$3.50 U.S.
$4.95 CAN.

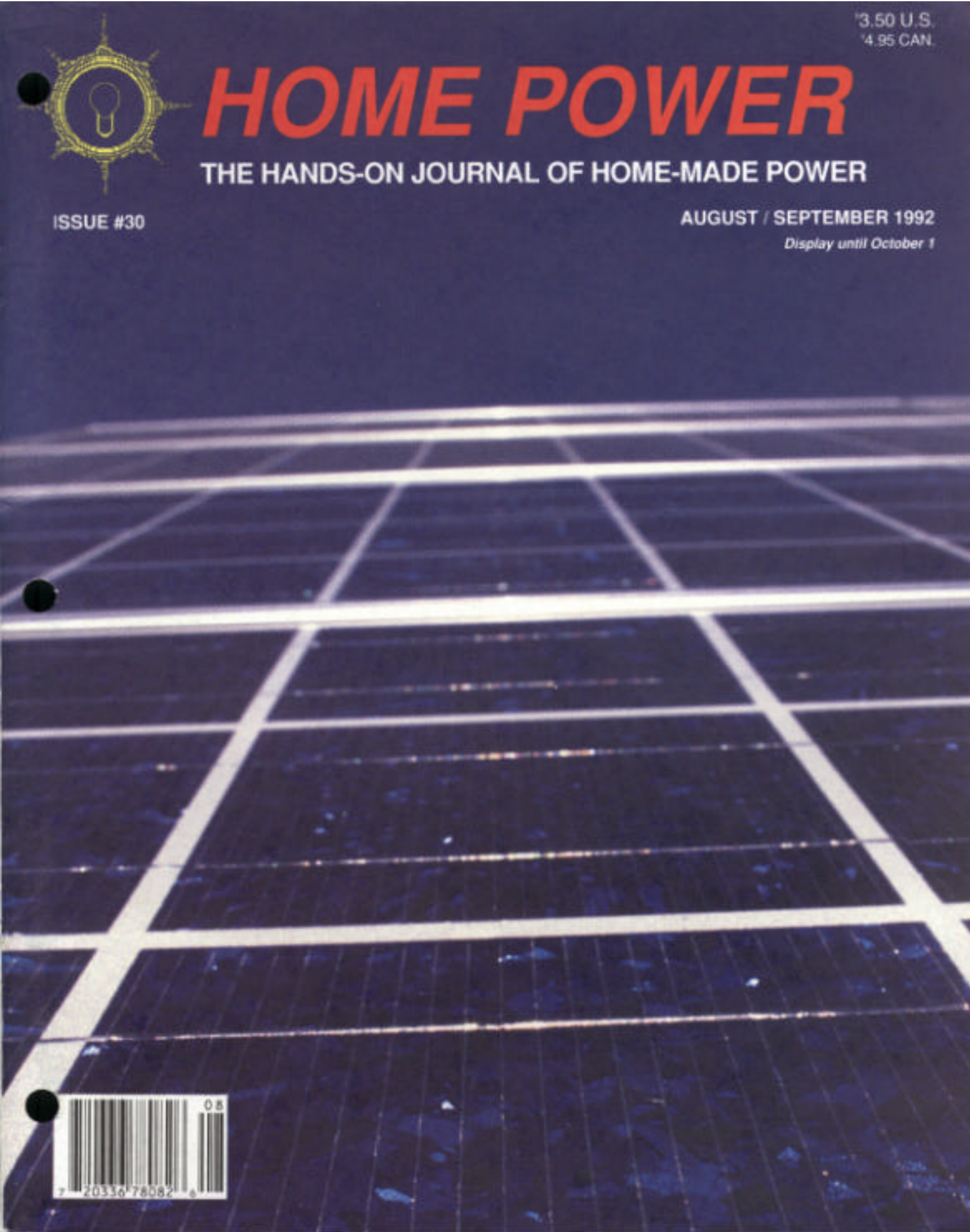
HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

ISSUE #30

AUGUST / SEPTEMBER 1992

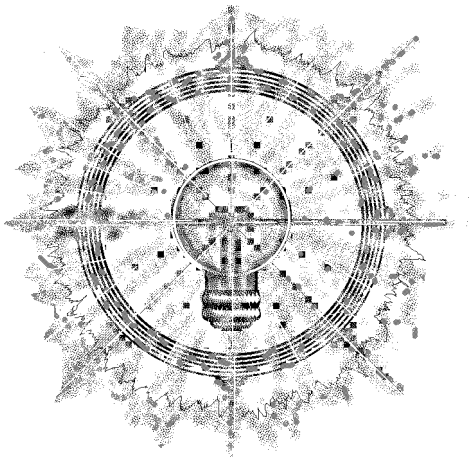
Display until October 1



08

7 20336 78082 6

SOLAREX
FULL PAGE
FULL COLOUR



HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

Contents

Access

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

Think About It

"To him whose elastic and vigorous thought keeps pace with the sun, the day is a perpetual morning."

Henry David Thoreau 1817 – 1862

Cover

A close up photo of some Kyocera photovoltaic modules smiling at the sun.

Photo by Richard Perez.

From us to YOU

Home Power Magazine's Fifth Anniversary: *growing, graying, helping, and paying*

Growing
As you may have noticed, Home Power Magazine has been growing. Growing is a natural process that is energy, ecstasy, and exasperation combined.

Graying
Home Power is now five years old and still growing. While growing is fun, it is also scary. Over the last five years, the amount of grey on our heads has definitely grown. We all pay a price. For Richard and I, the price was becoming too high. We needed HELP! So that's just what we did, we hired more help. BUT—and there's always a but—more help meant more mouths to feed.

In the beginning of Home Power, everyone's labor was donated. No one received a paycheck. Five years down the road, Home Power has taken over the lives of all those involved with it. Home Power must support the people who produce it.

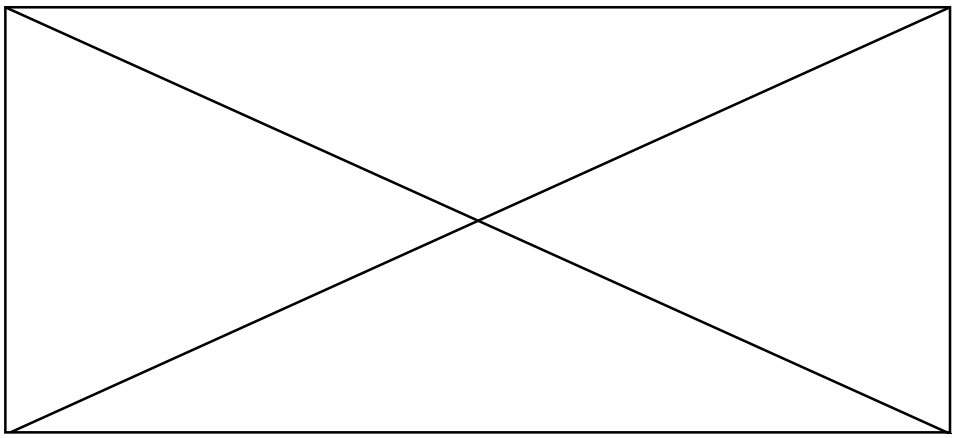
Helping
We welcome Therese Peffer and Chris Greacen to the Home Power Crew. They work, with Richard, Kathleen, and I, on Home Power—writing, editing, illustrating, processing the mail, and other chores on an endless list.

Paying
We have decided to raise Home Power's subscription rate from $10 to $15 per year. This increase allows Home Power to grow without Richard and I burning out or having nervous breakdowns. This increase allows us to support full time help in producing this magazine. Everyone who works here could easily be making twice the bucks, in half the time, anywhere else.

More Growing
So what will you get for your extra five bucks? More pages which cover more solar architecture, more domestic hot water, more solar heating, more do-it-yourself projects, and more electric vehicle articles. In this issue, Home Power has more recycled paper and soy-based color inks inside a 116 page magazine!

All of these changes means that it costs us more to publish and distribute Home Power. We are asking you, our readers, to help out by paying more for a subscription. We feel that fifteen bucks a year is a fair price. We hope you feel we're worth it, and stay with us. Thanks for listening,

Karen Perez for the whole Home Power Crew.



Above: Chris and Therese working on Home Power.

People

Stan Barr
Barry Brown
Stuart Caruk
Sam Coleman
Bart Diaz
Scott Ely
Chris Greacen
Kathleen Jarschke-Schultze
Kid's Corner Kids
Chrissy Leonard
Dan Lepinski
Bradley E. O'Mara
John Mills
Therese Peffer
Mark Peterson
Karen Perez
Richard Perez
Shari Prange
Richard Rahders
Al Rutan
Mick Sagrillo
Bob-O Schultze
John Takes
Michael Welch
John Wiles

Printing

Southwest Offset, Gardena, CA

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

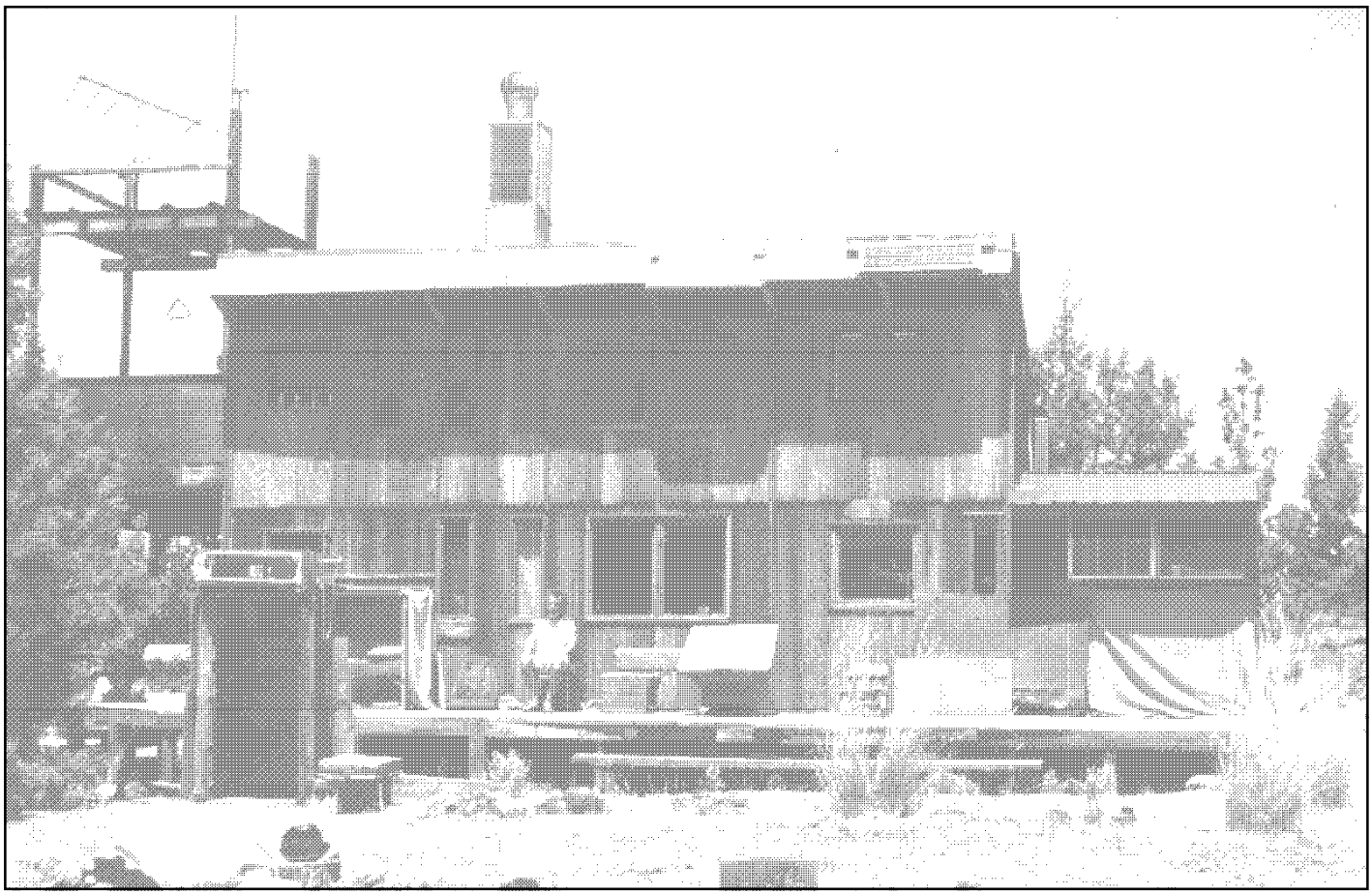
Legal

Home Power (ISSN1050-2416) is published bi-monthly for $15 per year at P.O. Box 130, Hornbrook, CA 96044-0130. Application to mail at second class postage rates is Pending at Hornbrook, CA. POSTMASTER send address corrections to P.O. Box 130, Hornbrook, CA 96044-0130.

SHURFLO PUMPS

Full page

Full four color



Above: Stu Ward's solar-powered and owner-built home in northern California. Two solar electric panels provide the power, a solar oven does the cooking, and passive solar architecture keeps the home warm. Photo by Kathleen Jarschke-Schultze

2 + 2 = More Than Enough

Kathleen Jarschke-Schultze

You first see the large yellow water tank, turn right and follow the abalone shell lined driveway to a place full of character and inhabited by one. Stuart Ward's small, owner-built cabin sits on the juniper flats below the north face of California's Mt. Shasta. His two photovoltaic panels and two lead acid batteries supply more than enough power for his lifestyle.

Homebase

Stuart Ward built his cabin over four years, from 1979-1982. The cabin is 16 feet by 28 feet with a main floor of 448 square feet and a loft area of another 200 square feet. His cost for building materials at that time was $13,500. The cabin has 15 windows on the southeast side and no windows on the north side, making the most of passive solar space heating. He used R-30 insulation in the ceiling and R-19 in the walls and floor.

He hosted the 1981 California National Rainbow Gathering at his homestead, then known as Earthbase and now called Homebase. The yard is lighted by a stand-alone solar path light system with its own built-in panel and batteries.

Stu purposefully chose his site, within a land subdivision, in an area that did not have grid power and the accompanying power lines through it. The closest grid power is a third of a mile away. For the first ten years, Stu used kerosene lamps for the most part and rotated batteries in his car.

He purchased his first photovoltaic panel in the summer of 1989. It was an ARCO M-75. The second panel, a

Stu Ward's Energy Consumption

12 Volt Appliances	*Watts*	*Hours per day*	*Watt-hrs per day*	*%*
5" color TV	12.6	4.5	57	21.5%
3 LED strips of light	2.3	24.0	54	20.6%
Main reading/working light	10.1	5.0	50	19.1%
9" color TV	44.1	0.8	33	12.5%
Main overhead fluorescent	37.8	0.8	28	10.7%
Kitchen fluorescent	18.9	0.8	14	5.4%
LED clock, battery chargers, fan	12.6	1.0	13	4.8%
VHS video player	12.6	0.8	9	3.6%
Porch light	6.3	0.8	5	1.8%
Stu's Average Daily Energy Consumption			264	*Watt-hrs.*

Kyocera K-51, was added late in the winter of 1990. The panels are fixed at 30° east of south with seasonal tilt. He uses a Trace C-30A charge controller, two Trojan L-16 batteries with six Hydrocaps and various meters to monitor his power. After reading a Home Power article, he added safety disconnects to the system. Stu did all the wiring and installation himself. He made the panel mounting racks from recycled materials. Throughout his homestead he has reused as many materials as possible. There is no inverter, no refrigerator, no generator, and no kitchen appliances in this 12 Volt system.

The main uses of the system are TVs (9 inch & 5 inch, both color), VCR, car stereo and lights. The miscellaneous uses are a car vacuum, Makita drill battery and nicad flashlight battery recharging, a digital clock, and a small fan. Stu figures his system produces two to four times the amount of power he uses. Usually by 11 o'clock in the morning his batteries are full. The only change Stu sees as a possibility in his system is a small inverter to run a computer. He is becoming interested in desktop publishing.

Solar Apparatus

Stu uses the Sun's power in as many ways as he can. His home is a wonderland of ingenuity. He made a solar shower from a camper holding tank and scrap lumber. It delivers 20 gallons of hot water on a sunny day. It stands just off the deck, on the south side of the house. The black tank sits on top of 2x4 inch framing. A handheld shower head allows more effective rinsing so less water is used. It has produced up to four showers in one day. With some salvaged windows and scrap lumber he has fashioned a solar sauna that can work up a good sweat in about 15 minutes. The main plexiglas panel faces south; the roof is made of greenhouse glazing. A cloth curtain allows entry and exit. After reading an article on solar chimneys he built one from recycled materials.

When there is no sun, propane fuels his cooking. When the sun shines, he regularly uses a SunStar solar oven, which was a gift from *Heaven's Flame* author, Joseph Radabaugh.

Energy Audit

Several years ago Stu was randomly picked from 14,000 American households for a free energy audit by the Dept. of Energy. Stu called to make sure the Auditor could find his remote home. When the auditor arrived she said not only was he the only renewable energy home she had audited, but he was the only person to call to make sure she was coming. She was amazed at how little energy Stu used in his home.

Water Saving Sanitation

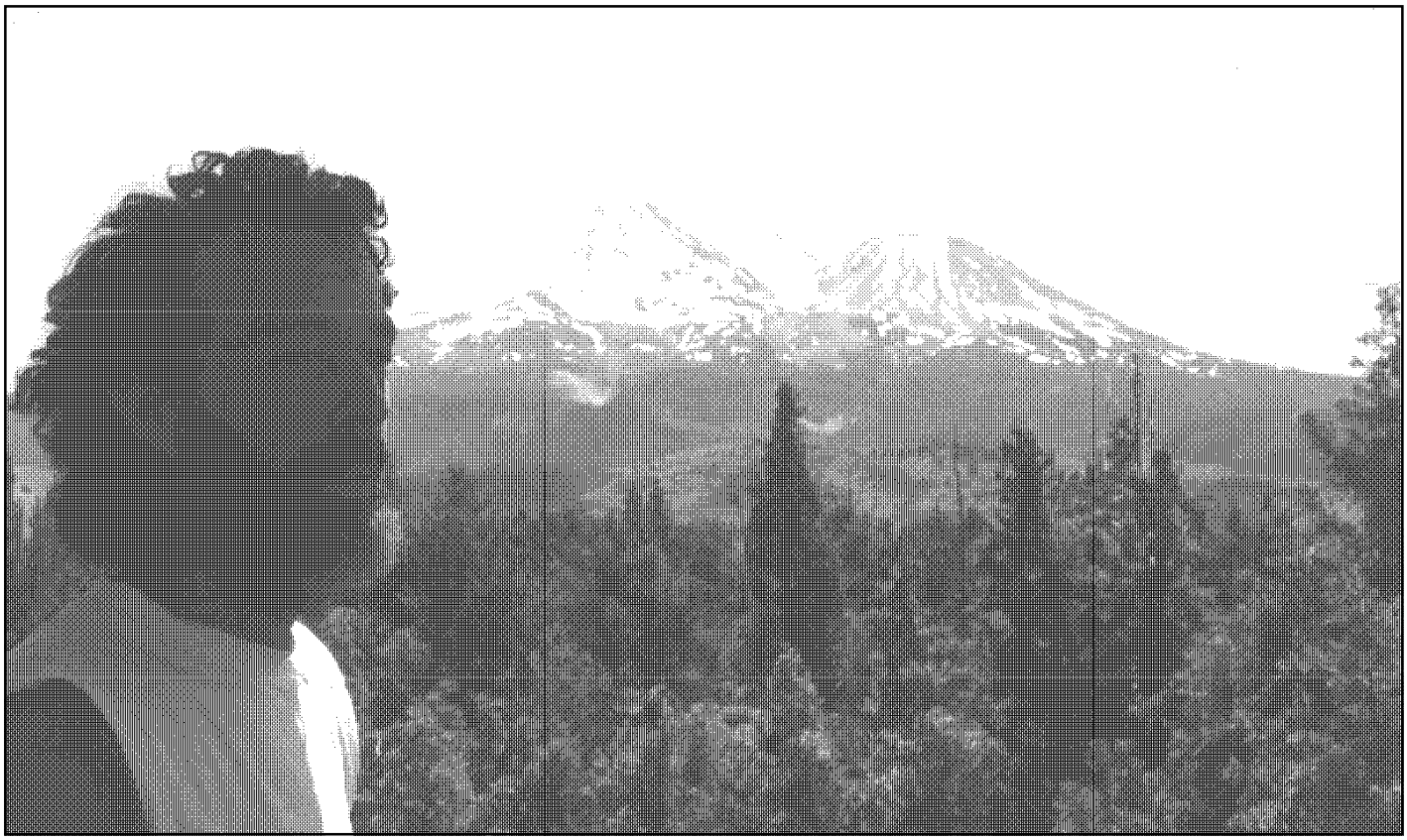
Stu uses a Sealand toilet. He collects and saves rainwater for flushing. As the Sealand only uses 1 pint per flush, it works well for Stu. This type of toilet works in conjunction with a composting system or with a septic tank like Stu's.

Conclusion

Stu's started using solar power to replace dangerous kerosene lamps. He now feels, that by using solar energy, he better appreciates that Nature provides us with the power we need. Stu learned how to design, wire, and

Where Stu's Bucks Went

System Component	*Cost*	*%*
2 Trojan L-16 lead-acid batteries	$375	29.5%
1 ARCO M-75 PV module	$325	25.6%
1 Kyocera K-51 PV module	$325	25.6%
Trace C30-A PV regulator	$90	7.1%
Disconnects, fuses, & meters	$70	5.5%
6 Hydrocaps	$30	2.4%
Battery Cables	$25	2.0%
Wire & Conduit	$20	1.6%
Fuse box	$10	0.8%
Total Energy System Cost	$1,270	



Above: Stu Ward with northern California's 14,000 foot tall Mt. Shasta in the background.
Photo by Kathleen Jarschke-Schultze

maintain his own photovoltaic system. For him, two PV panels and two batteries is more than enough.

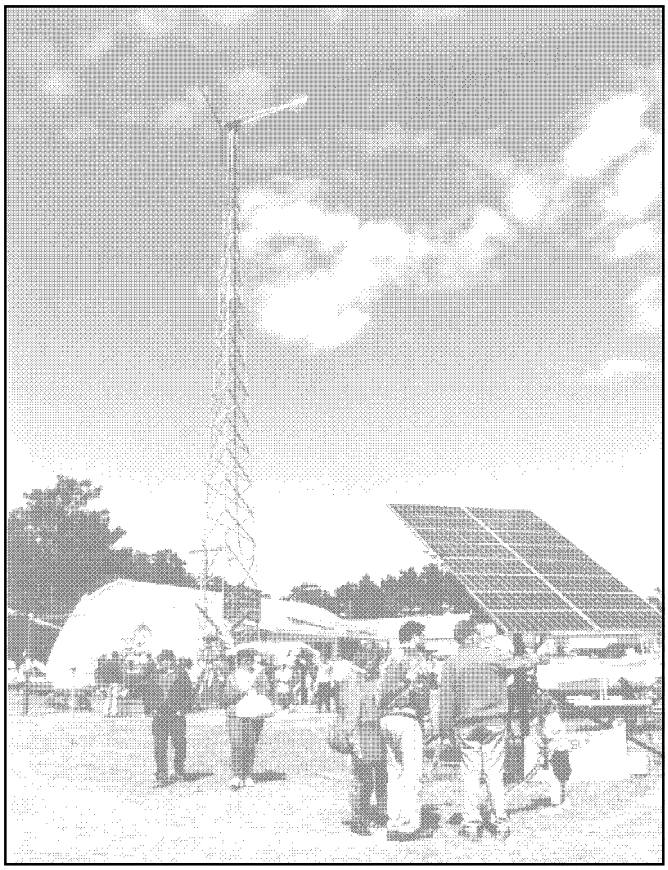
Shasta Sage

Living in the center of Shasta Sage country Stu hand picks and solar dries the fragrant sage. He then fashions it into colorfully wrapped sage smudge sticks. These have been made for hundreds of years by the local Native Americans. Stu takes great pleasure in making the sage sticks. It is against Indian custom to sell them; Stu will send interested Home Power readers his hand-made Shasta Sage Smudge sticks for the cost of postage.

Access

Author: Kathleen Jarschke-Schultze, c/o Home Power, POB 130, Hornbrook, CA 96044 • 916-475-3401

Homeowner: Stu Ward, 13715 Thrush Road, Montague, CA 96064 • 916-938-3989



Above: The Big Ole Jake whirls above thousands of fair attendees of this year's MREF. Photo by Therese Peffer

1992 Midwest Renewable Energy Fair

Chris Greacen

The 1992 Midwest Renewable Energy Fair (MREF) over solstice weekend in Amherst, Wisconsin was saturated in an intoxicating "doing-it-right, doing-it-now" spirit.

On the road again…

The Home Power crew rented a behemoth 15 passenger van for the trip. On Tuesday, June 16th we loaded "Moby Dodge" and drove for 45 hours, stopping only for gas and grits. At noon Thursday, just outside Amherst, we saw a large blue wind machine towering over a wooded lot, its 14 foot white tipped blades spinning in the wind. We knew we had arrived.

A Dynamic Flag

The wind machine, a 3 kW Jacobs from the 1930's, was the dynamic flag of MREF. You couldn't help but look up at it every now and then to see the motion pumping the electrons which powered the fair. Wind has excellent PR—you can see it happening. It also breeds a kind of wind-righteousness. Mick Sagrillo, the owner and installer of the 60-year-old "Jake", inspired mild wrath from solar folks when he commented on stage during the exhibitors' opening ceremony, "The PV racks can help trickle charge the batteries that the wind generator has charged." The PV racks held 3 kiloWatts peak of panels.

Thursday, everyone was hard at work. I joined a Stirling-engine tinkerer, a mother and daughter, and an older man with two grandsons who had volunteered to set up. We moved about 700 chairs into eight huge tents and two shelters that would hold the full schedule of workshops. Julie Weier, the official and full time mastermind of this year's MREF, did her work well. All was arranged, all was ready for the upcoming weekend.

Opening Day

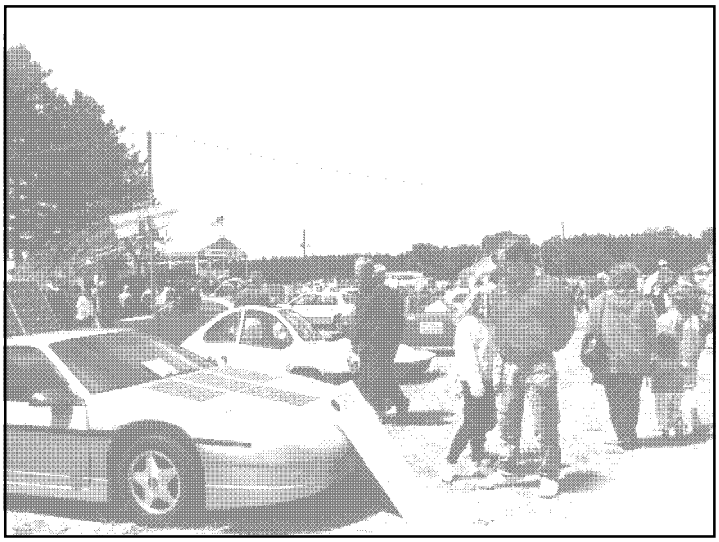
Not to break traditon, Friday was rainy and cold, but 1600 people showed up. There was serious work happening in those tents and shelters. At 10:30 am you could go to your choice of: Site Analysis for Renewables, The Passive Solar Home, Wisconsin's RE Assistance program, Elementary Science and Energy Books, Energy Efficient Lighting, Jordan Energy Institute: advanced education in our energy future, Vertically Integrated Farm Energy Systems, Solar Food Drying, Intro to PV Systems, Renewables are Ready: junior and senior high curriculum, Building a Renewable Village, or Energy Savers workshops.

An hour and a half later there was another set of twelve to choose from. These workshops continued every day from 10:30 am to 6 pm (9:30 to 7 on Saturday). There were workshops on electric vehicles by Michael Hackleman, wind systems by Mick Sagrillo, ultra-low head hydro by Ron MacLeod, concentrator PVs by Bob Hoffman of Midway Labs, batteries and inverters by Richard Perez, methane by Al Rutan, on the physics of PVs by Richard Komp, air to air heat exchangers, wildlife, sustainable gardening, utility.RE applications, high mileage cars, attached solar greenhouses, lobbying for energy and the environment...and on and on.

There were 72 workshops in all. Most were repeated during the three day weekend. Saturday and Sunday brought better weather, and attendance broke 7,500 for the three days combined.

"Real Work is Going on in those Tents"
The workshops were presented by people who have been working in their particular niche of renewable energy for ten, sometimes twenty or thirty years. Each had more to tell than he or she could possibly fit into each ninety minute workshop, but each knew where to begin and how to simply cover the ground. There were many questions, often on technical fine points.

The workshops taught and advised novices to techies. Attendees saw avenues they could pursue and dead-ends to avoid. The wealth of information is about as close as one can get to the 90-minute Vulcan Mind Meld. The only suggestion I have is for more beginner/advanced separation in the workshops. For example, the inverter class could be divided into a class on inverters for beginners and a class for advanced. That way the people who want to know intricate details won't waste the time of the folks learning the basics.



Above: Alternatively fueled vehicle showcase.
Photo by Therese Peffer

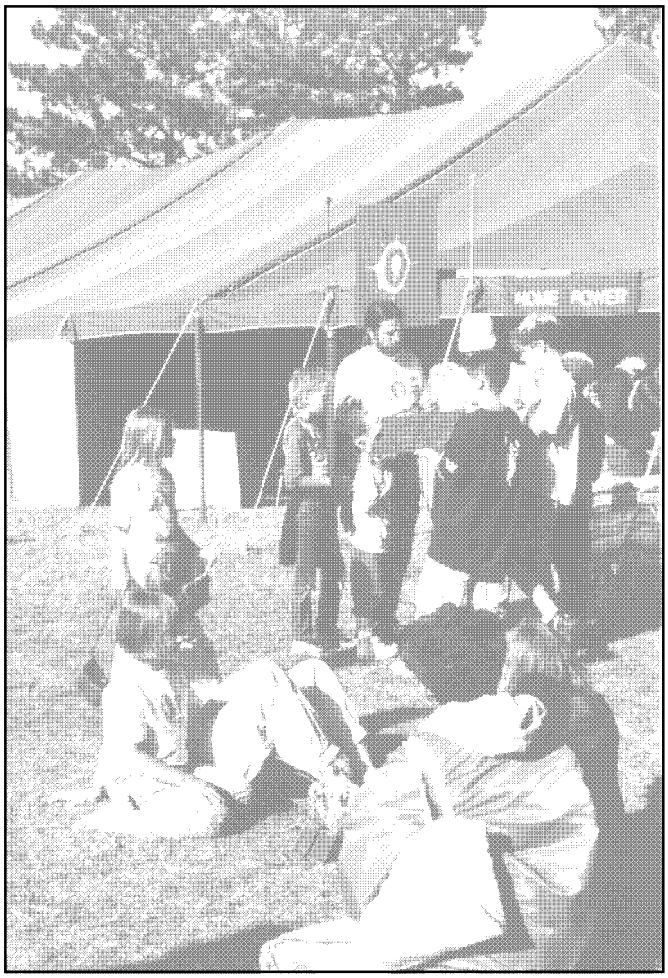
Renewable Kid Energy
Usually, energy fairs aren't places for kids. Not this one. MREF was full of kids, and high quality kids' and education workshops. Older kids led younger kids in a myriad of workshops involving solar powered Legos, cardboard villages, lots of musical instruments, and theater. In the Artists and Scientists workshop, participants took scientific measurements of the area (temperature, humidity, etc) and made an artistic mural of the findings. Kids built solar ovens from cardboard. Ellen Davis, Lyn and Jeff Mosurinjohn, and the young folks at Center Stage Productions are to be thanked for the "Next Generation" workshops.

Booths and People from Everywhere
You could have spent the three days just wandering around the 68 booths and exhibits and talking with the folks who ran them. Where to begin? There was a guy named Phil who built small stirling cycle engines out of tuna fish cans, wire, and pieces of shock absorber. On the other end of the spectrum was a tracking concentrator photovoltaic rack by Midway Labs, using fresnel lenses and non-imaging optics to concentrate light on small high-efficiency Spectrolab space solar cells. There were booths on wildlife rehabilitation, green politics, peace, efficient stoves, solar water heating, and building insulation. Manufacturers and distributors of renewable energy products came from near and far with their wares. It was encouraging to see some utilities present, too.

Electric, Human, and Corn Powered Vehicles
An Oil Overcharge Grant provided funding for the Alternatively Fueled Vehicle Showcase. Fourteen cars and vans powered by natural gas, ethanol (there's lots of corn in the Midwest) and electricity were displayed. For one ethanol car, the only modification was a unit that plugged into the electronic fuel injection which changed the injection timing. Michael Mack came all the way from Santa Rosa, California with Solar Electric's PV assisted electric Fiero. Mike Brown and Shari Prange of Electro Automotive brought a "Voltsrabbit". Buy a dead VW Rabbit (diesels are common) and install their kit—series motor, controller, beefed up suspension, etc.—and you've got a functional electric vehicle for a fraction of the cost of a new Detroit model. I drove it—it moves well and accelerates quickly. A solar race car was parked at the fair, and a solar powered racing catamaran.

There were several exhibitors of recumbent bicycles. Youth, adults, and some of the fair staff were frequently seen cruising and crashing these vehicles.

Model Home
Riding herd on the booths was a model conservation/renewable energy home. Cut-away walls showed energy efficient insulation techniques. Thermopane windows with night-time quilts and an appropriately-sized roof overhang illustrated ways to let nature warm the house in winter and cool it in summer. A low-flow shower head and complete solar water heating system, ultra-low flush toilet, compact fluorescents, and homemade efficient refrigerator showcased readily available technologies which save water and electricity with no sacrifice to the American standard of living. This home is the pet project of one of the more driven members of MREF, Kurt Nelson.



Above: Mickey Wurl-Koth leads a kids PV-powered Legos workshop. Photo by Therese Peffer

Wind Power

Just west of the Model Home was Lake Michigan Wind and Sun's blue "Jake" wind machine that helped power the fair. You could stand underneath it and feel the earth trembling slightly when there was a breeze. This booth became affectionately known as Mick Sagrillo's "windgenny supermarket". You could stand face to face with about ten different wind machines, from a 1920 era 6 Volt Wincharger to the 1992 1.5 kW Bergey.

The entire fair was powered by wind and sun. Thanks goes to Lake Michigan Wind and Sun, Carrizo Solar, and Jim Kerbel for the fair's 4,000 Watt photovoltaic system and the 3 kW wind generator. Jim Kerbel of Photovoltaic Systems Company, another MREF board member, was responsible for seeing that the entire fair was "off-grid". Jim and seven workshop participants put in two weeks wiring the wind system and PVs into one massive hybrid system. This included the Model Home, all lighting, the electric ovens cooking food at the food booths, and the sine-wave power for the evening concerts.

In the evening after the workshops were done, the fair participants gathered at the local eating places. Here we restored the day's spent energy with everything from Wisconsin fried cheese curds to some of the finest local moo ever eaten by this crew's carnivores. Here technical discussions ran rampant, their volume increasing with each penciled-up napkin.

At night, after the solstice sun had set, music by Stoney Lonesome or Greg Brown floated over the fairgrounds. The wind machine was lit from below by PV powered lights. You could see the ole' Jake from a pretty fair radius, all night long. Underneath the spinning wind generator, people gathered, sharing stories. Techies talked tech. Their souls rang like steel forged in the sun, water, and wind. I couldn't help imagining the wind machine as the site of alchemical renewable energy rituals to the wind energy god.

One late night session Chad Lampkin was at his booth nearby, and upon my request he demonstrated his 120 Volt DC to 120 volt ac inverter built in a Heart 2800 case. He had an 18,000 Watt bank of incandescent lights as a load to demonstrate the inverter surge capability. This is about twice the surge of a Heart 2800. The light from this load blinded onlookers for a good thirty seconds. These techies are seriously sick....

Back to the Future?

We saw hundreds of square miles of petroleum intensive agriculture, giant Montana coal pit mines, and coal burning power plants on the way to the fair. We also saw the fantastic energy of the wind that blows across these immense flat lands. We saw sunlight pouring over the Midwest like honey. We met thousands of folks who are ready for a change.

Get-togethers like Midwest Renewable Energy Fair not only show us the Future, but also give us the practical information we need to really get there. We at Home Power salute the hard work and dedication of the MREF crew, the information freely shared by the workshop presenters, the support of all the businesses attending, and all the fine folks who spent their weekend at Amherst. We had a great time and we'll see you there next year!

Access

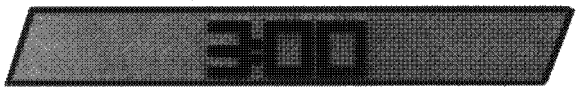
Author: Chris Greacen, c/o Home Power, POB 130, Hornbrook, CA 96044 • 916-475-3179

PACIFIC INVERTER
MODEL PI-3000

PHOTOVOLTAIC CO-GENERATION INVERTER

The inverter is supplied complete with all systems necessary to connect between a photovoltaic array and a commercial or domestic 240 Vac, 60/50HZ power system circuit breaker panel. The user can sell power to his utility whenever the net solar generated energy is greater than the user's electrical load. The local utility welcomes this extra power because during midday is the time that maximum utility load occurs. The user's advantage is that nighttime power cost is partly or completely recovered by the reverse power flow at midday. This bi-directional flow eliminates the cost and bother of batteries to store excess power.

Digital Display and Selector



Unique 7-position selector switch allows settings for: INPUT VOLTAGE, INPUT AMPS, OUTPUT VOLTAGE, OUTPUT AMP, OUTPUT KILOWATTS, CABINET TEMPERATURE, AND OUTPUT KILO-WATT-HOURS

SPECIFICATIONS

♦ ***SWITCHING ELEMENTS*** are field effect transistors for high efficiency over a wide power range.

♦ ***AC OUTPUT*** (Utility Inter-Tie): The inverter operates in a nominal distribution system and is capable of delivering rated power at or above the specified efficiency for utility voltages of 208 Vac to 254 Vac.

♦ ***DC INPUT*** (Loaded Array Output): 48 Vdc nominal; Power tracking from 42 Vdc to 58Vdc. Operational from 35Vdc to 72Vdc. Input of 0 to 80 Vdc is not damaging.

♦ ***RATED POWER:*** 3000 watts or as limited by available power from array.

♦ ***REACTIVE CURRENT:*** Limited during steady state operation from 1/8 load to rated load, to between 0.95 lag and 0.95 lead at the interconnection point to the utility.

♦ ***HARMONIC*** current distortion is less than 5 percent RMS. The maximum single frequency current distortion does not exceed 5 percent RMS. Total voltage harmonic distortion does not exceed 2 percent RMS.

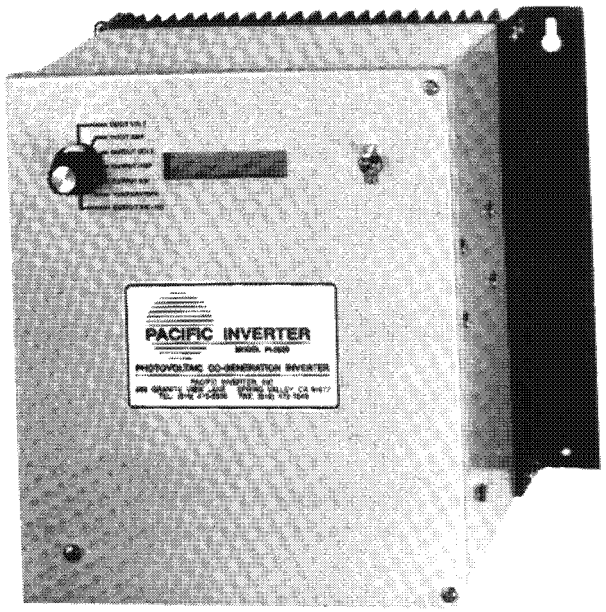
♦ ***RIPPLE:*** The peak to peak array current does not exceed 10 percent of the nominal input current at rated power. Frequency of the utility power can vary from 59 to 61 Hz or 49 to 51 Hz.

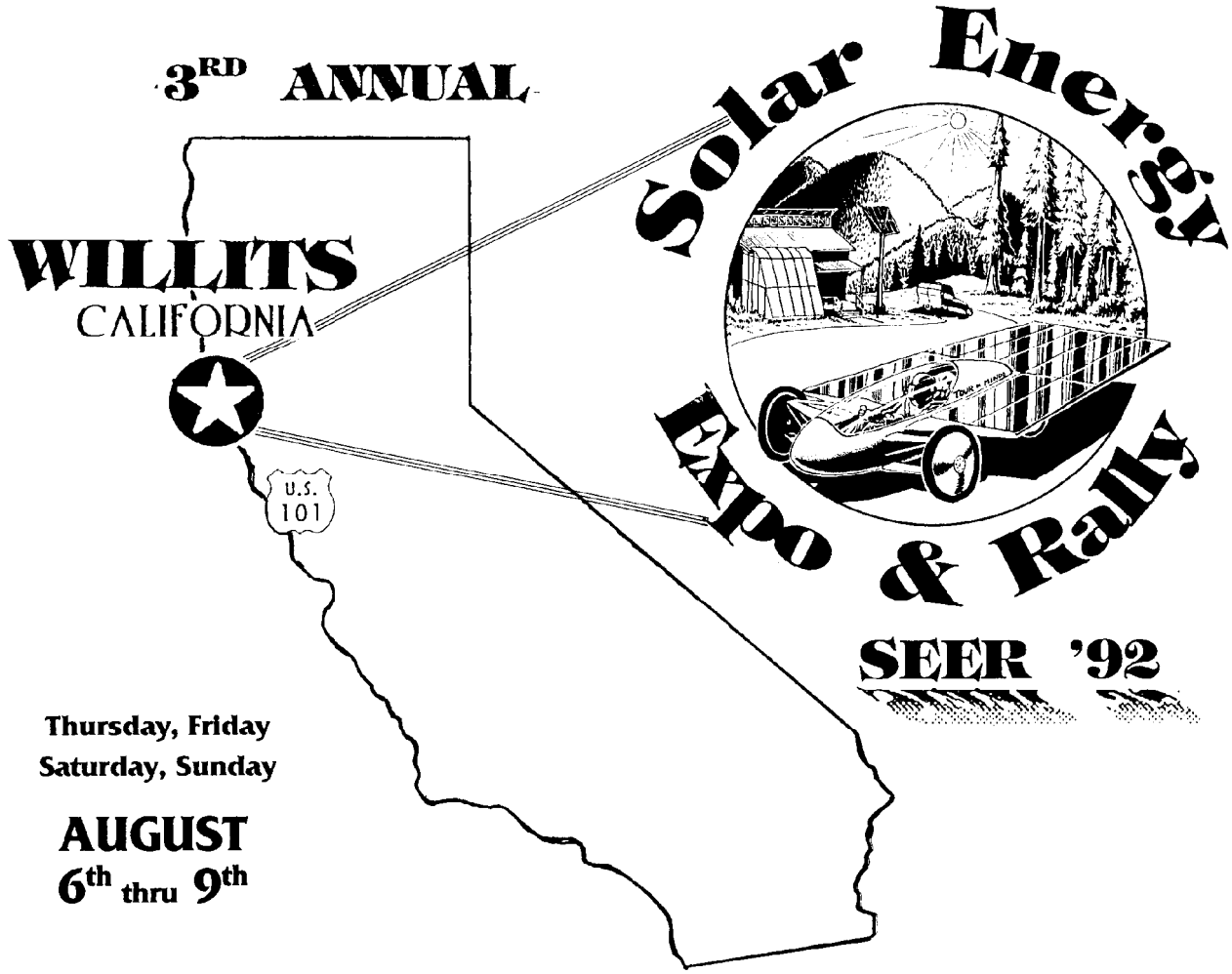
♦ ***EFFICIENCY:*** From array input to utility connection point exceeds 93 percent at full load and 92 percent from 1/4 to 3/4 load.

♦ ***AMBIENT*** operating temperature 0 to 45 degrees C; non-operating -40 to 70 degrees C.

PACIFIC INVERTER
MODEL PI-3000

PACIFIC INVERTER, INC
509 GRANITE VIEW LANE
SPRING VALLEY, CA 91977
TEL: (619) 479-5938 • FAX: (619) 479-1549





SOLAR ENERGY EXPO & RALLY 1992: EXHIBITOR ENTRY FORM

Name _____ Title _____ Organization _____

Address _____ City, State, Zip _____

Telephone (Home) _____ (Work) _____ Fax _____

***SEER '92** is a non-profit project sponsored by the Willits Chamber of Commerce. All payments for expo spaces, tickets and rally entries are considered donations to SEER, a non-profit renewable energy organization. Additional donations are accepted graciously.

