Purchase with Confidence

Quality
renewable energy system design

Professional
installation & service

Reliable
system performance

Xantrex and their Value Added Distributors announce the Certified Dealer Program.

This program is a joint initiative designed to ensure homeowners receive quality renewable energy system design, installation, and service from the most professional dealers/installers in North America.

xantrex
Certified Dealer
RENEWABLE POWER SYSTEMS

The Xantrex Certified Dealer program is limited to dealers uniquely dedicated to the highest standard of customer service and satisfaction.

Contact your local Xantrex Distributor for information on this industry leading program. Or, email us at TCDinfo@Xantrex.com.

tel: 360-435-8826 ext 703
fax: 360-435-2229
Arlington, Washington USA

xantrex
Smart Choice for Power

www.traceengineering.com or www.xantrex.com

USA

Alternative Solar Products - California
Toll Free: 800.229.7652
Phone: 909.308.2366
E-mail: mark@alternativesolar.com
Internet: www.alternativesolar.com

Atlantic Solar Products, Inc. - Maryland
Toll Free: 800.807.2857
Phone: 410.686.2500
E-mail: mail@atlanticsolar.com
Internet: www.atlanticsolar.com

Dankoff Solar Products - New Mexico
Toll Free: 888.396.6611
Phone: 505.473.3800
E-mail: pumps@dankoffsolar.com
Internet: www.dankoffsolar.com

Effective Solar Products - Louisiana
Toll Free: 888.824.0090
Phone: 504.537.0090
E-mail: esp@effectivesolar.com
Internet: www.effectivesolar.com

Intermountain Solar Technologies - Utah
Toll Free: 800.671.0169
Phone: 801.501.9353
E-mail: orrin@intermountainsolar.com
Internet: www.intermountainwholesale.com

Polar Wire - Alaska
Phone: 907.561.5955
Fax: 907.561.4233
E-mail: sales@polarwire.com
Internet: www.polarwire.com

Schott Applied Power Corp. - California
Toll Free: 800.777.7075
Phone: 707.923.2277
E-mail: sales@appliedpower.com
Internet: www.appliedpower.com

Solar Depot, Inc. - California
Toll Free: 800.822.4041
Phone: 415.499.1333
E-mail: info@solardepot.com
Internet: www.solardepot.com

Trace Engineering Inc · Morningstar Corporation · Surrette · Steca

Southwest PV Systems - Texas
Toll Free: 800.899.7978
Phone: 281.351.0031
E-mail: swpv@southwestpv.com
Internet: www.southwestpv.com

Sun Amp Power Company - Arizona
Toll Free: 800.677.6527
Phone: 480.922.9782
E-mail: sunamp@sunamp.com
Internet: www.sunamp.com

Talmage Solar Engineering, Inc. - Solar Market - Maine
Toll Free: 877.785.0088
Phone: 207.985.0088
E-mail: sm@solarmarket.com
Internet: www.solarmarket.com

CANADA

Powersource Energy Systems - Alberta
Toll Free: 888.291.9039
Phone: 403.291.9039
E-mail: info@powersourceenergy.com
Internet: www.powersourceenergy.com

Powersource Energy Systems - British Columbia
Toll Free: 888.544.2115
Phone: 250.544.2115
E-mail: info@powersourceenergy.com
Internet: www.powersourceenergy.com

Powersource Energy Systems - Ontario
Toll Free: 866.730.5570
Phone: 705.730.5570
E-mail: info@powersourceenergy.com
Internet: www.powersourceenergy.com

Trans-Canada Energie - Quebec
Toll Free: 800.661.3330
Phone: 450.348.2370
E-mail: rozonbatteries@yahoo.com
Internet: www.worldbatteries.com

CONCORDE
SUN XTENDER
SMA
TWO SEAS
Southwest Windpower

NOW in the US!

