries (to be replaced every 10 years)?

I suspect that photovoltaics may not be such an energy bargain. Indeed, I probably used up much potential energy of my first 35 watt panel the day I drove a truck 4 hours (one way) to pick it up. What I do like about PV's is that they are so expensive that I have learned to be extremely conservation minded. I cannot afford to use equipment that wastes energy. Getting the public to switch to photovoltaics is probably not as important as getting them to switch to the type of energy miserliness to which PV users are accustomed.

Sincerely, Mitch Lansky, Wytopitlock, ME

Gee, you HP readers sure ask easy to answer questions… Well, Mitch, the scuttlebutt I get within the industry says that a PV panel now will produce more power within its lifetime than took to make the panel. Whether this includes transportation, mining, and the lights in the showroom that sells the panel, I don't know.

The basic material of PV panels is silicon (like beach sand). The "sand" is highly purified and formed into wafers. This purification process is the major power consumer in PV manufacture. The hyperpure wafers are then doped much in the fashion of any semiconductor, transistor or integrated circuit. It is these dopants that present a hazard to the environment. Like any other industrial process, if one gets sloppy/greedy, then we all suffer.

At 6 hours of full output daily, a 50 Watt PV panel will produce 2,190,000. Watt-hours in a 20 year period. All financial calculations we make about these systems are based on a 10 year system life. This means the whole system is written off after ten years. Now, most of the components (PVs, inverter, controls, etc.) will last much longer than 10 years, so this method of estimating is very conservative.

The energy conservation techniques we are learning in these RE systems can well be applied to kilowatt guzzling America. Everyone, please listen, consider what that appliance will consume before you buy it. It's not a matter of doing without anything, but of doing whatever we need to do efficiently. Make appliance efficiency a prime criteria when you buy your stuff and you'll be a happy kinda guy! RP

Zapping Nicad Packs

Dear HP,

I've been loaned a copy of #11 and like the magazine. Your coverage of a broad range of alternative energy topics and helpful hints as well is great, and has peaked my interest. I hope you will add me to your mailing list for future issues.

I plan to build a home in the mountains and will be beyond access of conventional energy sources. I believe that through reading your publication I can gain the knowledge needed to make an intelligent decision toward which alternative method to choose. As an added bonus reading *Home Power* is just plain enjoyable!

In issue #11, under the Q&A section, there was discussion about rejuvenating ni-cads. I wonder if I might ask Richard to extend his advice to 12V portable VCR type ni-cads. I have about 10 of these that either hold only a very short charge or no charge at all. I've been close to throwing them away many times but have renewed hope after reading of Rick Goodier's success and Richard's encouragement.

Thank you for the good work you're doing.

Sincerely, J.F. Moore, Richmond, VA

The same info (HP#11) applies to zapping the cells in the VCR packs. The very real problem with nicads assembled into packs is that we no longer have electrical access to the individual cells. Zapping cells as series strings is entirely experimental and anyone with a success story please come forward. If you can take the VCR packs apart and get electrically to the poles of each cell, then regular zapping works. If you cannot electrically access the discrete poles of each cell, then good luck. Incidently whenever zapping nicads, wear gloves and glasses.

If you cannot get cell access, then consider the following procedure. Recharge the entire pack. Discharge it in two hours or less into a large 12 VDC load (like a lightbulb). Repeat this procedure about four times. If the pack has the will to live, then this usually does it. RP

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EVERYTHING YOU NEED to make 4-6 gallons (depending on your taste) of 100% natural, great tasting, real beer (ale). $19.95 postpaid-continental US only. Complete detailed instructions provided. You provide common household kitchen utensils and bottles (easily obtained from recyclers). The Homebrewer's Store PO Box 82736, Kenmore, WA 98028.

COMPLETE PASSIVE SOLAR DOMESTIC WATER HEATING KIT pumps water down from collector without pumps, or controls. This revolutionary new appliance -which requires no pumps, controllers, or check valves to operate-is available as a kit designed to be installed in as little as 6 hrs. with full set of instructions. This amazing system is designed to heat up to 80 gal./day and to operate without any maintenance for 30 years or more (except flushing heat exchanger yearly as with most systems). Total kit costs $1880.00 Approx. shipping weight 150 LBS. Call PMG Conservation at (704) 251-5557 collect or write PMG Conservation P.O. Box 18088, Asheville, NC 28814-0088

INVERTER SALE: Trace 2012, $975.00. Trace 612, $490.00, price includes shipping anywhere in the continental U.S. For further info., send S.A.S.E. to R.C.H., 2173 Rocky Creek Rd., Colville, WA 99114. Offer good until 12-31-89