TICKETS ~ EXPO SPACES ~ RALLY ENTRIES
Solar Energy Expo & Rally Admission Tickets: $5.00 Adults per day
Students & Seniors: $2.50 per day Children under 12 FREE
California Eco-Car Challenge: Tour de Mendo Vehicle Entry Form, Rules & Regulations: $5.00 per copy

Return to: SOLAR ENERGY EXPO & RALLY
239 SOUTH MAIN STREET, WILLITS, CA 95490
PHONE (707) 459-1256 FAX (707) 459-1360

Solar Energy Expo & Rally Exhibit Booth Spaces

12" X 12' space for dealers: $200	16' X 16' spaces (add $250.00)
12' X 12' space for distributors: $300	Rental table $15.00 Chair $1.50
12' X 12' space for manufacturers: $500	12' X 12' Shade Canopy $30.00

Dealer _____ Distributor _____ Manufacturer _____ Other _____
Booth Space Desired _____ 2nd Choice _____ 3rd Choice _____
Product/Service Displayed _____ Grid Power ($25.00 fee) required _____
Tables _____ Chairs _____ Shade Canopy _____

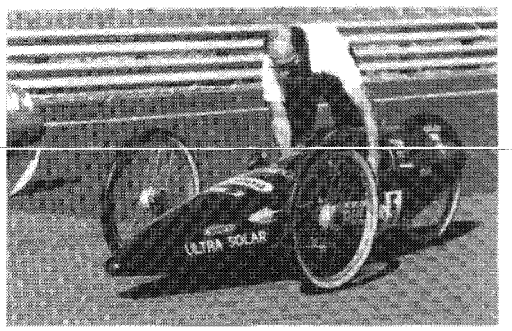
All payments/donations are non-refundable
- Four passes for each expo space
- Limited lodging available, so make reservations early

AMOUNT ENCLOSED $ _____
Please make checks payable to:
SEER '92

CONVERGENCE ON THE SOLAR CAPITAL OF THE WORLD

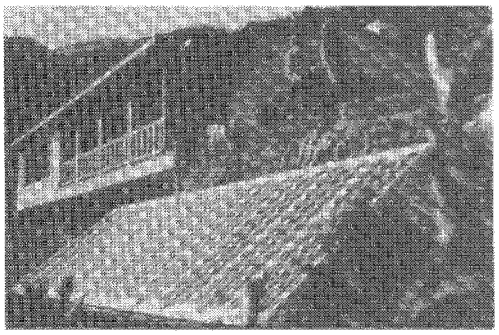
AUGUST 3 - 6 **PHOTOVOLTAIC INSTALLATION BASICS.**
The Solar Technology Institute will conduct a four-day workshop on photovoltaic system design theory and hands-on construction of a complete power system. Call (303) 963-0715 for registration information.

AUGUST 6 **THE CALIFORNIA ECO-CAR CHALLENGE**
from Eureka, Sacramento, San Jose, Los Angeles and San Francisco, Eco-Cars will be converging on the Solar Capital, Willits, CA. At noon, the cars will depart from the Exploratorium, across the Golden Gate Bridge en route to Santa Rosa, Ukiah, Real Goods and Willits.



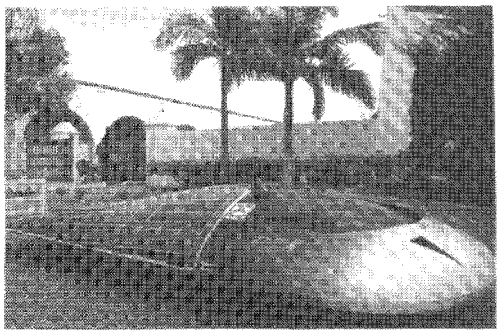
AUGUST 7 **SEER - NISSAN ELECTRATHON CHALLENGE**
Display of Eco-Cars begins at 10 AM with the Formula E Electrathon Challenge starting at noon at the Ukiah Fairgrounds - FREE ENTRY

- Eco-Car Parade and Open House at Real Goods Trading Corporation 3 - 6 PM
- Ridgewood Grade Challenge for Eco-Cars driving from Ukiah to Willits
- Industry Day at the Willits SEER fairgrounds (For exhibitors only)
- Solar Electric Specialties Hospitality Booth/informal exhibitor networking
- Gourmet Catered "Mexican Fiesta" dinner in Willlits (exhibitors only)



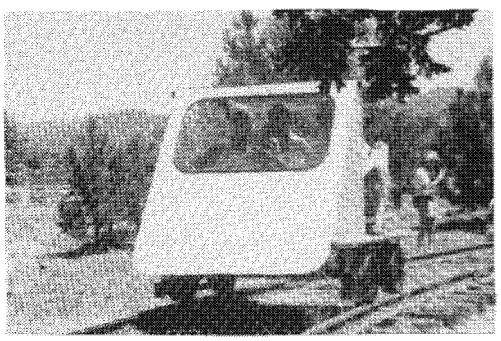
AUGUST 8 **SEER '92 OFFICIALLY OPENS WITH THE TOUR DE MENDO RALLY AND THE SOLAR EXPO TRADE SHOW**

- Solar Expo exhibitors present hundreds of displays of the latest in energy conservation and alternative energy technologies - New products unveiled!
- Tour de Mendo features dozens of clean air vehicles run on electricity, solar power, natural gas, hydrogen, human power touring the 18.5 mile course
- Panel Discussion on creating standards for HUD/FHA financing of independent power systems
- Battery Board presents the most recent information on battery storage technologies and system applications
- NCSEA presents half day seminar on solar for home heating and hot water
- Hawaiian Luau - catered dinner for exhibitors and guests
- Solar Powered Concert Saturday night with the Ruminators & Clan Diken



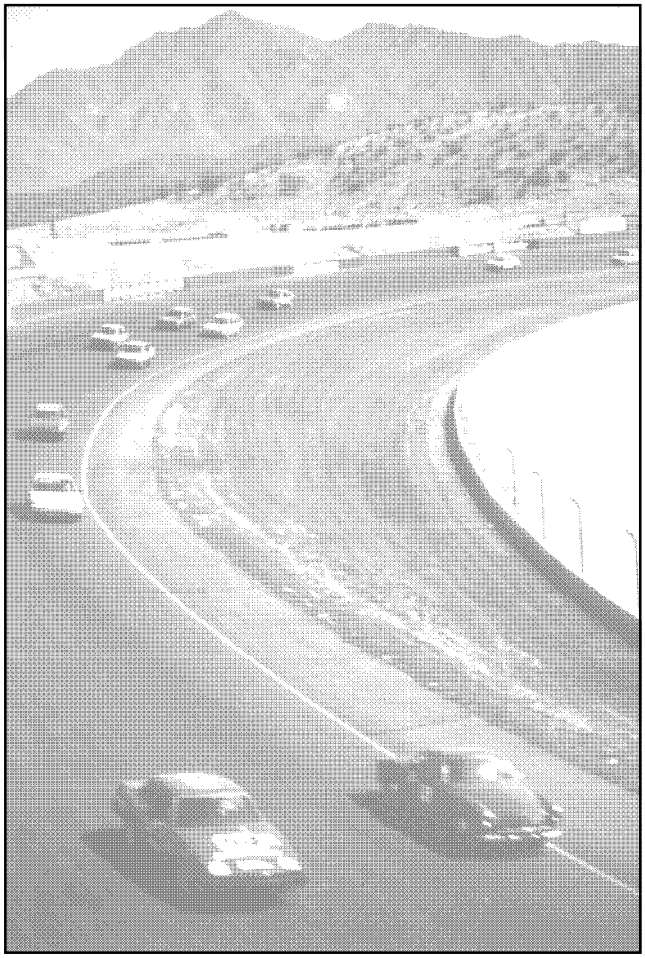
AUGUST 9 **HYDROGEN ENERGY CONFERENCE**
focusing on production, storage and transportation applications

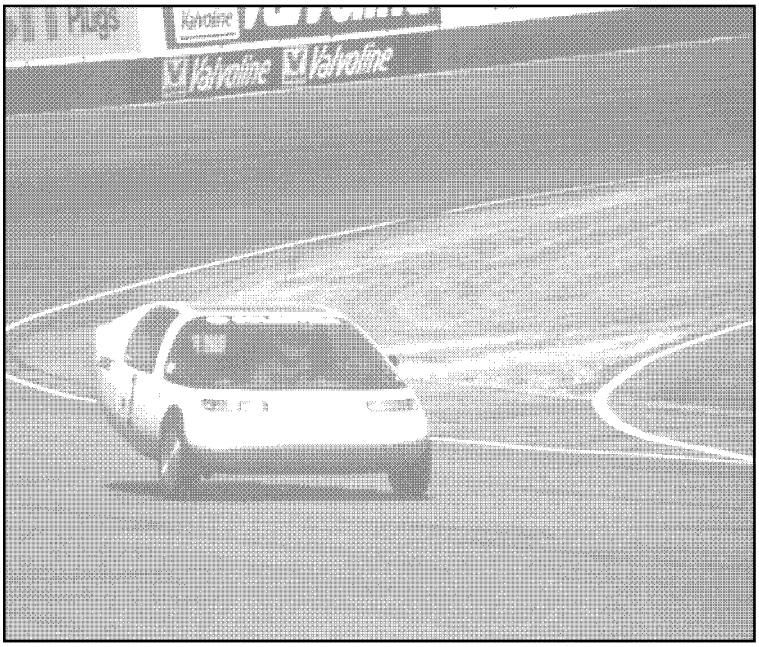
- Hydrogen fuel cell and hydride storage demonstrations showcasing new innovations in hydrogen technologies
- Larry Spring's Electromagnetic Spheres - new energy theory demonstrated both days with fascinating experiments and lectures
- Conversion of gasoline vehicle to electric power on-site
- Transportation Pavilion featuring all day seminars on vehicle alternatives
- Tour de Mendo Awards ceremony and trophy presentations

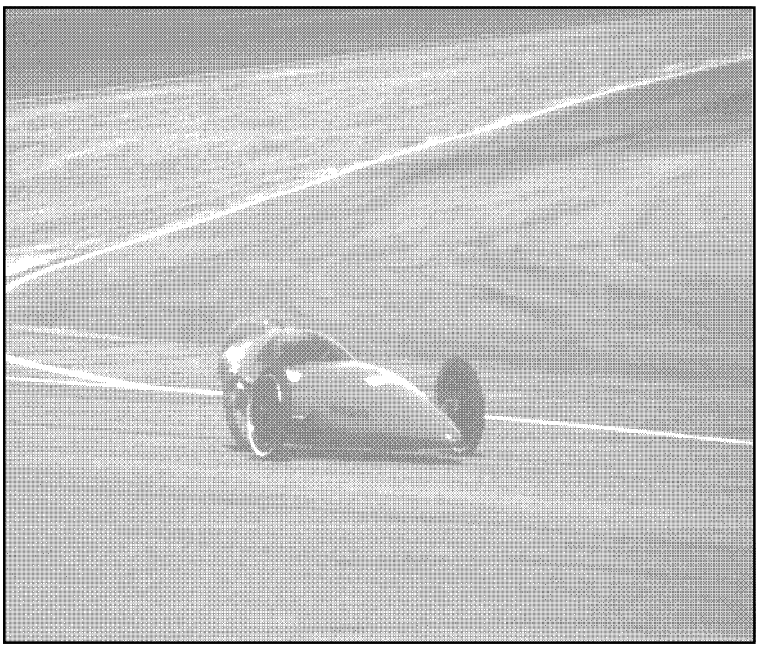


SPECIAL EVENTS **POLICE CAR DRAG RACE**
between a Willits police car and an "amped up" electric car

- The "Sol Train" rides the rails from Fort Bragg to Willits
- Actor Ed Begley Jr. & Director David Zucker will appear as M.C.'s
- EV's for kids - Solar Kit Car and "Diaper Derby" races
- Doran Electric Scooter Raffle - Win this $2000.00 prize!
- Advanced Biogest Toxic Challenge - the future of toxic waste treatment







Electric Stock Car Racing at the 1992 Phoenix Solar and Electric 500

John Takes

Top left and right: Much of the racing was between converted electric stock cars. Photos by Stan Barr

Right center: Not all EVs are stock cars, here's a Solectria entry. Photo by Bart Diaz

Right bottom: This Electrathon racer weighs in at less than 200 pounds. Photo by Bart Diaz

After attending the 1991 Solar and Electric 500 at Phoenix International Raceway, Bob, Peter, and I realized that we would be entering the 1992 event. Our 1981 Volkswagen Dasher was nearly finished. We felt that with its battery carrying capability and relatively good aerodynamics, it could be a competitive vehicle.

Preparation

Stan Barr, who is a writer and former auto magazine publisher , joined our group and began a sponsorship drive. Before long, we had equipment and/or funding from companies such as Michelin Tires, Cruising Equipment, KTA Instruments and many others. Then we got two big breaks. Ernie Holden, the founder and organizer of the race, suggested that we contact Bill Cheesbourg, a former Indy 500 racer who presently owns and operates a Volkswagen specialty shop in Tucson.

Although Bill had never been in an electric car, he was one hundred percent supportive and enthusiastic from the start. He had ideas for suspension modifications and suggested that we get the vehicle to his shop for work and testing.

The other break came in the form of sponsorship from Eagle-Picher Batteries of Missouri. They had nickel-iron batteries in a six volt package that would not only fit our existing lead acid battery cases, but had been tested at 200 amp/hrs discharge at a C/2 rate! Our calculations with our existing lead acid batteries showed that we would only get 55.5% of the available energy during the two hour limit of the race. This would mean that we would have to lower our amperage draw to around 65 amps continuous (pretty hard to imagine since we were drawing about 95 amps at 60 mph). Actually, we had been interested in these batteries for about three years but had always been told that each module (6 volt) would cost about $2,500. Eagle-Picher not only ran discharge tests according to our specs, but they sent out two nickel-iron engineers, Don and Harold, who worked with us in Tucson and at the race, installing, charging. and testing the performance of their batteries in our vehicle.

Shop Work

Bob towed the Dasher from our shop on California's Mendocino coast to Bill's shop in Tucson, Arizona two weeks before the race. Bob and I had been driving the Dasher for six months and we felt very good about its performance, range, and reliability. The main area that we knew needed work was the suspension and handling. The car sat low with over 1200 pounds of lead-acid batteries. Bill had a crew of six or seven people and in a few days the modified suspension was installed along with a full roll cage and aluminum racing seat.

Bill told me that one evening he accidentally left a door open on the Dasher, and a slight evening breeze caused the vehicle to gently roll up to his desk (about 15 feet away). At this point, Bill felt that we were doing well as far as rolling resistance was concerned.

Fine Tuning

New equipment arrived daily and was quickly installed. Then the nickel-iron batteries arrived. They were lighter (9 lbs. each) and fit perfectly. We installed metering for amperage, voltage, cumulative amp/hrs and motor, controller and battery temperature. After several afternoons and evenings of road tests between Tucson and the Mexican border, we were ready for Phoenix.

Race Day

We were all at the track at 8 a.m. on the day of the race even though our event wasn't scheduled until 3 p.m. The crew chief from the zinc-air car team was interested in how our batteries were doing (a good sign). Practice and races in other classes continued throughout the morning and early afternoon.

After what seemed like days we were called to the starting grid. All of the twenty cars looked good, ready for competition. I knew that few, if any, of these vehicles would be able to make the full 124 miles in two hours but somehow they all looked like they could. We set up our equipment behind the pit wall. Don and Harold organized for time keeping. Bob and I stood on the wall, gritting our teeth and wondering what else we could possibly do to be more ready. What could we have forgotten? I went over my mental checklist again and again. Tire pressure, metering, battery connections, instructions to Bill—all had been checked and rechecked.

Main Event

The flag was dropped and these silent, elegant vehicles were off. At the end of a somewhat disorganized pace lap the green flag was dropped, the cars surged ahead and the race was on. At the wheel of the Dasher, Bill was almost instantly in the draft position behind the two zinc-air cars. It looked like our coaching (paranoia) had paid off. It was apparent that the zinc-air team's strategy was to have the Saturn conserve its energy by drafting

1992 Solar & Electric 500 Race Results

Finish	*Start*	*Number*	*Driver*	*Laps*	*Car*	*Battery Type*
1	17	99(a)	James Worden	*91	Solectria Force Geo	Zinc-Bromine
2	1	11(a)	Tim Considine	86	Hackleman-Schless Honda Civic	Lead-Acid
3	9	95(a)	Andy Heafitz	86	Solectria Force Geo	Nickel-Cadmium
4	20	92(a)	Ed Trembly	83	Solectria Force Geo	Lead-Acid
5	4	54(a)	Mike Allen	79	E-Motion Popular Mechanics Triumph TR7	Lead-Acid
6	14	5(a)	Bill Cheesbourg	78	Burkhardt Turbines Volkswagen Dasher	Nickel-Iron
7	5	90 (b)	Scott Cornell	78	Advanced DC-ElectroAutomotive Karmann Ghia	Lead-Acid
8	2	2(a)	Chris Smith	77	AZ Public Service Demi Saturn SC	Zinc-Air
9	7	1(a)	Frank Deiny, Jr.	76	AZ Public Service Demi Honda CRX	Zinc-Air
10	16	15(a)	David Swan	76	Texas A&M Collmer Semi-conductor Opel	Zinc-Bromine
11	3	13(b)	Ron Rasmussen	75	Advanced DC-ElectroAutomotive Porsche	Lead-Acid
12	11	9(b)	Robert Hadden	73	Solar Electric-Sol Solutions Escort GT	Lead-Acid
13	8	84(b)	Mike Edwards	69	Sunbelt Battery Karmann Ghia	Lead-Acid
14	6	X(a)	Gene Cosmano	67	Cosmano Racing Geo Spectrum	Lead-Acid
15	19	7(a)	Ed Bass	65	Mabrito Dodge Omni	Lead-Acid
16	15	35(b)	Marianne Walpert	61	Advanced DC-ElectroAutomotive VoltsRabbit	Lead-Acid
17	12	19(a)	Norm Sirinik	61	Team 19 Volkswagen Rabbit	Lead-Acid
18	10	88(b)	Roy Rudy	53	AZ Department of Transportation Mustang	Lead-Acid
19	13	111(b)	Jeff Rickor	43	Solar Electric Electron Escort Station Wagon	Lead-Acid
20	18	8(b)	Rodger Ward	40	Deer Valley MAACO Auto Paint Escort	Lead-Acid

* Race Red-Flagged

Time Of Race: 1 hour, 29 minutes, 04.77 seconds. Average Race Speed: 61.294 mph

(a) indicates A Stock Class (1981 or newer) (b) indicates B Stock Class (older than 1981, did not compete for prize money)

the zinc-air Honda until well into the race and then the Saturn would make its move. After a few laps, several "trains" of vehicles drafting each other were proceeding around the track. It was clear that Bill was very experienced in this technique. Our two-way radio system failed almost immediately after the start of the event, but we had a back up system of hand signals that Bill had worked out with us. Don and Harold timed every lap and indicated that we were just about right at 62–63 mph—just what we would need to go the full 124 laps in two hours.

Strategies

From the beginning of the race it was obvious that James Worden in Solectria's #99 zinc-bromide powered car was moving substantially faster than the other vehicles. He continually increased his lead until he was maybe five or six laps ahead of the second place car. At some point, maybe an hour or so into the race, Bill got bored and pulled out from behind the zinc-air team. We were soon delighted to see the electronic scoreboard broadcast second place #5 Bill Cheesbourg! The thought that most of the other cars couldn't make the full 124 miles without stopping to charge made us feel that our chance of winning were very good.

We watched as Solectria's #99 car pulled into the pits. The crew was checking the tires and suspensions and the race announcer speculated that there were suspension problems. James was quickly back on the track. Then, about an hour and twenty minutes into the the race Bill pulled the Dasher in and indicated that the voltage had dropped. I checked the battery temperature and it was high, but still within normal range. Don checked the battery voltage and then decided that the batteries were discharged and we were through. Our cumulative ammeter read (-146), nowhere near the (-210) that we had hoped for. How disappointing! We had enough power for the last few laps so we would be counted as finishing the race. Shortly after Bill pulled in, James and the zinc-air cars pulled in followed by Michael Hackleman's Honda. At this point we had fallen to sixth.

Calamity on the Track

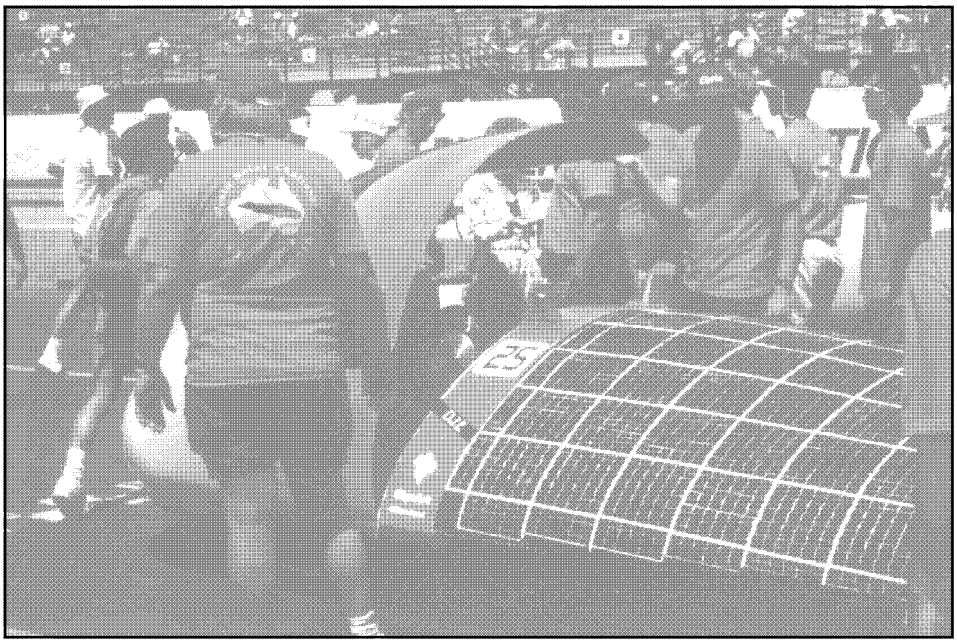
All of a sudden there was commotion and excitement coming from the far end of the pit area and crews and spectators were moving quickly away. Apparently the #99 car had developed a hose problem and its recirculating electrolyte (zinc-bromide solution) was in the car and on the track. The race was stopped and we soon learned

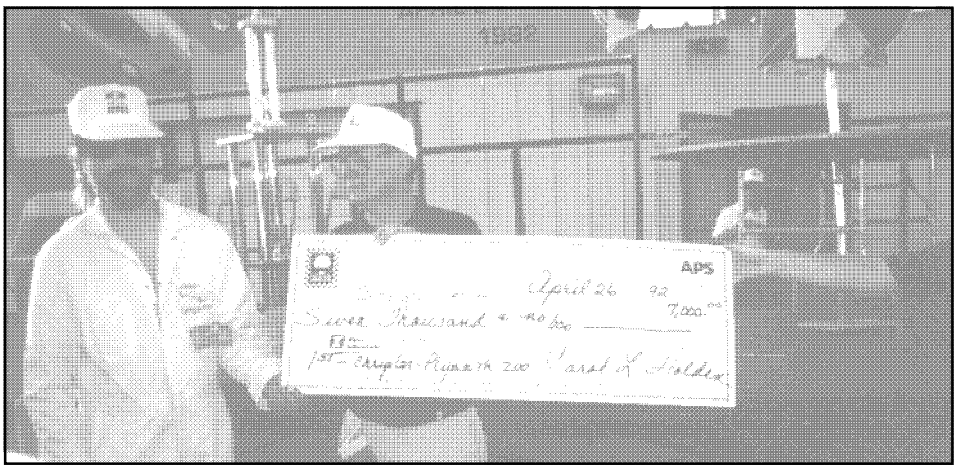
that James had to be hospitalized and about 15 people were being checked for bromine gas inhalation problems. The accident was extremely unfortunate and James and others were quite lucky—it could have been much worse.

The accident certainly raised safety awareness in both the participants and the race officials. The race organizers and tech people are well experienced in fossil fuel racing but they are new to electric racing. Fossil fuel racing safety has had decades to evolve to the point where it is today, but electric and solarelectric racing (on this level) is relatively new. New standards and safety measures are being formulated and implemented to prevent such accidents in the future.

Hindsight

After the race, Bob, Don, Harold and I looked back on our efforts from a technical perspective to try to determine what went wrong. It seemed obvious that our batteries somehow hadn't received a full charge, but why? On Saturday, there had been a 25 lap heat race and we had told Bill that he could "do anything he wanted to." Starting in tenth place he was in second place by 3/4 of the first lap. About ten laps later our 200 amp circuit breaker tripped and Bill





Top: Some of the electric vehicles were designed as EVs from the beginning.
Photo by Bart Diaz

Center: The World Solar Challenge Crew work on their PV powered car.
Photo by Bart Diaz

Bottom: The bottom line—Solectria accepting a $7,000 check for first place.
Photo by Stan Barr

pulled in. We decided to call it a day since this race was not critical to our winning the main event. It was about 4:30 p.m. and this race had left the battery cores hot. With hot cores these nickel-iron batteries are reluctant to take a proper charge rate.

On top of this, the track officials were closing the garage area and making everyone leave. In our testing in Tucson the week before, we had heated the cores and Don and Harold ended up waiting around from 7:00 p.m. until midnight to be able to properly charge the batteries. Since we had to leave the garage, we guessed at the charge rate and apparently this didn't work. What would we have done differently had we foreseen the outcome? We agreed that we would have skipped the heat race and trickle charged until Sunday's race. 20/20 hindsight.

Conclusions

My overall impression of the race was that the level of engineering had greatly improved over last year. This was really becoming a professional racing event. I didn't have the luxury this year of being able to share ideas with other builders or to even check out many of the fine entries. Those that remain to me examples of superior engineering and innovation include the Solectria cars (3), Michael Hackleman's 1992 Honda and Formula E racer and Lon Gillas' TR-7 Triumph. I truly believe that events like this will accelerate our transition into quiet, less polluting vehicles.

Batteries, photovoltaic panels, motors, controllers and monitoring equipment are all being tested here with the hope that people will see these vehicles as a practical alternative to the environmentally degrading fossil fuel vehicles that we now drive.

Access

Author: John Takes, 1258 North Main St., Unit B2B, Fort Bragg, CA 95437. John is the owner of Burkhardt Turbines. He is presently converting gasoline vehicles to electric power.

IS YOUR SYSTEM SAFE?

Are all your system components protected against dangerous short circuits and equipment malfunctions?

How do you choose the right protection device from the hundreds of different types available?

How do you connect components so that when problems occur it's a minor inconvenience instead if a major disaster?

ANANDA POWER TECHNOLOGIES IS DEDICATED TO PROVIDING YOU THE ANSWERS. With reliable equipment and superior service we make sure your alternative energy system is safe and protected, giving you peace of mind. Our user friendly, high quality products are designed to meet National Electrical Code standards and also be very easy for you to understand and install!

(**Power Center** Inside this border)

The **Power Center IV™** is the 'heart' of an AE home system and saves time, money and space by combining all of the NEC required DC safety devices, metering, controllers and terminal blocks into one compact easy to install unit. The Power Center IV comes prewired and fully tested in an attractive 24" X 24" X 6" UPS shipable enclosure.

"The PV industry has been waiting for this product for a long time...These good people are on the frontline, introducing safe, quality products. We highly recommend the products built by Ananda Power Technologies." Dan Brandborg, Sunelco.

The **SF400-T** is our **"Big Switch"** in a little package. It packs a full 400 amps of continuous power handling ability in a compact 8" X 9" X 5" unit (includes Class T fuse).

"The performance of the Ananda Big Switch is Outstanding!...When it comes to over current protection and switching high current, the Ananda SF400-T is the best device I have ever seen, tested, or even heard about. I sleep easier knowing it's on the wall of our power room." Richard Perez, Home Power magazine #27.

(**Switch** with cover inside this border)

(**Fuse block** inside this border)

Our new **Class T Fuseblock** includes an attractive red transparent cover with warning label and is less expensive than other comercially available units without covers! Available in 110 to 400 amp sizes to provide short circuit protection for a wide range of applications.

"A current limiting fuse should be used in the positive conductor of the battery bank in all stand alone systems." John Wiles, Southwest Technologies Development Institute, HP#17.

APT PRODUCTS & INFORMATION AVAILABLE FROM:

Integral Energy Systems	**Sunelco**	**Alternative Energy Engineering**	**Solar Electric Specialties**
Nevada City, CA	**Sun Electric Company**	**Redway, CA**	**Willits, CA**
800-735-6790	**Hamilton, MT**	**800-777-6609**	**707-459-9496**
	800-338-6844		

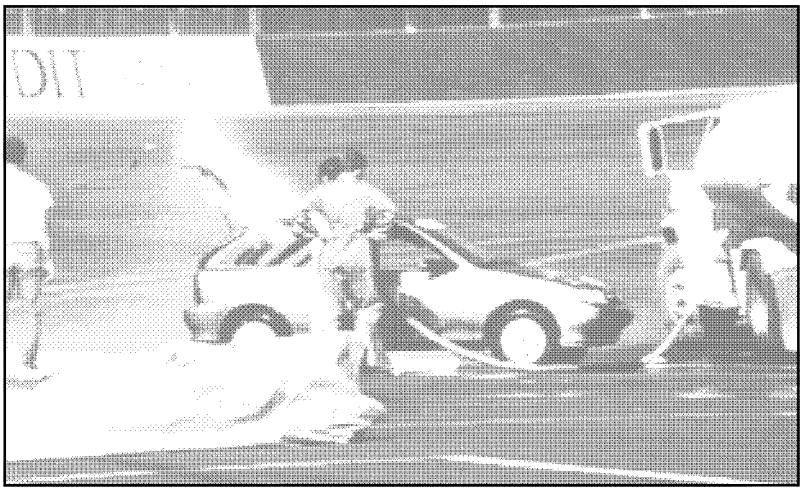
APT™

ANANDA POWER TECHNOLOGIES, INC 14618 Tyler Foote Road, Nevada City, CA 95959
(916) 292-3834 Fax (916) 292-3330 Dealer Inquiries Welcome

Manufacturing Quality Products for Safe Solar Systems

An End of Innocence

Shari Prange



Above: Solectria is sprayed with foam after the bromine leak.
Photo from video footage by Richard R. Rahders

Electric racing was forever changed one hot April Sunday at Phoenix International Raceway. The accident happened just past the grandstands, where a few hundred sat in the available patch of shade. During the final event of the Solar & Electric 500, the lead car, number 99 from Solectria, began to trail a smear of yellow fluid and vapors. It spun and came to rest not quite off the track. Driver James Worden struggled out of the car and collapsed on the ground.

The other cars stopped and soon retreated to the garages, yielding the track to ambulances and fire engines. The stands and infield were evacuated. Worden was flown by med-evac chopper to the hospital.

What really happened?

Rumors ran wild: exploding batteries, deadly gas, Worden severely burned, pavement melted. Actually, James Worden was released from the hospital in a few days with no burns and no lasting damage. The track surface was undamaged. There was no explosion, just a leak.

The drama has dissipated, but the questions remain. What really happened, and how dangerous was it?

New Technology

The Solectria car was using Zinc-Bromine batteries. This type of battery has its electrolyte, which is almost 80% water, stored in two tanks external from the reaction, and is continuously circulated by a pump for the battery to operate. Electricity is stored by dissociating zinc-bromide and storing the Zinc metal and Bromine for later recombination during discharge. During a charge, Zinc is plated onto one electrode and bromine evolves at the other electrode in the cell. As bromine is formed, it is "complexed" immediately—a complexing agent "holds" six bromine atoms. The complexed bromine is pumped to the external tank. During discharge, the electrolyte circulates to the cell for reaction with the zinc.

During the race, one of the hoses became disconnected and leaked the complexed bromine fluid, some of which vaporized on the 130° pavement. Pure liquid bromine is extremely toxic. However, the battery uses a complexed bromine solution which significantly reduces the emission of vapors. Phillip Eidler of Johnson Controls, manufacturer of the battery, said the fumes are comparable to ammonia fumes: irritating to the lungs and extremely unpleasant, but not dangerous unless inhaled in concentrated amounts. Eidler himself was on track within minutes after the incident, pouring baking soda on the spill to neutralize it just as you would for a lead-acid battery spill.

The Zinc-Bromine battery has been under development and testing by Johnson Controls for several years. It has a high energy density. The battery holds energy for short periods of time and can be totally discharged. It is intended as a battery for electric vehicles—commuter cars, busses, delivery trucks, etc.— and a load leveler for utilities and home solar power systems.

The Texas A & M entry also used Zinc-Bromine batteries, which were supplied by S.E.A. of Australia. David Swan, Assistant Director of the Center for Electrochemical Systems, said their car experienced no problems, and they still regard Zinc-Bromine as a promising technology.

The Questions
The questions raised by this incident extend beyond this specific battery, car, or race. What is the role of electric car racing? One role is to provide an exciting positive showcase for electric vehicles. Should racing then limit itself to proven "safe" technologies? Is there a "safe" technology in any car—electric or combustion? Another role of electric racing is to spur the development of new technologies and be their proving ground. As David Swan pointed out, the firewalls we now have in all our cars were developed in response to early racing accidents.

Perhaps separate racing classes would be appropriate: a "showroom stock" class, and a class for experimental or racing technology. Race organizer Ernie Holden said different classes are being considered for future events.

The Question of Safety
Racing is a dangerous sport and as electric racing matures and speeds increase, there will be accidents and injuries. Safety precautions will have to grow along with the technology and performance of the cars, but there will always be some risk. Accepting risks is the way humanity explores the edges of its potential.

However, not all risks are acceptable. It is not acceptable to endanger spectators. According to Johnson Controls, the incident in Phoenix did not pose any threat to spectators. However, it did raise the issue of the potential threat, which needs to be addressed in future racing rules.

Minimizing risks
Many procedures can minimize risks. Ambulance and fire crews were on site and properly briefed for the race. "The emergency crews did exactly what they were supposed to do, " said Eric Holden.

Not everyone was briefed. Mike Brown of Electro Automotive was in the pit and one of his team's cars was right behind Worden when the spill occurred. Said Mike Brown, "I know there were Zinc-Bromine batteries in the race, but I know nothing about how they work or what to do in an accident. Better safety briefings are definitely needed, especially on exotic technologies." Eric Holden agreed that more detailed information on possible hazards should and will be disseminated to all track personnel and driving teams.

What rules should apply to the batteries themselves? Both James Worden and driver Tim Considine agree the batteries should be contained and isolated from the driver.

What should tech inspections include? What are the qualifications of the inspectors? Eric Holden plans to bring in qualified independent parties to assess the safety issues specific to new technologies. Teams will be required to submit detailed plans of their cars, especially the battery systems, well in advance of the race.

Mike Brown, from his years as an auto mechanic, feels this incident is a strong argument for automotive-quality components in automotive applications. "Gauges and fittings that work just fine on a lab bench were never intended to withstand the temperatures, vibration, and jostling of a car. We already have the technology to handle hazardous fluids in vehicles. We need to apply it."

Professionalism is another factor. In the two years of the Solar & Electric 500, some of the cars were built in haste at the track under less than ideal conditions, and made their maiden runs to qualify. This erodes safety, and more so if experimental technologies are used.

Driver Responsibility
Drivers and teams are responsible for monitoring the condition of their cars, and must voluntarily pull out if they detect potential safety hazards such as leaks, bad tires, or unsecured batteries.

Tim Considine, a professional race driver, objected strongly to the poor skill of some of the amateurs, which was evidenced by numerous reported "bumps" between cars. Although "bumping" probably did not contribute to the bromine spill, it did unnecessarily lower the overall safety level of the race. "I saw some very foolish driving out there," he said. "There has to be better policing of the drivers." He does not rule out amateurs. "Amateurs can be good or bad. The fellow in the Porsche never made a wrong move, and he had never raced before."

One suggestion is that drivers be required to take several checkout laps under judges' observation to qualify for the race, or show some minimal driving experience. Perhaps the race sponsors could provide a short practical introduction to race techniques and etiquette by a professional driver prior to the race. Eric Holden agrees that there will be tighter security and controls on driver ability in the future.

Overreaction
And what about the release of toxic hysteria into the atmosphere? When the bromine hit the fan, there was a cry of "Run for your lives!" and a minor stampede through the infield. If the grandstands had been full, the panic could have been much more dangerous than the bromine.

Ignorance begets fear. In a world where we are daily warned of invisible dangers in the innocent-seeming sunshine and rain, the unknown red cloud had a terrifying appearance. The race announcer especially should have

information at his or her fingertips. A voice of calm sanity could do much to preserve order in such a situation.

The Conclusion of the Race

One final hotly debated question applies only indirectly to safety. Should the car responsible for ending the race prematurely be awarded first place? James Worden who was leading by several laps when the race was red-flagged was awarded the trophy. So far no one has found a precedent for the situation in racing history. Or is it possible, as Worden contends, that the spill could have been cleared and the race safely completed under calmer, better informed circumstances? “If I had to do it again, I’d do the same thing,” said Eric Holden. “I prefer to err on the side of caution.”

Off the race track

Aside from the rules and safety considerations of the race, do these technologies belong in our future personal cars and homes? There is irony in this question. The accusations being tossed at exotic batteries are the same ones the public throws at electric vehicles in general: “Aren’t they dangerous? What would happen in an accident? They’re too strange—we should stick to improving conventional technology.”

We must evaluate the risks and benefits, and techniques to minimize or eliminate risks both on and off the race track. Many common items in our homes and cars are dangerous if used carelessly or improperly, but we scarcely notice because they are familiar and well controlled. Methods exist for safely handling dangerous technologies like sulfuric acid or propane.

Coming of Age

“It’s time for electric vehicles to grow up,” said David Swan. “Up until now, they’ve been idealized as wholly benign. We need to acknowledge that, like any car, they have hazards that must be adequately addressed in their design.”

The Phoenix incident raises many questions that involve people as much as they do technology. The answers cannot blindly embrace all new technologies and ignore potential risks, nor condemn all new technologies and all risks as bad and unacceptable. The wise answers will lie somewhere in the middle.

As Tim Considine said, “Today electric cars came of age.”

Access

Author: Shari Prange, POB 1113, Felton, CA 95018, 408-429-1989

STATPOWER

camera-ready

UTILITY FREE

camera-ready

Above: Passive Solar home of Bob and Mary Donlan in the hills above Carbondale, Colorado
Photo by Chrissy Leonard

Passive Solar: Glass and Glazing

Scott Ely

Picture yourself staring calmly out a large window at the snow-capped peaks or the roaring ocean. The light of day brightens the room. It's cold outside, but the sunlight shines in, warming your bones. Your dog is launched on the carpet. You don't need to explain passive solar gain to him!

Harnessing the sun's light and heat is a clean, simple, and natural way to control the light and temperature in our homes. Passive solar design entails the arrangement of basic building materials to maximize the sun's energy. Glazing describes any material which allows sunlight to pass through it while retaining a certain amount of heat. Designing with glass and glazing provides our source of natural light and heat, and also a means for ventilation, moisture control, privacy, views, and outdoor access.

Understanding the Solar Spectrum and Heat Transfer

To make good choices on glazings, you need to understand a bit about light and heat. The sunlight that strikes the Earth is comprised of a variety of wavelengths. Ultraviolet (UV) light is short wavelength light (5–400 nanometers) and is invisible to our eyes. UV light comprises about 2% of the solar spectrum. Visible light is the light you see. It is light of medium wavelength (400–800 nm) and accounts for around 49% of the spectrum. Finally, infrared radiation (light in the form of heat) has long wavelength (800–1000 nm) and makes up most of the remaining 49% of the spectrum.

Different glazings will selectively transmit, absorb, and reflect the various components of the solar spectrum. For example, controlling ultraviolet light can save carpet, fabrics, and furnishings from fading. Likewise, reducing glare (via reflection or tinting) is helpful in the workplace. By allowing the transmission of visible, or natural, light you can save many watts of artificial light. But perhaps the greatest effect on human comfort levels is determined by infrared heat transfer. By specifying the right type of glass, you may choose to trap the infrared heat for warmth, or reflect the infrared heat to prevent warming.

There are three ways that heat moves through a glazing material. The first is conduction. Conductive heat is transferred through the glazing by direct contact. Heat can be felt by touching the glazing material. The second form of heat transfer is radiation; electromagnetic waves carry heat through a glazing. This produces the feeling of heat radiating from the surface of the glazing. The third method of heat transfer is convection. Convection transfers heat by motion, in this case, air flow. The natural flow of warm air toward colder air allows heat to be lost or gained.

The R-value of a glazing—its insulating capabilities or resistance to the flow of heat—is determined by the degree of conduction, radiation, and convection through the glazing material. However, air infiltration will also determine the overall R-value of a glazing system. The amount of heat that travels around a glazing is as important as the heat transfer through a glazing. Air can leak in or out of a building around the glazing via the framing. The quality, workmanship, and the installation of the entire glazing system, including the framing, affects air infiltration.

The concept of R-value is really "brought home" if you compare the insulation in your ceiling and walls with that of your glazings. If you were heat, and were plotting to get out, where would you go? Through the R-11 wall or the R-1 window? Window manufacturers often boast about the high R-values of their products. These figures are usually based on measurements at the center of glass and do not include the type of framing and overall window design. Ask the salespeople about the workmanship of the unit, the weather stripping, and installation recommendations.

Basic Glass Types

Glazing materials include glass, acrylics, fiberglass, and other materials. Although different glazing materials have very specific applications, the use of glass has proven the most diverse. In all fairness, there should be a discussion on other glazing materials; however, I have found glass to be the best all-around passive solar glazing material. The various types of glass allow the passive solar designer to fine-tune a structure to meet client needs. (see chart of glass comparisons on page 29).

The single pane, or lite, is the simplest of glass types, and the building block for higher performance glass. Single lites have a high solar transmission, but have poor insulation—the R-value is about 1.0. Single pane glass can be effective when used as storm windows, in warm climate construction (unless air conditioning is being used), for certain solar collectors, and in seasonal greenhouses. Structures using single pane glass will typically experience large temperature swings, drafts, increased condensation, and provide a minimal buffer from the outdoors.

Perhaps the most common glass product used today is the double pane unit. Also known as insulated glass (IG) or thermopane, double pane glass is just that: two lites manufactured into one unit. These IG units incorporate a spacer bar (filled with a moisture absorbing material called a dessicant) between the lites and are typically sealed with silicone. The spacer creates a dead air space between the lites. This air space increases the resistance to heat transfer; the R-value for double pane is about 1.8–2.1. Huge air spaces will not drastically increase R-value. In fact, a large air space can actually encourage convective heat transfer within the unit and produce a heat loss. A rule of thumb for air space is between 1/2 inch and 3/4 inch. You could go as large as 4–5 inches without creating convective flow, but at that point you are dealing with a very large and awkward unit.

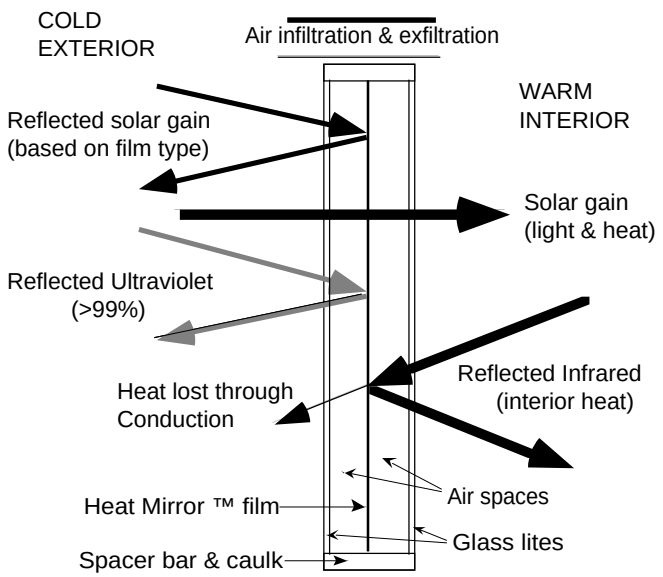
The demand for greater energy efficiency in building and retrofitting homes has made insulated glass units the standard. With good solar transmission and fair insulation, the IG unit is a large improvement over the single lite. Windows, doors, skylights, sunrooms, and many other areas utilize double pane glass.

High Performance Glass

High performance or enhanced glass offers even better R-value and solar energy control. By further improving the insulating capability of glass, you can dramatically increase your design options. What were once insulated walls may now become sunrooms. Solid roofs and ceilings become windows to the sky. Dark rooms can "wake up" to natural light, solar heat gain, and wonderful views! For a relatively small increase in cost you improve efficiency, provide better moisture and UV protection, and gain design flexibility. A variety of high performance glass is now available. What makes it so great?