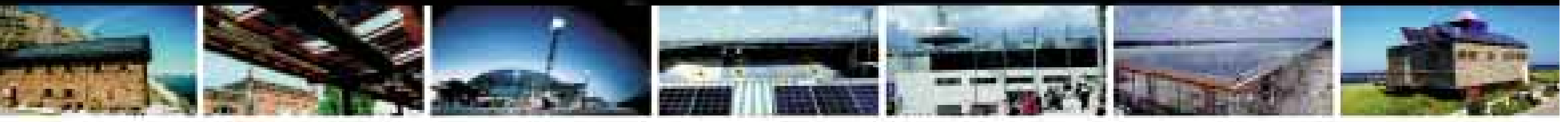
Sunny Boy 2500

- SMA, the leading supplier of grid tied PV systems in Europe , is now in the US!
- Get to know our trend setting technology of String Inverters
- We have over 60 MW AC of total "Sunny Boy String Inverter" power instal-led so far
- Over 40,000 Sunny Boy String Inverters sold up to now

Now UL Listed to UL 1741 for Grid Interactive Inverters

Join our Sunny Family and benefit from our Sunny Boy String Inverters with ...

- 5 Year Warranty - reliable and safe!
- Our Sunny Boys meet highest quality requirements - see our results in high-quality tests!
- Easy Outdoor Mounting with Protection Class NEMA 4X / IP 65
- Easy to install by using a three-point mounting system
- Multiple Communications and data collections that can be customized for any system



SMA America, Inc.
20830 Red Dog Road
Grass Valley , CA 95945

Phone 530 - 273 - 4895
Fax 530 - 274 - 7271

Advanced System Technology for the Successful Photovoltaic Future

SMA

www.SMA-AMERICA.com • www.SMA.de

www.usbattery.com

RECYCLED POWER

At U.S. Battery, we're committed to doing our part in keeping the environment clean and green for future generations, as well as providing you with premium deep cycle products guaranteed to deliver your power requirements when you need them.

U.S. Battery
MANUFACTURING
COMPANY

DON'T SETTLE FOR ANYTHING LESS THAN U.S. BATTERY PRODUCTS!

1675 Sampson Ave. Corona, CA 91719 (800) 695-0945 / 653 Industrial Park Dr., Evans, GA 30809 (800) 522-0945

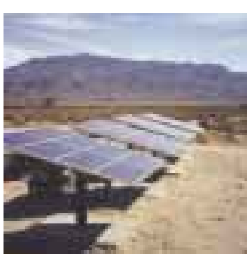
HOME POWER

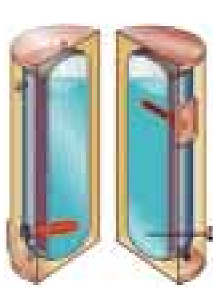
THE HANDS-ON JOURNAL OF HOME-MADE POWER

Issue #86

December 2001 / January 2002

Features





More Features

Energy Fairs

GoPower

Homebrew

David & Donna Sweetman's view of their PVs and mountainous desert-scape.

Guerrilla Solar

Things that Work!

Columns

More Columns

Regulars

Access and Info

Access Data

Home Power
PO Box 520
Ashland, OR 97520 USA

Editorial:
Phone: 530-475-3179
Fax: 530-475-0836

Subscriptions and Back Issues:
800-707-6585 VISA / MC
541-512-0201 Outside USA

Advertising:
Phone: 800-707-6585
or 541-512-0201 Outside USA
Fax: 541-512-0343

Email: hp@homepower.com

Web: www.homepower.com

Paper and Ink Data

Cover paper is 50% recycled (10% postconsumer / 40% preconsumer) Recovery Gloss from S.D. Warren Paper Company.

Interior paper, Pinewood Web Dull, a 55# 50% postconsumer, ECF, manufactured by Crown Vantage, a peroxide/oxygen based mill in St. Francisville, Louisiana.

Printed using low VOC vegetable based inks.

Printed by

St. Croix Press, Inc.,
New Richmond, Wisconsin

Legal

Home Power (ISSN 1050-2416) is published bi-monthly for $22.50 per year at PO Box 520, Ashland, OR 97520. International surface subscription for US$30. Periodicals postage paid at Ashland, OR, and at additional mailing offices. POSTMASTER send address corrections to *Home Power,* PO Box 520, Ashland, OR 97520.

Copyright ©2001 *Home Power,* Inc.

All rights reserved. Contents may not be reprinted or otherwise reproduced without written permission.