FRUIT TREES for coldest climates. Hybrid Siberian Pears, Apples, Crabapples, Plums, bush fruit. Handbook/catalog $1 Refundable with order. Moosebell, Rt 1 Box 240, St Francis. Maine 04774

55 GALLON PLASTIC BARRELS. Sturdy, clean, & perfect for drinking water, food storage, etc. $18/each. Shipping: CA, ID, MT, NV, OR, UT, WA, & WY -$5.50/ea. Other states, except AK&HI -$9/ea. Pacific Drum 1401 13th St, Bellingham, WA 98227 206-671-8108

WIND ELECTRIC PLANT, restored 1200 watt 36 or 24 volt Winpower generator with matching 80' SELF supporting 3 leg tower. 616-874-8899

RECORDING SOLAR AND WIND INSTRUMENT STATION: Used 12v recording anemometer and pyranometer, mounting brackets, wiring, cases for chart recorders and battery, enclosure for remote use. Lots else! All or parts. Call Bruce, 213/546-7295.

FOR SALE BY OWNERS, 37 acres, remote yet 1/2 Mi. to black top. Mostly meadows, yet plenty of fire wood. Newly built 2000 Sqft Super insulated home with vaulted ceilings, 2400 Sqft Work Shop. Massive 1.1 Kw Photovoltaic Array! Trace, Heart Inverters, SunFrost etc. Large pool with concrete deck, Quality Antenna tower. Sandy garden, Location for air strip. Many special features. Prime location 12 Mi. to Lake Stockton, MO. Priced below cost. $90,000. Ph. 417-876-3941

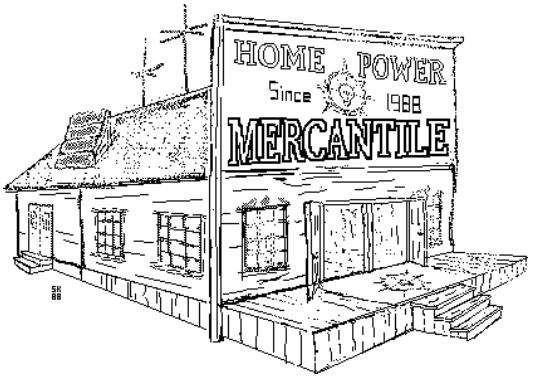
CONCENTRATING PV COLLECTOR fully-tracking, cone type, water heating 500 watts, 17500 BTU/hr 7 yrs old. $2500/offer BEST 24V 2500W inverter $700/offer AE experimenter surplus: tanks, pumps, collectors, heat exchangers, steam engine, motors, etc. 12 VDC 8 cu. ft. Artic Kold refrig. George Helmholz 74550 Dobie Lane, Covelo, CA 95428 (707) 983-6525

ARCO AND SOLAREX SALE. Arco module prices are up 15% and Solarex up 10%. We have a good supply of Arco M-75 48W modules at our old sale price $325 each. We also have a very large supply of Solarex modules at the old sale prices. MSX-50 48W - $299 and MSX-50 50W - $309. For hotter climates we have higher voltage modules, MSX-53 53W - $315 and MSX-60 - $355. All modules are shipped free UPS for 48 states. Fowler Solar Electric Inc., P.O .Box 435, Worthington, MA 01098 413-238-5974.

KYOCERA PANELS, HELIOTROPE ELECTRONICS, TROJAN AND SURRETTE BATTERIES, AND SUNFROST PRODUCTS are some of the items available from us at the absolute lowest prices. We are pleased to give a quotation on your requirements. This is our second decade in quotation on your requirements. This is our second decade in alternative energy. Call or write and let us know how we can help. System Electric, Box 67, Lydon, VT 05849. 802-626-5537.

GEMINI 4Kw 200 VDC to 120/240 vac line commutated inverter. $1,200 OBO. Also limited supply of Edison batteries. Call 303-963-9632 24 Hrs, answering machine or JD, 0171 HWY 133 C-2, Carbondale, CO 81623.

CONSIGNMENT LIQUIDATION: All sorts of PV equipment, below dealer cost. M65s, 4x4 cells, 2K & 5K inverters, Sunlites, Patiolites, Batteries, 10K Generator, Electric Car, more most new, some demo. Send $1 and SASE for description and prices. To view items, send VHS tape and $3, or just $7 (we'll send a VHS tape) to Mark Gilbert, Box 424, Colwich, KS 67030



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