Low emissivity (Low-E) glass is succeeding double pane glass in energy efficient buildings. Emissivity is the measure of infrared (heat) transfer through a material. The higher the emissivity, the more heat is radiated through the material. Conversely, the lower the emissivity, the more heat is reflected by the material. Low-E·coatings will reflect, or re-radiate, the infrared heat back into a room, making the space warmer. This translates into R-values from 2.6 to 3.2. In warmer climates you can reverse the unit and re-radiate infrared heat back to the outside, keeping the space cooler. Low-E·glass improves the R-value, UV protection, and moisture control.

Heat Transfer And Solar Gain Through Heat Mirror Glazing



Heat Mirror

Low-E glass has recently taken a back seat to Heat Mirror™ glass as the leader in energy efficient glazing and window technology. Heat Mirror glass incorporates a double pane unit with a suspended film stretched between the panes of glass (see above diagram). This polyester film or substrate has a wavelength-selective coating of metallic particles which controls emissivity and thus the re-radiated infrared heat, and controls UV transmission and visible light through varying degrees of reflectivity. The result is a glass unit with superior insulating capacity (R-values from 3.8 to 7+), outstanding UV protection (>99%), excellent condensation control (due to the warm interior pane), an improved sound barrier, and incredible design flexibility.

Heat Mirror offers a variety of film types with different reflective properties. Southwall Technologies, the manufacturer of Heat Mirror film, has assigned numbers to the film types corresponding to the reflective properties. For example, Heat Mirror 88 has the lowest reflectivity and highest transmission which translates into more heat gain. In the Northern Hemisphere, south-facing rooms provide the best orientation for light and heat. Typical locations for Heat Mirror 88 include vertical glass on the north, east, and south. Conversely, the Heat Mirror 66 film is more reflective. While visible transmission is slightly less, the higher reflectivity is very effective at blocking out unwanted heat. This is useful in skylights and west-facing glazings, where overheating is a potential problem.

Low Iron Glass

Another enhanced, or specialized glass is called low iron. Low iron glass has a reduced iron content which allows for maximum solar transmission—even better than single pane! Almost every solar hot water collector uses low iron glass for that reason: high transmission for maximum heat gain along with the strength of tempered glass. Low iron lites have a smooth side and a patterned, or textured side. The textured side allows the incoming light to be diffused into the space. The diffuse light is great for many plants and the diffused translucence provides privacy; this makes low iron a nice option for greenhouses and private spaces. Low iron lites are often fabricated into IG or even Heat Mirror units to increase their R-value.

Gas-filled Glass

You may have heard about gas-filled units that increase R-value. Properly done, gas-filling will increase the overall R-value of a glass unit by about 1.0. The air within an IG unit is displaced with an inert, harmless gas with better insulation properties. Typical gases used are Krypton and Argon. While the consumer certainly can benefit from greater glazing insulation, there have been some frequently asked questions regarding the gas-filled units: How do I know it's in there? How can I tell if it's leaking out? What kind of guarantee do I get for the extra money? The benefit lies in lower utility bills and increased comfort levels, but with so many variables involved, the consumer should be wary of the sales pitch and get some straight answers.

Glass Specification

When specifying glass, you will need to know certain characteristics in order to get the right glass for the job:

1) Dimensions—glass units are ordered from "block sizes", that is, the closest rectangular shape. Keep in mind that the spacer bar and sealant will invade the viewing area. When ordering high performance glass in an angular shape (trapezoids, triangles, etc.) you will need to note all dimensions for proper orientation. The glass people should help clear up any confusion. If in doubt, draw a sketch or have them visit the site.

2) Glass thickness—the thickness of the single pane(s). This is determined by the overall square footage of the unit (1/8 inch minimum for 15 square feet., 3/16 inch minimum for 30 square feet.). Larger units require thicker glass.

3) Overall unit thickness—you want to maximize R-value while staying within the limits of the framing detail. Overall thickness is the sum of one lite plus air space plus one lite.

Glass Type Comparison

	Single pane	*Double pane*	*Low-E*	*Heat Mirror 88*	*Low iron*
R-Value	0.9 – 1.0	1.8 – 2.1	2.6 – 3.2	3.8 – 7.0+	0.9 – 2.1
Characteristics	Poor insulation High transmission Large temp. swings	Average insulation Good transmission Ltd. design flexibility	Good insulation Good transmission Improved comfort Some design flexibility	Excellent insulation Variable transmission Excellent UV protection Condensation control Noise reduction Great design flexibility	Excellent transmission Textured surface
Applications	Storm window Solar collector Seasonal greenhouse	Std. glass/window	Std. glass/window Sunroom Skylight	Std. glass/window Sunroom Skylight Greenhouse	Solar collector Greenhouse Privacy area
Cost: Annealed*	$2 per square foot	$5.50 per square ft.	$8 per square foot	$9 per square foot	$3.50 per square foot
Tempered	$3.50 per square foot	$10 per square foot	$12 per square foot	$13.50 per square foot	$7 per square foot
34x76 Standard	$23	$72	$103 (1/8 inch)	$158	$34 lite / $102 IG

*Note: Square foot costs are based on 3/16 inch custom size rectangles. Special shapes, tints, and film types (HM) are additional.

4) Annealed (standard) or tempered (safety) glass—depends on the application. Annealed glass is standard (or float) glass, direct from the manufacturer. It is used for a majority of household applications. Annealed glass can break fairly easily from surface tension. And when it does break, the resulting shards of glass can be pretty dangerous. Building and safety codes therefore require the use of a stronger safety glass in many areas of a structure. Tempered glass is four times stronger than annealed glass. Tempered glass is annealed glass that has been heated to about 1200° F and then rapidly cooled. Tempered glass has a much higher resistance to surface tension. Unfortunately, this does not make tempered glass unbreakable. Pressure on the edges of tempered glass units may cause breakage. However, when a tempered unit shatters, the pieces remain small and relatively harmless. Other types of safety glass include laminated glass (two lites bonded together), glass treated with a shatter proof film, or glass with a wire mesh screen.

5) Glass type—single pane, double pane, low-E, Heat Mirror, or low iron.

6) Other specifics—it may be necessary to specify the type of seal desired. Most units with small overall dimensions use a "hot melt" seal. This is a single silicone seal used primarily to prevent moisture from getting inside the unit. The other option is the double seal silicone construction. This consists of polyisobutylene caulk as an inner moisture barrier and pure silicone for an outer structural seal. If units are to be transported through varying elevations, a breather tube should be included. The breather tube allows the unit to equalize pressure as it travels through changing elevations.

Standard Size Glass Units

Glass distributors, architects, and knowledgeable contractors will refer to"standards" when selling, designing, or installing fixed glass. Their dimensions have been determined by the size of patio door replacement glass. Low iron standards come in somewhat different sizes. Their dimensions have been determined by solar hot water collector glass replacement sizes. All standards use tempered glass because of the need for safety glass in patio doors. Standards can be single lites, IG, Low-E, Heat Mirror, or any other glass type. The glass thickness varies from 1/8 inch to 3/16 inch and they generally have a 1 inch overall thickness (except Heat Mirror which typically runs 1 3/8 inch).

Glass standards include these sizes (in inches): 28 x 76, 34 x 76, 46 x 76, 34 x 90, and 46 x 90.

Low iron standards (in inches) include: 34 x 76, 34 x 96, 46 x 76, 46 x 96, and 46 x 120.

Standards are usually manufactured in quantity and consequently carry a lower price tag than custom size units. They are typically a stock item and therefore readily available.

Square One

Understanding glass and glazing systems is only one piece of the total passive solar design puzzle. Ventilation and air quality, thermal mass, moisture control, material selection, framing detail, aesthetics and integration, usage patterns, budget and future needs, and a host of

other design issues must all be considered. By learning about the basics of glass and glazing, you are better suited to speak the language of the sales people and designers out there to get your business.

Further Info

For more background on glass and glazing systems:

1) Rocky Mountain Solar Glass in Boulder, Colorado has a wealth of information on glass, glazing and passive solar design information. Write or call: Rocky Mountain Solar Glass, 7123 Arapahoe, Boulder, Colorado 80303 • 303- 442-4772.

2) Your local energy office should be able to steer you toward glass companies that carry high performance glass.

3) Contact your local glass company. If they are up-to-date with the technology, they should be able to supply literature on high performance glass as well as assist you in understanding local building codes. Ask about passive solar projects in the area.

4) Many local builders and related associations sometimes offer owner/builder seminars where the issues of passive solar design can be explored. If you are looking for in-depth study of passive solar design principles, contact the Solar Technology Institute in Carbondale, Colorado (see ad this issue).

5) The local chapter of the National Association of Homebuilders should also be able to steer you toward information regarding glass and glazing options.

Access

Author: Scott Ely, POB 301, Carbondale, CO 81623 • 303-963-1420. Scott is the owner/operator of Sunsense, a solar design, consulting, and construction business located in Carbondale, Colorado.

Some Environmental Hazards of Lighting Systems — a Comparative View

John Mills

Dr. Ira Lubell, the Health Officer for Santa Cruz county, California, in thinking about the disposal problem of fluorescent lights, has written, "Looking for energy-efficient alternatives to incandescent lighting has produced hazards which society must weigh and assess as to the relative harm." Let's take Dr. Lubell's advice and examine various lighting systems and their potential environmental impacts.

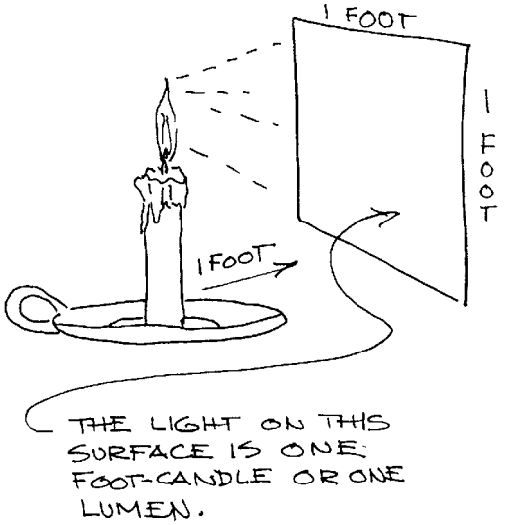
A Brief Look into the Past

Some time, long ago in the dim beginnings of human history, some extremely clever woman—or perhaps man—discovered how to make fire. From that point on, the flames of oil lamps, candles, or gas jets became our first lighting system. Thousands of years later Mrs. O'Leary's cow is said to have started the great Chicago fire by kicking over a lantern, and if it's true, this certainly illustrates the awesome hazard potential of this type of lighting. Surely there must be a safer way to light the barn.

Even though most of us think of Thomas Edison as the inventor of the electric light, others in fact proceeded him. In 1820 an Englishman named de la Rue connected a coiled platinum wire in a glass tube to a battery and noted that the wire gave off visible light. Between 1810 and 1872, a number of inventors also discovered that an electric arc jumping between two carbon rods produced light. This was the great grandfather of our current fluorescent lamps. In 1879, at the youthful age of 32, Tom Edison solved the practical problems and opened the door to commercial incandescent light bulbs. At about this same time, improvements in dynamos and the development of transmission wire and switches combined to make large scale electrical lighting systems a reality. So it was that just over 100 years ago this great electrical lighting experiment we are now involved in, began.

How is light measured?

The experts in this field routinely delve into the mysterious world of: lamberts, apostilb, bondel, lux, and even nits. You and I can simplify a bit by thinking in terms of the foot-candle. This is the amount of light cast by a candle at one foot distance on a one square foot surface. One foot-candle is also equal to one lumen. A 100 watt incandescent light bulb is rated at about 1710 lumen. This means that at one foot from the bulb is as much light as 1710 candles. On the brightest summer days with the sun overhead the natural outdoor light would be about 10,000 foot-candles. Moonlight, on the other hand, is about 0.03 foot-candle.



Over-illumination

Amory Lovins has stated, "Most modern architecture is extremely energy intensive with absurdly high lighting levels...." Could this be true? In order to answer this I set out to find out how sensitive our eyes really are. Selig Hect calculated in the 1940s that only 50–150 quanta are required to produce the sensation of light—far far fainter than even moonlight. In the days before electrical lighting, British government officials set the light minimum at 1 foot-candle. This was called the grumble line because below this level small printing became hard to read and clerks were apt to grumble. In the 1930s most illumination was below 50 foot-candles. Today, however, some authorities recommend 100 or more foot-candles of illumination. Our homes and businesses now blaze about 100 times brighter than those of the candle and kerosene lamp era. If one foot-candle is all that is necessary for reading and conducting business why do we use so much more today?

In the 1920s studies were done that indicated that the more light a person had the sharper their vision became. Light bulb manufacturers, electric companies, and enthusiastic sales personnel endeavored to bring more lighting and hence better vision to schools, factories, and businesses everywhere. Incandescent bulbs produced too much heat to be practical at levels over about 50 foot-candles. After the introduction of fluorescent lamps in 1938 the ceiling on foot-candle levels could be raised even higher. Over the years these high illumination levels have become standards for architects and engineers.

Ancient religion too, may have played a part in our desire for more light. The Zoroastrians of Persia associated light with positive virtue. After all, who wants to be thought of as dim? Businessmen have used high lighting levels as effective psychological means to attract attention and increase sales. The most compelling argument for using more light, however, is that it results in better vision. This is sort of like an investment—we pay our money and get a return. The problem is that a lot of investment is required for only a little return. If we increase lighting levels, for example, ten times over the one foot-candle level, vision improves only 1.3 times. One hundred times more lighting yields a 1.7 fold improvement. This indicates that using high level illumination over large floor space areas may be a poor personal and business investment. It also may be environmentally unsound in that it is an inefficient use of our limited electrical resources.

Perhaps Mr. Lovins is right when he chides us for our over-illumination. Times have changed since the 1920s, and today the electric utilities and the lamp manufacturers generally urge responsible conservation of electricity.

What About Incandescent Light Bulbs?

Incandescent light bulbs are all quite similar. The halogen lamp has a halogen substance included to prolong the life of the filament. The quartz halogen has a small quartz bulb and can withstand higher temperature thus putting out more light. Screw-in type quartz halogen bulbs are now available for either 120 volts ac or 12 Volts DC use. These bulbs are from 10 to 50 percent better in efficiency than standard incandescents. Non-halogen incandescent bulbs seem to be composed of relatively nontoxic substances and therefore are not a disposal problem. Some incandescent bulbs are advertised at having 20,000 hour, or even 135,000 hour lifetimes. However, 3,000 hours is a typical life for most halogens, and standard bulbs may last only 750 hours. In general, longer lived bulbs are less efficient ones. When used on alternating current, incandescent bulbs will have a slight flicker at 120 times per second. Most of the energy from these lamps is given off as heat and in the red to yellow area of the spectrum. If you live in a cool climate this extra heat will be welcome. In the summer, it may be a nuisance.

Incandescent bulbs do not generally emit excess amounts of radio interference or microwaves. They emit only comparatively low levels of extremely low frequency (E.L.F) magnetic fields. Some track lighting units with individual transformers may have substantially higher levels of E.L.F. magnetic fields.

Fluorescent Lamps

Fluorescent lamps are either the long tube or the new screw-in compact type. The principle of operation is the same in each. An electric arc jumps from one end of the tube to the other through hot mercury vapor producing ultraviolet light which causes the phosphor inside of the tube to glow. Fluorescent lamps are popular these days. One of their greatest virtues is they produce about the most light for the electricity they use. Another advantage is a longer life. A quality fluorescent will last 10,000 hours.

Because of the way they work, however, there are other things that come out of these tubes and their circuitry that may be less welcome than their abundant light. Electric arcs are also radio transmitters. As early as 1910, a voice transmission was made between Stockton and Sacramento, California using an electric arc. By 1917, giant 500 kilowatt arc transmitters were sending radio signals across continents and over oceans. Every time we turn on a fluorescent lamp we also activate an arc transmitter that sends out electromagnetic waves of many types. Some of these may be a health hazard or have the ability to interfere with our thinking process.

Extremely Low Frequency (E.L.F.) Magnetic Fields

All fluorescent lamps need special electric circuits for starting and power regulation. This is called a ballast. This ballast and its associated wiring can produce E.L.F. magnetic fields. Some of the newer high frequency switching ballasts have been designed to produce much lower amounts of E.L.F. Studies indicate that prolonged exposure to intense E.L.F. fields can cause serious health problems and interference with the thinking process. Richard Perez and Bob-O Schultze have written an in-depth article about E.L.F. in issue number 23 of Home Power. This article, with its excellent bibliography, is a fine resource for more information on E.L.F.

Radio Noise

Fluorescent lamps and their circuitry also generate other, higher frequency radio waves. If you have a portable radio and you put the antenna near a fluorescent lamp you will hear signals in the long wave and short wave

bands. This is called broadband radio frequency interference (RFI). These signals are generated in the tube and ballast. They then use your wiring as an antenna to radiate into space. Some types of modern, high frequency ballasts and their tubes are certified RFI quiet by the FCC, and they are silent to most radio receivers. Incandescent lamp dimmers and inverters can also produce RFI. As we have increased our use of electrical items, broadband radio interference has also increased world-wide to the point where it has limited communications and some scientific research. Dr. John Kraus mentions the impact of this interference on radio astronomy in his interesting book *The Big Ear*.

Microwaves

You might be surprised to find that fluorescent lamps also produce microwaves. So does your wife, your husband, your dog, and your cat. In fact any object that is warm produces microwave energy. There is an important difference however. Fluorescent lamps produce a lot more microwaves than natural sources—thousands to many thousands of times more. On the other hand, the amount they produce is far below the levels considered a health hazard by the most conservative government standard. So why worry? Well, responsible scientists have found that pulsed microwave energy can penetrate deeply into and be absorbed by models of the human head. Also, pulsed microwaves can interact with our nervous system in strange and still unexplained ways. It is possible, but by no means yet proven, that the microwave radiating from fluorescent lamps may be having some measurable effect on our senses of hearing, taste, smell, our memory or our ability to think clearly. Since fluorescent lamps have only been around for 54 years the impact of the long term pulsed microwave exposure from them is still unknown.

Flicker and Color

Think for a moment about the light from a fireplace or candle. There is a slow irregular flicker that we easily recognize. Some authorities would even claim that this type of light has special romantic power. Now think about a fluorescent tube powered by the ac line or an inverter. It flashes on and off at a rate of 120 times per second in a regular synchronized pattern. Some compact fluorescent lamps with electronic ballasts flash at faster rates. Some people find this strobe effect annoying while others don't seem to mind. Incandescent lamps powered by pure DC do not flicker but rather give off a steady continuous glow.

Lighting systems approximate but do not exactly match natural daylight in color. Most of us are aware of how how color can affect our moods and perceptions. Just imagine eating a hunk of green meat or a black tomato. Although some of this work is considered controversial, John Ott has spent years investigating the effects of light and color on plants, animals, and humans.

The Toxic Waste Problem

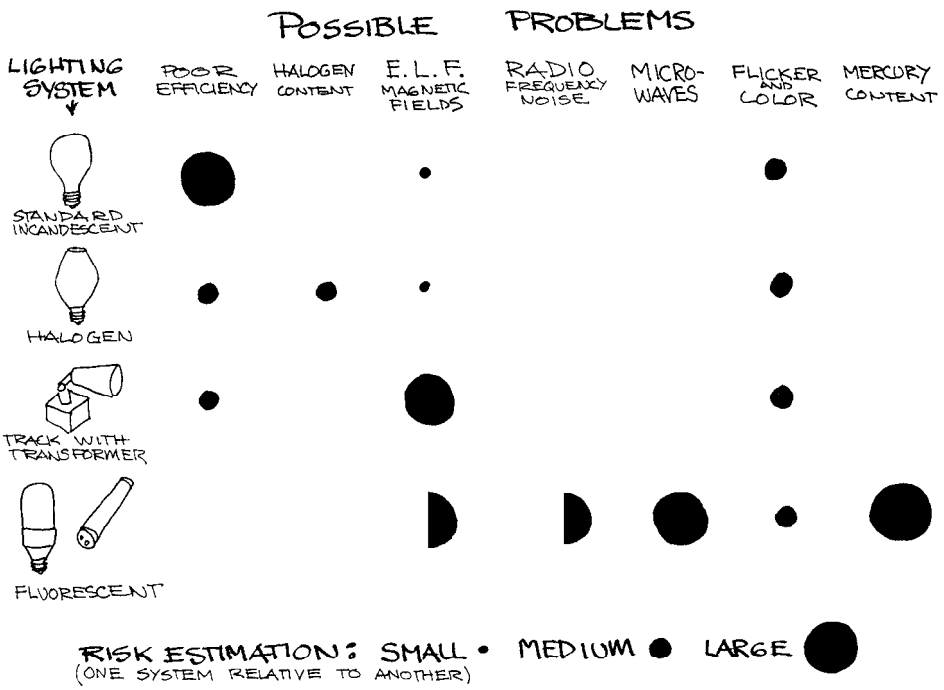
The manufacturers of fluorescent lamps have made a sincere and successful effort to reduce the levels of toxic substances in their products. Over the years they have introduced new and safer phosphors. They have also been able to use less mercury. Because of the way they work, however, all fluorescent lamps contain variable amounts of mercury. Some compact fluorescents also contain small quantities of a radioactive substance to aid in starting. We can toss a regular incandescent light bulb into the trash, and if it should break, it would release a small quantity of inert gas, typically argon or nitrogen, glass fragments, some tungsten wire, and the bulb base. Halogen incandescent lamps release a small amount of halogen substance which may have environmental consequences upon the ozone layer. When we dispose of fluorescent tubes, in addition to the incandescent bulb elements we will release mercury.

Mercury has been recognized as toxic for a long time. The Mad Hatter of Lewis Carroll's *Alice in Wonderland* most likely slipped off his rocker because of his occupational exposure to mercury compounds used in the preparation of felt for hats. Mercury and its compounds are used in a number of consumer items; however, the recent trend in industry has been toward reduction or elimination. The N.I.O.S.H. recommended exposure limit for mercury vapor is 0.05 milligrams per cubic meter of air. Fluorescent tubes contain from 20-350 milligrams of mercury. A little math here will show that one fluorescent tube contains enough mercury to contaminate a rather large air space.

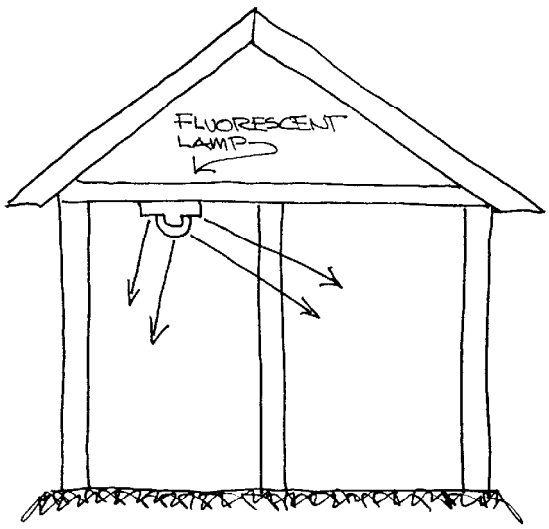
Fortunately, only a fraction of the mercury from a broken tube will enter the air at any one time. Tests reveal that about 10% of the total will vaporize in a 14 day period. This indicates that a broken fluorescent lamp in your home will not be be a major disaster; however, if this occurs it might be wise to ventilate the area and dispose of all bulb fragments promptly, out doors, in the trash. You might want to do this gently, if possible, so as not to stir up a lot of dust. The breakage and disposal of larger numbers of fluorescent tubes is a recognized toxic waste problem and potential health hazard.

Thoughts about Risk

Judging the environmental hazards of lighting systems involves the problem of how each of us defines risk. This is sort of personal matter and it probably depends upon



our age, our philosophy of life, our occupation, and perhaps upon the information we have. Our sensitivity is also important. Consider the case of someone with a cold who cannot smell smoke. Their ability to warn us of a fire has been impaired. Hazards may be dramatic and immediate like a candle in a hay barn or more subtle and long term like the effects of groundwater contamination. Some decisions that we make about risk might only affect us personally or they might affect large numbers of others.



What Can We Do?

We can affect our own and the larger environment by our choices of lighting systems and by how we use them. Depending upon our personal assessments of the risks involved we might use conventional incandescent or halogen lamps for study or work areas where the lamp will be near the user. We could also utilize efficient fluorescent lamps in outdoor or more remote locations that need low cost, long-lasting illumination. Using only the needed amount of light for the task is basic and wise. We might remember that E.L.F. magnetic fields and pulsed microwaves from fluorescent lamps and their ballasts penetrate normal walls and floors. They do this with little loss in power. The easiest ways to reduce exposure is to change to incandescents or move further away from the fixture and tube. When you move twice as far away, the E.L.F. magnetic fields and microwaves become one quarter as strong. Common sense counsels that we be careful in handling fluorescent tubes to prevent breakage and to ensure their safe disposal. Dan de Grassi, a solid waste disposal planning expert, recommends that homeowners put plastic trash bags over tubes prior to breaking them, if necessary, in order to reduce the exposure to mercury vapor.

The Luminous Conclusion

We are privileged to live at a time when each of us can use relatively inexpensive and powerful electric light. Today, with the flip of a switch even a child can call up and control more light than the mightiest ancient kings. Yet we need to be mindful of the consequences and responsibilities of this remarkable power. This genie has come out of the lamp and lighting has a bright future.

Access

Author: John Mills,10475 Vineland Road, Ben Lomond, CA 95005

Sources and Resources

1. Aitken, H.G.J., *The Continuous Wave Technology and American Radio 1900-1932*, Princeton University Press, 1985.
2. Barron, C., Study of 226 Microwave Exposed Employees, Lockheed Corp., Burbank, CA, 1954.
3. *Facts on File 1987*, Hazardous Chemicals on File, TM, Inorganic Mercury. M005 1-2.
4. Frey, A.H., "Auditory System Response to Modulated

Electromagnetic Energy," *J. Appl. Physiol.,* 17: 689-692, 1962.

5. Frey, A.H., "Auditory System Response to Radio Frequency Energy," *Aerospace Med,* 1961, 32:1140.

6. Gibson, R.S. and Moroney, W.F., "The Effect of Extremely Low Frequency Magnetic Fields on Human Performance, A Preliminary Study." Naval Aerospace Medical Research Laboratory, Pensacola, Florida, 1974.

7. Hopkins, R.G., Petherbridge, P., and Longmore, J., *Daylighting,* Heineman: London, 1966.

8. Keating, P.W., *Lamps for a Brighter America*, McGraw Hill, Copyright 1954 by the General Electric Company.

9. Kraus, John D., *The Big Ear,* Cygnus-Quasar Books, P.O. Box 85, Powell, Ohio 54065.

10. Lovins, Amory B., *World Energy Strategies Facts Issues and Opinions,* Friends of the Earth, Inc., 1975.

11. Olsen, R.G. and Hammer, W.C., "Thermographic Comparison of Temperature Probes used in Microwave Dosimetry Studies," *Proceedings of the 1978 Symposium on Electromagnetic Fields in Biological Systems. Ottawa, Canada,* I.M.P.I. Naval Aerospace Medical Research Laboratory, Pensacola, Florida.

12. Ott, John, "The 'Light' Side of Health," *The Mother Earth News,* Jan/Feb 1986 (interview).

13. Wertheimer, N. and E. Leeper, "Electrical Wiring Configurations and Childhood Cancer," *American Journal of Epidemiology,* 109: 273: 284.

BACKHOME
MAGAZINE
camera-ready

Photron

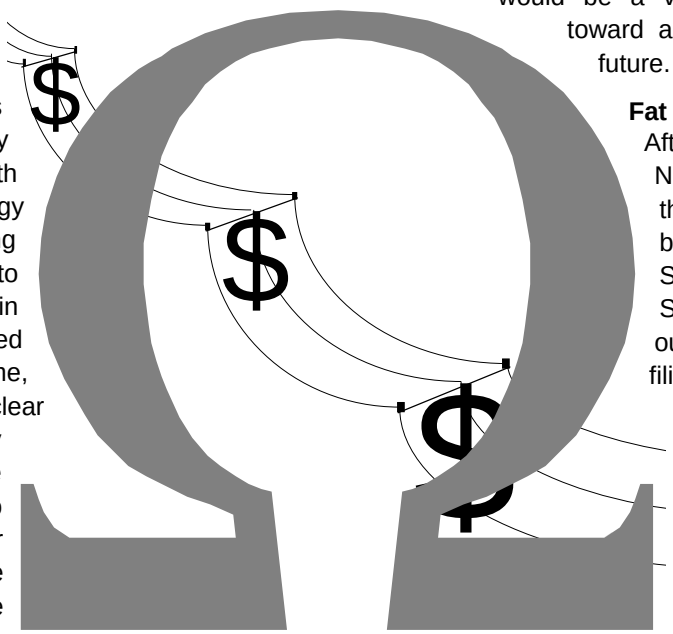
camera-ready

Ecologic
camera-ready

The lights are on but nobody's home…

Michael Welch

I am mad as hell, and you should be too! We, the people of America, are in a downward-spiralling situation—we are losing control of our government. A case in point is our president's National Energy Strategy (Tragedy) and the bills that the U.S. Senate and our House of Representatives passed in order to shape energy policy. We need a national energy policy, but I am sad to report that much of these new bills go against public opinion.



Our national energy policy is being unduly influenced by special interest groups with financial stakes in the energy industry. Many citizens are feeling disempowered by their inability to have an effective voice in government. Many have stopped voting entirely. In the meantime, lobbies like those for the nuclear power industry, the oil industry and the automobile industry are spending millions of dollars to get direct access to our legislators in Washington. The fact that more and more people are giving up their voting influence on our legislators boosts the relative leverage of special interests. This, again, makes voters feel even less effective which then gives special interests a still larger share of the power which then… A downward spiral is created. This makes our government less and less responsive to our wants and needs and puts it further in the pockets of special interest groups. It is likely that our next president and many lawmakers will be elected by an extremely small percentage of eligible voters.

Vote a Revolution

There is only one way to deal with it: revolution. Yes, a voting revolution. We all need to register and vote our convictions. With our ballots we need let our "leaders" know that we will not tolerate them mucking around with things as important as the National Energy Policy and other significant issues. We can also influence our lawmakers by direct contact. Many legislators count very carefully the phone calls and letters they receive from their constituents. Politicians assume that every message they receive expresses the same opinion as a hundred other constituents who did not or could not send a similar message. This means that just by calling, your voice will count as a hundred voices!

Back to our case in point. Years of grass roots organizational effort forced the Reagan and Bush administrations to finally write a National Energy Strategy setting the direction of America's energy future. In spite of those two administrations' strong ties to the oil, nuclear, and automobile industries, I hoped that the opinions of the majority of citizens would prevail. I hoped that the N.E.S. would be a visionary document leading us toward a sustainable and clean energy future.

Fat Chance

After Bush's horribly slanted N.E.S. came out, hope was laid in the hands of our legislators. A bad bill (Johnston-Wallop, Senate Bill 2166) came out in the Senate, and after hearings, an outpouring of public opposition, a filibuster killed it last fall. Citizens and environmental groups alike stepped back to catch a breath. Then suddenly the bill was reintroduced with some concessions. Although some of the concessions were very important to the environment, many serious defects in the bill were left intact. The bill was placed on the fast track, and within a short period of time and before opposition could be reorganized, it was passed.

Then an energy bill (House Energy Bill H.R. 776) was introduced into the House of Representatives. H.R. 776 looked much better than the Senate version. At least until the our legislators, and the special interest groups that sway them, got hold of it. The nuclear industry was able to obtain language in the bill that would significantly decrease the public's involvement in future nuclear power plant hearings. This bill would allow the Federal Government to overrule states' laws and rights in the siting of nuclear waste facilities. The next step for these two bills is a Conference Committee where differences will be hammered out by representatives of each House. There is not much that can be done to influence the process at this point. It is almost strictly a matter of combining the two bills through a series of meetings and back-room deals.

In spite of public opinion, these bad laws were passed on our behalf. And public opinion was not unknown to our representatives. Surveys show that 79% of the public was in favor of retaining the nuclear power plant hearings that these bills take away. Eighty-one percent of the public believes that states' rights should not be stripped away in the siting of nuclear waste facilities, yet these bills will do just that. Only 11% wants the nuclear industry to receive the highest funding priority to meet our future energy needs. Only 5% thinks our primary future energy source should be oil. Yet our president and lawmakers bend over backwards to make sure that unwanted and polluting technologies get the most money and attention. Sixty-three percent of the public believes that the United States can meet future energy needs by increasing efficiency, yet the emerging energy bill will barely touch on efficiency as a viable alternative to building more new power plants.

You see how it's going? The public needs to get angry at the way Congress is ignoring its wishes. Next time you read about something that you don't like, take the time to call your representatives, and by all means register to vote and be sure to vote for the good guys, because there really are still a few of them out there.

You can make a difference

Right now, you can make a difference for the users and future users of home-made electricity. Congress is beginning to consider appropriations, which is how much money they want to spend on each item in the budget. When Congress spends more money on research and development for renewable energy, energy efficiency, and alternative transportation, it means that new and clean technologies for making and storing energy will be developed. Government research means new and more efficient methods of manufacturing RE equipment and efficient appliances will be developed. This translates to more, better, and less expensive products with which to take our homes off-the-grid.

Since these decisions are going to be made soon, call your Senators, Congressperson and President today. Ask them to give renewable energy, alternative transportation, and energy efficiency a larger portion of the Department of Energy's Research and Development budget. Also ask them to make more grants and small business loans available to RE entrepreneurs. At the same time, tell them that you are concerned with the energy situation in the U.S. Tell them you will be deciding who to support in upcoming elections based in a large part on the candidates' willingness to back a renewable energy future. Then go out and vote your convictions.

Let's take back our government and make it responsive once again. Try to influence politicians' work in areas you feel are important. Give them the positive feedback they deserve when they do something right. Support a reasonable, safe, and renewable energy future. Support laws that decrease the amount of influence that special interest groups have over our political process. Ask for your Senators by calling 202-224-3121, your Representatives by calling 202-225-3121, and your President by calling 202-456-1414. Give 'em hell.

Access

Author: *Hi, I'm Michael Welch and my good friends at Home Power Magazine have asked me to write a column about what's happening in political and government arenas with regard to energy issues. They want me to "write from the heart", so you'll get more than just hard facts when you read this column. As a matter of fact, it may get down right radical from time to time.*

My background is as a community activist in Humboldt County, California, and as the Office Coordinator for Redwood Alliance, an environmental organization that deals almost entirely with energy issues. Redwood Alliance got its start by fighting the reopening of a particularly dangerous nuclear power plant in our local community, and was instrumental in getting it permanently shut down. Since then, Redwood Alliance has spent a lot of time and energy informing the public about the dangers of various unsafe methods of energy production. Then we found Home Power Magazine.

Suffice it to say that HP gave myself and Redwood Alliance some new direction. Now, much of our efforts are directed at promoting the use of renewable energy and especially letting people know that they, too, can make

their own energy. Toward that end, we are piecing together a solar electricity demonstration facility. We are also hoping to have our Home Power Computer Bulletin Board System ready for demonstration at SEER '92. From this system, a home computer with a modem will be able to look up and obtain any article from past Home Power Magazines, all the way back to HP#1. This computer bulletin board will put its users into online contact with many other folks having similar interests and experiences.

Redwood Alliance still works on other energy issues, too. Our important current projects include trying to influence the proposed construction of a nuclear waste dump that the nuclear industry is attempting to shove down the throats of residents near Needles, CA and the many California taxpayers that will end up being liable for future problems at the dump site.

Redwood Alliance's could use your support very much. We need funds to continue our many projects through this recession. We also need certain home power components to finally get our photovoltaic demonstration up and running. For more info or to make a contribution, contact us at 707-822-7884 or POB 293, Arcata, CA 95521.

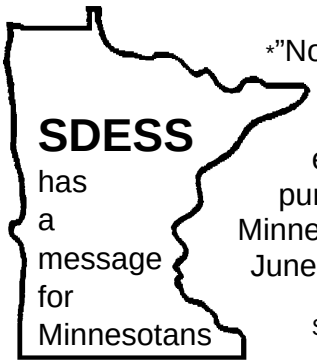
I live off the grid, even though PG&E's wires pass my driveway. Redwood Alliance's offices in Arcata will soon be off the grid and consuming electricity made directly from the sun. Michael

HITNEY SOLAR

camera-ready

TRACE ENGINEERING

camera-ready



SDESS
has
a
message
for
Minnesotans

*"No sales tax on PV & Wind equipment purchased in Minnesota as of June 30,1992."

*Thank you Senator Janet Johnson.

Savings of 6.5%

SDESS will discount ALL catalogue items thru Aug 15, 1992. Savings of 6.5%

Total You Save 13%

SDESS

SOLAR DESIGNED ENERGY SYSTEMS AND SERVICES

• Solar Heating • Solar Electricity • Wind/ Hydro Electricity • Wood Heating-Hot Tubs & Space Heating • Energy Efficient Appliances and Lights • Consultation

Stephen Dess, General Manager

218-546-5369

P.O. Box 36 Crosby, MN 56441

NEW CONCEPTS ENGINEERING

camera-ready

Even More On Methane

Al Rutan, the Methane Man

Temperature is critical to the success of any methane operation if it is to be considered an energy system. If the primary concern is waste management and not energy production, then a net energy loss is not a major consideration. If the intent is to produce energy, a net energy gain from the process is everything.

Body Heat

Methane activity, in one of its natural situations, is found in the digestive tract of warm blooded animals, people included. For people, the normal body temperature is 98.6° F. In a chicken or pig it is 103° F. So right at 100° F is the ideal working temperature for the methane process. To maintain this temperature outside an animal is a problem if the ambient temperature is cool or cold.

Sewage Plants ≠ Energy Producers

There were several methane farm operations launched in the upper midwest with much bravado and publicity. All of them are now out of business. On the other hand, sewage plants of medium size still commonly use the process to treat toilet waste and destroy pathogens, but in each instance they consume much more energy during the cold part of the year than they produce. The toilet water flowing into each sewage plant is ordinarily cold. It would be exceedingly difficult for sewage plants to be anything but energy users rather than producers at any time except in the hottest part of the summer.

Universities' verdicts at the end of the methane studies were always the same: "It's possible, but it isn't practical. It takes more energy to run the system than the system can provide." In harnessing methane as an energy system, it is important to conserve heat in the process of producing gas. A few years ago a new sewage plant was built at St. Cloud, Minnesota to the tune of 17 million dollars. I asked the engineer, "Did you insulate the tank?" He said, "Oh yes. The old one used to actually freeze on the north side during the winter." My next question was, "Did you run the insulation into the ground?" His reply, "No. The ground never gets cold." My reply was, "That's right, but it never gets warm either." This sewage plant burned $750,000 a year in fuel oil to keep the digester at 100° F. It costs big bucks to flush the toilet in St. Cloud.

Capturing Warmth

Heat has to be considered as something that is very slippery. Conserving heat requires understanding insulation. We are fortunate that there are many types of insulation available now that simply did not exist a few decades back. On the other hand, there's a general lack of understanding of insulating properties of common building materials such as wood, metal, and concrete. I recommend *Movable Insulation,* published by the Rodale Press in 1980.

Anyone familiar with insulation knows that if it gets wet, it is no longer insulation. Some "closed cell" insulating materials such as urethane, styrofoam, and polyethylene foam are more impervious to moisture than cellulose or fiberglass insulation. Even closed cell materials can break down if moisture under pressure is present.

Styrofoam is used on the outside of the foundations to provide a frost barrier for basements. Soil pressure and moisture can cause the styrofoam to be less than "bone dry" and thereby lose much of its insulating ability.

Situating the Tank

My personal preference is that the methane tank be as effectively insulated as possible. Insulation should be below the flow line of the material entering the tank, but should not be buried in the dirt, regardless of the insulation. The temperature of the ground several feet below the surface stays quite constant at 50° F – 55° F. To the methane tank, the earth is a "heat sink", a cool mass always ready to absorb its heat. The best way to fight this heat sink is to insulate the tank and build it above the ground. Another good reason for a free-standing tank is access to the grit trap at the bottom. A free-standing tank should be covered with six to eight inches of high quality insulation.

Various people have asked if a buried tank would work. I can't say that it won't, but I've never seen any that work in a cold climate, and I have seen several that don't.

Restoring Warmth

When feces leaves the body, the waste is at exactly the right temperature for working within the methane digester. Whatever heat is lost in the interval between leaving the

animal and entering the digester has to be restored. If the heat needed is significant, there needs to be a heat source available with an abundance of "free" energy, such as solar or wind.

Relation to Fermentation

The methane process is a type of fermentation. Most folks have baked bread or made homebrew beer or wine at one time or another. For instance, after a yeast dough is kneaded, it is put in a warm place free of draft and allowed to rise. A draft could produce cooling. The yeast organisms feed upon the mixture's sugar. This produces carbon dioxide bubbles, which cause the dough to rise. There is a similar activity within the methane tank. The methane organisms feed upon simple sugars, alcohols, and peptides produced by acid forming bacteria. Methane gas, CH_4, is the result.

I've been asked if the digestion process within the tank doesn't produce some heat, such as the heat produced in a compost pile. It probably does. Because the metabolic activity is so diluted and spread out within the tank, the heat available is minimal in comparison to the target temperature.

Awareness is Essential

You'll need to know how hot the tank is, day to day, season to season. To eliminate the guesswork, install sensors both inside the tank and outside the tank. Record temperature both inside and outside the tank over a period of time. Then you will know how efficiently the tank is retaining heat, at what rate the temperature drops when no heat is added, and how much energy is needed to raise the temperature. If this is done, then a reliable calculation can be made of how much gas is needed to maintain working temperature if "free" heat is not available.

Producing methane gas is relatively easy. The conservation of heat more than any other factor determines whether a methane system will "fly" or not. Of all the systems I've seen that failed, the principal reason is improper handling of heat.

Care and Feeding of your Methane Digester

Having thought about temperature, we can turn our attention to feedstock. I work with a mixture of manure and vegetation. Sometimes the question is asked: can't one use just vegetation to produce methane? It can be done because Mother Nature does. Swamp gas burning over a marsh is just that. Because the methane bacteria are part of the "flora and fauna" of the digestive tract, every time there is a fresh deposit, there is fresh input of the microbiological organisms needed.

How Much Gas Can I Get?

There's a wide range of mixes of material you feed a methane digester. It's similar to what happens when we eat. Some of the material enters our system to maintain it and some of it passes on as waste. When manure is considered, all of it, minus the water, is designated as "total solids", and the part that is digestible to the bacteria is labeled "volatile solids". The numbers of what is and what isn't available for gas production have been gathered repeatedly over the years. Each account is quick to qualify any statement by saying that there is any number of variables when dealing with animals regarding what they are eating and how they are housed. One of the clearest reference sources is a newsletter printed in 1973 by the New Alchemy Institute in California. Their figures correspond to what I've experienced.

The numbers run like this: a cow drops an average of 52 lbs. of feces a day, of which about 10 pounds are solids, the rest being water. Of the 10 pounds of solids, 80% or 8 lbs. are volatile—can be turned into gas. A horse produces an average of 36 pounds of feces a day, of which 5.5 lbs. are volatile solids. A pig produces 7.5 lbs. per day of which 0.4 pounds are volatile solids. A human produces 0.5 pounds of feces a day of which 0.13 pounds is volatile solid. Chickens produce 0.3 pounds a day which 0.06 pounds is a volatile solid.

All of this is good information, but it still doesn't tell us how much gas we can reasonably expect. If you ask an "expert" in the field, you'll get an answer something like, "It all depends..." All manure contains a degree of nitrogen, but because nitrogen exists in so many chemical forms in nature—ammonia (NH_3), nitrates (NO_3), proteins, etc.—it's difficult to test the total amount of nitrogen in a given material.

Why Consider Nitrogen?

The process wants one part nitrogen to every 30 parts of carbon. Manure is nitrogen rich, averaging about 15 parts carbon for each part nitrogen, so all the studies show that gas production is substantially increased by including some carbon material along with the manure. The

nitrogen proportion may be even higher in animal waste if urine is included with the feces because urination is the principle way an animal rids itself of excess nitrogen.

To illustrate, straight chicken manure will produce only five cubic feet of gas for each pound of manure, but chicken manure mixed with paper pulp will produce eight cubic feet of gas for each pound of manure used. My experience was an outstanding ten cubic feet of gas for each pound of chicken manure when the manure contained some ground feed that had been spilled. Cow manure will produce only 1.5 cubic feet of gas per pound, but cow manure mixed with grass clippings will produce 4.5 cubic feet of gas per pound of manure.

The Nature of Biogas

Assume that we have a gas producing system and it's making gas nicely and filling the gas holder. What do we actually have? It's important to understand that it isn't all methane. A proportion of it is carbon dioxide, produced by the acid forming bacteria, which doesn't burn. This fact isn't immediately evident because if one ignites the end of a hose coming from the gas holder, there is a blue flame.

The fact that is important to know is: if we had pure methane we would have a hotter flame—about 1000 BTU (British Thermal Unit) for each cubic foot of gas. With the dilution of carbon dioxide, we have roughly 600 BTU for each cubic foot of gas.

The composition of the gas in our gas holder will be:

CH_4 methane: 54 – 70%
CO_2 carbon dioxide: 27 – 45%
N_2 nitrogen: 0.5 – 3%
H_2 hydrogen: 1 – 10%
CO carbon monoxide: 0.1%
O_2 oxygen: 0.1%
H_2S hydrogen sulfide: trace

Wouldn't it be nice if we could separate out the methane and dump the carbon dioxide. Interestingly enough, Mother Nature has made it very easy to do just that because these gases all have different specific gravity weights.

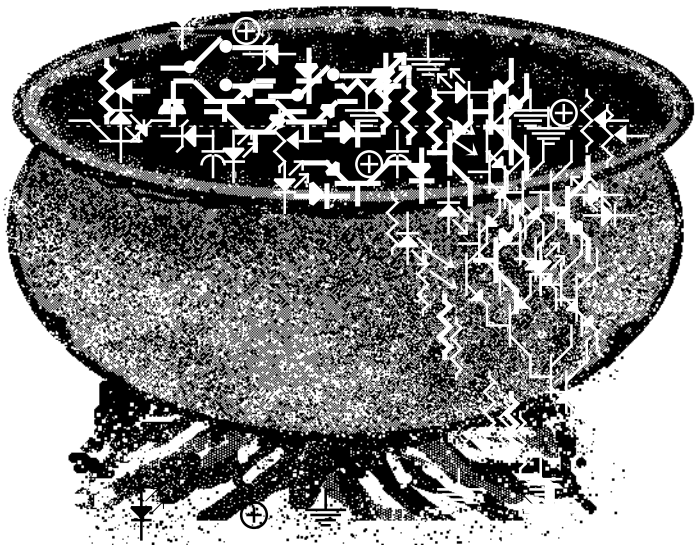
How to Get Pure Methane

The specific gravity of methane is about 0.55 in relation to the weight of air, so it rises, as does hydrogen. Carbon dioxide on the other hand is twice the weight of air. Within a vertical gas container, if the gases are allowed to settle, they will naturally separate themselves, the flammable gases rise to the top. This fact suggests that a good design should have a petcock at the bottom of a vertical gas holder. Use it to bleed off the accumulated carbon dioxide. In the right setting, this isn't environmentally harmful, because the trees and growing things around the yard will welcome a fresh sniff of carbon dioxide.

Next time we'll consider some of the safety aspects needed in working with homemade gas.

Access
Author: Al Rutan, the Methane Man, POB 289, Delano, MN 55328 • 612-860-3998

Homebrew



"Watt-Tester" turns any Voltmeter into a Wattmeter

Brad O'Mara

The benefits of knowing more about what really runs our electrical world—watts of power—go largely unknown because of the difficulty in measuring them. Volts and amps are easy, but watts are new territory for many. You can't troubleshoot or search out your system's 'lost watts' if you can't measure them. Knowing actual output power can also help you better select used modules. Low cost becomes high cost if power is lacking, regardless how well current (Isc) or voltage (Voc) check out. With the WattTester you'll never bring home a worn out "sundog" module again.

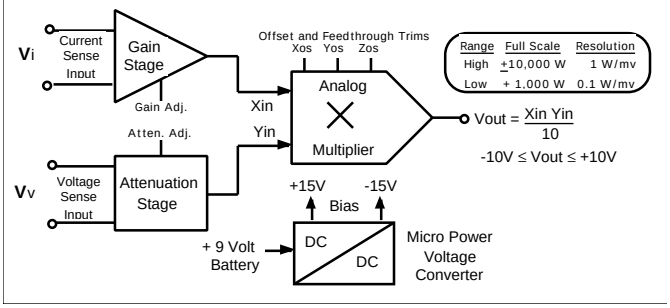
Power Meters Don't (Usually) Come Cheap

For under $50 you can construct a portable power transducer to instantly turn your trusty voltmeter into a precision power meter which works like industrial models priced upwards of $1,000 or more. You can dial in any full scale (FS) reading you want by changing a few resistor values. From 1 Watt for you micro-power designers, to more than 10 KW for those with the largest array or inverter on the block, measuring power is easy when all you need is a current shunt and a voltmeter. Now any low cost digital multimeter (DMM) can measure watts with a precision of 0.10W per millivolt (W/mV) at an accuracy of 2 %. All of this from 3 smart chips and a 9 volt battery!

Why Watts Haven't Been Much Fun (Until Now)

Measuring power is a complicated affair. Both voltage (V) and current (I) must be measured, recorded (or memorized), and then manually multiplied to compute wattage. Should sunlight, battery, or load conditions fluctuate rapidly, this becomes tedious if not impossible to do. Using two separate meters simultaneously helps, but the inherent need to manually multiply the I and V readings prevents getting an intuitive feel for what's going on at the moment of concern. Taking measurements, recording columns of data and then punching a calculator or setting up a computer spreadsheet to later calculate watts is too much work for most of us...and with the WattTester, unnecessary.

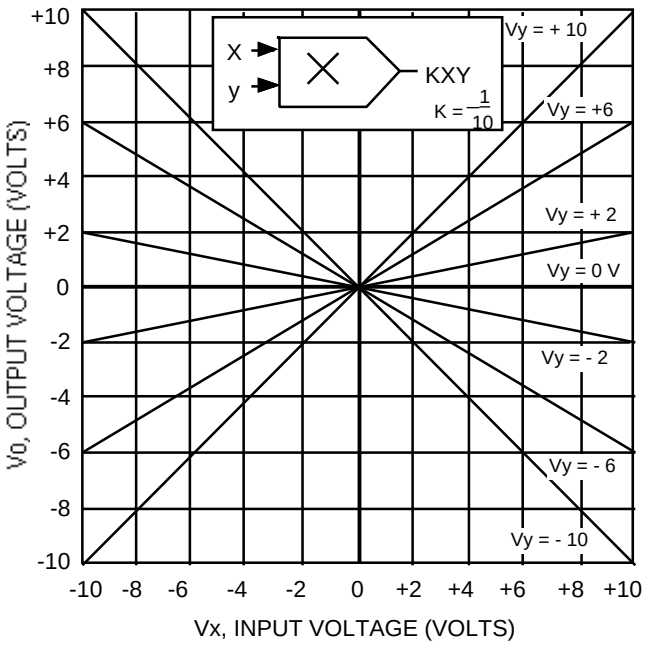
Figure 1 - Precision Power Measurement Circuit - Functional Block Diagram



Theory of Operation — Or, How It Works

Figure 1 shows at a glance how the WattTester works. It uses a Harris ICL8013 Analog Multiplier chip to multiply two signal-level voltages (see Fig. 2) proportional to I and V. A gain stage amplifies the millivolt signal from a current

Figure 2 - ICL8013 Four Quadrant Analog Multiplier



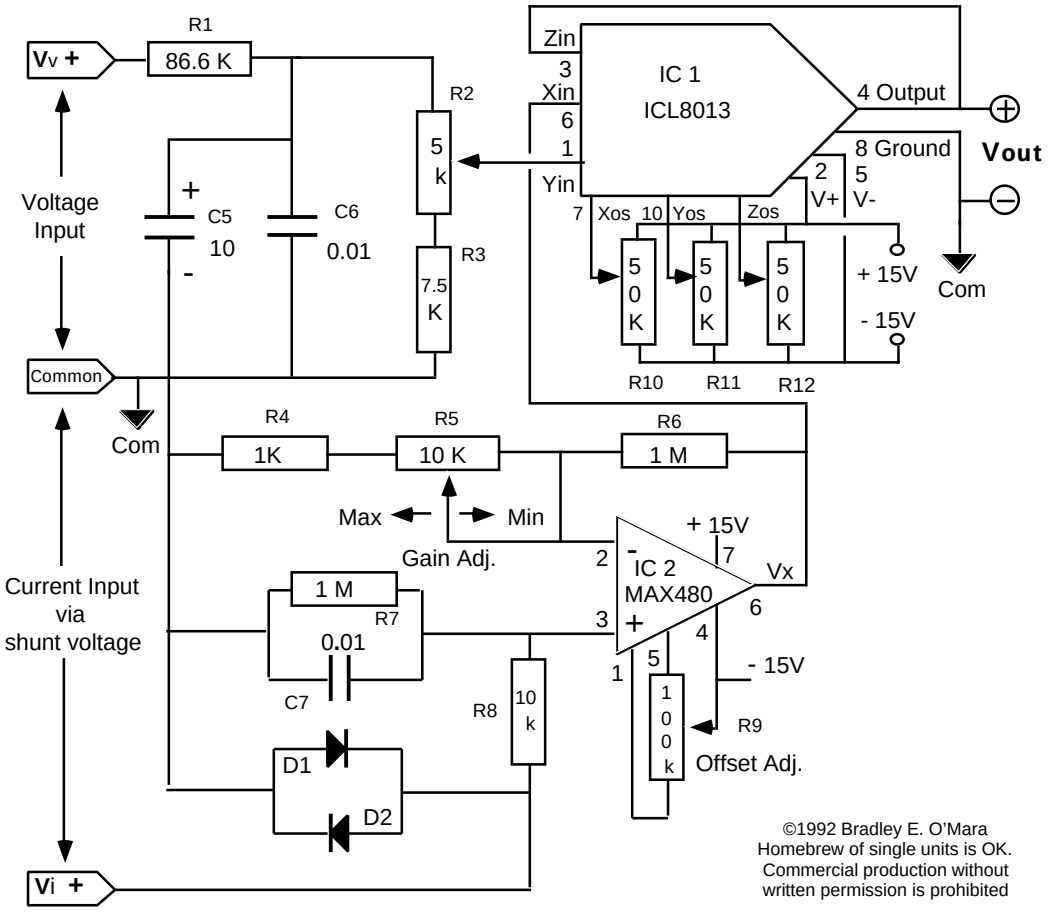
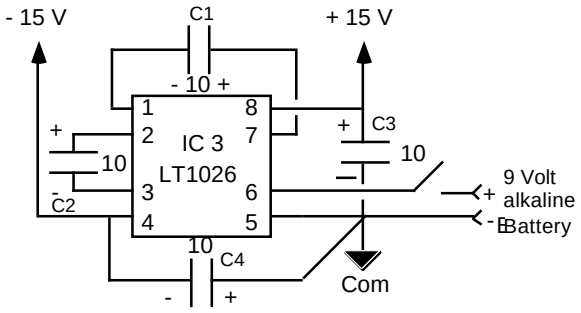


Figure 3 - Electrical schematics



9V to ±15VDC Converter Circuit Power Supply

shunt for the 8013's Xin input. Attenuation factor A reduces V for the Yin input. Scale factor K=0.1 is built into the 8013 because it's output is limited to ≤ ±10V. Amplifier gain G and A are set by the readout conversion factor and the desired FS. Highest accuracy occurs if Xin and Yin see ±10V at FS. For ease of use and to avoid skewing the multiplier's calculations (by weighting either voltage or current unevenly) A and G are set so Vout is a power of 10 of the measured power at FS.

The schematic in Figure 3 shows how a true ±15V split-voltage supply is obtained from a single 9V alkaline battery using the Linear Technology LT1026 Voltage Converter. It is a special device which eliminates need for an inductor or complicated switching circuitry by using an internal high-frequency oscillator to drive C1 – C4 in a charge-pump fashion. The Maxim MAX480 is a micropower precision Op Amp also powered off the ±15V. Two quadrant '8013 operation allows bidirectional (+) current flow without the need to reverse the shunt connections. The voltage input Vv+ must always be connected to a positive voltage relative to COMMON unless 4 quadrant operation (thus dual-polarity voltages) is also desired. C5 must then be a non-polarized type.

The 480's key spec is input offset voltage, Vos. Typically 25 micro-volts, 80 times less than the 2 mV of a general purpose Op Amp, it's needed because Vos is amplified by gain G into a large error voltage. It is trimmed out by R9 but if Vos is too large to begin with, its temperature coefficient will cause the error to quickly reappear and drift badly with temperature. The 480's 14uA bias current is also low enough for the '1026 to power the entire circuit from the 9V battery.

Attenuation and Gain Selection

Table 1 gives values for A and G. They depend upon the shunt resistance, maximum V and I, and FS. For example, with a 0.001Ω shunt and a 1KW FS reading (i.e., @ P=1 KW, 8013 Vout=10V, thus conversion factor = 1,000W/10,000mV = 0.1 W/mV) the gain needs to be 1000. Potentiometer R5 varies gain approximately 100 to 1000. Before adjusting it first trim potentiometer R9 for Op Amp Vo=0V for 0V input by shorting together the I inputs, COMMON and Vi+. Then hook them to the shunt and adjust R5 so Vout=10V when maximum I is flowing.

Table 1 - Gain and Attenuation Values

Full Scale Watts	*Shunt Ω*	*Max. I ADC*	*Max V. VDC*	*Gain 'G' V/V*	*Atten. 'A' %*	*Vout CF W/mV.*
1	0.1	1	1	100	0	0.001
10	0.1	1	10	100	0	0.001
100	0.01	10	10	100	0	0.01
1000	0.001	10	100	1000	90	0.1
1000	0.001	100	10	100	0	0.1
10000	0.001	100	100	100	90	1

Note :To achieve attenuation of 0% replace R1 with a zero Ω jumper wire. For 90% adjust potentiometer R2 so Yin = 0.10 of Vv+., i.e., 10% of measured voltage passes through resistors R1-R3 to 8013.

Analog Multilpier IC Offset Error Trim Procedure

The internal errors of the ICL8013 can be trimmed out using R10-R12, use the following procedure :

1. Set Xin = Yin =0V and adjust potentiometer R12 (Zos) for zero output.
2. Apply +10V to Yin with Xin=0V and adjust R10 (Xos) for minimum output.
3. Apply +10V to Xin with Yin=0V and adjust R11 (Yos) for minimum output.
4. Readjust R12 (Zos) as in step, if necessary.
5. Apply +10V to Xin and between R1 and R2, adjust R2 so Vout = 10.0V.

WattTester Parts List

C1-C5 – 10 uF/25V electrolytic
C6,7 – 0.01 uF/25V disc ceramic
D1,2 – 1N4001 1A/50V silicon diodes
R1 – 86.6 KΩ (all resistors 1/4W,1%)
R2 – 5 KΩ Potentiometer
R3 – 7.5 KΩ
R4 – 1 KΩ
R5 – 10K Ω Potentiometer
R6,7 – 1 M Ω
R8 – 10 KΩ
R9 – 100 KΩ Potentiometer, 10 turn
R10-12 – 50 K Ω Potentiometer, 10 turn
IC1 – ICL8013CCTX Analog Multiplier
IC2 – MAX480CPA Precision Op Amp
IC3 – LT1026CN Voltage Converter

Note: The following items are available from Outside Power Co., 130 E. Main St., No. 325, Medford, OR 97501: • IC Kit-Chipset of IC1,2,3 w/data sheets and new Technical Bulletin "Analog Solar Design" ; $28 • WattTester Design Kit-IC Kit plus all parts, PCB, •IC sockets & reprint of chapter on Power Measurement from author's book "Maximum Power"; $48 Please include $3 S&H, $5 outside US

How To Use Your WattTester

Your WattTester is very versatile. You are free to choose any FS and V and I maximums you desire. The examples in Table 1 are based on a 1:1 ratio between measured power and the actual integers displayed on your voltmeter's LCD readout. This simplifies readings because you only need shift decimal places to read watts directly. Circuit variables can be changed, but be careful to make note of your conversion factor if you choose other than 1:1 lest you forget it while measuring power away from home. It would be embarrassing if your neighbor's brand new 50 Wp module tests 5 watts in full sun, or 500 watts in the shade!

Figures 4–6 show how to make various power measurements. Remember that the voltage across the transducer's current sense inputs, COMMON and Vi+, must always be low level, on the order of a few hundred millivolts or less. Diodes D1, 2 are cross-connected across the inputs to offer a degree of protection should they become disconnected from the shunt. Adding a resistor ≥ 10 KΩ between R8 and the Vi+ input will increase protection but at the expense of requiring more gain G.

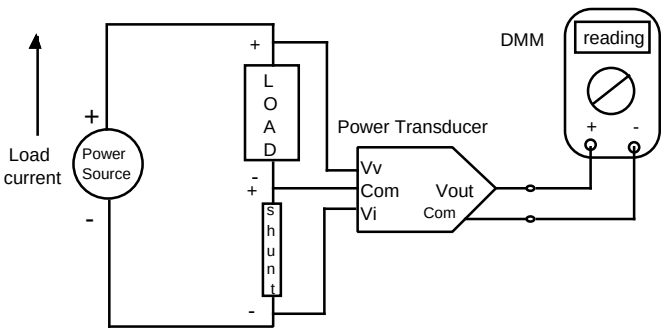


Figure 4 - Hook up diagram for measuring power consumption of a load.

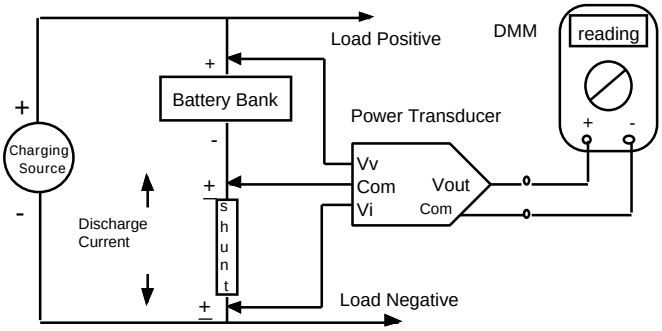


Figure 5 - Hook up diagram for measuring bi-directional battery power flow .

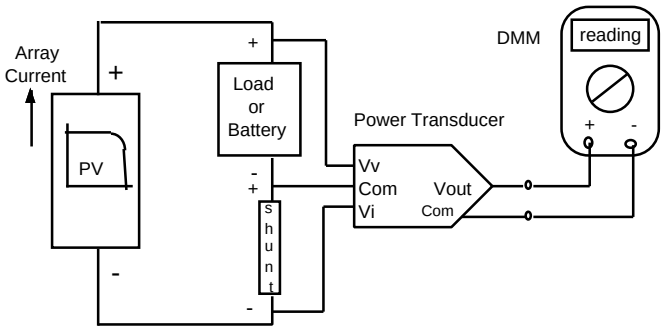


Figure 6 - Hook up diagram for measuring PV array power generation.

Lastly, bear in mind the transducer's output voltage is bipolar. Negative voltages can mean positive power or vice versa. What's positive and negative power is only a matter of definition. You can choose by simply reversing your voltmeter's leads. A negative reading occurs in Fig. 4 because the transducer sees a positive voltage across Vv+ and COMMON but a negative voltage across Vi+ and COMMON. A positive reading occurs when the battery is discharging in Fig. 5 because both inputs see a positive voltage. Polarity then reverses when charging. The PV array power readings in Fig. 6 are negative unless you switch the leads to your voltmeter. However you hook things up, though, always remember that it's watts that do the work, or as Mr. Sun sez:

" Volts are fine and Amps a perk, but ... it's Watts of mine that DO your work! "

Access

Author: Brad O'Mara, Outside Power Company, Midwest Lab Facility, 7477 Lakeshore Drive, Spirit Lake, IA 51360 • 712-336-5045 • Fax 712 -336-5046. Pacific Northwest Address, 130 E. Main St. , #325, Medford, OR 97501

WATTSUN
camera-ready

VANNER

camera-ready

TODD-FORBES PUBLISHING

camera-ready

SUNNYSIDE SOLAR

camera-ready

Things that Work!

Things that Work!
tested by Home Power

Energy Systems & Design Model FT Stream Engine™

Tested by Bob-O Schultze — KG6MM

To anyone familiar with living on renewables, a working hydroplant is an awesome thing to behold. Power comes in 24 Hours a day, no Sundays off; the sun doesn't have to shine and the wind doesn't have to blow. It just doesn't get much better than that! Using a water runner designed to take advantage of relatively low head situations, ES&D's latest offering has the potential to make usable power at a wide range of hydro sites.

The Product

The Model FT uses a standard 70 Amp Ford (Motorcraft) alternator directly connected to a turgo type impulse water wheel or runner. The alternator is available with different windings to optimize the machine's output for the site conditions, including a special low-head winding. Standard voltage configurations are 12, 24, 36, 48, and 120VDC. Other output voltages may be available depending on your site conditions. Consult the factory for details.

The 4 inch pitch diameter turgo runner is manufactured in-house of a very dense, high abrasion and impact resistant polyurethane. This is tough stuff. I have seen other runners made from the same material which have been spinning for five years without showing appreciable signs of wear. The nozzle holder terminates in 1 1/2 inch pipe thread, making adaptation to any water system a snap. Standard nozzle sizes are available from 1/8 inch through 1 inch diameter. Three nozzles of your choice per nozzle holder are included in the purchase price. The Model FT is available is 1, 2, 3, and 4 nozzle input configurations. Two long allen wrenches are supplied with the unit. With just these two tools and maybe a small crescent wrench, you can take nearly the whole thing apart.

Packaging & Documentation

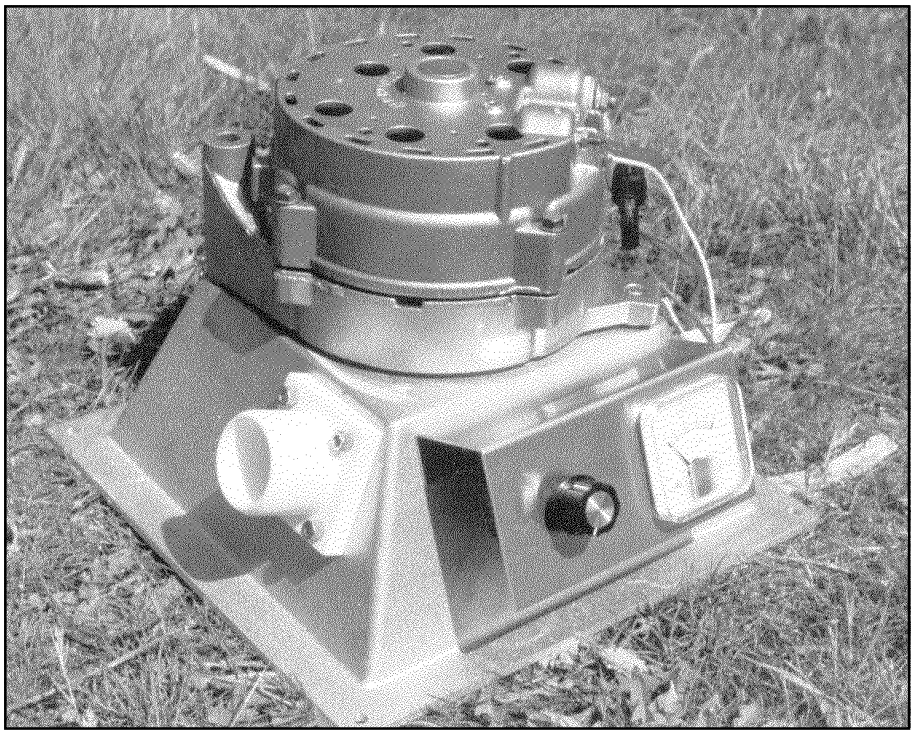
The FT Stream Engine™ arrived protected by a custom plywood and 1 inch x 1 inch frame enclosed in a cardboard box. Since ES&D is based in New Brunswick, Canada, the package had survived the rigors of both the US and Canadian postal systems. No small thing, that. The docs, on the other hand, are less than great. ES&D manufactures several different Stream Engines™ besides the FT we tested. They have tried to make one manual fit all. While the siting info, pipe friction loss, wire sizing charts, and a lot of other general information are the same for all situations, they are interspersed with diagrams and pictures relating to specific products and models. The result is pretty confusing. In addition, they are constantly modifying their product to extract better water-to-electricity efficiencies and give longer life. While the energy that goes into R&D is certainly worth an Attaboy, the docs have suffered by being out of date with their current model.

Test Environment

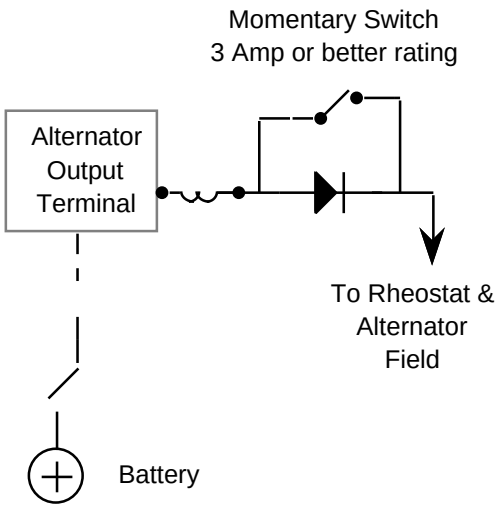
Our test site here on Camp Creek on the California-Oregon border is typical of the majority of hydro sites across the US and Canada. During the rainy season, it runs about 30-50 CFM (225–375 GPM) and drops about 50 feet per 1000 feet of run. As microhydro goes, that's a fair amount of water, but kinda weak in the vertical head department. Since there are other users for the water instream, notable the riparian flora and some small fish and amphibians, we decided to limit our share of the water to about 10% of the available flow. We ended up with a little over 800 feet of 2 1/2 inch and 2 inch PVC pipe running 24 GPM thru a 5/8 inch nozzle. Our static (gross) head was 23 feet and the running (dynamic) head ended up at about 17.5 feet.

Installation

Installation is pretty straightforward. Battery negative is connected to the "GRD" terminal of the alternator. The red wire from the FT's ammeter is connected to the battery positive through a fused safety switch (not supplied). A forward-biased diode sized to handle your highest power output is recommended to prevent battery drain through



the rheostat and field windings to ground should the alternator quit producing power. Any number of thing could cause this to happen. The most common are nozzles or the intake penstock clogged with trash, but I've seen everything from a runner unscrewing itself from the alternator shaft to a bear munching up whole sections of pipeline. You may have to provide a diode bypass circuit like the one pictured here to allow the alternator field to "boot up" after a shutdown. Any momentary switch rated for 3 Amps or better and whatever voltage you are using will do.

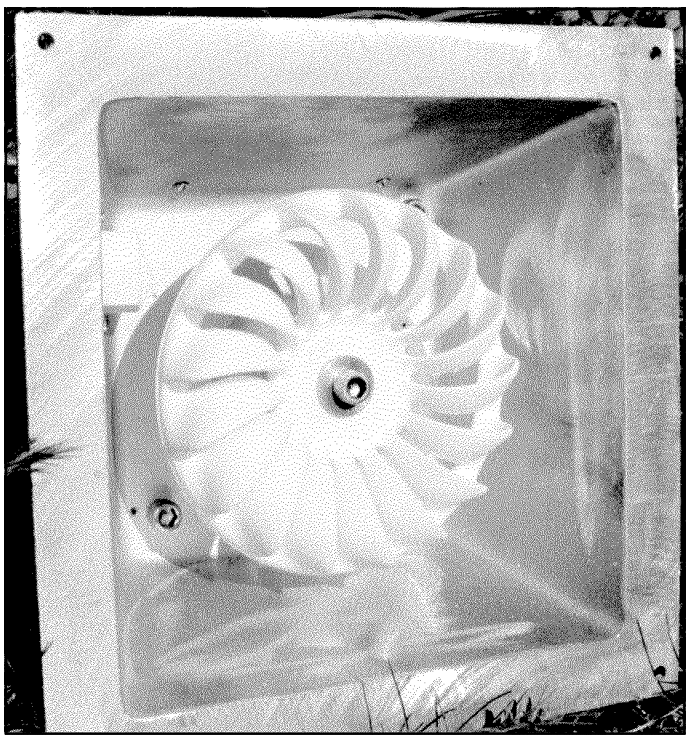


Operation

A simple rheostat field control and ammeter is used to maximize the FT's output. This is the same kind of control scheme utilized by the Harris Hydro machine and others. Just turn on the water, adjust the rheostat up to reflect maximum amperage output and you're done. While this type of field control is simple and effective for optimizing the alternator output or matching the output to your uses, it is not a battery voltage regulator and will not prevent your battery bank from overcharging if left unattended. For automatic regulation and battery protection, it must be used in conjunction with a shunt type load diverter or replaced with an electronic field controller. Both options are commonly available and easy to fit or retrofit.

Conclusions

According to ES&D's charts, we should have generated between 25-30 Watts. Our measured output was 2 Amps into a 15 VDC battery bank (nicads): 2 Amps x 15 Volts = 30 Watts.



That may not seem like a lot of power, and it isn't, but consider this: during the wet part of the year our PV system produces about 150–175 Watts per module on average. Since the FT runs 24 hours per day, EVERY day, that's a reliable 720 Watt-hours, or the equivalent of over 4 modules during the season when we need the power the most. What can you run with 720 Watt-hours a day? Well, our SunFrost RF-16 only draws about 600 Watt-hours during the winter. The FT handled that load and threw an additional 120 Watt-hours into the battery bank to boot! For the price of two extra PV modules, the FT did the work of four when we needed the power the most.

The base price of a single nozzle input Model FT is $700 US. Additional nozzle inputs are $50 each and additional nozzles are $15. The low-head (under 50') option costs $50.

Access

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

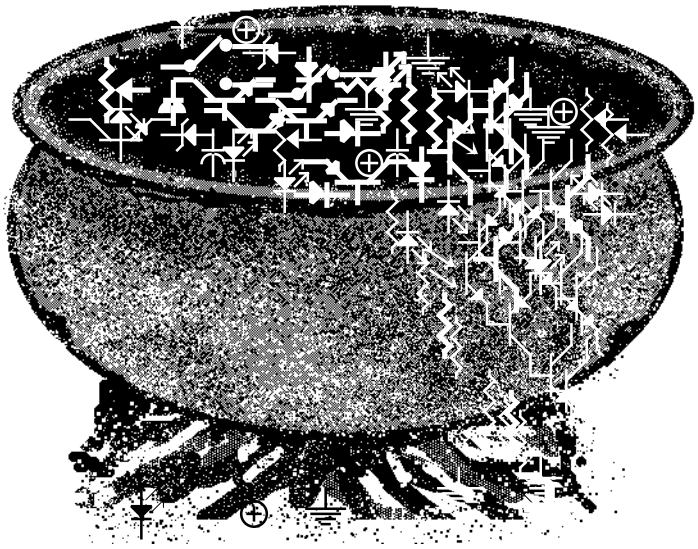
Manufacturer: Energy Systems & Design, POB 1557, Sussex, N.B. Canada EOE 1PO • 506-433-3151

REAL GOODS
camera-ready

CRUISING EQUIPMENT
camera-ready

HELIOTROPE
camera-ready

Homebrew



Recharging Small Nicads using a "Pulsar"

Richard Perez & Chris Greacen

Rechargable nicads are today's solution to the expensive and environmentally nasty addiction to "use-'em-once-and-throw-'em-away" alkaline batteries. Here at Home Power we use nicads universally to power flashlights, instruments, portable radios, and Karen's business calculator. While a nicad holds about 1/2 the energy of an alkaline "disposable" cell of the same size, you can use your nicad over and over, 200 – 1000 times depending on the quality of the cell and how the cell is recharged. This circuit is a nicad battery charger which is user programmable to fit any of the small nicad battery sizes, either in singles or assembled into packs. It is efficient and extends the battery's lifetime by proper recharging. Read on for how to build your own "Pulsar".

Requirements for recharging nicads

Any machine that is designed to recharge nicads must perform one basic function. It must limit the amount of current flowing into the nicad. This is essential to keep the nicad from overheating, overcharging, and eventually being destroyed. The simplest method uses a resistor to limit the amount of current flowing into the nicads. This is the method used by most commercially available chargers. It has two disadvantages: it wastes a lot of energy as heat, and in most situations, charges in a way which reduces cycle life. This charger takes a different approach to the problem. It charges the cells with rapid pulses. Electricity is not excessively wasted as heat, and the cells are charged in the healthiest way we know.

Using pulses to control power

The concept involved here is really quite simple. Let's consider this analogy. Imagine a lightbulb hooked up to a battery with a switch in line. This situation is exactly the same as the lighting circuits you use in your home. Turn the switch on and the lightbulb lights. Turn the switch off and the lightbulb ceases its operation.

Now consider turning the switch on and off rapidly, say about 200 times per second. Let's say that the switch spends half its time ON and half its time OFF. The result will be a dimming of the light as the switch is rapidly turned ON and OFF, or pulsed, in electronic jargon. The lightbulb has the amount of power flowing through it controlled because the light is only consuming power half the time. For the remaining time, the light is off. This technique of controlling power by rapidly switching the load on and off is called Pulse Width Modulation (PWM). Now, 200 times a second is a little too rapid for a manually operated switch. Besides, it's just plain boring to stand there and switch something continually ON/OFF just for control. So instead of a manual switch, let's use a transistor as a switch. PWMs, using transistors, are extensively employed in the electronic power control of many devices/processes like lighting, motors and in our case, recharging batteries.

Power is controlled by the amount of time that the electronic switch spends on in relation to the amount of time the switch spends off. This ratio is called "duty cycle" and is expressed as a percentage of ON time divided by ON time plus OFF time, or in algebraic terms:

Duty Cycle = ON time / (ON time + OFF time)

If the electronic switch spends half its time ON, and consequently half its time OFF, then its duty cycle is 50%. If the switch is ON 1/4 the time and OFF 3/4 of the time, then the duty cycle is 25%. And so on…

The actual amount of power available from a PWM is influenced by one more factor, the voltage (or amplitude of the pulse). This is the voltage that the pulse attains when in the switched ON condition. A pulse may attain any ON voltage that we desire, it could be 1 volt, 5 volts, 10 volts, or whatever. Consider two separate pulse trains, each with a 50% duty cycle. A sequence of regularly spaced pulses is called a pulse train. One pulse train has 5 Volts supplied to the switch, while the other has 10 Volts available for switching. Given the same duty cycle, the power content of the pulse train switching 10 Volts is twice that of the PWM supplied 5 Volts.

This then is the whole story: power can be controlled by two factors in a PWM. The first is the duty cycle of the pulse train, and the second is the voltage of the pulse when it is switched ON. Now, the math involved here can get sticky (it is best described by calculus), but the idea can be very simply expressed in a diagram. Consider the illustration below.

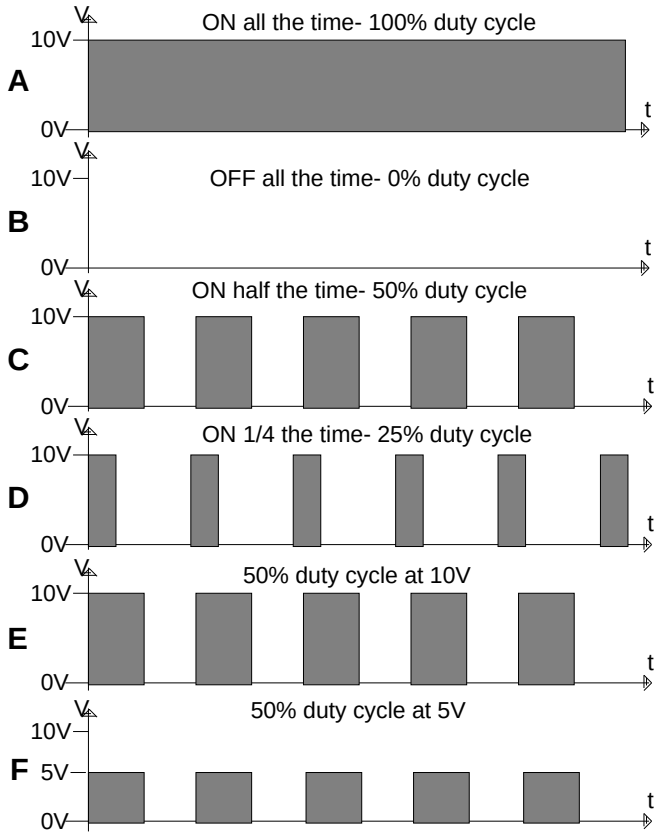


Fig. 1- The Power Content of Pulse Trains

This illustration is a graphical representation of the pulse situation. The vertical axis of the graphs represents voltage, while the horizontal axis represents time. The Section marked A shows the switch in the always ON, i.e. a duty cycle of 100%. The power of the pulse train is represented by the shaded area of the pulses. Section B illustrates the OFF condition, where there is no shaded area as the power is always OFF. Section C shows a pulse train of 50% duty cycle, i.e. the pulse is ON to the voltage level of 10 Volts for one half the time and OFF the remaining one half of the time. Section D illustrates the situation for a pulse train of 25% duty cycle. Sections E & F of Figure 1 show two pulse trains, each with a duty cycle of 50%. The pulse train in Section E has an amplitude of 10 Volts, while the pulses in Section F have an amplitude of 5 Volts. The shaded area in Section E is twice that in Section F, and the same is true for the power content of the respective pulse trains. The main idea to be gained from these illustrations is that power can be represented by the area under a curve, in this case the area under a series of rectangles. The secondary idea is that power can be controlled by time, by the duration over which the power is applied.

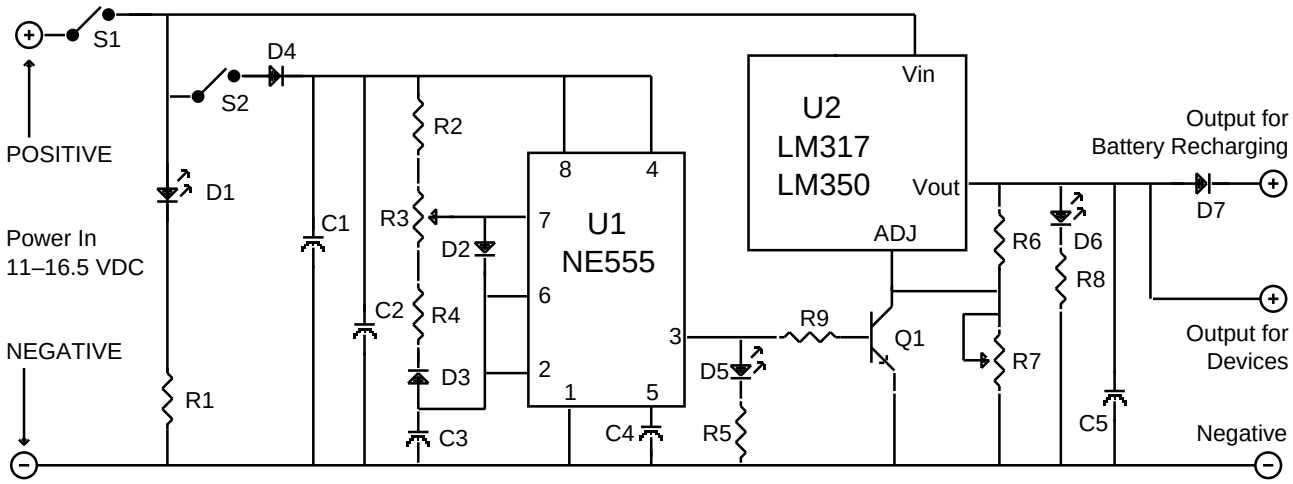
So why go to all this trouble?

One reason to use pulses is efficiency. Consider the amount of power being consumed in Section C of Figure 1. This pulse train is transferring NO energy during its OFF time. The switch is completely shut off. The use of a resistor involves continual loss as it always has electrons flowing through it. The pulse train enables us to control the energy flow without high loss.

Pulse trains have added benefits when it comes to recharging nickel-cadmium batteries. The nicad has very low internal cell resistance. As such, it is possible to run very large amounts of current through the cell without damage, *provided* that the duty cycle of the pulses is small. The high current (and voltage) of the pulse zaps the interior of the cell into increased electrochemical activity. If this pulse train had a duty cycle of say 90%, it would overcharge and ruin the cell. But if we keep the duty cycle of the pulse train from around 5% to 40%, then we can have the benefits of high current recharging without the danger of cell damage.

I've been using pulse trains to recharge nicads since 1977. My experience is that a properly sized and applied pulse train can more than triple the life of sintered plate nickel-cadmium cells. I've used pulses on AA, C, and D sized sintered plate nicads. By proper application of high current pulses, it is even possible to rejuvenate nicads suffering from dendrites. These dendrites are whiskers of nickel that grow within the cell as the cell ages. The dendrites may grow long enough to make a short circuit between the poles of the cell. Then the nicad will no longer hold a charge because it discharges itself through the dendrites. The high current pulses employed in recharging can vaporize the ultra thin whiskers before they become substantial enough to ruin the cell. Sintered plate nicads are also infamous for their memory effect. If you partially discharge the cell, and then recharge it, the capacity of the cell is diminished on the next discharge. An incomplete charge also seems to reduce capacity on the next charge. This memory affect is the root of the mysterious but successful “complete discharge–full charge” ritual followed by adept nicad users. Charging with high voltage, high current pulses pushes the cell’s electrochemical bonds to a high level. This reduces the sintered plate nicad’s memory effect.

NiCad Pulsar
Battery Charger & DC/DC Power Supply



Parts Listing

Integrated Circuits
U1- NE 555 Timer (8 pin DIP)
U2- LM 317 or LM 350 Adjustable Voltage Regulator

Transistors
Q1- 2N2222A NPN Silicon

Diodes
D1- Red LED
D2 & D3- 1N914
D4- 1N4001
D5- Yellow LED
D6- Green LED
D7- 3 Amp. Diode, heatsunk

Resistors (1/4 W.)
R1 & R5 & R9- 1 kΩ
R2 & R4- 2.2 kΩ
R3- 50 kΩ Potentiometer
R6- 240 Ω, 1/2 Watt
R7- 2 kΩ Potentiometer
R8- 500 Ω

Capacitors (25 VDC rated)
C1 & C3 & C4 & C5- .1 µf.
C2- 100 µf. Electrolytic

Switches
S1 & S2- SPST use >2 Amp rating

Enter the Pulsar

In 1983, I built a machine that custom tailors pulse trains for the recharging of small nicad batteries. I called it the "Pulsar". It generates pulse trains of duty cycles between 5% and 95% with ON voltages from 1.2 VDC to 10 VDC (assuming 12 VDC as input power). The current output of the pulse train is 1.7 Amperes in one model, and 3 Amperes in the other. While the schematic may look complicated, the Pulsar is really very simple and many have been homemade here on Agate Flat.

The Pulsar uses two integrated circuits. U1 is a NE 555 electronic timer wired up as a variable duty cycle pulse train generator (a PWM really). U2 is an adjustable voltage regulator using either the LM 317 (1.7 Amps out) or the LM 350 (3 Amps out). The Pulsar accepts power input from 11 VDC to 16.5 VDC. Switch S1 turns on the unit, while switch S2 disables the pulse generator and makes the unit into a battery eliminator. With S2 open, the unit can make any DC voltage (not pulsed) between 1.2 and 10 VDC from a 12 VDC battery. It can directly power cassettes, radios, and other electronics than require 10 VDC or less to operate. With S2 closed, the pulsar is operational and the power output of U2 is a pulse train for recharging nicads or small lead acid gel cells. Note that there are two outputs. The one with the series diode is for battery recharging, while the one without the diode is for directly powering appliances with the pulse generator disabled (S2 open).

Resistor R3 is a potentiometer that controls the duty cycle of the pulse train. Resistor R7 controls the voltage (amplitude) of the pulse train, or the regulated DC voltage if the unit is used as a battery eliminator.

U2 is a very rugged device, being internally protected from short circuit and overtemperature. The LM 317 is available in two different packages. The LM 317T has the smaller TO-220 case, while the LM 317K has the larger TO-3 case. In any case, the LM 317 must be heatsunk

and the larger TO-3 case gets rid of heat better. While very much more expensive, the LM 350K gives the ability to move up to 3 Amps of current through the device.

Most of the parts can be purchased from Radio Shack. We encourage you to build your own. Or take the info to your local electronics head for help.

Using the Pulsar to recharge Nicads

In addition to the Pulsar, you will need the appropriate metering for information about the recharging process. A DMM with a shunt or ammeter is sufficient. To recharge a battery or a battery pack use the following procedure. 1) Turn the voltage control pot (R7) until the voltage is as high as possible. 2) Turn the amperage control (the duty cycle control–R3) to the minimum. 3) Connect the unit to the battery to be recharged via the diode (D7) output, and use an ammeter or shunt in this line to measure the amount of current flowing into the battery. 4) Close S2. 5) Close S1- The unit is now operating and recharging the battery. 6) Adjust the amperage control (R3) until a C/10 rate is flowing into the battery. 7) If the batteries are completely empty, then leave them under charge for 15 hours and they'll be full. When the nicad cell is totally full, its voltage peaks at 1.62 to 1.65 Volts (this is for a C/10 rate) and slowly drops. This is because the cells start to turn more of the electricity into heat, and the heat lowers the impedance of the cell. We set a Fluke 87 on min-max recording mode, and when the cell's voltage stops rising, we know we're done. Even with a pulsar you don't want to overcharge nicads.

The current that we are measuring is averaged out by the way that we are measuring it. Neither the DMM or the analog ammeter has the speed to measure the instantaneous amperage output of the pulse. What we see on the meter is a time-averaged version. This is also how the nicad cell sees the pulse, as an average charge current. For example, if our meter shows 0.1 Amps as the charge rate, and the duty cycle is say, 10%, then the instantaneous amperage of the pulse is about 1 ampere. While the instantaneous amperage is very high, the average is within the operational range for recharging the cell. So just use any old ammeter and set the recharging current for the C/10 rate for that particular cell or pack. If you are recharging very small capacity nicads and are unable to get the current low enough via the amperage control (R3), then reduce the voltage control (R7) until you get a C/10 rate into the battery.

Using the DC/DC Converter

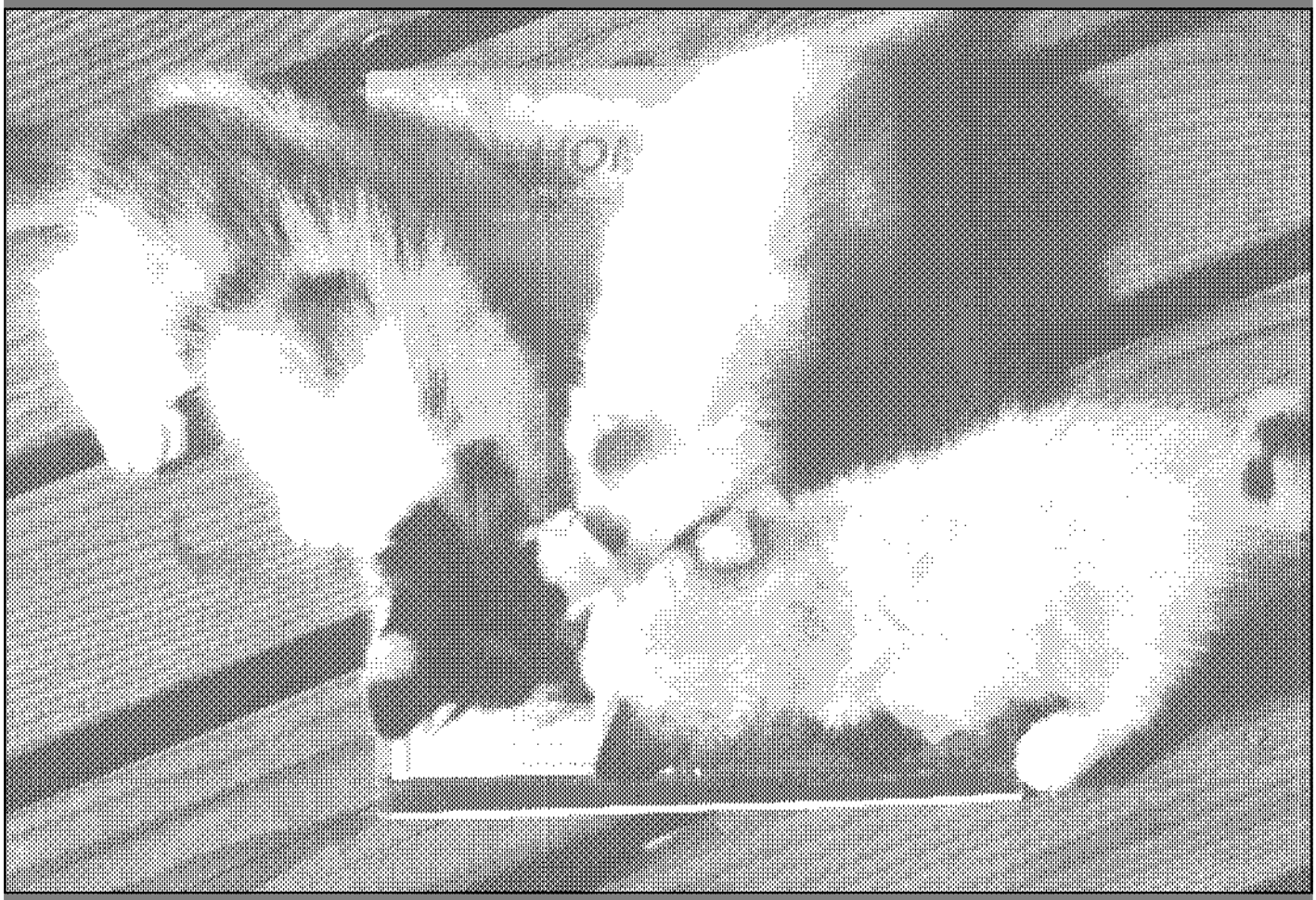
If S2 is left open, then the Pulsar operates as a straight DC regulator; its output is smooth DC rather than a pulse train. Consider all the small electronic devices we use that employ internal batteries. In DC mode, the Pulsar can power your Walkman™, stereo, radio, or what-have-you directly from your larger 12 VDC battery system. This is really an added benefit. All that is required is the addition of one switch (S2), and the device becomes dual purpose. It recharges batteries or it directly powers devices without using their internal batteries.

To use the Pulsar as a DC/DC converter simply open S2 (disabling the pulse generator) and adjust the voltage on R7. Use the output bypassing D7 for greater efficiency.

Access

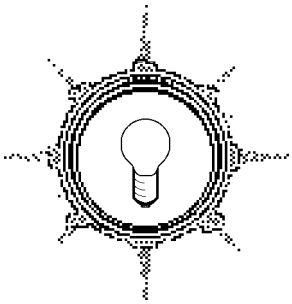
Authors: Richard Perez and Chris Greacen, c/o Home Power, POB 130, Hornbrook, CA 96044 • 916-475-3179

Even itty bitty kitties are able…



TO CHECK THE MAILING LABEL

It tells you when your subscription expires!



Home Power Subscription

$15 per year (6 issues) to US Zip Codes via 2nd Class
$30 per year (6 issues) to US Zip Codes via 1st Class

If you want to subscribe or renew to Home Power Magazine, please fill out the subscription form below, write a check or money order and drop it in the mail. Tape the form well or use an envelope so your check doesn't fall out in the mail. Your sub or renewal will start with HP's next regularly scheduled issue. Please allow up to ten weeks for the start of your 2nd class subscription. For those wishing **International Subscriptions or Back Issues of Home Power, please see page 97**.

☐ New 1st Class Sub-$30 to USA Zip Codes
☐ New 2nd Class Sub-$15 to USA Zip Codes
☐ Subscription Renewal Specify 1st or 2nd Class
☐ Change of Address **Include old Address**
☐ Gift Subscription From (give **your** name and address here):_____

We do not send out subscription renewal notices. When your subscription expires is printed on your mailing label. We feel that renewal notices are a waste of everyone's resources. CHECK YOUR MAILING LABEL!

PLEASE PRINT CLEARLY. GIVE YOUR COMPLETE ADDRESS.

NAME_____

STREET_____

CITY_____ **STATE**_____ **ZIP**_____

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

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

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

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

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

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

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

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

HP#30

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

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

FOLD HERE

& TAPE

Please write to us here. Tell us what you like and don't like about Home Power. Tell us what you would like to read about in future issues. Thanks for your time, attention & support.

☐ Check here if it's OK to print your comments as a letter to Home Power.

FOLD HERE

Return Address

_____

_____

_____

Place 29¢ Stamp Here

Home Power Magazine
Post Office Box 130
Hornbrook, CA 96044-0130

HP#30

ATLANTIC SOLAR
camera-ready

SUNFROST
ON NEGATIVE
leave border

C. Crane & Co.
camera-ready

LOWEST PRICE ON NEW PVs

***NEW ARCO M52L**

5.7+V, 6+A $175.00 each

Special August Only 3 *NEW M52

17.1+V, 6+A $499 w/frame kit $549

These are new 'B' stock, there is no browning, quantities are limited.

RECYCLED! Bronze, blemished laminates 95 watts set of 4 $275.00 • Carrizo Golds 105 watts set of 4 $495.00 • Carrizo Bronzes 95 watts set of 4 $395.00

M52L Monster Module's as seen in issue #24 are in stock

NEW PRODUCT - 12-24V DIGITAL PROGRAMMING TIMER 24 Hour, 7 Day Multiple Event Timer, LCD Readout, Real Time Clock, 68705 Microprocessor, Relay 10 amp at 120 vac or 28VDC, Reg. $105.00 each SALE August Only $85.00

We have a large inventory of new and used satellite receiving equipment. Call for best pricing on inverters, charge controllers and batteries.

ADVANCED ELECTRONICS

8525 ELK GROVE BLVD STE. 106 ELK GROVE, CA 95624

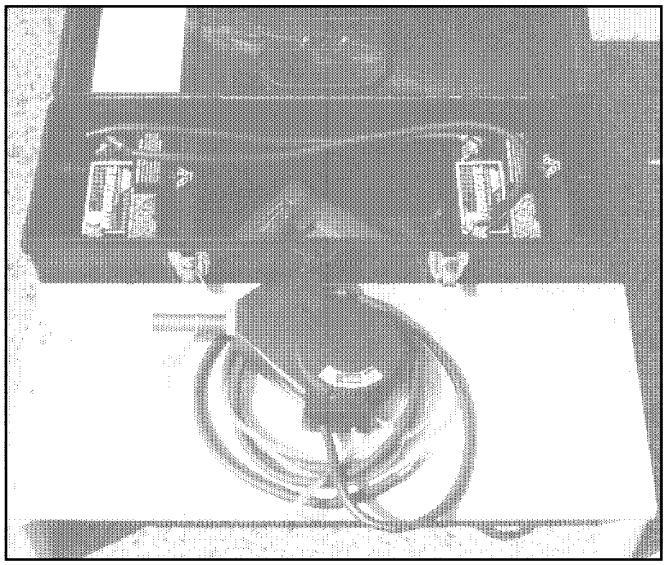
(916) 687-7666

Equipment shown by appointment

Things that Work! The MigMaster DC Welder

Things that Work!
tested by Home Power

Tested by Dan Lepinski and Stuart Caruk



Above: MigMaster and optional electric drill, batteries, and toolbox available from On Line. Photo by Dan Lepinski

What do you do when you need a welder and utility power is nowhere around? What if you do have commercial power and want an affordable portable welder? The MigMaster may be the solution in both cases.

So just how does one evaluate welding equipment? Use it! This Things that Work is based on a MigMaster that has been in use for more than a year in the welding shop of Stuart Caruk in Vancouver, Washington.

What is "MIG" welding?
Until recently, arc welding meant either being connected to commercial power, lugging around a massive generator, or taking the metal to a welding shop — all unsatisfactory if not impossible solutions. Not long ago, portable battery operated MIG welders sprang on the scene. They were large and expensive. Until now.

What is "MIG"?
It stands for "Metal Inert Gas". A gas such as carbon dioxide or argon is injected right at the welding tip. This displaces oxygen and lets the welding process work better. The gas also cools the welding tip thus providing 100% duty cycle operation. Operation without the gas limits operation to a 10% duty cycle.

How does a MIG welder work? A fine wire is fed to the tip of the welder from a spool located inside the welder. The wire passes through the tip and strikes an arc with the metal being welded. The wire is fed from the spool by using a variable speed motor. In the MigMaster, the electric drill provides the motor and variable speed. The battery powered, electric arc creates the heat that welds the metals together.

The inert gas is not always needed. Some wire contains a special material called "flux" that performs essentially the same task as the inert gas. However, there is a tradeoff. The wire/flux combination is more expensive than just plain welding wire but is more convenient since a container of inert gas is not needed.

The MigMaster
The Migmaster came packaged with two eight foot long cables for connection to the batteries and an eight foot plastic hose for the inert gas. Since the MigMaster requires 24 Volts, a short connecting cable for joining two 12 Volt batteries in series was also provided. All cables were constructed of #4 AWG copper wire and included crimped-on copper lugs for connection to the batteries. Four extra MIG tips completed the accessories.

The Manual
The instruction manual should be called the warning manual. Throughout its 21 pages, no less than 47 warning paragraphs in bold capital letters jump out at the reader. At times, I had trouble differentiating between real instructions, warning instructions, and precautionary warnings. Welding is dangerous. The warnings clearly point this out. While a professional welder with MIG experience should have little difficulty understanding the MigMaster manual, a beginner might find the extensive warnings a bit overwhelming.

Performance
We connected the MigMaster to two very tired 12 Volt "marine" lead-acid batteries. Even so, the weld quality was exceptional. In later tests, a healthy 100 Ampere-hour nickel-cadmium battery pack was utilized with a resulting improvement in current output and weld quality.

The MigMaster welds as well as large units costing thousands of dollars. In a side-by-side comparison with a 400 pound 220 volt $3,500 Miller welder, no differences could be noted in weld quality or strength. MigMaster will weld regular steel, stainless steel, and aluminum.

While the manufacturer specifies current consumption at up to 200 Amperes, the actual current used depends greatly on the type of welding done. Using a 500 Ampere, 50 milliVolt current shunt in series with the batteries, the current varied from 90 to 230 Amperes as we welded.

Reliability
At first glance, the MigMaster appeared to be constructed of fragile plastic. A visual examination of the internal parts was not reassuring either. However, after more than a year of use, the MigMaster has yet to give any trouble. In fact, the test unit was accidentally dropped from a height of 20 feet and survived the fall intact. So much for fragile appearances. The only source of trouble has been an occasional welding of the wire to the welding tip. This is an operator error, not a MigMaster design flaw, and is a problem encountered by even the most experienced welder using any MIG type welder.

Repair should be a breeze. Almost all replaceable parts are name brand items readily available from most welding supply stores. Even an anonymous test call to Omniverse Research (the MigMaster manufacturer) netted a quote for less than $2.00 to replace the gears inside the unit.

Hints from a Pro
Stuart turns out some of the finest welding I've ever seen. In addition to his MigMaster (which he's owned and used for over a year), he also owns several other MIG type welders, so I asked him for his comments. He had two very good suggestions. First, get longer battery leads. Stuart recommended 50 foot leads of #4 welding cable. Why? Unless you have the batteries completely enclosed, the 8 foot cables supplied with the MigMaster are not enough to keep sparks completely clear of the batteries. Batteries can give off explosive hydrogen gas. Keeping sparks away from the batteries simply makes sense. Second, get extra tips for your welder, especially if you're just learning how to use it. At about sixty cents each, it's cheap insurance against an unplanned trip into town. Buy at least a dozen. I'd suggest two dozen.

A Personal Note
If you've never used a MIG welder, find someone who already knows how. Stuart produces welds that are glass smooth. I don't. In just 15 minutes of instruction, Stuart had me welding with the MigMaster. Not perfectly, but a lot better than I'd ever have done on my own. I learned much about different types of welding wire, techniques, and welding gas. Stuart pointed out errors in the use of MIG welders that often lead to poor welds which in turn are often blamed on the welding equipment. Good advice from a pro is priceless.

Conclusions
The MigMaster is a very portable, cost effective welding system. From a year of hard use, it has a proven track record of reliability. It can do almost anything the big guys can do, yet is a simple handful. Although two hands are needed to operate the MigMaster, it is completely self contained and can go places the large MIG welders can't. At $249 for the basic unit, or $599 for a toolbox model complete with batteries and the electric drill for wire feeding (toolbox model available through On Line Marketing, Inc.), the MigMaster is an exceptional value.

Access
Author: Dan Lepinski, 791 Lakeshore Drive, Klamath Falls, OR 97601 • 503-885-5698

Manufacturer: Omniverse Research, Inc. POB 33243 Los Gatos, CA 95031 • 408-354-6611

Distributor (Western U.S.): On Line Marketing, Inc., 12315 Mukilteo Speedway Blvd. Bld. 1, Ste. 2, Lynnwood, WA 98037 • 800-743-1403

Grounding Inverters

John Wiles

Any renewable energy system that employs an inverter to produce 120-volt alternating current must have a grounding system for safety. The National Electrical Code (NEC)®, where applicable, also requires proper grounding. There is no specific standard established by Underwriters Laboratories (UL)® for the manufacture and testing of residential, stand-alone PV inverters and inverters that contain standby battery chargers. With no standard for residential inverters and with several being designed using the UL standard for recreational vehicle or marine inverters, there is variation in the grounding requirements and methods used in each unit.

Underwriters Laboratories — The Standards Maker

The design of UL-listed power-handing equipment (NEMA enclosures, outlet boxes, disconnects, and power contactors), and the existing UL standards for battery chargers, power supplies, uninterruptible power systems, and residential electrical equipment give some indication of the requirements of a possible future UL standard for residential inverters. A future UL standard for residential PV inverters might require that the ac output be isolated from the DC input and the chassis or case be isolated from both. The standard might also require the metal case to be connected to the equipment-grounding system, the green, equipment-grounding conductor on the ac output to be connected to the case, and no other connection be made inside the unit between any of the current-carrying conductors and ground or the case. The standard, to meet the existing NEC requirements, may require the hard-wired ac output to have the white, neutral wire connected to ground in the ac distribution panel. If the open-circuit PV voltage is above 50 Volts, one of the DC input conductors (usually the negative or the center-tap) is required (by the NEC) to be grounded. The standard may require this connection to be made outside the unit. On systems with open-circuit voltages below 50 Volts, the requirement to ground one of the DC conductors is optional in the NEC and the UL standard will have to address this.

Endless Variations

Today, although most inverters provide the isolation between DC inputs and ac outputs, there are numerous variations on the internal connections used to ground the systems. Many of these variations have evolved from inverters used in vehicles where the negative conductor is always grounded and the case is tied to the negative conductor because the metal chassis of the vehicle is the negative conductor. Inverters with ac receptacles nearly always have the white, neutral wire and the green, equipment-grounding wire connected to the case.

The AC Side

If this type of inverter, with multiple ac receptacles, is connected to a distribution panel (circuit breaker load center), some care must be exercised to ensure that the white, neutral wire is not bonded to the bare or green, equipment-grounding conductor in the load center. If this happens, parallel paths will exist for the currents to flow in the neutral circuit and one of these paths will be the bare, uninsulated, equipment-grounding conductor. This represents a safety hazard and is not allowed in installations falling under the NEC. There are several ways to fix this problem. The NEC says to open or remove excess bonding connections between the neutral and grounding conductors until there are no parallel paths. The obvious location is in the inverter.

But opening this connection would not only void the warranty, it might cause the inverter to not operate properly, and it might be hazardous to open even a disconnected inverter. Furthermore, the other ac outlets would not have the proper connection between the white, neutral and green, equipment-grounding conductors.

The other option when using an inverter with ac receptacles is to break the extra connection in the load center. This would require connecting the white, neutral conductors only to other white neutral conductors. The grounded bus bar in the load center would be used only for the bare or green equipment-grounding conductors. For a few white conductors (3-4), an insulated twist wire connector or split bolt could be used. For a larger number of connections, an insulated terminal strip could be used.

Inverters with hard-wired outputs (as opposed to those with multiple ac receptacles) may have the same problem with an internal connection between the neutral and equipment-grounding conductors. The solution outlined above will also work in this case.

Standby Inverters

What about standby inverters with battery chargers working from an external ac power source? The system should be connected so that when operating in either the inverting or in the standby mode, there should be one and only one connection between the neutral and equipment-grounding conductors. Gasoline and diesel engine driven generators usually have the neutral connected to the equipment-grounding conductors and both connected to the frame. When installing such a unit with power transfer relays (either internal or external), the system should be carefully checked to ensure there is no more than one bonding connection in either mode.

Some systems use the utility grid to provide the backup power. If this grid power comes from an ac utility load center, then it will usually have an internal bonding connection. In either the case of the generator or the ac utility load center, it seems best to allow the first piece of power handling equipment or power producer in the string to contain the bonding connection and to break the connections in downstream units. Each operating mode should be checked carefully and the manufacturer of each product consulted when there are any questions. If the PV inverter is located in a different building from the generator or the ac utility load center used for backup, then an electrician should be consulted concerning the proper grounding of separate buildings and separately derived sources.

The DC Side

The NEC requires that the inverter metal case be connected to the equipment ground and for safety, this connection has already been made through the green, equipment-grounding conductor on the ac output. Since the currents on the DC side are higher than the ac side (10 times at 12 Volts, 5 times at 24 Volts), the equipment grounding needs are different. The size of the DC equipment-grounding conductor is related to the size of the overcurrent device protecting the DC conductors. For example, a 400 amp fuse or circuit breaker would require a number 3 AWG equipment-grounding conductor, 200 amps: 6 AWG, 100 amps: 8 AWG, 30-60 amps: 10 AWG. Table 250-95 in the NEC gives the values. Having both an ac and a DC equipment-grounding conductor does not create any parallel path problems.

However, if the case or chassis of the inverter is connected to the DC negative conductor, then the manufacturer has already made the decision that the DC system will be grounded. No option is available for systems with less than 50 volts open-circuit PV voltage. In this case, the conductor between the negative DC input (and the chassis) and the ground rod becomes the system grounding conductor and must be the same size as the largest conductor in the system—probably the conductors between the battery and the inverter. Only one DC grounding conductor is needed and the larger size is the one to use.

On systems where the DC input conductors are isolated from the chassis, the DC equipment-grounding conductor is sized according to Table 250-95 in the NEC and is usually connected to an appropriately marked lug or terminal on the inverter chassis. With this isolated design, the user has the option of grounding the negative conductor on systems less than 50 Volts (nominal 12 and 24 Volt systems). If a system ground is used, then the NEC recommends that it be connected on the PV source circuits as near the modules as possible. Some savings in wire may be realized if the negative inverter input terminal is selected as the system grounding point and the large conductor is connected from here to the ground rod. The equipment-grounding terminal can be connected to this point with a short jumper and all other equipment-grounding conductors can also be connected to this point.

Confused?

Make careful measurements to avoid parallel paths. Contact the inverter manufacturers for full information on their products. Work with a PV professional, a local electrician, and the local electrical inspector. Ask the manufacturers how to install their products and power transfer relays in a system meeting the requirements of the NEC. Ask them if they comply with UL standards for power supplies, battery chargers, and other applicable standards.

Access

Author: John Wiles, SWTDI, PO Box 30001/Dept 3 SOL, Las Cruces, NM 88003

Results from Home Power's book survey

Home Power issue #27 contained a survey for our projected book. We will correct and update material from the out of print issues, add to it, and compile the information by subject with tables and our database of RE businesses as appendices. The survey asked readers to rate 39 subjects, and asked for feedback on binding and price.

The results

The subjects were rated on a scale of 1 to 5: 1 = rarely useful, don't reprint; 2 = okay, print best few; 3 = good, but I could miss some; 4 = really good, reprint all; 5 = great, reprint all and add more. The top thirteen subjects are: Photovoltaics, Batteries, Things that Work!, How-to Articles, Inverters, Efficient Appliances, Instrumentation, Safety, Basic Electric, Solar Hot Water, Controls, Basics Articles, and Tech Notes (see complete results to right).

Of the 467 readers that responded to the survey, the majority like the soft-cover option as more durable than a three-hole punched binder and less costly than a hard-bound copy. The average price people would pay is $21.09.

Comments

Many people commented about the need for a complete index. We publish an index once a year. Check page 109 this issue—we have a new format for this index and hope it will be more useful! Let us know what you think!!

Many said that what they liked in the magazine was not appropriate for a book. Some mentioned that Energy Fairs are important to read about but don't need to be archived in a book. Some want Letters and Q&A sorted by subject or by the article that they deal with, and some thought they should be left out. One reader wrote, "A book form should selectively edit past issues for the most current and accurate information, but historical information on experience of users is also quite useful."

Many readers stressed the importance of detailed basic articles (siting, wiring, soldering, how to build/design a battery room and venting system, grounding, plumbing for solar hot water). Readers want practical do-it-yourself articles, and system articles, and information that won't go out of date quickly.

Readers envision a book geared for those just starting out but with schematics and projects for seasoned folk as well. "Education at the beginning and intermediate level should be the focus."

Many readers suggested other categories: passive solar, foreign country coverage, wood stove furnaces, woodstove water heat, heat exchangers, solar space cooling. Many suggested annual supplements and updates.

We will publish a basic reference book for home-powered systems. Past articles will be edited to ensure up-to-date information. The book will be over 400 pages and in softcover. Price will be about $20.

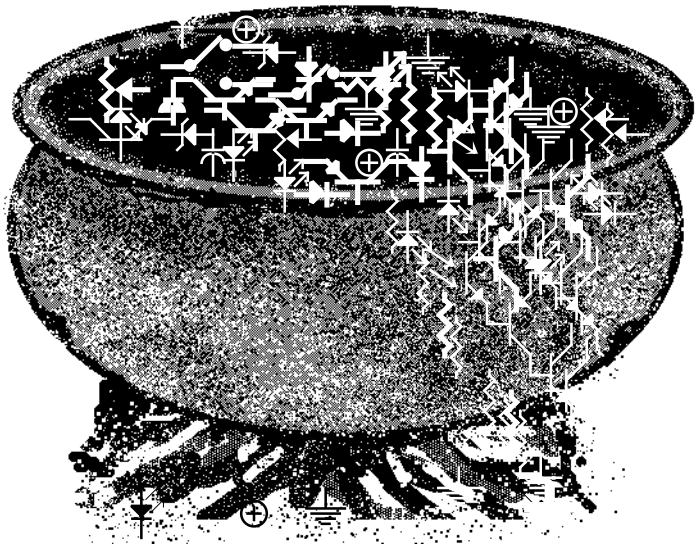
Thanks to all who took the time to fill out the survey. We value your comments!!! *–Therese and the HP Crew*

Survey Results

Subject	*Avg. Rating*
Photovoltaics	4.41
Batteries	4.20
Things that Work!	4.17
How-to Articles	4.16
Inverters	3.93
Efficient Appliances	3.87
Instrumentation	3.72
Safety	3.71
Basic Electric	3.69
Solar Hot Water	3.69
Controls	3.67
Basics Articles	3.65
Tech Notes	3.64
Solar Space Heat	3.60
Pumps	3.55
Engine Generators	3.49
Wind Generators	3.47
Q&A	3.37
Electric & Solar Vehicles	3.34
Conservation	3.29
Glossary	3.23
Homebrew	3.18
Code Corner	3.15
Micro Hydro	3.11
Hydrogen	2.94
Letters	2.87
Health & Environment	2.86
Education	2.80
Architecture	2.80
SolarCooking	2.78
Communications	2.76
Methane	2.64
Wizard	2.63
Home and Heart	2.61
Book Reviews	2.53
Editorials	2.52
Energy Fairs	2.48
People	2.43

KANSAS WIND POWER
FULL PAGE
camera-ready

Homebrew



A Digital Ampere-hour Meter

Mark A. Peterson

Introduction

In designing any electronic instrument a few fundamental principles should be kept in mind throughout the creative process. Economy of design is perhaps foremost. This implies that the complexity, cost, size, and concessions be minimized. Rule 1: Make your ideas into "recyclable" building blocks. You get spin-off technology that way. Rule 2: Don't reinvent the wheel. Take advantage of existing devices. In the design of my digital ampere-hour meter I used an IC (the AD654 voltage-to-frequency converter) which took care of most of the engineering problems associated with the cost, accuracy, and complexity constraints. After all, this is supposed to be a practical project.

Amp-hour Meters: General Theory

Ampere-hour meters can be engineered in many different ways. A Fluke 87 multimeter can be used to collect data and provide accurate results over a 36 hour period. The Homebrew in Home Power #26 featured an amp-hour meter with an architecture termed "charge-balance" in electronics jargon. It uses entirely analog components (op-amps) except for the counter/LCD display. My meter uses a precision voltage-to-frequency converter (VCF) which converts the millivolt analog input signal to a digital data stream. The digital information is then processed, stored and displayed in ampere-hours (counts up to 9999.9 Ampere-hours). Finding an accurate VCF capable of sensing millivolt inputs and needing only a single 5 Volt supply was a non-trivial task. Single-supply circuits like this one can be battery operated, important for hand-held instruments.

Parts List

U1—LM 7805 five Volt regulator

U2—AD654 voltage-to-frequency converter (VFC)

U3–U7—CD4017 decade divider

U8—CD4066 Quad analog switch

RS—0.01 Ω precision shunt 1% 2 Watt Dale type LVR-2 (for 20 Amperes maximum current) or 0.001 Ω precision shunt (for 200 Amperes maximum current)

R1—1.5 kΩ wire wound, low temp coefficient (100 ppm)

R2—10 turn quality potentiometer (PC mount)

C1—10,000 µF 35V electrolytic

C2—0.01 µF ceramic

C3—1µF tantalum

C4—1000 pF polystyrene or mylar

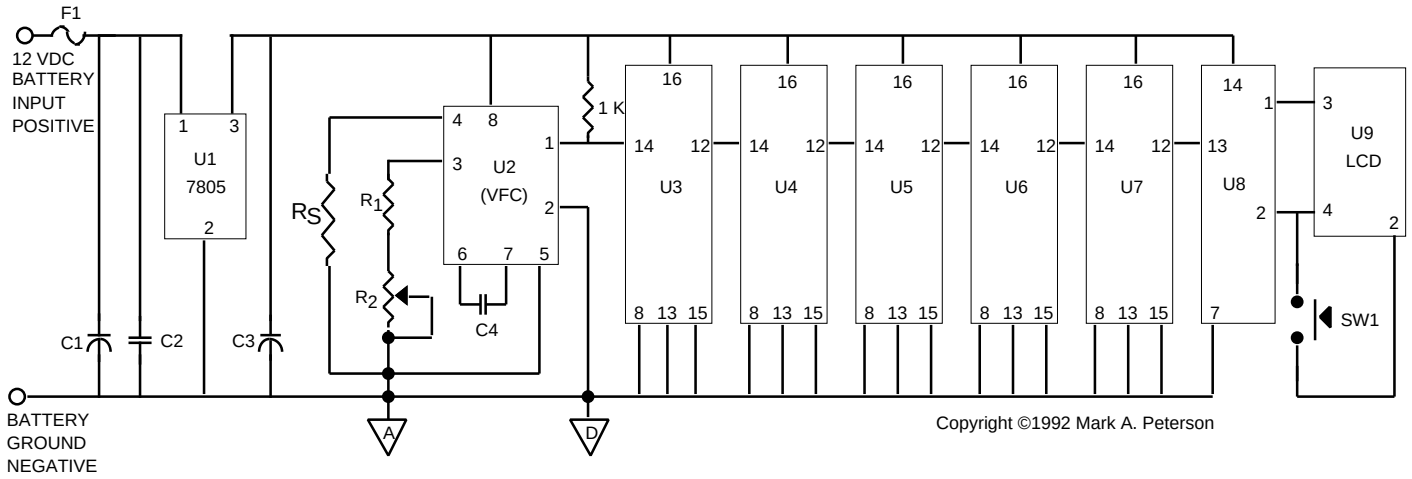
F1—2 Amp fuse

SW1—momentary on-off switch (normally off)

Circuit Operation

The meter was designed to produce 100 counts-per-hour with a 100mV input across the precision shunt RS. This is equivalent to 10 Amperes flowing through a 0.01 Ohm shunt or 100 Amperes through a 0.001 Ohm shunt. The 5 digit display should therefore have a decimal point placed before its last digit. The voltage drop across the shunt controls the VCF's squarewave output frequency (CMOS compatible). This frequency is directly proportional to the magnitude of the input voltage. The resultant data stream (digital information) requires scaling because the VCF produces a kHz range output (necessary for accuracy and dynamic range at low level signals) and the LCD display/counter requires a very low frequency input (well under 1 Hz). Information scaling is achieved by sending the data stream through a cascaded series of five decade dividers (U3 through U7) to derive a data stream of frequency $1x10^{-5}$ (1/100,000th) of the VCF's output. The resultant low frequency squarewave is ready to be counted. The divider chain output is fed to an analog switch (U8) which acts as a relay, shorting the appropriate pins of the LCD counter to advance the count. An external reset button provides a CLEAR DISPLAY function.

DIGITAL AMPERE-HOUR METER



Breadboarding the circuit

Total assembly time can be cut to a minimum by being well prepared. Purchase a couple of quality prototyping breadboards (JAMECO sells some excellent ones with dual supply busses on the top and bottom). You'll need about 40 pieces of #20 gauge solid wire in 2.5 inch – 3 inch lengths. The wires should be red, black and white to keep wiring errors to a minimum. Use red for 5v, black for ground, and white for signal path interconnects. It is essential that the digital ground be connected to the analog ground at one point only. Failure to do this will cause ground loop currents to flow into the AD654's input amplifier and severely degrade performance. The power supply can be external or 9V transistor battery operated. CAUTION: When handling CMOS devices wear a grounded wristband! These ICs are static-sensitive and can be destroyed if you're not careful.

Calibration

If you have a frequency counter, such as a Fluke 87, or can borrow one, the meter will be very easy to calibrate. Obtain a 100mV reference and apply it to the input of the AD654. Monitor the frequency output at pin 1, and adjust the 10 turn pot (R2) to give a reading of 2777.7 Hz. The frequency output of the divider chain will be 0.0277 Hz. which corresponds to 100 counts-per-hour, THE DESIRED COUNT.

If you don't have access to a frequency counter there is an alternate method. You'll need a stopwatch, and a little more time, but the meter can be calibrated to within 5% error this way. Remove (temporarily) the signal jumpers connecting to and from U7. Connect pin 12 of U6 to the control input of the analog switch pin 13 of U8. The counter will now count 10 times as fast. Adjust the trimpot to give 16.66 counts-per-minute (perhaps do a 3 minute or 5 minute sample to get higher accuracy). Now reconnect U7 into the circuit and you're ready to go. If you want a counter which counts to 999.99 instead of 9999.9 Amp-hours, leave out the last decade divider.

Testing the meter

About a year and a half ago I measured the output of my Arco 50 watt and Solarex 45 watt self-regulating panels for about a week during the summer. I used both the digital amp-hour meter and a Fluke 87 and found that my meter agreed with the Fluke to within 1%. Close enough. Since I live on the coast of Northern California, the panels put out a variable amount of power. They averaged between 15 and 30 Amp-hours per day. I tested the meter's accuracy recently and found it to still be in calibration, and am now fully satisfied that it has good stability with respect to time and temperature variation. The AD654 (and probably the equivalent LM331) does indeed hold true to the manufacturers claims regarding precision, and stability.

The only real limitation of the meter is that it doesn't measure current in both directions (although that limitation could be overcome with the AD654 in an enhanced circuit). The meter is therefore not suitable for monitoring your Sun Frost or any load that returns current to the battery bank.

Beyond Amp-hour Meters

This meter is really a "long-term integrator" with a current sensing module as a front end. Another front end could be substituted for the shunt. The AD654 will accept any millivolt input from thermocouples, phototransducers, etc. So the meter could be used to integrate parameters such as insolation, temperature, pressure or whatever.

Access
Author: Mark A. Peterson is production manager at Sun Frost. He can be reached at POB 4902, Arcata, CA 95521

Parts sources
AD654; Analog Devices, Route 1 Industrial Park, Norwood, MA 02062 • 617-329-4700 $50 minimum order

Prototype breadboards and misc. components; Jameco Electronics, 1355 Shoreway Rd. Belmont, CA 94002 • 415-592-8097 $30 minimum

Misc components; Digi-Key, 701 Brooks Ave. S. POB 677, Thief River Falls, MN 56701-0677 • 800-344-4539

LCD counter/display; Radio Shack

ABRAHAM SOLAR
camera-ready

BATTERIES

NI-CADS (RECONDITIONED) 160 AMP/HR. $599 @ 12 VOLT.

NICKEL IRONS (RECONDITIONED) 150 AMP HOUR $562 @ 12 VOLT.

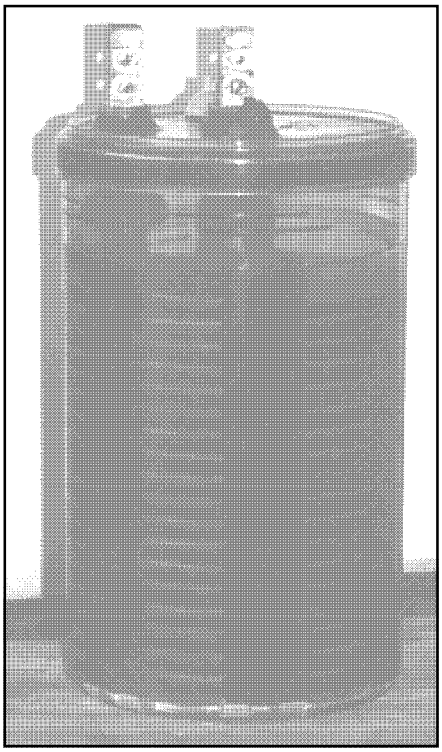
NEW NICKEL IRONS 300 AMP HR. $1485 @ 12 VOLT (5 YR. FACTORY WARRANTY).

SURPLUS LEAD ACID STATIONARY BATTERIES RECTANGULAR DESIGN/LEAD ANTIMONY OR LEAD CALCIUM $400 TO $800 PER 12 VOLT SET DEPENDING ON AMP HOUR CAPACITY AND AGE. LIFE EXPECTANCY IN HOME POWER USE 7 TO 10+ YEARS. (PROVEN TO WORK UNDER FIELD TESTING FOR OVER 20 YEARS.)

Rob and Jean Shappell
Northwest Energy Storage
POB 137, Colburn, ID 83865
208-263-6142

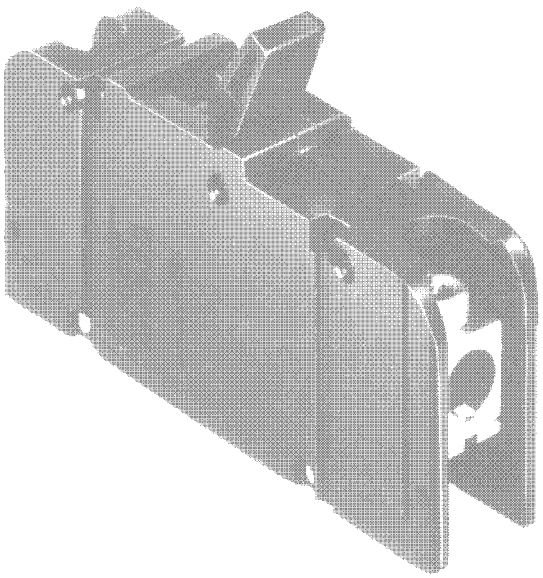
THE LINEAGE 2000 IS A PURE LEAD BATTERY, 1680 AMP/HRS. LIFE EXPECTANCY UNDER FLOAT 50 - 70 YEARS. THE FACTORY CONSIDERS THIS BATTERY MAINTENANCE FREE. UNMATCHED IN PERFORMANCE, QUALITY, RELIABILITY, AND SAFETY. THESE BATTERIES ARE 11 TO 15 YEARS OLD AND COST $1399 PER 12V. 1 YEAR WARRANTY. CUSTOMER SATISFACTION GUARANTEED!! EXAMPLES ON FREIGHT:
REDDING, CA $230.
SACRAMENTO, CA $245.
LAS VEGAS, NV $300.
BRUNSWICK, ME $360.

CRUISING METER-AMP HOUR + FOR ONLY $269 WITH ANY BATTERY PURCHASE.



LINEAGE 2000 Made in the USA

Northwest Energy Storage



Is Your Inverter Covered?

Inverters and other solar electric system components need safe disconnects and over-current protection that do not degrade the performance of your system.

Inverters in particular can be difficult and expensive to safely protect since they often have high current requirements that need large fused disconnects. As a result many inverters and their cables go unprotected without a disconnect or even a fuse.

HEINEMANN CIRCUIT BREAKERS act as both a disconnect and over-current device. They are compact in size (7" long), far more efficient than a fused disconnect, and are rated to withstand larger DC fault currents than fuses. More importantly, they now cost less. In short they are the ideal device for this purpose.

Rainshadow Solar is distributing the Heinemann 250 Ampere breaker (GJ1-H3-U-25G-1C-DC) suitable for use with the Trace 2012, stacked Trace 2524s, Heart 2800, PowerStar UPG1300, Statpower 1500, and other inverters.

DC SPECIFICATIONS:

MAXIMUM VOLTAGE..... 125 VDC
INTERRUPTING CAPACITY.... 25,000 A (UL listed 65 VDC)
APPROVALS..... UL LISTED, CSA APPROVED
TERMINAL TYPE..... CU/AL BOX LUG 6-250 MCM
TESTED CYCLE LIFE..... 10,000 OVERLOAD CYCLES
RESISTANCE..... 0.0015 TO 0.008 OHMS

$149.50 each

Back mounting kit available $3.50 • Metal enclosure available $64.00

Rainshadow Solar

POB 242, ORCAS, WA 98280 • 206-376-5336 • FAX 376-3000

The Next Generation

Therese Peffer

Kids definitely knew their place at the Midwest Renewable Energy Fair (MREF) in Amherst, Wisconsin this year. A look around the fair saw young faces, bright with curiosity and eyes lit with creative energy.

The Home Power crew joined the third annual MREF the third weekend in June. I take no credit for the arduous 45 hour drive the rest of the Home Power crew endured to get to the fair (I flew out a few days early to visit Minnesota relatives). This was the first MREF for me and I was quite impressed with the people and the variety of seminars, especially those for youth.

Renewable Fun

Two tents housed the "family" events for the three day weekend. I saw up to 30 kids at a time each day creating the Renewable Village out of large cardboard boxes. Houses had a pattern of juice can lids representing the photovoltaic cells that make electricity from the sun. Someone made a windmill. Houses, stores, and jails quickly outgrew the tent and spread out on the grass. Youngsters 2 and older cut, colored, and crawled all over their cardboard village.

The other tent held various workshops. Kids built solar ovens. The ingredients? A cardboard box, a shoe box, newspaper, black paint, black tissue paper, a thick plastic sheet, and a two foot elastic band. First the inside of the shoe box was painted black. Then newspaper was crumpled up and stuffed in the cardboard box under and around the shoebox. Black tissue covered the newspaper. The plastic sheet covered the top and was secured with the elastic band. Within 30 minutes of painting and assembling, kids of all ages were watching (or munching!) squares of cheese pizza.

Young girls and boys got into groups of 5-7 for the Lego-building workshop. Small photovoltaic cells powered the spinning windmills, working cranes, and trucks that resulted.

The program listed 13 workshops for kids, two at a time, that spanned each day of the three day fair. I only caught part of the drama workshop that ran overtime. A lively gentleman, Rogers Keene, directed the seemingly non-stop series of dramatic activity. Music from the make-your-own-music workshops drifted past the Home Power booth. I saw groups of kids in one tent or the other all day long.

I was impressed by the variety and creativity of the family workshops. I've been to four different energy fairs and was involved in organizing one of them. I had never seen the number and quality of kids workshops that took place at the Midwest Renewable Energy Fair. I can appreciate all the time and effort these people undertook for these workshops. Kudos to Ellen Davis, Lyn and Jeff Mosurinjohn, folks from Center Stage Productions, and all others who helped these "Next Generation" workshops happen. I hope this sets a precedent for other fairs!

For Teachers, Too

The six curriculum workshops for kindergarten through 12th grade teachers was another welcome addition to an energy fair. Some of the workshops could be applied towards the state's teaching certificate. At one workshop I picked up the 100 page Renewables are Ready: a Guide to Teaching Renewable Energy in Junior and Senior High School Classrooms from the Union of Concerned Scientists. It lists many activities for social studies, economics, math, and science units and at the end lists sources of further information and aids. Well worth the five dollars. Ann Quale of the Wisconsin Center for Environmental Education collected pamphlets and books on learning activities for Kindergarten through 6th grade. She would like to spend a year reviewing the material—I look forward to her comments next year! (See sources on the next page)

For the Older Kids

Of course those of us older kids had plenty of workshops to keep us busy. There were a total of fifty-two different workshops on wind and photovoltaic basics, batteries and inverters, electric vehicles, solar cooking, sustainable gardening and living, home conservation, and so on. All the workshops took place on the fairgrounds, nine workshops at a time, all day long.

Looking Forward to the Future

I left the energy fair tired from the three full days, but filled with good, positive energy of a different sort. I learned a lot both from the workshops and from the people I met. Education is what these fairs are all about: renewable energy for all ages, levels of education, and experiences.

The information is out there and available to those who ask for it. Sometimes it takes a little energy to find it.

As Summer turns into Fall, the memory (or reality) of school prevails. It's time for teachers and educators to plan good activities on energy for their students. For those in high school or college it's time to look to the future of renewable energy in planning careers. Those at the Midwest Renewable Energy Fair started the Next Generation Workshops. It's up to the rest of us to continue the education. As Mick Sagrillo stated, "It can be difficult to change some adults minds. If we're going to change the world, it will be through our children."

Sources:

Here are a few sources from the fair. Share them with your favorite teacher or student!

General Info on Renewables:

American Solar Energy Society has a 1992 Publications list of materials about solar, some material for teachers and educators. For example, NREL's 1991 161 page Elementary and Secondary Science Projects in Renewable Energy and Energy Efficiency for K-12, ($10). ASES, 2400 Central Ave., G-1, Boulder, CO 80301 • 303-443-3130

Conservation and Renewable Energy Inquiry and Referral Service (CAREIRS) provides free information on renewable energy and efficiency. POB 8900, Silver Springs, MD 20907 • 800-523-2929

National Appropriate Technology Assistance Service (NATAS) provides free information and assistance for those interested in renewables, including educators. POB 2525, Butte, MT 59702-2525 • 800-428-2525

Curriculum:

Contact the Department of Public Instruction or Department of Education in your state. Materials on renewable energy may be in a science or environmental education unit. California has the California Energy Extension Service that provides educational materials on renewable energy. Conserve & Renew: An Energy Education Activity Package for Grades 4-6, from CEES, 1400 Tenth St., Sacramento, CA 95814 • 916-323-4388.

ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Ohio State University, College of Education and School of Natural Resources, 1200 Chambers Rd, Third Floor, Columbus, OH 43212. Has a list of science education and environmental publications, and collection of energy activities for the classroom.

Renewables are Ready: a guide to teaching renewable energy in junior and senior high school classrooms. 100 pages, $5 from the Union of Concerned Scientists, 26 Church St., Cambridge, MA 02238 • 617-547-5552. Well-worth the money. Lists many more resources and organizations.

National Energy Foundation, Materials catalog lists resources for education. 5160 Wiley Post Way Ste 200, Salt Lake City, UT 84116 • 801-539-1406

Energy Education Sources (December 1991) A list of free or low cost energy-related educational materials. from the Energy Information Administration, National Energy Information Center, U.S. Dept. of Energy, Washington DC 20585

Energy Education Materials Library sells a HyperCard database of energy education materials ($12). The Energy Center, Sonoma State University, Rohnert Park, CA 94928.

Further education:

Jordan Energy Institute offers a B.S. in Applied Environmental Technology or Renewable Energy Engineering Technology. Those with bachelor degree may apply degree. 155 Seven-Mile Rd NW, Comstock Park, MI 49321 • 616-784-7595

Solar Technology Institute has 1 and 2 week courses on all aspects of renewable technology. POB 1115, Carbondale, CO 81623-1115 • 303-963-0715

NATAS (above) will help you find further education programs.

Solar Service Guide: A Career Opportunity Guidebook lists leads on career opportunities and a list of colleges and universities with renewable energy programs. 8 pages, $5 from Solar Service, POB 1767, Pahoa, HI 96778.

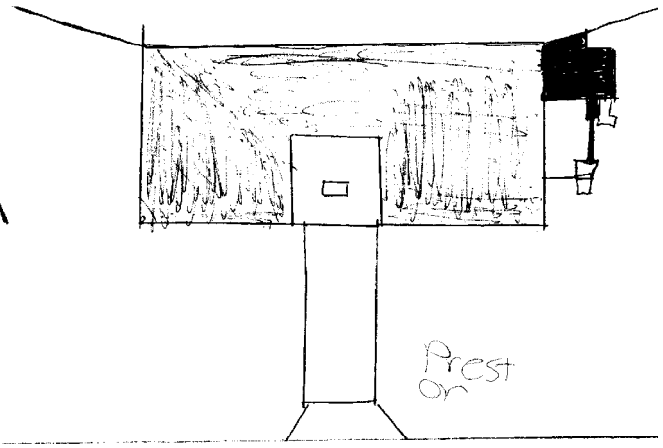
Student Pugwash is concerned with science, technology, peace, and the environment. Many college campuses have chapters. They have a book on jobs and internships, not necessarily in renewable energy. Call 1-800-Wow-A-Pug for more information.

Access

Author: Therese Peffer, c/o Home Power

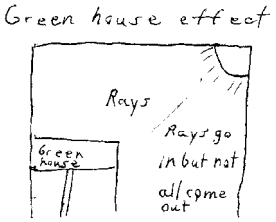
Jordan Energy Institute
camera-ready

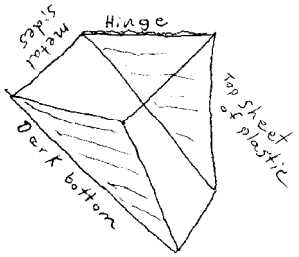
Kids Corner
My Solar Oven



by Hatina Ali Rockssi

My solar oven is a triangle to preserve materials. The suns rays creat heat in my solar oven but to creat more heat my solar oven has plastic on top, and a dark ~~black~~ black bottom to atract heat with meatal on the inside walls, to make more heat reach the item being cooked, the top opens up so you can get items inside. Solar ovens work with the green house effect.





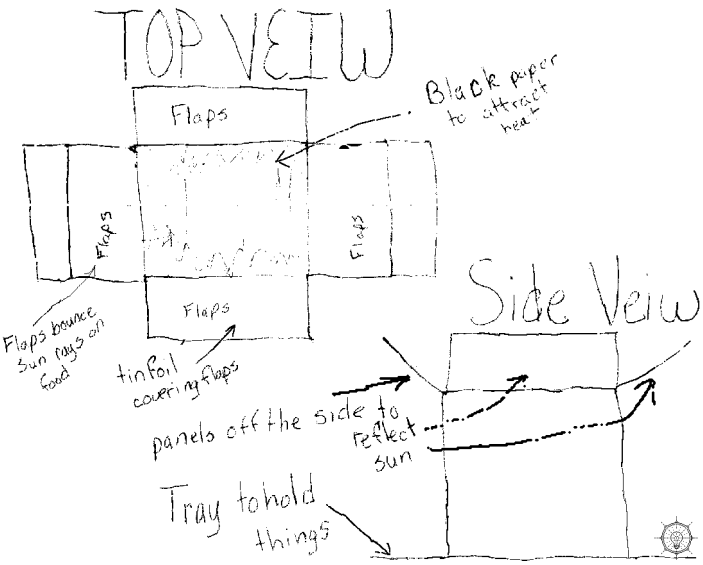
My oven has black sides to keep heat in. It also has tin foil on the inside to keep the suns rays moving. A two layer peice of glass keeps the rays from leaving the box. My beverage dispencer will give out the most wanted beverage. It also has a stand to keep the cooking at waist level, and an extra shelf for cooking more.

My solar oven is a box with panels on the top covered with tin foil. The tin foil is to bounce the sun rays off and onto the food. The bottom of the oven is black so when the food sits on it, it attracts heat. It has a tray hooked to the bottom to hold food or drinks. It also has plastic wrap over the top to keep the heat in.

By Sara Marder

BY KEVIN CONNELL

MY GROUPS SOLAR OVEN HAS FOUR SIDES. BLACK ON THE OUTSIDE TO ABSORB MORE HEAT . IT HAS TIN FOIL ON THE INSIDE TO REFLECT SUN RAYS ONTO THE FOOD . ON THE TOP IT HAS SOLAR PANELS THAT REFLECTS SUN RAYS ON THE FOOD THAT WOULD NORMALLY MISS THE SOLAR OVEN. ALSO ON THE TOP IT HAS A JUICE DISPENSER. UNDER THE PANELS WE PUT CLEAR PLASTIC WRAP OVER THE TOP SO SOLAR RAYS CAN GET IN BUT CAN'T GET OUT. ON THE SIDE THERE IS A DOOR THAT CAN OPEN AND CLOSE TO GET THE FOOD IN AND OUT. OUR SOLAR OVEN CAN COOK OUR FOOD AND HEAT OUR DRINK AT THE SAME TIME. I THINK USING SOLAR ENERGY MAKES GOOD CENTS.

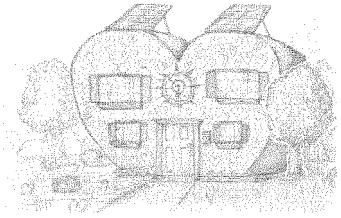


Contents

2 cardboard boxes, 1 smaller than the other
Aluminum Foil
Black Construction Paper
Clear Plastic
Crumpled Paper for insulation

Thanks to the Fifth Grade Class (and teacher Mr. Tom Scott) of Bear Creek Elementary from Bend, Oregon for sending their solar oven designs! Attention all kids: send us your pictures and letters about what you've learned on renewable energy and we'll print as many as we can! ——Therese & the Home Power Crew.

Home & Heart



Kathleen Jarschke-Schultze

I have been working with solar food drying in some capacity for years. Now I have built the most ambitious (for me) dryer yet. I am well pleased with the results and expect to dry many foods from my garden this year.

Dry History

The first solar food drying I can remember is a wooden table set up by Aunt Anna's grape arbor. We would pick the grapes and eat them but Aunt Anna would spread them to dry under cheesecloth. That's when I realized dried grapes were raisins.

Then when I first lived with Bob-O we had a lot of peaches and strawberries one year. I laid out cookie sheets lined with freezer paper and poured fruit puree into them. After covering them with plastic and waiting a couple of sunny days I had fruit leather.

Presently

After a question from a reader and a request in this column, I received alot of information on food drying. (See HP #29) The model I chose to make was Lucien Holy's Active Dry Climate dryer. I was very ambitious and got a large cardboard box for the drying area. Then it rained. Even on the covered porch, where I thought it was protected, it took a direct hit and lost its shape completely.

Then we got a shipment in a plywood box. It was small, sturdy and put together with Makita wood screws. My kind of materials.

My mother had given me her old electric food dryer. I considered running side by side tests. When I saw that the power draw on the electric model was 600 watts I decided differently. However, the shelves in the unit were really nice. They measured 2 foot by 2 foot of washable white plastic trays with a liner of food grade plastic screening. I realized that the plywood box would work if I added 2.5 inches to each side of the box. It took me one day to accomplish this. I also cut a hole in the top and placed a small 12 V muffin fan to draw the air through the drying chamber. The fan is powered by a Solarex SA-2 amorphous silicon module. It is designed to be a 6 volt battery "charge maintainer" and runs the fan from dawn to dusk.

I took one half of a PV panel cardboard shipping box, cut the sides on a diagonal, cut along the front and painted the inside black. After cutting vent holes in the ends of the box and one side of the dryer box I thought I was ready to apply the Saran Wrap glazing. I had not considered the windy qualities of our canyon home. After due deliberation, I carefully chose some flat rocks and placed them into the collector. I reasoned that not only would they hold the darned thing down, but would act as heat sinks and keep the air warmer longer as the sunlight changed position. On with the glazing and I was done. On the dryer box I added hinges and two wooden knobs so I could hold the door tightly shut with a large rubber band.

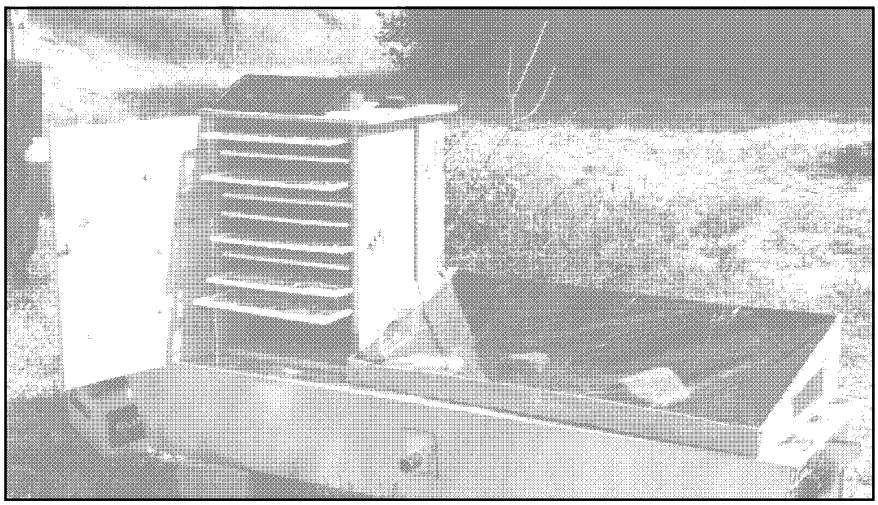
Fruit & Veggies

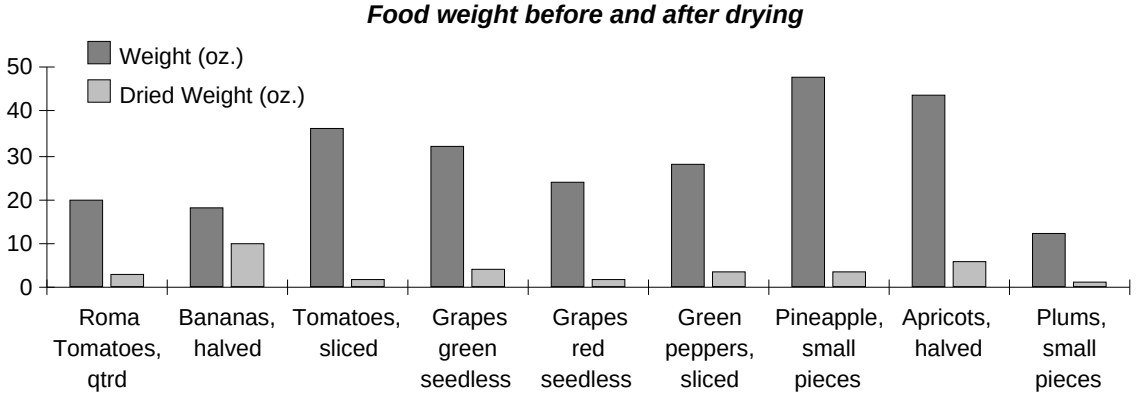
Since the only thing my garden was producing at the time was artichokes and snow peas I went shopping. I chose two kinds of tomatoes, seedless grapes, plums, apricots, pineapple, bananas and green peppers. Some I blanched, some I did not, according to the type of food. I weighed the food before I dried it and afterwards. I cut rather large pieces of everything. I like dried apricot and banana halves. I quartered the Roma tomatoes for sun dried tomatoes. I knew it would take a little longer to dry, but I felt the food would look better.

Drying Time

I started drying the foods at 10:45 one morning. This would give them the better part of a day to get the surface moisture out. I placed a thermometer in the collector. For

Below: The completed food dryer. Air enters the right vent, is warmed in the solar collector, and wafts across the food.





"The air coming from the dryer... had a wonderful tropical smell."

most of the day it read 150° F. The ambient temperature was about 85° F. The air coming from the dryer box through the fan had a wonderful tropical smell. I was eager to see if the dryer worked so I must have checked it three or four times that first day.

I did not remove the food that evening. The next morning I checked and it did not seem to haved picked up any moisture in the night. By the end of that second day the smaller pieces of food were leathery. By the third day most of the food was dry—the apricot halves took another day.

I noticed that one grape had not dried at all, but was just as juicy as when I first set the tray in. I had blanched the grapes, then plunged them into cold water to crack the skins. This allows the moisture to escape during the drying process. Apparently the skin of this grape didn't crack which illustrates the importance of blanching.

Correction

In the Things that Work! on the Bar-B-Que Box in HP# 28, Bob Taylor is listed as the maker. Bob distributes the Box but does not make it.

Access

Kathleen Jarschke-Schultze is drying her heart out and can be reached c/o Home Power Magazine, POB 130, Hornbrook, CA 96044 • 914-475-3401

HAPPENINGS

NATIONAL

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

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

Public education will be a major focus of the "Renewables are Ready" campaign. UCS activists will also focus attention on policy-makers and work on changing the regulatory climate to encourage the growth of renewables. A set of eight posters is available covering solar architecture, electricity from renewables, and alternative-fuel vehicles. All 8 posters sell for $14 plus 20% shipping. For more information, contact the Union of Concerned Scientists, 26 Church St., Cambridge, MA 02238 • 617-547-5552

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

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

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

Audubon Solar Brigade If you pay an electric bill every month, let them know you'd like to see more utility solar power. The National Audubon Society's (NAS) Solar Brigade is an effort to coordinate a million people nationwide to demand 10% solar in ten years. Send a SASE to the NAS, 950 Third Ave, Dept. AB, New York, NY 10022 or call 212-759-6354 for more information, or to become a Solar Brigade leader. A roving video/slide show and free Audubon Technical Guide on energy efficiency are available by calling 212-546-9195.

CANADA

SW Alberta Renewable Energy Initiative Information Centre–This group provides Canadians with information and workshops on renewable energy. For more information contact Mary Ellen Jones, Information Centre Manager at POB 2068, Pincher Creek, Alberta, Canada T0K 1W0

CALIFORNIA

Solar Technology Institute of Carbondale,CO will be conducting a hands-on training work in Willits, CA, August 3–6, the week before SEER '92. The class will include PV system design theory as well as hands-on construction and installation of two photovoltaic systems–including the large system that will power SEER 92. If you're interested in a home system or RE business, this workshop's for you. The cost for the four day class is $350. For information contact STI, POB 1115, Carbondale, CO 81623 or call 303-963-0715

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

North San Francisco Bay Chapter of the Electric Auto Assoc. (EAA) holds meetings on the second Saturday of each month at the PG&E Business Center, 111 Stony Cir, Santa Rosa, CA from 9:30 AM–Noon. For information on the EAA and the chapter nearest you, send an SASE to 1249 Lane St, Belmont, CA 94002, or call 415-591-6698 (10 to 5 on weekdays).

AlTranEx'92 Sept. 23–27, at the Burbank Hilton convention Center, will feature an electric vehicle endurance competition, exhibits of electric cars, natural gas, alternative fuel-flexible, solar, hybrids, conversions & human-powered vehicles; photovoltaic & energy efficient products, and environmental organizations. The Expo is being held in association with Alternative Transportation News, Energy West Publishers, & Greenbrokers. For more info contact Greenbrokers, POB 11088, Burbank, CA 91510 • 310-285-0093

Solar and Electro-Expo September 19, Plaza Park, San Jose, CA. The expo combines exhibits and seminars on solar water , PVs, and conservation technologies. Contact Mary Tucker, Northern Calif Solar Energy Assoc., POB 3008, Berkeley, CA 94703 • 408-277-5533

Siemens Solar Industries is offering a training program, Photovoltaic Technology and System Design for 1992. Learning begins by purchasing the two volume set of Training Manual and Technical Appendix for $175. The fee includes their award winning 30 minute videotape "The World of Solar Electricity". Step two is a 5 day training class at Siemens Solar in Camarillo, CA on July 27–31 and September 21–25 1992. The training class is $175 (food and lodging not included). The course offers hands-on experimentation with inverters, controllers, batteries, modules, trackers and loads. For more information contact: Mark Mohrs, Siemens Solar Industries, 4650 Adohr Ln, Camarillo, CA 93011 or call 805-482-6800

Electrathon Championship and International Challenge and 20th annual Electric Auto Assoc. Rally at the San Jose Solar Fair, City Center, San Jose CA. The grand championship Electrathon event of the year. The event will follow a series of builders workshops, technical seminars and panel discussions now in planning. For more information contact, Clean Air Revival, 55 New Montgomery, Ste 424, San Francisco, CA 94105 or call 415-495-0494

COLORADO

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

Photovoltaic Design & Installation–Sept 7-18. • Advanced PV for Remote Homes (Richard Perez guest instructor) –Sept 21-Oct 1. • Micro-Hydro Electric Systems–Oct 5-8. • Solar Home Design & Construction–Oct 12-22. • Advanced Passive Solar Design–Oct 26-Nov 5.

See ad on page 93. For a detailed description of SOLAR HOME PROGRAM WORKSHOPS, costs and scholarship information, write STI, POB 1115, Carbondale, CO 81623-1115 • 303-963-0715

Red Rocks Community College Solar Workshops: Photovoltaics Workshop 3-14 August, Solar Domestic Hot Water Workshop 17-21 August, Solar Controls Workshop 24-28 August. Contact Jim Klima, Red Rocks Community College, 13300 W. 6th Ave., Lakewood, CO 80401-5398 • 303-988-6160 ext 320

FLORIDA

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

The **Florida House Foundation** is building two model homes incorporating passive solar architecture, energy and water efficient appliances, solar electricity and hot

water, and edible landscaping. Contact The Florida House Foundation, POB 21583, Sarasota, FL 34276 • 813-924-6833

IOWA

Iowa Renewable Energy Fair (I-RENEW) presented by the Iowa Renewable Energy Assn. October 17 1992, Cedar Rapids, Iowa. Workshops on wind, PV, solar thermal, biomass, batteries, energy efficiency, farm applications, legislative issues, electric cars, eco-entrepreneuring and more. Working demonstrations of wind, photovoltaics, hydrogen, solar thermal, electric cars, solar cars, and water pumping. Exhibits and vendor booths, music, food and Fun! Contact: Tom Deves, 3863 Short St, Dubuque, IA 52002 319-556-4765 or Jim Sievers, 1857 Edgewood Dr NW, Cedar Rapids, IA 52405 319-396-6576.

IDAHO

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

MAINE

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

MASSACHUSETTS

Solar and Electric Vehicle Symposium (S/EV'92) Boston, October 9 - 10, 1992, sponsored by the Northeast Sustainable Energy Assoc. (NESEA). "With clean air legislation currently passed in the Northeast, the EV market is about to explode, and new EV and components for EVs are announced monthly," says Nancy Hazard of NESEA. The S/EV'92 will be a forum for advancing the electric vehicle market, infrastructure and technology. Interested parties include NESCAUM, Electric Edison Institute, the DOE, GM, Ford, Trojan batteries, the E.P.A., and Unique mobility. Call 413-774-6051

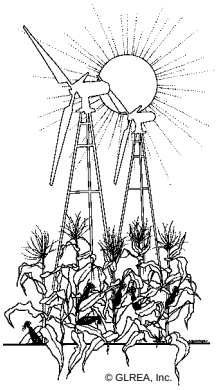
Fowler Solar Electric Inc. Workshop, Sept 12, in Worthington, MA. Jeffrey and Lea Fowler, authors of *The Solar Electric Independent Home Book,* will hold an all day workshop on living with, designing, and installing a PV system. $35 each or $45 per couple. FSE P.O.Box 435, Worthington, MA 01098, 413-238-5974

MICHIGAN

The Second Annual Great Lakes Renewable Energy Fair (GLREA) Saturday & Sunday, August 22 & 23, 1992 at the Traverse City Junior High School. Demonstrations, Display booths, Workshops, Speakers, Children's Activities, Alternative Transportation, Tours, Food, & Entertainment. To get on our mailing list, join our association, or for more information please indicate your interest when you contact us at 11059 Bright Rd, Maple City, MI 49664, 616-228-7159 (GLREA is a non-profit organization.)

VERMONT

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



Announcing the Second Annual

Great Lakes Renewable Energy Fair

Saturday and Sunday, August 22 & 23, 1992

Traverse City, Michigan

at the Traverse City Junior High School

• Demonstrations • Display Booths • Workshops • Speakers • Children's Activities • Alternative Transport • Tours • Food • Entertainment •

The Energy Fair will display windmills, solar panels, solar water heaters, solar cookers, batteries, inverters, efficient lights and refrigerators, composting toilets, and more. Solar and electric cars will be displayed. Workshops will cover conservation, recycling, composting, basic electricity, hydrogen and alcohol as fuel, biomass and others. The Renewable Energy Home Tour and the Kids' Activities have been expanded since last year.

Admission is $3 per day or $5 for the weekend. Children under 12 are free.

To get on our mailing list, join our association, or for more information, please contact:

The Great Lakes Renewable Energy Association, (GLREA)
11059 Bright Road, Maple City, Michigan 49664 (616) 228-7159

GLERA is a non-profit organization

The Great Lakes Renewable Energy Fair is not sponsored by Traverse City Area Public Schools

The Iowa Renewable Energy Assn. (nicknamed I-RENEW) presents the

Iowa Renewable Energy Fair

Saturday, October 17, 1992 8:00 am to 8 pm

Cedar Rapids, Iowa

Exhibits, Workshops, Vendor Booths, Music, Food, and Fun!
Come see it all at the I-RENEW Fair!

Workshops

Wind, PV, Solar Thermal, Hydrogen, Biomass, Batteries, Energy Efficiency, Farm Applications, Legislative Issues, Electric Cars, Eco-Entrepreneuring, and More.

Working demonstrations

Wind System, Photovoltaic System, Hydrogen, Solar Thermal, Electric & Solar Cars, and Water Pumping.

Anyone interested in having a booth or exhibit, or interested in joining I-RENEW, a non-profit Corp., or participating in the fair contact:

Tom Deves
3863 Short St., Dubuque, IA 52002
(319) 556-4765

Jim Sievers
1857 Edgewood Dr. NW, Cedar Rapids, IA 52405
(319) 396-6576

the Wizard Speaks…

Ecology and Green-Washing

Ecology

Many problems beset the earth today. Among them are global warming, the ozone layer, and loss of species diversity. There is much disagreement among scientists about the severity of these problems. As a result, the political leaders of the world cannot agree on a quick and drastic solution to these problems.

It does not matter what the scientists and politicians believe. If there is only a 10% probability of the harshest scenario coming true, something drastic must be done immediately. If someone told you that you could lose all of your material possessions and possibly the lives of your children by not drastically changing your lifestyle, I am sure you would change immediately. You would change even if there was only a 10% probability of actuality. This is the situation we face today on planet Earth. Consider it.

Green-Washing

I find many large companies today who are still not eco-friendly putting on their green masks. Major polluters are pretending to be friends of the Earth. I have seen this in their advertising and in their quoted corporate policies. Beware of green-washing. It wipes right off.

Letters to Home Power

Selected & Entered by
Kathleen Jarschke-Schultze

An Open Invitation to Home Power Readers — especially Bob-O Schultze

The deadline for submitting proposals to change the 1996 National Electrical Code is November 1992. It takes nearly three years to thoroughly review the proposals and solicit comments from all concerned. Anyone can submit proposed changes. The schedule and process can be found in the introduction to the NEC found in the first few pages of the Code. Write the National Fire Protection Association at Batterymarch Park, Quincy, MA 02269 and ask for copies of the forms for changing the NEC. These forms require a specific format for the proposals along with specific engineering and/or test results to justify the proposed changes.

Each and every proposal will be reviewed by at least one panel of professionals who write the NEC and in many cases several panels and other coordinating officials will review it. Public comments are solicited. Written feedback is provided to the submitter on each stage of the process.

Those of you who wish to “rip up and rewrite Article 690" may have your chance. I will be working with a panel of technical experts selected by the Solar Energy Industries Association and The National Fire Protection Association to review all sections of the NEC that bear on photovoltaic and other renewable energy systems. There will be an attempt to make substantial revisions to not only Article 690, but other applicable articles such as Article 240 on overcurrent protection and Article 250 on grounding. If you have any suggestions, feel free to send them to me or submit them to the NFPA by the method outlined above. Items submitted through me will have a much more thorough review by numerous professionals in the PV business including manufacturers, distributors, and dealer/installers. These coordinated proposals will have a greater chance of being implemented because they will have the support of several industry organizations.

The National Electrical Code is the law in 40 states and will eventually be the law in all states. We in the renewable energy business are going to have to learn to live with it and the inspectors that enforce it. Letters to Home Power and editorial comments on the NEC are easy to write, but don’t change the law or influence the inspectors. Providing technically substantiated proposals that can withstand the reviews of your peers in the industry is not so easy, but can result in positive changes in the NEC.

Now is the time to put your thoughts and feelings into words and affect some changes. To do otherwise means that you will have to live with the results without having formal input. Sincerely, John C. Wiles, Research Engineer, Photovoltaics, Southwest Technology, Development Institute, PO Box 30001/Dept 3 SOL, Las Cruces, NM 88003

Thanks for the info, John. I for one am going to put my two cents worth in. Home power users form the largest knowledge base of hands-on information about the small scale RE use. Here’s our chance to influence new code regs. Richard

Wild vs Wind Power

Spouse and I are absolutely delighted with the performance of our PV-based electrical system (see “Grid Power Pigs No More,” Letters to HP, Issue #17). Someday there’ll be an article... Now we’re thinking seriously of putting up a wind machine, and could use some help from the collective experience of the HP community, to wit:

What, if any, effect does putting a large, rapidly-spinning object way up in the air have on the local wildlife, and on your ability to enjoy their presence? In particular:

Do wind machines seem to pose any flight hazard to birds or bats? (or bugs, if anyone’s that close an observer) I suspect that they’re visible and audible enough that flyers can avoid them.

However, are they obtrusive enough to drive any wildlife from the area? Yesterday we watched a marsh hawk hunt for voles in our field, going back and forth, not twenty feet off the ground and almost that close to the house. Is she likely to be repelled by a Whisper 1000?

Is a wind machine noisy enough to drown out subtle, wonderful sounds like the “beep” of a woodcock in the evening? Or is it noisy only when the wind itself would drown out the woodcocks, if it didn’t prevent them from courting at all?

Any information, especially first-hand observations, that you folks can provide us with would be most welcome. I’m frankly hoping to hear a rousing chorus of “No problem”, with a few heart-warming anecdotes about things nesting in and around towers. I want—and will support and work for—alternative energy technologies which are benign in every possible way. But if not, hey, we can take the truth.

We have in mind a Whisper 1000, about fifty feet up on guyed-pole type tower, and about 100 feet from the house. The whole mess is on the northern edge of a 30-acre meadow surrounded by mixed woods; we share it with just about every sort of wild critter known to frequent such haunts in the Northeast. Thanks in advance for your help! Kate Mink, 629 Valley Rd., Brooktondale, NY 14817

Kate and Spouse; I appreciate your concern, as a PV user, about wind generators. I mean, they're so, well, dynamic, whereas PVs just lay on the roof and smile at the sky. First of all, you will be pleasantly amazed at how much power you will get from a wind generator that is the same size as your PV array. This has to do with the power available from the respective resources. Folks who have gone to hybrid systems combining wind and PVs swear they will never look back.

Regarding your concerns about wind generators and bird or bat collusions: not to worry. Birds are very wary of anything that moves. And bats, with their radar, are even smarter than birds. Birds like to perch on wind generator blades and tails when they are not moving. But as soon as they begin rotating they are "out of there". They won't go near them.

The only bird/genny collision that I am aware of in many years of work with wind generators on two continents actually occurred on one of my own machines. We took out a Canadian goose one night. The goose, in turn, took out one of my blades. Canadian geese will fly very low at night during the fall migratory season. We are on a migratory route. Birds do not see very well at night, which is why virtually all species roost about sunset. And they have no radar, like bats do. On the night in question, a flock apparently flew near enough to one of the generators, which is 50 feet from my house, to have lost one of the last members in the "V".

Bugs are a different story. We probably are responsible for thousands of deaths a year. But I'm sure that's still less than an equivalent sized power plant!

Good wind generators are not noisy at all. They are very unobtrusive. By the time that a well designed wind generator is making noise in a high wind, trees are speaking up and tin roofs (common in our area) are moaning in chorus with the genny. We live in the middle of nowhere, and from the ground squirrels to the red tailed hawks, no one seems bothered by our wind systems.

This is also true with people. There's something quite mesmerizing about a wind generator quietly spinning in the sunset while you are taking a solar shower. It's very soothing and peaceful. Something akin to a waterfall at dawn, or a campfire at night, or grain rippling in the afternoon breeze. Life doesn't get much better than a solar shower at dusk powered by your own wind-generated electricity, with music supplied by the local whip-or-will. – Mick Sagrillo, Lake Michigan Wind & Sun

Inverter Information

Hello! Being very interested in the inverter digestion question, I submit some of my experiences during the last year with my PowerStar 700. So here's what a techno-weenie-in-the-woods found out.

1) I find the PS700 to be very noisy on both my AM & FM radios when they are in the same room.

2) I have had no trouble at all running my home-built Taiwan Clone 386SX-25Mhz PC. It doesn't seem to notice and I'm not surprised since these techno-beasties run on low power DC anyway! Now if I just had a DC-DC converter...

3) For a monitor I prefer the Magnavox gray scale VGA. I've used green screens and a top-of-the-line color screen and they all work perfectly. But the green screen is hard on my eyes and the color monitor is an energy hog (I forget exactly, I think 70-90 watts). The Magnavox is crisp, changes colors into shades of gray, and uses a maximum of 30 watts! And it costs less than half that of color (about $135).

4) For a printer I think the HP (Hewlett-Packard that is) DeskJet 500 is the best for the $. I've used a number of dot matrix printers and they all are too loud! I've got a little daughter that often sleeps when I work and I need a printer that won't interrupt her nap. The HP DJ500 is an inkjet and whispers. Its quality is 300dpi and laser-like. Now, it's a little weird too, it runs on 20V (where are those DC-DC converters?) and has an inverter that buzzes. And it's efficient too—25 watts peak!

5) I've used a modem occasionally to access local BBS's and the WELL. I've tried out 3 in the last year and like the ZOOM Telephonics line best. The Practical Peripherals modem I used couldn't handle all the noise from the inverter and I got a lot of data corruption. The 2 ZOOM's I've used both worked with hardly any data loss. Why the difference? I have no idea. The ZOOM FC 96/24 (our current unit) is also assembled in the US and has a seven year warranty.

6) We have a several Osram EL lights. The 7 watt is a little slow starting but the two 15W start right up. Good lights.

7) We have Lights of America (1/2 made in Japan) 30 watt circular with electronic ballast that buzzes a little bit.

8) We have a Code-A-Phone answering machine/telephone which is so noisy I can hardly talk on it with the inverter on! I've wired it directly to the 12 V batteries, but unfortunately our telephone line and inverter are close together (ahhh, the troubles of retrofitting...), buzzz buzzz buzzz.

9) Our hot air popcorn popper shut off the inverter in about 20 seconds. Oh well, have to run the generator for popcorn...

10) We have an old and beautiful Amica sewing machine. Model is "Super Professional". It operates perfectly. I have no idea what it draws (at least 120 watts) and I really ought to convert it to a more efficient motor.

Well, I think that does it for our high-tech hovel. If any of these items deserve a Things That Work article I would be happy to expound on my system into a full page worth of text. Let me know.

I look forward to the compilation and tabulation of the inverter/appliance information. Many times I think of something and wonder... "Yes, but will it be inverter-friendly?" Thanks folks, John Fricker & Nicole Kapp, 705 Thompson Creek Rd, Selma, OR 97538 • 503-597-4852

Hello Jack & Nicole, Thanks for your additions to the "inverter friendly" list. I'm kinda surprised that you have any interference in the FM band of your radio. Just how close is it to the UPG700? Usually a separation of 12 feet or so will do the trick. AM interference, on the other hand, is usually bad with modified square-wave inverters. Give a little, get a little... We all use the HP DeskWriter (the Mac version of your Deskjet 500) 'round heah. They're great. I had a ZOOM fax/modem for awhile which worked OK as a modem but couldn't send or receive a fax at all. Could have been inverter noise, as fax goes at a much faster Baud rate than modem as a rule, but I could never quantify it one way or the other. The Osrams always seem to come on somewhat dimmer than full luminescence then brighten as they warm up, even on grid power. As to your popcorn popper, gimme a break! I've never seen one yet that draws less than 1000 Watts. Ours sucks back 1150 and runs just fine on the UPG 1300. PowerStar will upgrade your 700 to a 1300 for $300. Might save you some generator headaches in the long run. – Bob-O

Intertied Up

Although the use of grid buyback of AE sounds like an ideal situation as John & Pam MacDonald suggests (Q&A HP #28) let me add to Richard's points with real life experiences.

Indeed Richard is correct about the "avoided cost" in buying back power by the utility. My utility, Consumers Power, charges about 8¢ kiloWatt-hour, yet only pays back about 2.4¢ kWh. With my 17 1/2 kW Jacobs wind generator (26 foot dia. blades) and the wind speeds in my area, that means for me that I would need twice this power just to break even in a typical year. Obviously the costs of such a huge machine is restrictive at best.

My utility was very "cooperative" with me in the initial stages before I bought a machine by sending me a free 83 page report by Michigan State University titled "Windmill Performance in Michigan". The report was quite thorough but very questionable mainly in the fact that the wind speed records taken at the test sites in my area showed wind speeds 2-3 mph less than the local airports showed. So I compromised by taking a machine larger than the airports' data showed I needed. Some months later, I learned from an experienced wind dealer that sure enough Consumers Power had sent me a bogus report!

So although the utility may seem fully cooperative at first, the real truth is they don't want your power even when they can mark it up 400%! My solution was to go with a battery bank, despite the cost and all the headaches that go with them. I'll give my excess power to my neighbors rather than sell it to the utility at 2¢ kWh. When my batteries need to be replaced I'll check again with the utility. Someday the poor attitudes of the utilities must change. Although my address is in Indiana, the property where I am to build my home and install this system is near Onsted, MI. Craig Davalos, 3948 Guthrie St., East Chicago, IN 46312 • 219-397-9377

One major problem with PURPA (grid intertied RE systems) is that each producer must deal individually with his local utility. Some utilities are very open to solar and wind sources, others are not. Two examples of RE minded utilities are SMUD (Sacramento Municipal Utility District) and PG&E (Pacific Gas and Electric). Never forget that utilities are in fact ***public*** *utilities. They are given a monopoly because they serve the public. Richard*

Sol Food

Greetings, Just built my first solar cooker to prove the concept to my wife, the eternal SKEPTIC, that it would work. ONE pan of corn bread muffins later she was convinced. Now she insists that I do get the very same "Heaven's Flame" book which I have been asking for over the past 6 months. (Maybe I should have built the experimental cooker a little sooner?) Anyway here's to more and better solar cooking, Jack & Susan Pouchet, 19085 Consul Ave, Corona, CA 91719

Hi, Jack. I just got back from MREF where I taught a solar

cooking workshop. I learned a few things from my students. One fixes ears of corn in her solar cooker by first putting each ear into a black sock to aid cooking. I can't wait to try it. There is a whole culinary world waiting for you now. Try it, you'll like it. – Kathleen

RE Recruit

I love this magazine! Thanks to what I've learned, there are people who see what we are doing out here in the weeds and become convinced that it is not only feasible, but even boneheads such as ourselves can actually do it! As time goes on it will be more and more SUN-DRIVEN!

As my trade is power line construction, it is especially fun to tell folks how far away from power company right-of-ways we live. Then I describe the wooded 40 acre "lot", the "just-like-downtown" house, the electric refrigeration, 24 hours-a-day electricity, a phone (so it's by radio!), and someday: automatic sprinklers and other weird stuff.

Lots of credit is due HP with respect to the job taking off, much less getting as far as it did. Please accept our thanks for being people who not only put up considerable effort, but succeed! Steady as she goes, and I won't suggest changing anything. (Four miles off pavement and power lines.) Billy & Diane Jones, Sugarpine Ranch, 1340 Sugarpine Springs Ranch, Hesperia, CA 92345-9479

Good for you Billy & Diane, Producing your own power doesn't sound too "boneheaded" to me. One of my favorite stories is from a couple of winters ago when our local area (most of southwestern Oregon) lost its natural gas supply during a cold snap. All the residents plugged in portable electric heaters which—you guessed it—overloaded and took out the power grid. A real "freeze in the dark" situation. I remember discussing it with Richard on the 2 meter Ham radio while we both watched it on TV. Then I fired up the electric popcorn popper, threw another log on the fire, and... – Bob-O

RE User Upswing

Here is our first year's subscription. I enclosed our brochure and a picture of our home. The wind generator is a Wellington made here in Ontario. It's hardly the state of the art, but it's built like a tank. We store our power in 60 Exide 360 Amp-h glass batteries, at 120 Volts DC. Lights and water pump run on DC. The rest of the power is inverted to ac through our 6 kW Dynamote inverter. We have been in business since 1986, but last year was the first one we considered successful. If all the indicators are right we are in for a very busy year. It's going to be great to have information on what people are doing out there and what's new in the industry (like Trace I usually don't hear about improvements 'til I open the box). You can thank Powerhouse Paul for my sub. He sent me a back issue which I sat down and read cover to cover. I'll write again later and let you know what's happening here in Ontario, Canada. Yours sincerely, Laurence McKay, Northern Lights Energy Systems, RR1, Richards Landing, Ontario, Canada POR 1JO • 705-246-2073

Good to meet you, Laurence. I certainly will thank Paul. Currently we are sending about 300 copies of each Home Power issue to Canada. Interest in RE is quickly growing everywhere. Richard

Sunroofing

Dear Richard, For some years now I've had this vision of the "roofs of suburbia" covered with solar panels. I think of clear, sunny days as "mega-watt days".

Imagine my delight at reading your comments about Spring in #28. "Each roof a power producer..." THAT'S EXACTLY WHAT I WANT TO DO! I live outside Washington, DC. Do you know anybody in this area I can link up with? I'd really appreciate any comments, suggestions, pointers, feedback or whatever. Thanks for your terrific magazine. It's clear you are putting your vision into action. P.S. I helped organize Sun Day on the Mall in DC on April 22. The weather was spotty, but we did have a decent turn out of exhibitors and the interested. Still, it would be great to have a show 10x as large! Your Friend, John Peterson, 12823 Sage Terrace, Germantown, MD 20874-2045

Well, John, by publishing your letter and address we are hoping that Home Power types in your area will contact you. Richard

Elemental Cruising

Dear Home Power: Please sign me up for 1 year of Home Power. I have been cruising Mexico on my sailboat "Runaway" for the past year and have missed your mag. very, very much. We have been living off the grid in a big way! We have two solar panels and a windbagger wind generator. No problem living a comfortable life style. (We were rather bummed out when our VCR went on the fritz!) our boat has 2 stereo systems (one with 500 watts rms output) fluorescent lighting, color TV, VCR, freq. radio telephone, weather fax, radar, two satellite navigation receivers, electric piano, 4 track recording studio, sewing machine & inverter. All of them run on home made power! P.S. We even power our boat with wind power, something you can't do with a car. Sincerely, Larry Cooper, 550 Marina Pkwy D-2/53, Latitude N 32° 37.50 Longitude W 117° 06.15, Chula Vista, CA 91910 • 619-427-9830

Dear Larry, Ah, an RE adventure under a spread of sail. Who sez you can't take it with you? – Bob-O

Deep Cycle?

Please renew my subscription for another year. I have been off grid for about 5 years now (Bergey 1000, 20 6-volt Surrettes, Homelite generator backup—120 DC). Except for a lightning strike in '88 & occasional surges due to poor battery maintenance (cable corroded) which blew my control panel, I've little to complain about.

Your articles on batteries have been informative, however, I've yet to fully understand the economics of purchasing the much touted Trojans vs., for instance, a good Sears Marine deep cycle. My neighbor has an identical 120 VDC system without control panel! It blew years ago and he jury-rigged a system limiting voltage somehow.

Anyway, his marine deep cycle batteries are just now punking out after 5 years of serious abuse. I discussed battery replacement with Mr. Surrette himself—now in Nova Scotia. He recommended I replace my 20, 6-Volt batteries with 10 of his best 12 Volt marine deep cycle models $2400.00+. No question that my Surrettes currently in use are good value (9 yrs old) but they're fading fast. I'd think that 5 yrs of 120 A-h batteries (Sears deep cycle marines) for $88 beats the hell out of nine years for $2400. Question is, will I get 5 years out of marine batteries? If not, why not?

Please do an article on batteries which give cost vs longevity comparisons, not only between Trojans, Surrettes and other widely touted alternative energy-use batteries, but include good marine/RV deep cycle batteries used by off gridders over the years. Thanks, Dave Hornell, WPTZ-TV, RR #1, Box 92, West Chazy, NY 12992

Hi Dave, There are hundreds of different types and brands of lead-acid batteries. The main problem with delivering the information you want is statistical. We need data from hundreds of systems. Not only what battery they use, but also about HOW they use it. Even a regular car battery will last years in shallow cycle float service. Even the most rugged deep-cycle type can be killed in a year from improper cycling (notably operating the battery regularly at between 0% SOC and 25% SOC). Richard

Homemade

Home Power Magazine; Witukom 'nom Farm School Land Trust is named for the people who resided in this location for about 6,000 years. We cross the Eel River in Mendocino County, CA by canoe to reach the Farm School, and so site sustainability and off-the-grid living are part of the situation.

I appreciate Home Power Magazine for the informative articles on power system development and operation. It is one of the "must keep" magazines in my reference library along with Whole Earth review and Beth Book's New Settler Interview.

I would like to see more information on "how to" sources for "low cost" systems development. Build your own solar panels, sources for cells, and other primary electrical equipment, make your own lead-acid (cement-epoxy?) built in battery systems, agricultural level solar systems development, off-the-grid telecommunications. Yours Truly, Verne Peterson, Witukom 'nom Farm School Land Trust, POB 68, Covelo, CA 95428

Hi, Verne. Check out Stu Ward's system on page 6 of this issue. It doesn't get much simpler and inexpensive than this. Solar panels can be assembled from surplus cells, but weather tight encapsulation is very difficult to obtain without expensive machinery. What I'm trying to say is that even the most independent of us need help from others. Renewable energy devices like batteries, PV cells, and turbines are high tech manufactured devices using pure raw materials. Their manufacture requires tools. This is not to say RE equipment cannot be 'homemade". Consider Don Harris' hydro powered factory where he makes his hydroelectric turbines. If I wanted to make batteries here on Agate Flat, I'm sure I could do it. I am also sure that it is not cost or time effective to do so just for my own batteries. Now if I wanted to make hundreds of batteries, then tooling up would make sense… We get by with a little help from our friends. Richard

DC to VAC Dilemma

To Home Power: My PV panels are connected in series for 24 Volts to recharge my 6 Volt golf cart batteries which are in multiples of 4 batteries to produce 24 Volts. By doubling voltage to 24 Volts you use half the amount of current of a comparable 12 Volt system and smaller gauge size of copper wire. This also means less power or I^2R less in the copper wire. Nearly all inverters are 12 V and there are few 24 V models. Ten PV panels can be wired in series for 120 VDC and twenty 6V golf cart batteries can be put in series for 120VDC. You will find that 120 vac universal motors run better on 120 vac rms. Why doesn't someone market a 120 VDC to 120 vac inverter? No step-up transformer is needed. Len Kush, 30120 US 20W, Elkhart, IN 46514

Actually, Len, nearly all inverter manufacturers now offer 24 VDC models. For a 120 VDC to 120 vac inverter contact Chad Lampkin at Michigan Energy Works, 616-897-5161. – Bob-O

Solar Domes
Dear Home Power Crew; I recently returned from a ten day trip to Turkey. We passed many small towns with solar hot water heaters on almost every roof. We knew they were for hot water because the tanks were on the roof. I assume it doesn't freeze in that area. I was impressed.

A question for you and your readers: have you knowledge of geodesic dome homes with solar heat? How effective is it? Is your knowledge "first hand"? Would you choose to have a geodesic dome home again?

Another question: most of your pictures show photovoltaic modules mounted on roofs. I wonder what happens if it snows or there is an ice storm? Does the owner have to climb on her slippery roof to clean the array? I ask this question because I am retired (and going to get older, if I'm lucky), have a fear of heights and a problem knee. Keep up the good work. Sincerely yours, Barbara P. Jureidini, 6304 Mori St., McLean, VA 22101 • 703-821-0814

Hi, Barbara. Karen and I built a dome home on Agate Flat in 1970. This 26 foot diameter hemisphere was occupied as a house for five years, and then converted into a barn. We learned a lot about domes. One, they are all roof and don't tolerate funky carpentry. Two, they expand and contract with great vigor and can develop leaks. Three, they are wonderful to live in. Our dome was originally constructed with too many windows. We were warm in the winter, and fried in the summer. The acoustics in domes are fantastic— a whisper can be heard everywhere. Domes are a natural for passive solar heat. You have the option of windows wherever you need them, and a minimum outside surface area which reduces heat loss. I would like to live in a dome again. It would be larger (at least 50 feet in diameter); this gives more interior volume for the effort and money. I would have it built by someone in the dome building business. I'm not much good at construction.

My choice for a PV mounting location is on the ground. Mount the PVs firmly, use cement piers and good metal frameworks. Or pole mount the PV on the ground and use a tracker. I've lived with PVs on the roof and I'd rather not. They are hard to wash, and become clogged with snow and ice. Also, I don't need any more holes in the roof. Check out the photo of our modules on page 101. Richard

Acid Test
Dear HP: Just a note on battery acid neutralizer... Baking soda is great since it is so available but if you are going to order something ahead of time, then Sodium Sesqui Carbonate works a lot better for acid spills at 40¢ lb. It is a whole lot easier to work with than baking soda (it stays loose and soft). Good article! Hoping you will never need it, John Mottl, Rainshadow Solar, POB 242 Guthrie Cove Rd., Orcas, WA 98280 • 206-376-5336

Alright, John. It's great to have a more effective and less expensive neutralizing agent around. OK, battery users, do you have enough neutralizing agent to handle a spill or cell failure in your battery room? John has the answer to lead-acid spills above. Use either vinegar or muriatic acid for alkaline electrolyte spills. Richard

Urban Users
Hey Guys: We started with HP #17 and have every one since then—two of #23 'cause I thought I'd lost it and sent for a replacement.

Your renewal form asks for comments. I guess a lot of mine revolve around a basic question: How many of your readers live off grid? I realize that your magazine was first conceived to address the off-grid folks; I seem to detect a bit of snobbery sometimes towards the rest of us poor suckers who're captive to the industry. Example: HP #17, Letters—"How Do They Do It?". The writer asks how "ordinary" people use 600-1000 kWh/month. Your reply, while making sense to someone well acquainted with off-grid realities, was absolutely useless to me. At the time, we had never (still haven't) gotten under 20 kWh/day. That one letter disturbed me for months, until I borrowed some testing equipment from work (I'm a helper in the control and electrical shop at a 1300MW coal-fired power plant, imagine that!) And found out how much energy our electric range, electric water heater, refrigerator (self-defrost), water pump, etc. were using. The answer is that it is very easy for "ordinary" people to use 600-1000 kWh/month until all major appliances are non-electrical.

Let me jump ahead—HP #26, Letters, "Illuminating", pg. 88. Richard's response is a little strange and sounds like a put-down. Suggestion: If you're going to print letters like Mr. Bruse's, which don't ask any questions but simply preach, editorialize, state, bamboozle, etc. just run 'em, like *Time* magazine does, without a response. If you're going to respond, please resist the temptation to do your own editorializing (you already get pg. 4), and try to remember that a lot of your readers know just enough to get themselves into deep shit, and that they may be hanging on every word you print. Pretty heavy responsibility.

HP puts a lot of emphasis on inverters, batteries, PVs and turbines. Yet it's a basic fact (and one I did not

comprehend until at least HP #21-#22) that off gridders have brought their demand down to whatever level of power they can produce. So conservation is the other half of independent production.

For those of us on the grid, the logical progression (it seems to me) would be to prepare for off grid living by working on the demand side of the equation.

How about some articles on how off-gridders have gotten down to 1-2 kWh/day? There must be hundreds of ideas for cutting down on consumption—extra jacketing on refrigerators, timers on water heaters, drying clothes on a rack instead of dryers, etc. Some of us are so ingrained we don't question our habits. If people could see how to get down to small levels of power, they might feel off-grid is actually do-able.

I'd really like to see some articles on whatever electric cars show up as a result of LA's new smog laws. I'd love nothing more than to commute to work in an electric car and plug in to one of the 110v plugs on the back row of the parking lot for the diesel trucks! Bill Barmettler, POB 1462, Chehalis, WA 98532

Thanks for the comments, Bill. You pose a good question. As of the last issue 28.4% of our readers were totally off-grid, 10.86% use RE as a primary power source, 13.32% use RE only for back-up and 15.28% are RV RE users. As for conserving ideas that on-gridders can benefit by, I refer you to the index in this issue. All Back to Basics and Home & Heart columns, Phantom loads (#14, pg. 13), Energy Conservation in the City (#22, pg. 11) Timer to Turn Off Loads (#16, pg. 49), and Hidden Energy Costs (#16, pg. 21). Look under the headings of Refrigeration, Domestic Hot Water, and Conservation, and read all Letters and Q& A. We'll try to keep our soapboxing to a minimum. – Kathleen

The new index (see page 109 in this issue) details systems by power source (and its quantity) and battery type. Many of the systems detailed in Home Power use much less than 2 kWh per day. None of these systems use electric stoves, electric hot water heaters, electric fired clothes dryers, or standard 120 vac refrigerators, but may have a microwave oven or efficient electric refrigerator. Richard

National Products

Dear Home Power: I have enjoyed reading your magazine over the years and have watched it grow. I have always appreciated your editorial style.

A topic I have not seen much coverage on is the depth and quality of American renewable energy and photovoltaic products. These are industries that have not been dominated by foreign companies. This is changing as the market grows bigger. Anyone who has purchased a gasoline powered generator knows how hard it is to buy American.

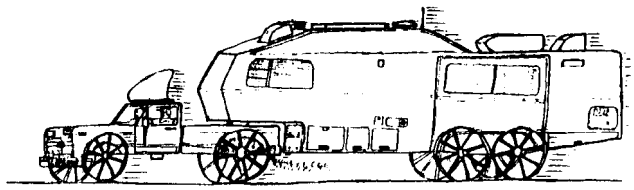
I am sounding pompous, but I truly believe that we alone can make a difference in our economy. Our government does nothing to preserve American jobs. It is up to us to make the decision to support American technology.

An area that is particularly sensitive right now is photovoltaics. Solar panels were an American industry up until a few years ago. Now there are serious threats being made by Japanese and German companies. American photovoltaic research must be funded by American dollars.

If your readers and advertisers will make a conscious decision to choose to support this country, everyone will benefit.

In reading my own letter, I realize I may sound like a protectionist. That is not my intention. I don't blame foreign companies for what they do. Businesses want to grow, and they are doing what they must do to survive. The situation for this country has grown critical, however, and we must try to rebuild it. Thank you for printing this letter. Robert Heller, Box 916, Mendocino, CA 95460

Robert, the greatest majority of RE products that we test are American. This is especially true with inverters, controllers, and instrumentation. Of the major PV manufacturers, Solarex is a wholly owned subsidiary of Amoco, an American company. That being said, don't look for us to support one company over another on the basis of nationality. We owe it to our readers to test and report our findings strictly on the basis of performance, reliability, and value. Given the best of unbiased information, folks can make their own choices. -Bob-O



RV'er Answers

Dear Tom; I too read Home Power avidly. After seeing my first issue, I subscribed, borrowed all copies right from #1, bought all the back issues available, and methodically read them all. We are full-time RVers, since last fall, and have the capability to live independent of the grid. Home Power has been a great help. Of course, as you know, while RVs get occasional mention there is much lacking

which we could use. (Yes, Richard and Karen, I realize RVs are not your thing.) An example is battery storage capacity versus size and weight. After checking several types and brands, I concluded that you still can't beat the dreaded lead-acids for an RV. And Bob-O's advice is right-on. I settled on Trojan T-125s as the best combination of size, weight, capacity, and cost, and purchased four of them. They are fed by eight Arco M-51 panels on frames supplied with them by Kirkby (no, sorry but I have not fabricated any mounting structures); four of the panels are controlled by a Power Guard controller/monitor, and four are on a manual switch. The Power guard and switch were supplied with the panels, otherwise I would have used a Heliotrope controller. The panels are mounted conforming to the somewhat rounded roof. I do not tilt them, so some of the efficiency is sacrificed for convenience and to allow the double panel frames to be placed close together. If I ever decide to add more I will probably build a frame to support them over the air-conditioner, giving the bonus of shading it. A Trace 2012 SB with turbo completed the original setup.

After four months last winter in the Southwest, I added two more Trojan T-125s. That fills my compartment, gives 705 Amp-hours, and brings the battery weight to a whopping 360 pounds, plus inverter, plus cables, plus panels and frames, plus-plus-plus. This weight is of no concern in a home, and of lesser concern in a motorhome or bus conversion, but in our 30 foot fifth wheel it is a substantial load. Hydrocaps were installed on all six batteries last month. Our fifth wheel was generator ready, so the batteries are in the generator compartment and the Trace in a separate compartment immediately above. I didn't take it last winter, but plan to carry my Honda 400 watt portable generator in the future. When introducing RVing friends to boondocking, we invite them to "plug into us", if they are not equipped to be off-the-grid, and we need to occasionally boost our batteries, using the charger in the Trace set a highest output the generator will handle.

Our loads include 30 lights (yes, 30!) inside the coach, which include a twin tube fluorescent over the dining table and a single tube fluorescent over the sink. These are the most heavily used lights. All are 12 Volt except for four decorator type lights, which are seldom used. Two 13 inch color TVs and the stereo AM-FM-tape deck are all 12 Volt. Two Fantastic vent fans help cooling.

Loads on the 110 volt side include a VCR, microwave, toaster, popcorn popper, sandwich maker, vacuum cleaner, portable mixer, computer (color), printer, coffee maker, rechargeables such as a dustbuster, toothbrush, kitchen mixer/whipper, cordless screwdriver, flashlights, and a charger for Nicad cells used in the recirculating fan in the refrigerator. All of the above are used as needed on the inverter when we are not connected to the grid.

But here comes the rub for the purist! As members of their camping networks, we stay at Thousand Trails at no cost, Coast-to-Coast at $1 per night, or RPI at $2 per night. All of these include hookups. Now as a matter of personal economics and because I am not fond of removing-replacing-refilling LP gas bottles, we use electric hookups when supplied, and switch our refrigerator and water heater from LP to 110 volt. Also, a ceramic heater controlled by a wall thermostat is then the primary source of heat, supplemented as necessary by a 6000 BTU catalytic LP heater, and as a last resort, by the inefficient LP central furnace with the big 12 Volt blower. The air conditioner is used if needed, but we usually manage to be where it is not that hot.

Back to batteries. Go where they sell golf carts. You should get T-125s for $60 each, or T-105s for about $5 less.

And I must mention for the benefit of those Home Power readers who see RVs as fuel-hungry monsters which spend their live hurtling down highways. We have found that our preferred schedule goes something like driving about a hundred miles, sometimes less. Then sit back for a week or two at one spot. Then, do the above all over again. I imagine that we drive less than many of the folks who "never go anywhere". But over a period of several months, we see a lot of this great country of ours, and in the process consume far less energy than feeding that big custom built tri-level we had when I was working. We tow with a diesel 4x4 which gets 11 mpg towing and 16-18 mpg solo. That is not an economy car by any means, but it is a far cry from the common alternative, a big-block gas engine which gets 6 towing and 10-12 solo!

Lastly, anyone who is serious about RVing should be a member of Escapees. In their "newsletter" (actually about 50 pages), Phred writes some good stuff about inverters, batteries, pumps, etc. Sincerely, Bob Livesay,101 Rainbow Dr, #2159, Livingston, TX 77351-9300 Toll free message service • 1-800-255-2273 Member #267 9651

SES '93

Dear Karen & Richard; The Solar Energy Symposium '92 had to be cancelled as we had only two reservations with deposits. George Smith would like to try it March 14 & 15, 1993 as the new date to hold the The Solar Energy Symposium '93. To all the folks in the growing Solar Industry please consider our advantages for holding SES

'93, similar to that of Willits, CA SEER '90, '91, '92: 1. Our area is three times larger. It's all grass, enclosed with a wire fence. 2. The Palm Desert College of the Desert has four auditoriums of different sizes to hold more than one lecture class at the same time. 3. There will be a separate area for all the electric cars. They would have their own area to display and demonstrate all their electric components. 4. The College has plenty of free parking facilities. 5. We have good spring weather, an excellent location with all the facilities.

All of us at the College want to thank you and Karen and Home Power Magazine for your excellent help in getting out the word. We knew we were against time; but, we did get a start. We now have 12 months for SES 93.

Our question is: How many folks would come to next year's March 14 and 15, 1993, to display their products? Everything from Solar Systems, Hydro Electric, wind power, and especially, all types of Electric and Hybrid Electric Cars and their components? We would like to know. Write to: George E Smith, Jr, College of the Desert, 43-500 Monterey Ave, Palm Desert, CA 92260.

Respectfully yours, Charles Hubler, Solar System, 30-900 Happy Valley Rd., Desert Hot Springs, CA 92240 • 619-347-5781

Well, Charles, at least you tried. Organizing an Energy Fair is a hell of a lot of work, most of which needs to be done months in advance. Anyone organizing an Energy Fair is best advised to contact someone at SEER or the Midwest RE Fair. These folks have successfully pulled it off several times now. They are open folks and overjoyed to share their experiences with you. Richard

Conserving Power

Richard; Between your curiosity about urban readers and my love of talking about energy, I feel obliged to write this response. I live in the heart of the city, am fully on the grid, and using an ever shrinking amount of coal fired kilowatts.

By day I am an engineer for a major aerospace company. By night, however, I convert to Mr. Applied Engineering. As a frequent traveller to the third world, I fully understand the many difficulties and opportunities which exist. I established this company to develop basic technologies, and disseminate information to those who will use it. Current projects concern energy conservation and efficiency, bicycle drawn utility trailers and solar thermal applications. In fact, I plan to submit one of my cooker designs to the HP contest (and loudly applaud HP for launching this competition). Within the next three years, Applied Engineering will become my job.

My personal energy axe to grind is not electricity, but gasoline. Gasoline is a wonderful fuel, with the highest energy density of any commonly available substance. We shouldn't be squandering it by hauling 3000 pounds of steel wherever we want our 150 pound bodies to go. Many of our largest national burdens (air pollution, trade imbalances, health decay and defense for the big ones) are directly caused by the support of the fantasy that we are entitled to unlimited use of private automobiles. About half of the national energy consumption is derived from oil, and the largest slice of that is for single occupant private automobiles.

I have used my bicycle as my primary mode of transportation for 14 years, and enjoy many benefits unimaginable to those powered by dinosaurs. Physical and mental health, environmental and financial improvements which would individually justify pedalling, combine to provide an unbeatable combination. I was appointed by the Mayor to a citizens advisory board to improve and expand the existing bikeways system throughout the metro area. We now have funded plans in place to greatly improve access and range for bicycles (and walkers, joggers, etc.) over the next several years. We helped lobby for funding for alternate transportation during this congressional session, and were all rewarded well. I am now active in directing that money to high use projects.

As you can see, I may not share your specific priorities on energy usage, but am working towards the goal of an overall sustainable energy future, and dedicated to making it happen. The residential applications HP promotes are an essential part of our future, but are only one facet of the overall achievement of the goal. Policy must be developed and enforced, technologies improved, education and awareness developed and, most importantly—habits must be changed. You and I both know that the technology exists today to resolve our energy problems, but many human and institutional barriers stand in our way.

I support your efforts and will stay abreast of progress in household energy alternatives, but choose not to convert my house to solar electric right now. Some day I will, just as I hope you will consider bikes, busses and other appropriate transportation when you are ready. There is still a lot of work to do, but it is good work. Keep it up! C. Jay Campbell, Applied Engineering, 218 Dartmouth SE, Albuquerque, NM 87106-2220 USA • 505-848-7674 • 505-256-1261

Learn Solar Energy Technology

SOLAR TECHNOLOGY INSTITUTE

New York Colorado

Learn to design and build state-of-the-art solar homes that are self-reliant, thermally efficient, healthy to live in, and environmentally conscious.

The 1992 SOLAR HOME PROGRAM

consists of the following
`How-to' and `Hands-on' Workshops:

❑ **Solar Home Design Principals - 2 weeks**
Learn the fundamentals of solar and energy efficiency • Passive Solar Concepts • Design Guidelines • Construction Techniques • Insulation Strategies • Remodel/Retrofit Opportunities • Solar Water and Air Heating • Sunpaces and Greenhouses • Case Studies and Tours of successful designs. A comprehensive overview for those who want to design/build.

❑ **Advanced Passive Solar Design - 2 weeks**
Learn state-of-the-art design tools • Super-Insulated Building Envelope Design • High Performance Glazings • Daylighting • Building Science • Progressive Building Techniques • Health Issues • Mechanical Systems. For professionals who understand solar principles.

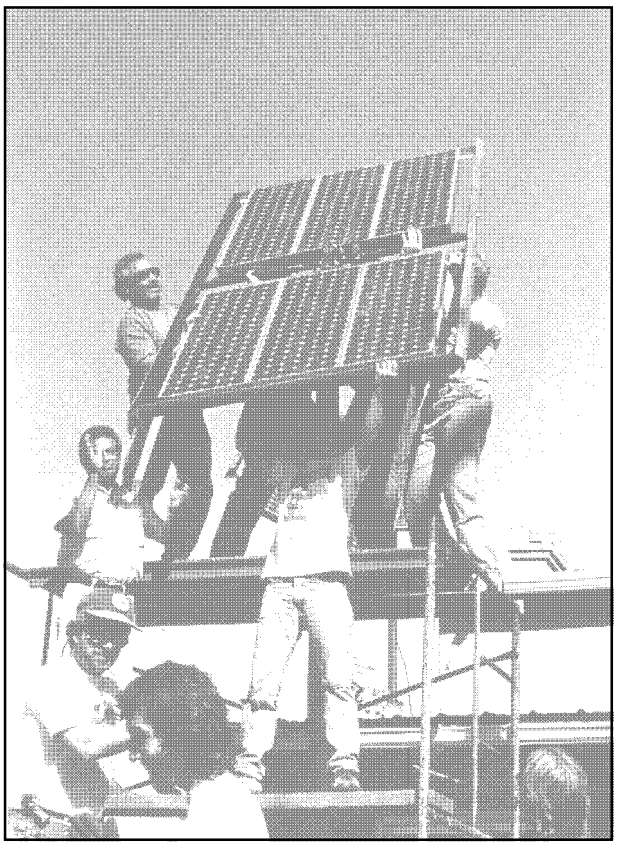
❑ **Photovoltaic Design And Installation - 2 weeks**
Learn to design and install solar electric systems. • Fundamentals of Practical Design/Sizing • Typical Applications • Hardware Selection • Safety • Case studies • Field Installation. For those who want to use PV or seek employment in the renewable energy industry.

❑ **Advanced Photovoltaics For Remote Homes - 2 weeks**
Guest Instructor: Richard Perez, Home Power Magazine.
Learn to design/install residential systems • AC/DC PV/Hybrids • Lab Exercises • Hardware Selection • Code Compliance • Wiring • Retrofitting Appliances • Water Pumping • Case Studies and tours. For those with experience in PV systems.

❑ **Micro-hydro Electric Systems - 1 week**
Guest Instructor: Don Harris, Harris Hydroelectric • Learn to install residential systems. • Advanced Design/Sizing • Commercial Products & Suppliers • Safety • Site Installation. For those who want extensive field experience installing working systems.

❑ **Wind Power - 1 week**
Guest instructor: Mick Sagrillo, Lake Michigan Wind & Sun.
Learn to design and install wind generator systems. • Aerodynamics • Generators, Alternators & Induction Machines • Tower Design • Site Analysis/Sizing • Safety • Energy Storage • Legal Issues • Hybrid Systems • Installation Procedures. Get practical experience designing and erecting wind generators.

❑ **Hydrogen Energy- 1 week**
Learn how hydrogen can be used in energy applications. • Fundamental Principles • Safety • Historical Overview • Electrolizer Theory and Operation • Storage • Available Products • Appliance Conversion • Fuel Cells • Future Perspective. Hands-on experience generating and using hydrogen.



WORKSHOP SCHEDULE

July 20-30	Advanced PV for Remote Homes
Sept. 7-18	Photovoltaic Design and Installation
Sept. 21 - Oct. 1	Advanced PV for Remote Homes
Oct 5-8	Micro-Hydro Electric Systems
Oct. 12-22	Solar Home DesignPrinciples
Oct. 26 - Nov. 5	Advanced Passive Solar Design

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

For more information, contact:

SOLAR TECHNOLOGY INSTITUTE

P.O. Box 1115, Carbondale, CO. 81623-1115

or call Ken or Johnny at (303) 963-0715, FAX 963-3198

"I've worked with Ken and Johnny. Not only do they know their stuff, but they effectively and quickly teach their hands-on knowledge to others. STI offers the most comprehensive, intensive, and practical training... STI is your best source for training." Richard Perez, Editor – Home Power Magazine.

Q&A

EV Stuff
Dear Richard Perez: Two things; Does anyone know of a battery-powered electric lawnmower marketed in the US? I'm getting tired of the long cord.

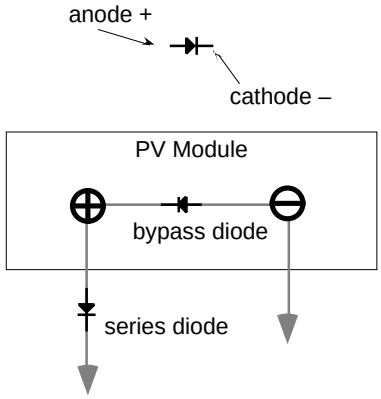
Also I have an electric car with 17 6-Volt and 1 12-Volt lead-acid batteries. I keep seeing ads for reconditioned nicad and nickel-iron batteries. Has anyone tried that sort of conversion, and how did it work?

Second, I've written a book about my experience as an EV owner with a PV system to power it. The NY publisher Norton will be publishing it this October. It's a book for the mechanically inept—people like me who couldn't possibly do their own conversion, but must buy a ready-made EV. I'm still assuming it's a book HP might want to review. Unless you beg me not to, I'm planning to have Norton send a review copy along. Sincerely, Noel Perrin, RR 1, Box 8, Thetford Center, VT 05075

Hello, Noel. Sorry no info on battery lawnmowers, how about it readers? Reconditioned nicads and nickel-iron cells are generally not used in EVs because of their low energy density. You are talking lotsa weight and volume for the number of kWh stored. There are exceptions—Chrysler and GM are both experimenting with special nickel-iron batteries for their EVs. Send us a copy of your book, we'll give it a read. Richard

48 Volt Conversion
Dear Home Power; Please renew my subscription starting with #30.

The biggest mistake we made was choosing a system voltage of only 12 Volts for our 14 Arco M55's. On a sunny day we exceed the capacity of our Trace C-30 regulator and have had to bypass it. We have just acquired 48 two volt gel cells weighing 250 pounds a piece and having a capacity of 1500 Amp-hrs each. My guess is that this 6 tons of batteries should give us 3000 amp-hrs at 48 Volts. Information on how to hook up a 48 Volt system is very hard to find. For example, exactly where does a bypass diode go when you talk of configuring solar panels for higher voltages? Do I ignore the diodes that are built into my panels. Please explain blocking diode vs. bypass diode and their placement in a circuit. We would like to see Home Power Articles that address these higher voltage systems. Thank you. Sincerely, Nelson & Debby Henne, RD 1 Box 104, Robsonia, PA 19551



The bypass diode, used to protect shaded modules in high voltage arrays, is connected reverse bias and in parallel across the output terminals of each and every module. Each ARCO M55 module already has this diode in place, you need to do nothing extra. A blocking diode prevents the battery discharging through the modules at night. The blocking diode is inserted, forward bias and in series with the positive power lead from the PV module, subarray, or array. Richard

Poop Paddles
Dear Home Power; I always find something new and interesting in Home Power. My interests have long been in individual or independent production of useable and practical energy and its application for the benefit of the less affluent, including myself. I enjoyed Al Rutan's article on methane generation and hope you enlarge on the subject with different designs and their inherent problems and advantages. The Rutan diagram did not indicate how the hard foam/crust which occurs on the top of the effluent is to be broken up, nor did it detail the clean out and recharging of the system.

I hope to see future updates on catalytic conversion of gaseous or liquid fuels to heat and thermal electricity and the advances in fuel cell technology, and better batteries.

If you could either explain or debunk the idea of magnetic water softening and whether the ordinary householder could benefit from workbench tinkering with the idea it might save us all some scarce resources.

I'm always delighted by elegant, simple, and innovative solutions to the problems that confront the envenerate tinkerer and inventor. Thanks for being there,

Boyd Getsinger, POB 67, Iona, ID 83427-0067

Dear Boyd, You ask how the foam/crust on the top of the slurry is broken up and also how the system is recharged and cleaned.

You're right that there was an omission of how the mixture is stirred, although mention of it was made in one of the articles. Multiple drawings are needed to include all the features without having the picture so cluttered that it is unintelligible.

Much of my feeling about what does and does not work has been the result of visiting various municipal sewage plants. The plant at Laurel Montana is a vertical tank with a large paddle mechanism driven very slowly by a motor mounted on the top of the tank. It was a trouble free operation.

The plant at Billings Montana was eventually abandoned after the digester failed and several attempts to start it were futile. The major difference between the two was the fact that gas was recirculated in the Billings system rather than the slurry stirred to provide movement. Everyone involved came to the conclusion that this recirculation was .picking up inorganics—sand and gravel—and was literally "shotgunning" the bacteria. They couldn't stand it.

In a horizontal tank such as the one pictured in HP#26, a workable solution is a few small paddles along the length of the tank, mounted on a shaft either from the top or the side and motor driven, although they could be turned by hand once a day or so.

While there is a gathering of "stuff" on the top of the slurry which needs to be moved around, the more important aspect is that food needs to be transported to the bacteria by some kind of movement. They don't have the mobility of fish. In our guts, the action is accomplished by peristalsis. Any kind of movement simulates this.

The recharging is done on a continuous basis, either daily or frequently, as opposed to a batch system where everything is enclosed and sealed. Notice the fill pipe at one end of the drawing and the overflow at the other end. The advantage of the limited and frequent introduction of new material is that the chemical balance of a plus pH is easier to maintain as well as a steady gas output.

Cleanout is needed rarely if the manure is relatively free of sand and gravel. The digested material merely spills over past the baffles which provide a seal to prevent gas escaping or air entering the tank.

If livestock are picking up a fair amount of inorganic material on their hooves, this can be a problem. Provision has been made by a bottom drain with a gate valve at the floor of the tank.

The reason for the uneven floor of the fill basin shown on page 45 of #27 is to hold back most of the sand and gravel before it enters the tank.

Hope this will help. - Al Rutan, The Methane Man

Antenna Adventure

Dear Home Power; About a year ago I began to build my own solar electric system with the intention of providing power for my amateur radio station and a few back up lights. The events of the last several years (the Loma Prieta earthquake and Oakland fire) here in the East Bay near Oakland and an interest in the technology of solar power definitely encouraged me. I began to acquire the needed components at some of our local bay area hamfests and to talk with people who were doing similar things This is how I found out about your wonderful magazine. One person whom I work with has an amateur repeater at 8,000 ft in the Sierra Nevada mountains that is solar powered and he suggested very strongly that I use a temperature compensated charge regulator to protect my gelled lead-acid batteries. I choose a SCI model 1 with the temperature compensation option, this regulator has worked well until just recently when an odd problem cropped up.

One morning while working 10m SSB, running 90 watts into a 4 element yagi that is 35 ft high and located 25 ft away from the radio, I heard the charge relay drop out on the regulator and at 10:00 in the morning my batteries are definitely not charged. I reset the regulator by disconnecting the panels and keyed a carrier causing the relay to drop out. Further investigation showed that this would only occur if the beam was pointed towards the house (my station is in the garage) and that this would also occur using a dipole antenna but not with a trapped vertical I also have in the backyard. The match on the yagi is fair, 1.7:1 and on the dipole terrible, 3:1 and flat with the trapped vertical. All the radio equipment is grounded to a ground rod that is under the radio bench using 1 inch copper braid and the batteries are tied to the same ground point.

I then tried various methods, first of which was to relocate the coax to the yagi, but to no avail. I then called SCI in Canoga Park and the factory suggested ferrites on all the power leads—battery, panels and grounds, and capacitors between the positive and negative leads. After several hours of work I did the above, plus ran larger gauge wire for the battery and braid to the charger case. Then I noticed the temperature compensation sensor is attached to a battery with a 10 ft long wire—close to a quarter wave length at 10 meters. I took a ferrite donut

from an old switching power supply and then wrapped the sensor wire through it 6 times as near to the charge controller as possible, end of problem. Previous testing had shown that the ferrites on the regulators ground and hot leads hadn't been effective.

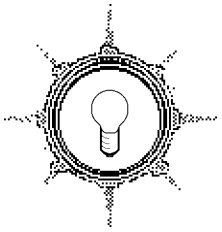
After thinking about this for awhile, I realized that the temperature sensor is a thermistor and that it must operate in the millivolt range making it very RFI sensitive. This SCI is a good regulator, I have only had one other problem that turned out not to be a problem but just a quirk not mentioned by the manual. Had there been a schematic provided, I may have figured the cure out sooner but SCI considers that to be proprietary.

I'm a communications technician by trade and have been interested in electronics since I was a child and am definitely a tinkerer. Your magazine is something that I look forward to every 2 months. Many environmentalists seem anti-technology, while condemning they offer no viable options other than freeze in the dark. The people who write this magazine are not that way at all. They have an alternative and rather than use empty rhetoric, demonstrate that it works and is worthy of consideration by the best of all methods—showing it functions in practice. Tom Murphy (ARS N6IHU), 15929 Via Alamitos, San Lorenzo, CA. 94580

RFI is sneaky. Good detective work, Tom. Many controls use voltage sensing, current sensing, and temperature sensing. In most cases there is a very sensitive OpAmp connected to a long set of wires—perfect invitation to radio frequency interference. If you have wires longer than two feet, then make a twisted pair of the wires. Still use ferrite beads and capacitors (≈ 0.01µF). Bottom line is most designers of RE gear don't give enough consideration to either their units sensitivity to RFI, or worse yet, the amount of RFI their unit generates. Richard

Home Power's Business

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



Display Advertising

Advertising Rates per Insertion

	Single Insertion	*Three Insertions*	*Six Insertions*	*Ad Area sq. in.*
Full Page	$1,200	$1,080	$1,020	67.5
Half Page	$672	$605	$571	33.8
Third Page	$480	$432	$408	22.5
Quarter Page	$377	$339	$320	16.9
Sixth Page	$267	$240	$227	11.3
Eighth Page	$214	$193	$182	8.5

Maximimum vertical dimension is 9 inches. Maximum horizontal dimension is 7.5 inches. For full four-color rates, spot-color rates, and current subscriber demographics, please call us.

Home Power is published bi-monthly. Ad Deadline for the Oct / Nov 92 issue (HP#31) is 22 August 1992.

Call **916-475-3179** for further details.

International Subscriptions

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

1 YEAR- 6 ISSUES
INTERNATIONAL RATES:
All payments in U.S. currency ONLY!

Canada: Air–$30. Surface–$20.

Mexico: Air–$31. Surface–$20.

Western Hemisphere: Air–$33. Surface–$20.

Europe: Air–$44. Surface–$20.

Asia and Africa: Air–$53. Surface–$20.

Pacific Rim: Air–$53. Surface–$20.

Surface shipping may take up to 3 months to get to you. All issues shipped in mailing envelopes. If you have friends with a US Zip code who regularly send you packages, then we can ship them a copy for forwarding to you for $15 U.S. annually.

Mercantile Advertising

One insertion per customer per issue.
We typeset all ads. We do the best we can to make your ad look good. If you send too much copy, then you're bound to be disappointed. Flat Rate $80.
Advance payment only, we don't bill Mercantile Ads.
Your cancelled check is your receipt.

Back Issues of Home Power

Back issues through #20 are $3 each ($4 each outside U.S.), while they last. Sorry, no more Issues #1 through #9 are available, except a few #4. Back Issues of #21 through #29 are $4.50 each ($6 each outside U.S.). All back issues shipped via first class in an envelope or box.
Home Power Magazine, POB 130, Hornbrook, CA 96044

MicroAds

MicroAd rates are 10¢ per character. Characters are letters, numbers, spaces & punctuation marks.
$15 minimum per insertion. Send check with your ad.
We don't bill MicroAds.

Home Power Magazine for Resale

Quantities of Home Power Magazine are now available for resale by newsstands, bookstores, energy businesses, and others. Please write or call for the specifics.

First Class Home Power

Home Power Magazine (6 issues) via First Class U.S Domestic Mail for $30. Many of you have asked for faster delivery of your issues. So here it is: FIRST CLASS HOME POWER. All First Class issues shipped in an envelope. We start your sub immediately.

Second Class Home Power

Home Power Magazine (6 issues) via Second Class U.S. Domestic Mail for $15. Second Class is forwardable, but please let us know if you move! We start your sub with the next scheduled issue, so please allow ten weeks for your first copy to arrive.

Home Power MicroAds

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

SOLAR PATHFINDER™ MANUFACTURING BUSINESS. See HP26, page 40. Things that Work! HP16, page 44. Easily relocated to your Basement or Shop. 303-945-6503 Let's talk.

WANTED: Secluded rural solar home or rural acreage with good solar homesite. Quiet family of 4 will relocate to buy or build. Need school bus access. Prefer western U.S. but all offers considered. Dan Lepinski, 791 Lakeshore Dr, Klamath Falls, OR 97601, 503-885-5698

NEEDED- Equipment for drug rehabilitation community located in central CA. We are a totally private funded, self supporting foundation trying to convert to alternative energy and need PV panels, solar thermal and wind power equipment, batteries, inverters, generators, etc. Donations are tax deductible. Call Sylvester Herring-408-926-5369

MICRO-HYDRO SOURCEBOOK an excellent practical guide for hydro design is available for $26.00 postpaid. This book has valuable information on the design and construction of the civil works for hydro site development. WPM, Box 9723, Midland 08, Texas.

JACOBS WIND ELECTRIC replacement parts, new blades, and blade-actuated governors. We make replacement parts and have new blades for most all wind generators, pre-REA to present models. Many used parts, too. Lots of used equipment available: wind generators, towers, both synchronous and stand alone inverters, and Aermotor waterpumpers. Best prices on TRACE inverters and Bergey Wind Generators. Whisper 1000, $1350 and we pay shipping to anywhere in the lower 48. Trade Wind's wind odometer for $140.00, delivered. Information: $1; specify interests. Lake Michigan Wind & Sun, 3971 E Bluebird Rd., Forestville, WI 54213 Phone 414-837-2267.

CEILING FANS,12 and 24VDC, modern and antique styles, 4 or 5 blades, 42” and 52” diameters, Hugger and Down Rod models. All fans draw only 0.4 amp at either voltage. For free brochure and list of dealers. send SASE to R.C.H., 2173 Rocky Crk Rd, Colville, WA 99114. Dealer inquiries welcome FAX 509-684-5286

DWELLING PORTABLY in tent, tipi, dome, van, trailer, remote cabin, etc. Readers’ experience & candid product reports. Sample $1. POB 190-hp, Philomath, OR 97370

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

HYDROELECTRIC SYSTEMS: Pelton and Crossflow designs, either complete turbines or complete systems. Assistance in site evaluation and equipment selection. Sizes from 100 watts to 5 megawatts. Manufacturing home and commercial size turbines since 1976. Send for a free brochure. Canyon Industries Inc., P.O. Box 574 HP, Deming, WA 98244, 206-592-5552.

INEXPENSIVE 12V LIGHTING. Use car bulbs in 110 fixtures with our nifty adaptors (See HP4 Things That Work). $5 ea, dealer discounts. AE-powered home industry. Northern Lites, POB 874-HP, Tonasket, WA 98855

SOLAR MIND - Newsletter with a holistic view to appropriate transportation, technology, and mind. Also electric vehicles and parts listings. Send $3 to: Stevenson, 759 South State St. #81, Ukiah, CA 95482

MAKE FREE HYDROGEN FUEL from rain water and your renewable power source. Send for plans to make your own gas generator or buy a ready made Water Electrolyzer. For plans and information, enclose $1.00 to - HYDROGEN WIND, INC., Lineville, Iowa 50147

EDTA RESTORES SULFATED BATTERIES. EDTA tetrasodium salt, info., catalog, $10/lb. ppd. Trailhead Supply 325 E. 1165 N., Orem, UT 84057 801-225-3931

FREE ALL COOPER HEAT EXCHANGER with purchase of any 2 motors or motor & compressor. York 206 12V-24V-90V-115V PMDC motors 1/4 to 1 HP $50 ea 36V 2.5 HP motors $150.00 ea. DIRECT CURRENT ALTERNATIVES PO Box 12, Oro Grande, NM 88342 505-434-1344. Our Ph. service may be interrupted while we are moving. Please prepay shipping. Send LSASE for motor spec sheet.

HYDROELECTRIC POWER: Waterpowered components and systems for do-it-yourselfer. AC-DC 1/2kW-2 meg. Since 1973. Send $14.00 for energy guide/catalog. SASE for free brochure. Water Power Mach. Co., Box 9723HP, Midland 08, Tex. (915) 697-6955.

LOW WATTAGE KIRBYS (110 VAC) As reviewed in HP#23 Home & Heart. Rebuilt- 6 mth guarantee. 3 Amp- $175 4 Amp- $150, tools- $25 + UPS - $15. SANDERSON'S (408) 628-3362

XXXXXXXXXX USED SOLAR MODULES XXXXXXXXXXXXXX XXXXXXXXXXXX 16-2000 - $150.00 XXXXXXXXXXXXXX XXXXXXXXXXXX M51s - $165.00 XXXXXXXXXXXXXX New PowerStar Inverter's 1300 watts-$839, 900 watt(24V) $699, 700 watt $550, 400 watt $450, 200 watt $139 - shipped free.

Trace inv 2012 - $1079, low cost sine wave UPS inverter 500 watt-$150. Quadlam's from $225 to $495. New & used ni-cads from AAA to 280 AH cost approx. $0.30 per AH. Will match or beat anyone's prices on equipment. Call or write for free flyer. M/C VISA Discover Craig PO Box 1802 Hesperia CA 92345 619-949-9246,(Trade-in's broken units welcome)

CHINESE DIESEL GENERATORS $1795.00 7.5 KW generator diesel $1995.00 10kw generator with diesel engine $2195.00 200 Amp diesel electric welder. CHINA FARM MACHINERY, 23985 Rolling Meadows Dr., Perris, CA 92570. Tel: 714-657-0379 Fax: 714-657-8120. We guarantee that our products are not made with forced labor.

ATTENTION NEW YORKERS/NEW ENGLANDERS! Want/need an alternative energy dealer in your neck of the woods? We're here! Located in Central New York, we offer a full line of Solar, Wind, and Hydro products, as well as Sunfrost, SunMar, Shurflo Pumps, Trace/Powerstar Inverters, Deka Batteries and Fran-Mar Control Centers. Installation available. Free consultation and system design. FRAN-MAR ALTERNATIVE ENERGY, BOX 163E Babcock Rd, Camden, NY 13316, 315-245-3916.

WANTED: USED 10 Watt PV panels any make or model for Christian Missionary work. Light On The Word, c/o Bill Keys 8111 Stanford #159, Garden Grove, CA 92641

DIESEL ENGINES--4HP to 30HP, from $350 3KW Diesel Gen. Set $795 * I.P.S. 3070 Kenneth St., Santa Clara, CA 95054 PH# 408/988-1672 * FX# 408/988-6071

ENERGY EDUCATION. University credit, in-service workshops. Solar and conservation pro. Hands-on activities. Mike Arenson 142 Darwin, Santa Cruz CA 95062 408-423-8749.

USED EQUIPMENT.ARCO 16-2000 $145 M51 $175 M75 $260 95W Quadlams $395 5 or more sets $375 all plus shipping. Minimum 4 panels per box . New MR16 Track Lights & Fixtures for 12VDC $28 Head Track with live end $12. Leftover from Midwest Energy Fair: DEMO UNITS 2012 $960 2524 $1299 Whisper 1000 $1249. We buy used wind send SASE for complete used LIST. Alt Power 128 Weister Creek Rd. Cashton, WI 54619

PCB LAYOUT. From your schematic to camera ready art. All sizes. On powerful CAD Computer. (818) 703-5930 eves.

SOLAR PANELS (liquid) 4'x8', salvaged American Solar Kings, Pressure tested OK. $150 ea., $1,340/10. Community Builders, 1494 Cedar, Green Bay, WI 54302. 414-432-2882.

GRAPHITE * BLOCKS & SLABS DIY electr. contacts, switches, molds, TROMBE WALLS, 3 lb. SAMPLER/$20prepd. Small sample & litr.-$1+SASE Hebb(HP) Box 999 Mead, WA 99021

TRADE SOLAR PANELS FOR TRUCK. Have qty. of ARCO M51s @ $180 ea. Will trade for late model truck with 327 or 350 eng. auto & air (818) 703-5930 eves.

INTERESTED PARTY SEEKS SELF-SUSTAINING solar home to purchase. Please phone or write to: Alex & Patricia Ortega-6285 Hwy 2-Sandpoint, Idaho-83864-(208) 263-0374 Sun.-Thurs. only.

THIN FILM SOLAR PANELS. new 1' x 3', 12" wires. Output @ 25 deg C is 15V @ 1 A. Strong aluminum frame & mounting feet. Reliable soldered connections. Limited qty. $89 ea. 11 for $890. (818) 702-5930 eves.

"GET MORE POWER" - See page 48 to order new book on Maximum Power Point Tracking technology, written by PV industry consultant Brad O'Mara, BSEET.

INTENTIONAL COMMUNITY Mountain homesites for sale. Spiritual, ecological, equalitarian principles. Union Acres, Rt1 Box 61J, Whittier, NC 28789 (704)497-4964

CARRIZO QUAD LAMS: 75W $222, 85W $275, 95W Framed & J boxes $399. Non toxic/long life Nickel Iron 1.2V cells: new .50 AH, reconditioned .30 AH. Energy Options 1755 Coon Rd, Aspers, PA 17304 • 717-677-6721

BUILD THE WORLD'S PREMIER, patented SOLAR COOKER. Portable. Durable. Superior heat accumulation. Free information or $9.95 for illustrated book. Satisfaction guaranteed. SUN, Box (A)630816, Miami, FL 33180

MARY'S MESSAGE TO THE WORLD is a powerful message sent by Mary, Mother of Jesus. In her chapter on PREDICATIONS she warns of the sequence of events that will happen between now and 1999, when the planet turns on its axis. To order send $14.95 to: B&A Products, 2965 Country Place Circle, Carrollton, TX 75006

WANTED: Private party wishes to purchase rural hydroelectric power plant in operable condition. Any size output considered, home and acreage on same property a plus. Contact Lennort Nilson Jr., 756 Navesink River Rd., Red Bank, NJ 07701. FAX 908-291-0003 or phone 908-291-4567.

MOUNTAIN PROPERTIES in beautiful Scott Valley, Northern California just 15 minutes west of Yreka off I-5. 40 to 250 acre parcels, some with springs or creek frontage and owner carry, $21,500 to $75,000. Call Scott Valley Real Estate Brokerage for lists. (916) 468-2252.

SUNFROST - SF RFV 4, 4 cu ft. vaccine frig/freezer–Demo Like New - Cost $1500.00 Sell $900.00 714-650-7042

EMPLOYMENT OPPORTUNITY-Technician - full time position in sales/service department for charge controller and inverter manufacturer. Must be willing to relocate to San Diego area. Send resume and salary requirements to: Heliotrope General,

3733 Kenora Drive, Spring Valley, CA 91977

5 WATT 12" X 12" panels. Same as GL100 but without frames. $20.00 each while they last. 619-460-3940

POWERSTAR UPG 1300 for sale. New, never used. Upgraded to 24V system. $700.00 firm. Paul Ney, POB 687, Mountianair, NM 87036. (505) 847-2361.

VERMONTERS (and those close by); we are your one-stop place for PV, Micro-hydro, and Wind System Design, Sales and Installation. We stock quality components at competitive prices. Complete System Kits our speciality. We offer professional service on existing systems, and we install Kits from other suppliers (such as Real Goods) when we are not too busy installing our own Kits. Hot prices on cool Sun Frosts! Independent Power & Light, RR1 Box 3054, Hyde Park, VT 05655 phone 802-888-7194

HOME POWER ISSUES 2-27 except 11 and 16, $50 plus postage. Jacobs 12.5 KW wind generator, 100' Rohn tower and lots of spare parts. $5000. Call 319-438-1204 in Iowa.

JACOBS 120VDC Wind Generator 3500W new rotary inverter, solid state controls. Best Offer. Box 10 Franklin WV 26807 (304)358-2749 or 567-2666.

THE ULTIMATE SOLAR FOOD DRYER BOOK. Not like the toys on TV. Complete plans and instructions. $8.00 ea. 45 pgs. R.O.C. 10422 North Rd. SC 13, Tomahawk, WI 54487 715-453-4225

WINDY DANKOFF, author of 16 HP articles, is back to serve you for PV home and water supply. Used Windseeker wind gen, 12V $400. Unused 24V $600. Winco 12V gen only, $150. Used SunAmp 24V 50A PV charge/load controller $300. 12V fans, 6,7,9, or 10" diam., .3-1 amp (5 yr wrnty) $45, $80/2, UPS-paid. Catalog $5 POB 548, Santa Cruz, NM 87567. (505) 351-2100. DEALERS: Call with your water pumping questions!

BATTERIES from Cell Energy, Inc. your Battery Specialist 24 volt-547 amp hr 900 lbs $500, 6 volt-210 amp hr 81 lbs $50, 2 volt-1450 amp hr 315 lbs $300, 2 volt-2016 amp hr 350 lbs $200. CEI has batteries for everything. Call for availability-800-321-0714 or 916-484-7974

REMODELING, ADDITIONS, AND TILE WORK. General contractor in Northern Virginia with a great interest in solar energy. (703) 764-1320

QUALITY SOLAR SERVING NW MONTANA AREA. Specializing in remote site electric, handling only quality equipment, providing quality service. Sales, Site inspections, installation. Call for free estimates. 406-295-5072, 31923 S. Fork Yaak River, Troy, MT 59935

ARE YOUR CIRCUITS PROTECTED? Heinemann #JA1S-V3-A, ac/DC, 10A, 65VDC, A.I.C. 1Kv, easy mount only $7.50 + CA tax & $3 ship. Dallas Solar Power, P.O.B. 611927, San Jose, CA 95161 1-800-345-4913

THE METER AIDE lets you make true amp and volt readings on 120 Vac appliances with your multimeter. Safe, accurate, easy plug-in hookup. $40 plus $5 S&H or S.A.S.E. for more info. Barten Co., 160 W Main, Kipp, KS 67401-9065.

NEW! ULTRA HIGH EFFICIENCY REFRIGERATOR 12 cu ft, 12, 24, 120V $1400, other models available Contact Dan Alway at Low Keep Refrigeration, 24651 Second Ave, Otsego, MI 49078-9406, (616) 692-3015

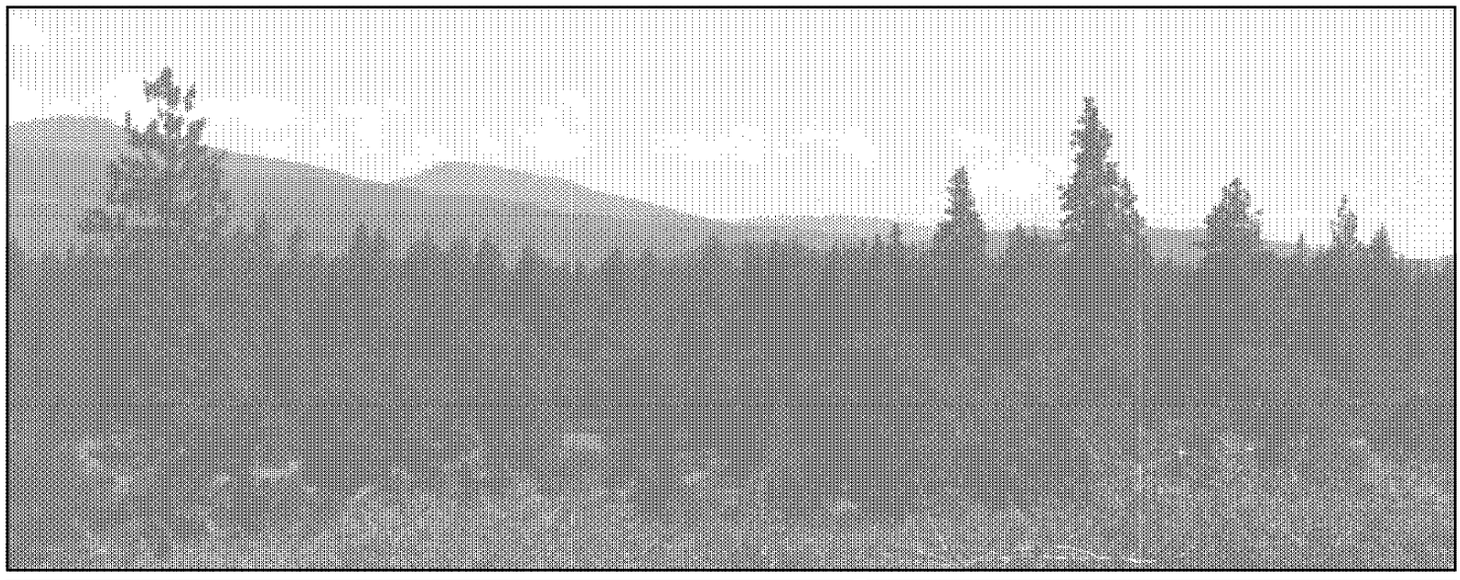
VERMONT SOLAR ELECTRIC - Your North Country source for a wide variety of system components, distribution hardware, lighting, & appliances, custom kits, competitive pricing, and free UPS shipping. Also offering professional design, installation, & service. We enjoy working with the client to design systems which fit the application instead of churning out standardized kits. Write or call for a price list. 69 Thibault Pkwy., Burlington, VT 05401, 802-863-1202. A portion of all sales donated to Greenpeace.

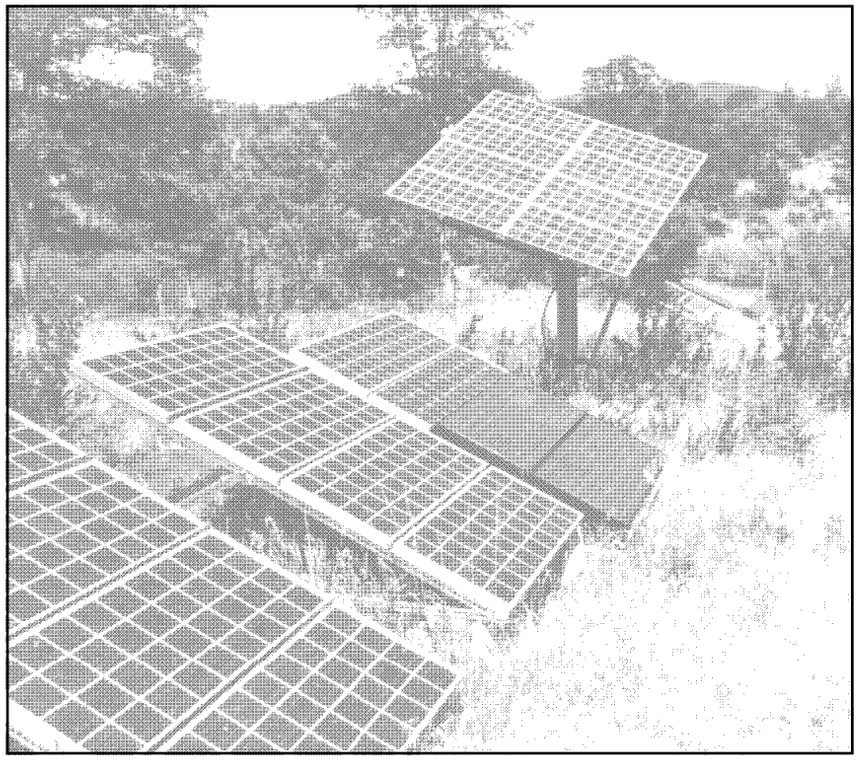
AFFORDABLE! ENVIRONMENTALLY GREEN! LONGEST LIVED! Nickel Iron 1.2V cells New! 300 AH or Reconditioned 600AH $120@ Energy Options 1755 Coon Rd. Aspers PA 17304, 717-677-6721

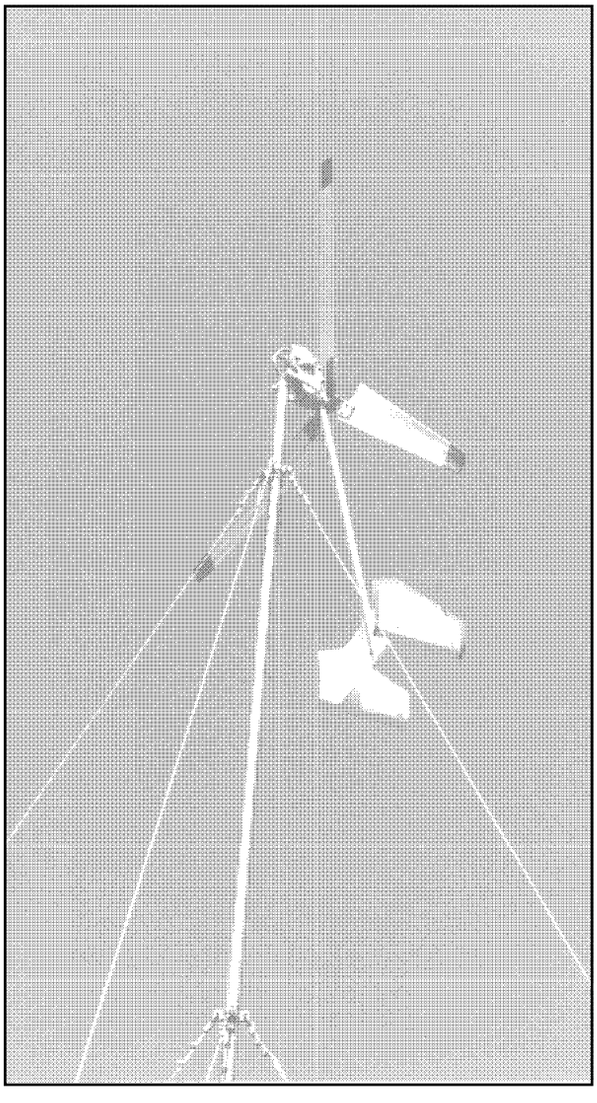
TWO 1974 BATTRONIC ELECTRIC STEP-VANS. One runs, one for parts. Under 5,000 miles on each. Heavy Duty. Must sacrifice. $975 for both. (503) 482-9585.

ELECTRONIC/PCB DESIGN. Update your existing product, design or new ideas with microcontroller technology. Electronic/PCB design and consulting at reasonable rates by experienced Electronic Engineer. (501) 293-3127.

WANTED in Wash. State; N. Snohomish or S. Skagit areas: 1-10 Ac for RE Homestead. Cash, Contract, ?? Please Leave Message (206) 859-4773.







Top: the view shows why we live in the mountains. Bottom left: the assortment of photovoltaic modules powering this magazine. Bottom right: the Survivor wind generator. Photos by Richard Perez

Home Power's System

Richard Perez

The story of Home Power's energy system is a saga of constant change. Here is a profile of the ever growing photovoltaic (PV) and wind energy system that energizes this magazine and the crew who publishes it. Here are the successes (and failures) in our system's transition from fossil fuel to sunshine.

It Grows!

Over the last five years, the renewable energy (RE) system producing Home Power has grown, just like the magazine. Five years ago, we started with three PV modules and ran our gasoline fueled generator every other day. Now we use the power produced by 32 modules and a wind generator. We gave away our aged gasoline fueled generator eleven months ago. Our electricity now comes strictly from the sun and wind.

Home Power started out with a crew of two—Karen and I. We used a single small Macintosh computer. We are now a varying crew of five to eight folks and use three full blown Mac computer systems to produce this magazine. In addition to publishing Home Power, our system also supplies the crew's household power on Agate Flat.

Don't look for Agate Flat, Oregon on a map because you won't find it. That's why Karen and I moved here in 1970. We are very rural, located at 3,300 feet elevation in the Siskiyou Mountains of southwestern Oregon. Everyone who works at Home Power Central lives here because the area is too remote for commuting. The nearest town, Hornbrook, is in California. Hornbrook is 22 miles, and one hour's driving time, away. Eight of these miles are unimproved dirt. The rutted dirt roads that claw their way through these mountains test the survivability of the toughest vehicles. We are located eight miles from the nearest grid power outlet. We are six miles from the nearest hardline telephone. If you want to find us on a map our coordinates are 42° 01' 02" North and 122° 23' 19" West.

Our site on Agate Flat may be far away from it all, but Nature smiles on us none the less. We have abundant dawn-to-dusk sunshine. The wind blows enough here to be a major power source. While we may live and work in the outback, we are happy and content to be here. We give daily thanks and wonder to the renewable energy sources and devices that allow us not only to live in the mountains, but also earn our daily bread here.

Our Power Needs

Our need for electricity is two fold. We need power to run the computers—the primary tools of our publishing business. We need power for our household of six to eight people—the normal appliances found in most homes. So this is really a saga of two distinct electrical consumers. About 60% of the power we make goes down the gaping maw of the computers and their friends the peripherals. The remaining 40% is used for household hum-drums like keeping cool, cooking, cleaning up, and having fun.

Business appliances—120 vac from an inverter

No.	Appliance	Run Watts	Hours /Day	Days /Week	W-hrs /day	%
1	Two Page Mac Display	80	12.0	6	823	12%
2	Mac SE Computers	38	12.0	6	782	11%
2	40MB Harddisks	30	12.0	6	617	9%
1	Mac IIcx Computer	48	12.0	6	494	7%
6	Osram EL Fluorescents	15	5.0	7	450	6%
1	650 MB Harddrive	36	12.0	6	370	5%
1	220 MB Harddrive	28	12.0	6	288	4%
1	Impact Printer	165	6.0	1	141	2%
3	DeskWriter Printers	26	2.0	6	134	2%
1	Scanner	85	1.0	6	73	1%
1	Cordless Phone	3	24.0	7	72	1%
1	Computer Modem	5	3.0	1	2	0%
	Subtotal in Watt-hours per day				4246	60%

Home appliances—120 vac from an inverter

No.	Appliance	Run Watts	Hours /Day	Days /Week	W-hrs /day	%
1	Evaporative Cooler	350	5.0	2	500	7%
1	Power Tools	1000	1.0	2	286	4%
1	Microwave Oven	900	0.3	7	270	4%
1	ShopVac	750	0.5	3	161	2%
1	Toaster Oven	1500	0.1	6	129	2%
1	21" Color TV	85	2.0	4	97	1%
1	Coffee Grinder	350	0.1	7	35	0%
1	VCR	40	2.0	3	34	0%
1	Food Processor	400	0.1	5	29	0%
1	Makita Recharger	30	1.0	2	9	0%
1	Satellite TV System	40	2.0	1	6	0%
1	Sewing Machine	80	0.1	1	1	0%
	Subtotal in Watt-hours per day				1555	22%

Home appliances—12 VDC from the battery

No.	Appliance	Run Watts	Hours /Day	Days /Week	W-hrs /day	%
1	Sun Frost RF19	96	10.0	7	960	13%
2	Incandescent Lamps	26	2.0	7	104	1%
1	Stereo	20	5.0	7	100	1%
1	2 Meter Ham Radio RX	3	24.0	7	72	1%
1	2 Meter Ham Radio TX	25	1.0	7	25	0%
1	Inverter Standby	1	24.0	7	24	0%
1	DC/DC Power Supply	10	2.0	7	20	0%
1	Nicad Battery Charger	6	4.0	3	10	0%
1	Electronic Fence	0.3	24.0	7	7	0%
1	DC Heating Pad	15	3.0	1	6	0%
1	Soldering Iron	25	0.5	2	4	0%
1	5 inch B&W Television	4	0.5	7	2	0%
	Subtotal in Watt-hours per day				1334	19%

Total Energy Consumption in W-hrs. / day 7136

Our total systemic power consumption is about 7,000 Watt-hours per average day. One of the problems we have faced in our system is that we rarely have an average day. While our household needs are relatively constant, our business power use is very binge oriented. Just before an issue of Home Power goes to press, the computers run from 16–24 hours per day. After the issue goes to press and its mailing is done, we relax and sometimes don't touch the computers for several days. Here is a breakdown of our power consumers.

Our business power usage is dominated by computers. We use a Mac IIcx as the main machine. It is equipped with three large harddrives, a scanner, a two page monochrome monitor, and a 300 dpi printer. The two other Mac SE systems are also equipped with ancillary harddrives and 300 dpi printers. It's not that these computer systems consume so much power, it is that they are operating many hours a day. This long-duration, sustained usage adds up to enough electricity to run two average RE homesteads.

Our household usage is dominated by the Sun Frost RF-19 refrigerator/freezer. While Larry Schlussler and the Sun Frost crew make the most efficient refrigerator and freezers in the world, the RF-19 is their largest model. This freezer is big enough to hold a big garden's output, or a quarter of a boned out moose. Our crew is divided 50/50 between veggies and omnivores. Our RF-19 stores the food for the entire crew, and we all like rock-hard ice cream!

The evaporative cooler uses a fair amount of power during the summer and none at all during the winter. While strictly not a business appliance, the evaporative cooler has allowed us to work on summer days that would have been too hot for the computers, never mind the sweating humans punching the keyboards. In our low humidity (≈15%) summer environment, the evaporative cooler lowers the air temperature by about 18°–20°F. It also hydrates the air to a humidity of about 40% and this reduces the static electricity that has plagued our computers.

Our lighting is almost all powered by 120 vac from the inverters. We are using the Osram EL series compact fluorescents. These lights are not only efficient and long lasting, but they also produce color-correct, nonflickering light that we can work under for hours without fatigue.

Our other household appliances are small-time consumers. We use a variety of power tools including a worm-drive Skil™ saw, various drills, sabre saw, big soldering gun, and other tools usually found in backwoods homesteads. The microwave oven gets a workout most lunch times. The toaster belongs to HP crew member, Therese Peffer, who is addicted to toast with her breakfast. The entertainment electronics are shared by all and are not used very often because by evening we are mostly too tired to watch the tube. The 12 Volt stereo (an old Mitsubishi component car unit) gets a regularly daily workout and plays on after 14 years on the job.

System Parameters

We are a 12 Volt, battery based, system. By all rules of PV system design, we should have been a 24 Volt system when our production/consumption exceeded 4,000 Watt-hours per day. But then our system wasn't designed, it just grew. We still use 12 Volts as our battery voltage. We test and review a wide variety of equipment. Some of this gear is only available for 12 Volt input. We still have many 12 Volt appliances (like TVs, and all our Ham radio gear) left over from the early days when reliable inverters were just a dream.

Power Sources

We use the sun and wind to make over 7,000 Watt-hours of power on an average day. Our all time high production was 11,400 Watt-hours during a single day last winter when the sun shone all day and the wind blew at 45 mph+ all day and all night.

This is perhaps the first success story we have to tell you. Photovoltaics and a wind generator are excellent companions. At Agate Flat, when the sun isn't shining, the wind is often blowing. We also have many days, especially during the winter, when the sun shines brightly and the wind blows. Using a combination of renewable energy sources has allowed us to kiss our gasoline powered generator goodbye.

Photovoltaics

Our system contains a motley assortment of photovoltaic modules. We have been investing in PV modules for the last eight years. You will find virtually every make of PV module somewhere in our system. We divided the modules into different arrays. This makes it easier to measure their power output and to wire them to the system. Array One consists of eight Kyocera J-48 modules, each producing about 3 Amperes at 16 VDC. Array Two consists of eight Kyocera K-51 PV modules mounted on a two-axis Wattsun tracker. Array Three is our "democracy rack" and contains an assortment of modules: Siemens M55, Solarex MSX60, Kyocera K51, Hoxan 4310, ARCO M52 QuadLam, ARCO 16–2000, ARCO M51, Solec S50, and Sovonics R100. While this rack supplies the main battery, its real purpose is

on-going testing of PV modules under real life conditions. Each module has its current measured individually, but all provide power at the same voltage, temperature, and solar insolation. This ensures accurate measurement and provides all the modules with an even playing field in a working system. Array Four is just now being installed and consists of eight Kyocera K51 modules mounted on a Zomeworks tracker. Array Five is in the planning stages and will consist of Midway Labs concentrating PV array mounted on a Wattsun tracker. The measured energy output of all our currently installed photovoltaics is roughly equivalent to the output of 32 modules—about 7,000 Watt-hours per average day. Power output is about 1,400 Watts (≈92 Amperes at 15.5 VDC).

Each of the arrays is wired to the power center with its own cables. These array cables are twisted pairs (one cable for positive and one cable for negative) made from 0 gauge copper wire. The shortest cable is 105 feet (actual round trip wire length) and the longest is 415 feet (once again two-way wire length). Making twisted pairs out of 0 gauge cable is difficult and requires five people. Each person grabs a cable's end and one person stands at the centers of the pairs. The folks holding the ends "skip rope" with the ends and wind the cable into a twisted pair. We were able to get about two twists per foot. Twisting the cables radically reduces the radio interference and magnetic fields surrounding the cables when the arrays are being regulated.

When we get Arrays Four and Five wired up to the system, we will have a large (≈3 kWh per day) energy surplus. We are going to use this surplus power to produce hydrogen gas from a water electrolyzer. We are going burn this solar-produced hydrogen in our cook stove which is now fueled by propane.

Wind Generator

Since September 1991, we have been running an Australian-made wind generator called the Survivor. This wind generator is different from any other design that I have ever seen. It has a very large propeller (11.5 feet in diameter) in proportion to the wind generator's size (9 feet long and weighing in at 132 pounds). The Survivor is optimized to provide substantial power at low wind speeds and still survive high winds. The Survivor uses a permanent magnet alternator rated at 800 Watts. The Survivor produces about 100 Watts at 9 mph, 400 Watts at 13 mph, and 800 Watts at 20 mph. It has survived 60 mph winds here on Agate Flat. Our actual energy production from the Survivor has been an average of 860 Watt-hours per day. But this figure doesn't really tell the tale…

On cloudy, stormy days the wind really blows here. The largest daily energy output we've actually recorded from the Survivor was 4,230 Watt-hours during a storm last December. During this same storm, all 32 of our PV modules produced less than 450 Watt-hours of energy. This storm occurred before we had attached the linear current booster to the wind generator. Since we have installed the linear current booster, we have seen a peak wattage of 1152 Watts from the Survivor. This amounts to 68 Amperes at 15.5 VDC into our battery.

The big news is that when the PVs aren't producing power the Survivor is! We haven't burned a drop of gasoline to make electricity since the Survivor was installed. Instead of using the generator during cloudy periods, the Survivor makes the power instead. What is more, we also get 15 mph+ winds on sunny days. On such days, we have a surplus of energy and can do things like let the woodstove go out and run the 1,500 watt electric heater for a while.

The Survivor is mounted atop a 63 foot breakover tower. Our tower is located on a hill about 450 feet from the battery in the main office. The tower design, and all tower hardware (except the 3 inch, schedule 40, steel pipe) are supplied with the Survivor. Karen and I can raise and lower the Survivor in less than 30 minutes with no aid except for our trusty Toyota 4WD truck. The tower uses three levels with four guys at each level. We put 2.75 cubic yards of cement into the five tower footings. The Survivor is electrically connected to the rest of the system with about 900 feet of 0 gauge aluminium USE cable.

Describing in words how the Survivor works is difficult, although instantly apparent to everyone who sees it working. Imagine a helicopter hanging, by its nose, from the top of the tower. As the wind blows, the helicopter picks up its tail and the machine "flies". Even though the photo here shows the Survivor with its nose in air and its tail to the ground, it becomes almost horizontal in winds over 40 mph. At winds of 20 mph, the boom of the wind generator forms about a 45° angle with the ground. This concept is called "Infinitely Variable Rotor Area (IVRA)" and is patented. This design presents a decreasing rotor area to the wind as the wind speed increases. It works great!

I never thought we had a wind generator site here on Agate Flat. The Survivor proved me wrong.

Controls

A Heliotrope CC–120C controls the output of our photovoltaic modules. Since we use an alkaline battery, we set this 120 Ampere PV regulator at 16.3 VDC. We

control the wind generator with the Bobier LCB–40 which allows us to operate the 24 Volt Survivor at about 30 VDC. The LCB-40 converts the wind generator's extra voltage into current for our 12 Volt battery. See HP29, page 53 for a thorough discussion of the LCB–40. The bottom line is that the LCB–40 improved the performance of the Survivor in our system by about 60%.

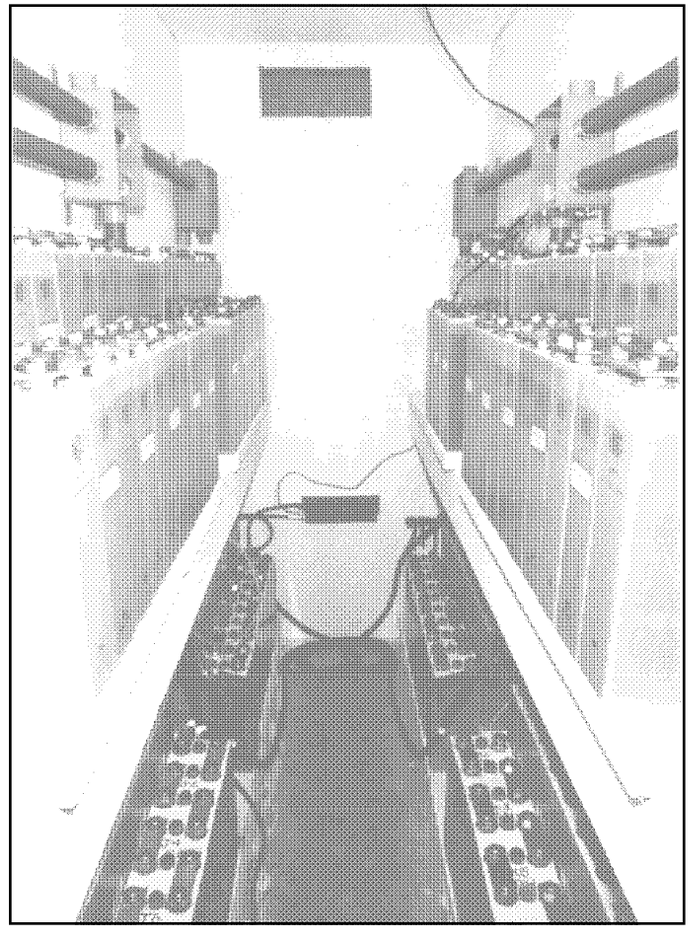
Battery

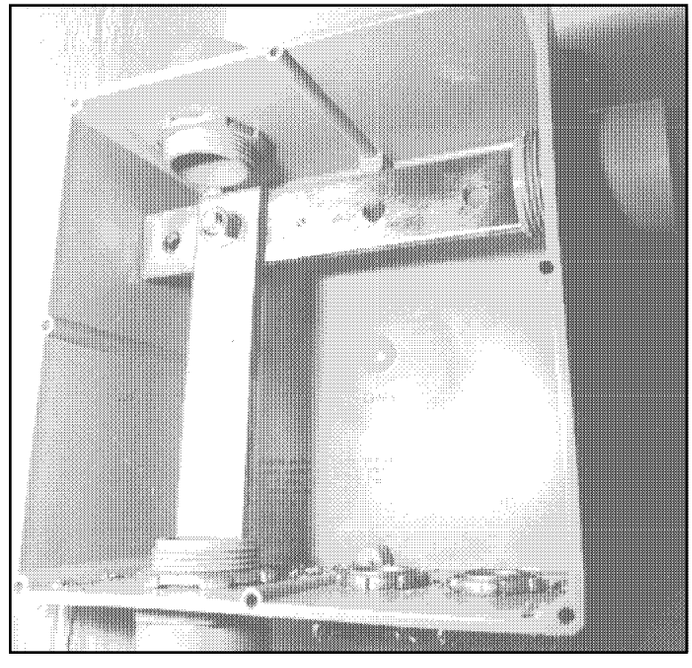
After twenty-two years of lead-acid battery life, we finally went alkaline. Last December we installed 150 reconditioned NIFE nickel-cadmium cells. Each of these model HIP10 cells stores 100 Ampere-hours at 1.2 VDC. We have these cells connected into series strings of ten, and then 15 of these strings are connected in parallel. The resulting battery has a capacity of 1,500 Ampere-hours at 12 VDC.

These nicad cells have a room all to themselves. This insulated, vented, 3.5 foot by 7.5 foot room is equipped with "stair step" racks to hold the cells. This stair step arrangement allows me to see the electrolyte level in every cell without removing the cells' caps. The series strings of nicad cells are connected in parallel with 0.25 inch thick, 1.25 inch wide, copper buss bar. There is over fifty feet of this buss bar inside the battery room and it all runs inside 1.25 inch diameter plastic conduit. Each series string of cells is connected to the buss bars by two 00 gauge copper cables with soldered connectors. This arrangement was a hell of a lot of work. It took three of us about five working days to cut and fit the buss bars within their conduits. The result is spectacular. We can withdraw hundreds of Amperes from the battery with a voltage difference of less than 0.05 VDC loss in the buss bar system. Our actual measured resistance across the buss system was 0.0003 Ohms.

Low resistance bussing assures that each string of series cells is equally charged and discharged. Keeping all the cells at the same state of charge is paramount in any battery. This is best accomplished by allowing series strings of cells an equal resistance path to all incoming and outgoing current.

This battery is large enough to provide energy for three days if all the power inputs (both PV and wind) produce nothing. During the last nine months, we have never had a day where energy production was anywhere near nothing. There is always some sunshine and very often some wind as well. According to our instruments, we have yet to use more than 860 Ampere-hours from the battery before it refilled. Our system is "stand-alone PV & wind" and we no longer have a backup generator. When the





Top: the 3.5 ft. by 7.5 ft. battery room.
Battom: the buss bars before the battery cables were installed. Photos by Richard Perez

battery starts to get low, we just back off on the big power consumers and luxuries. In a day or so, the battery is fully recharged and we can rock-n-roll to our hearts' content.

Power Center
We use an Ananda Power Center IV to interface our battery with all the power sources and loads. This power center contains all the NEC required safety devices, and many shunts for current measurements. This power center was not only convenient to install, but it is also efficient and safe. See HP29, page 56 for a detailed report on the Ananda Power Center IV.

Inverters
We went from a 12 VDC household to an almost all 120 vac household and business because of computers. We could not get the functions we needed out of the 12 VDC computers available back in 1983. So we installed a radical new (back in '83) device that allowed us to convert (actually called "invert") the 12 Volt DC power stored in our battery into 120 vac like "Big Noisy" our gas generator (and the electric company) made. These inverters gave us access to normal everyday appliances—like computers. It didn't take us long to catch on that all appliances didn't have to have cigar lighter plugs anymore.

If all the inverters that passed through my life were stacked end to end, the line would reach from Cleveland to Xanadu. Over the years we have owned over a dozen inverters, the ones that work stayed, the rest were junked. Ten years ago, a good inverter lasted six months and barely ran the vacuum cleaner. Things have really changed. Now inverters are reliable, quiet, efficient, and cost about 70¢ to a buck a watt.

Currently we use any one of five inverters: a Heliotrope 2.3 kW PSTT, a Trace 1512, a PowerStar UPG 1300, a Dynamote 2.4 kW sine-wave, and an Exeltech 250 Watt sine-wave inverter. Of particular note is the 2.4 kW (10.6 kW surge!) sine-wave inverter, made by Dynamote, that we are testing now. This inverter (named Brutus by its maker) produces pure sine-wave power. Our computers love it! Time will tell if it lasts and finds a permanent home in our power processing room.

The controls, inverters, and power center are housed in their own room located right next to the battery room. This tiny "power processing" room is sound insulated and is 3.5 feet by 4.5 feet. Here the inverters, controls, circuit breakers, fuses, disconnects, distribution panels, and instrumentation are comfy being close to each other, and we humans are comfy not being bathed in their audio noise and electromagnetic fields.

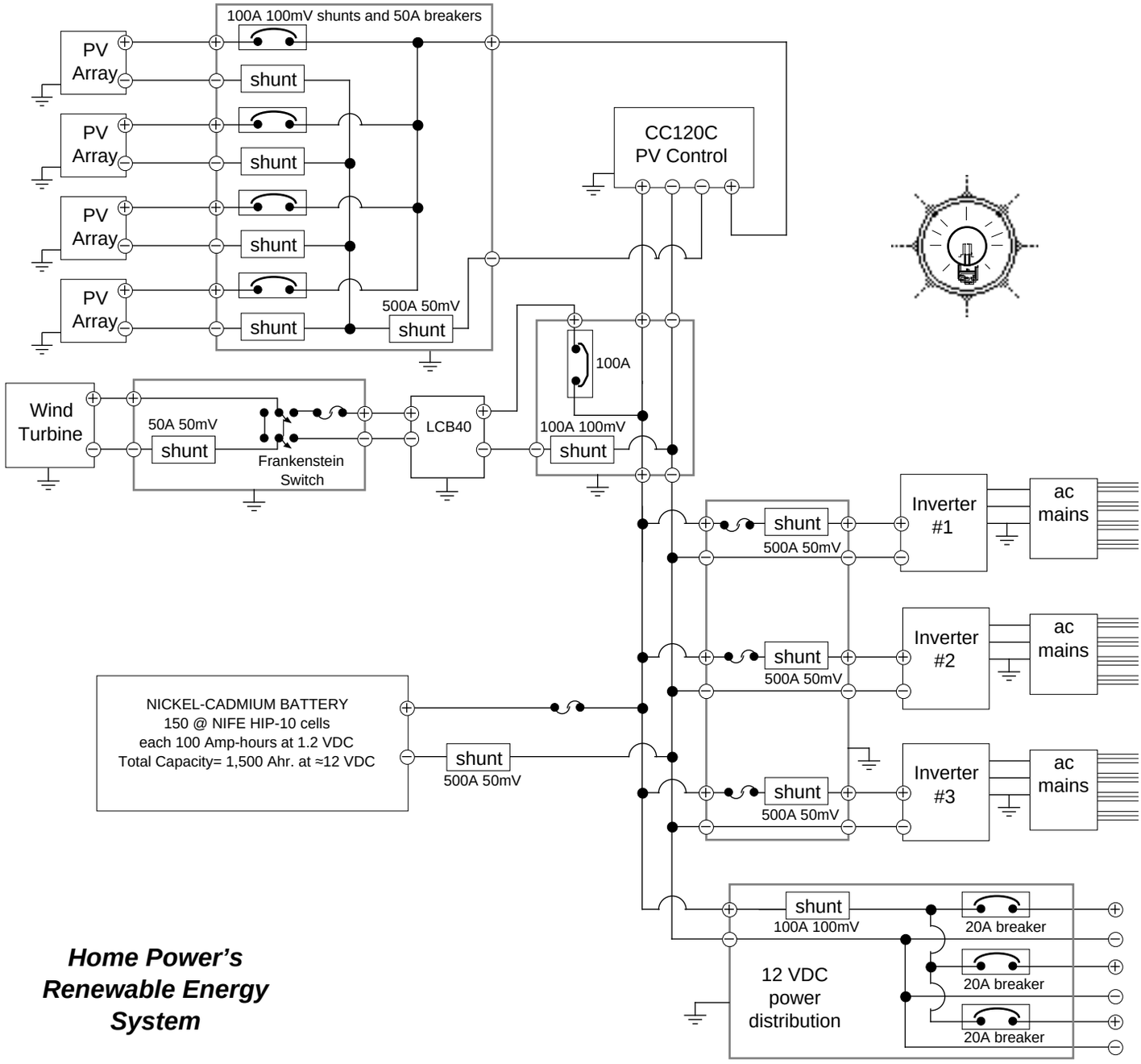
Instruments
Our business is information about home power. The instruments we use are our eyes into the invisible world of electricity. We have many more instruments than are required to actually operate this system. We are interested in sticking our noses into the esoteric and diverse functions of every piece of equipment in this system. We then report our measurements, ideas, and conclusions to you within these pages.

In terms of actual operation, we fly our system using only one instrument—the Cruising Equipment Amp-hour+2 meter. This net-reading, battery Ampere-hour meter not only acts a "gas gauge" for our battery, but also measures battery voltage and battery amperage. It works and is really all we need. See HP26, page 59 for a report on this fine instrument.

Bottom Line Time
Well by now you must be thinking that all this hardware must have cost a pile of dough. You're right. But then Home Power's system is big enough to supply three or four country homesteads. We are a large crew who makes our living with tools that eat electricity. So if the $34,000 price tag sounds out of place, then how about 52¢ per kilowatt-hour? I figure that is what our system produces power for over its estimated 25 year lifespan. And I fully expect the PVs, battery, and some of the power processing equipment to last far beyond twenty-five years.

Anyhow, the local power company, Pacific Power & Light, wants over $250,000 to run in the lines and for the privilege of paying them a monthly bill. Instead we are energy self-sufficient and can live and work in a beautiful, remote mountain site. We know our power comes from a clean and renewable source—the sun!

No.	*Item Description*	*Price@*	*Item Total*	*%*
32	Photovoltaic Modules	$325	$10,400	32%
150	Recond. NIFE HIP10 Nicad Cells	$43	$6,900	21%
1	Survivor Wind Generator	$5,000	$5,000	16%
1	Ananda Power Center	$3,100	$3,100	10%
1	Modified-Sine Wave Inverter	$1,300	$1,300	4%
1	Conduit, Boxes, Buss Bar	$1,200	$1,200	4%
1	Eight Panel Wattsun Tracker	$1,195	$1,195	4%
1	Power Cables (≈2,000 ft.)	$1,005	$1,005	3%
1	LCB-40 Controller	$550	$550	2%
1	Exeltech Sine Wave Inverter	$395	$395	1%
1	Crusing Equip. Amp-hour 2+	$325	$325	1%
1	CC-60C Controller	$310	$310	1%
30	Battery Cables	$10	$300	1%
4	PV Mounting Racks	$45	$180	1%
		Total Hardware Cost	$32,160	



Home Power's Renewable Energy System

Successes

Here is a list of things that have worked for us over the years.

• House the battery and the inverters/controls in their own rooms. I thought nothing of sharing a room with a battery until a cell exploded last December. Now I'd rather eat a bug than hang out in the same room with electrochemical cells. Inverters and controls can produce some very intense electromagnetic fields (EMFs). There is no human minimum daily requirement for EMFs, so keep high powered electronic processors out of living spaces.

• Plan on your system growing. We didn't at first and made several expensive false starts such as too small inverters, controls, and wiring.

• Buy the highest quality hardware that you can afford. Cheap prices mean poor design, poor materials, shoddy construction, and early failure. If you can't afford the best, then save until you can. It took Karen and I two years to save up for our second and third PV modules. We're still using their power. Your energy system should last you a lifetime. Make it good enough to will it to your kids.

• Don't rely on that good ole' boy, the engine/generator. I know it makes lotsa power for a small initial investment, but it will eat you up with fuel bills, and maintenance. It will deafen you with its noise and stink you out with its fumes. Burning fossil fuels is part of the problem, not part of the solution.

• Get some help! Our system would have never been a reality without the help of many. Thanks go first to Bob–O Schultze of Electron Connection for his expertise, sweat, and refusal to do a half-assed job. It is primarily due to Bob–O that Home Power's system meets the National Electric Code's requirements. Also along the way, Dave Wilmeth, Chris Greacen, Barry Brown, Richard "Grizzly Bear" Clark, George Patterson, Dale Hodges, Brian Green, John Pryor, Scott Hening, Ralph Belden, Kenton Lewis, Scott Sayles, Allan Sindelar, Allan Trautman, and many many others. If you get stuck and need info or technical help, give me a call. In that way, maybe I can partially repay the debt I really owe to many many fine and helpful folks who have aided us. We get by with a little help from our friends….

Failures

The failures we have had are the result of not doing the successful items I have mentioned above. Instead of viewing failure as a specific incident, I see it as a matter of attitude.

• Our biggest source of failure was timidity. We were half-hearted in our initial transition to renewable energy. It was so expensive, it was so unsure, it was so unusual, it was so new, it was so… The list of uncertainties seemed endless in the beginning.

• Our next biggest cause of failure was lack of information. We felt like freshmen at a college not yet invented. Well, school is now open and hopefully the pages of this magazine will keep you up to date on all the concepts, devices, and information you need.

What a long strange trip it's been…

I blame it all on the Grateful Dead. In 1976 I got tired of buying dry cells for our midget tape deck. I made our first system—a car battery sourced by a lawnmower engine and junkyard alternator. I wanted the music, but I wanted it without the waste, cost, and pollution of those throw-away batteries. If if weren't for the Dead, I think we'd still be using kerosene lamps.

As soon as my neighbors saw what was going on, they wanted systems too. By 1978 we were in the business designing and installing generator/battery/inverter based power systems.

Around 1985, PV modules became affordable. We started adding PVs to our systems. We watched the gas generator's operating time shrink. We liked it! We went back for more! Eleven of the thirteen homesteads within an eight mile radius of Home Power Central are now powered by sunshine. Maybe a more amazing statistic is that six of the RE homesteads within eight miles of us also support their owners with work at home businesses. Our neighborhood contains a computer programmer, a full service PV/hydro dealer, a publisher, a financial advisor, and two cattle ranchers.

In 1987, I saw folks clambering for information about practical, effective application of RE power sources. I saw an emerging industry with no place to reach its customers. I saw solar power in all our futures. In November of 1987, the first issue of Home Power Magazine hit the streets and dirt roads. You hold the result of the saga in your hands at this moment.

When we started publishing information about renewable energy we had no idea where it would take us. What we are doing is novel—we make our own electricity instead of relying on someone else. We have chosen this for many reasons—our desire to live in the country, our desire to do for ourselves, our concern for Nature, and others. What we are doing now seems unusual, but our efforts point the way to a livable future we can all share.

The resources now used to produce electricity are finite. The consequences of unrestricted combustion, tinkering with the atom's interior, and damming our rivers are now apparent. We are looking for something better, something that can provide our power without polluting and bankrupting future generations.

In the Grateful Dead's words, "Everybody's dancing the ring around the sun, ain't nobody finished, near even begun."

Are we finished yet?

You got me. I used to think that Home Power's system would be done someday and I could relax and enjoy our work. Now I realize that I was deluded. We are all part of an ongoing, ever changing process called life. We tuned in during the middle, and we'll tune out before it's done.

Access

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

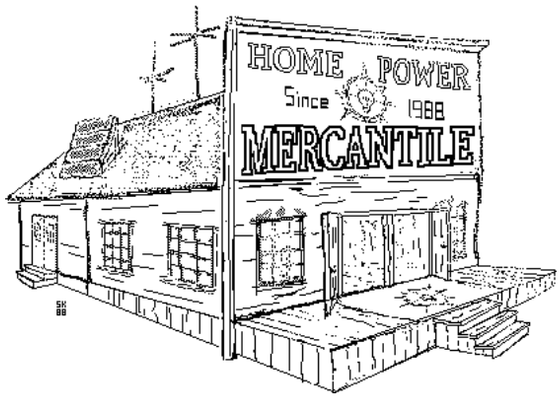
Wind generator maker: Survivor Energy Systems, POB 244, Melville, Western Australia, Australia, 6156 telephone: (09) 330 2357

Index to Home Power Issues #1 through #30

On the right side of each entry are two numbers, for example, 22-81, referring to issue 22, page 81.
Books are italicized. *Name* of System owner is also italicized.
Abbreviations: (TtW!) = Things that Work! product test; Wp = peak watts output from PV panels; L-A = lead-acid battery

Please see page 97 for availability of back issues. Issues 1 through 3 and 5 through 9 are sold out.

Index to Advertisers



SOLOPOWER

FULL
PAGE

BACK
COVER