While *Home Power* magazine strives for clarity and accuracy, we assume no responsibility or liability for the use of this information.

This paper is recycled and recyclable.

Act of War—Act of Peace

Just after the terrorist attacks on September 11, 2001, a friend and I stopped to see Erv Bell at his renewably powered home. Erv is a gentle and thoughtful philosopher, raised in the South. He moved to the Pacific Northwest years ago, and is trying to tread lightly on the earth, walking his talk. He's been living with solar-electric and wind power for 14 years. Erv's home and RE system are small and practical. His homebuilt wind generator tower is a masterpiece of design and artistry, and his color-coded power room conduit is unique and attractive.

As Erv showed us his PV array, he told us what got him started with renewables. When Washington Public Power Supply (WPPS) went bankrupt in 1987, he bought his first two solar-electric panels. WPPS was behind several nuclear power plants in the Northwest, and many people lost a lot of money when it went under. Erv was concerned that they would make consumers pay for the debacle, and wanted to put his money into something more positive.

Erv then told us that right after the terrorist attacks in September, he decided to start saving money for a few more solar-electric panels. While others were getting mad at Arabs, Muslims, and everything "un-American," Erv was making a more practical and intelligent response to the murderous attacks. He knows that no war has ever been fought over solar energy, and no war ever will.

—Ian Woofenden for the *Home Power* crew

People

Mike Brown
Sam Coleman
Eric Grisen
Kathleen Jarschke-Schultze
Andy Kerr
Stan Krute
Don Kulha
Tom Lane
Don Loweburg
Tom Muckey
Ken Olson
Stephany Owen
Karen Perez
Richard Perez
Linda Pinkham
Jason Powell
Shari Prange
Benjamin Root
Connie Said
Joe Schwartz
Solar Guerrilla 0008
Solar Guerrilla 0017
Douglas Stockman
Laurie Stone
David Sweetman
Michael Welch
John Wiles
Dave Wilmeth
Jennifer Wine
Ian Woofenden
Rue Wright

"Think about it…"

I have learned through bitter experience the one supreme lesson to conserve my anger, and as heat conserved is transmitted into energy, even so our anger controlled can be transmitted into a power that can move the world.

—Mahatma Gandhi

Most Power Now

NOMAD 1500

Portable Solar Power System

No tools needed

A modular, portable system that's ideal for backup power or remote electrification.

- **Charge protection**
- **1500 watt inverter**
- **AC 110v and DC 12v**
- **60 amp hour battery (easily expanded)**
- **32 to 240 watts of PV**

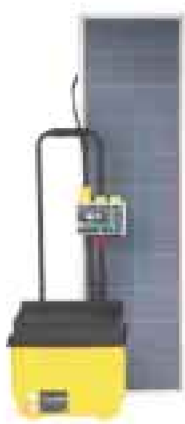
Shown with 240 watts of Kyocera PV

$1930 USD + S&H

Also available with Uni-Solar

ALSO AVAILABLE

NOMAD 300



NOMAD 600

Complete portable systems from $279

Toll Free **1-877-797-6527**

www.SolarSense.com

SolarSense.com

A Division of ARISE Technologies Corporation

Renewable Energy in the Cloudy Northeast

Douglas Stockman

©2001 Douglas Stockman

Upstate New York is not known for its solar potential. The winters seem to last six months. During most of those cold months, the inhabitants are not sure if there is a sun in the sky because of all the cloud cover. Even with this limitation, a growing number of pioneers are exploring the renewable energy potential of the area.

This past year, my family moved into our version of upscale living. Even though we more than doubled the size of our living space in comparison to our previous home, we reduced our energy use. This was true even before our wind turbine and solar-electric panels were online.

Energy Consciousness

There are probably as many arguments for resource conservation as there are readers of *Home Power*. Some could argue that living in a mud hut without lights, heat, or external energy sources would have the least impact on the environment. That might be correct, but I cannot see the developed world moving in that direction.

Having lived in the African bush for three years in primitive conditions, I can appreciate the benefits of a few creature comforts. My wife and I chose to build a home with all the modern conveniences, but without all the energy guzzling characteristics of a typical American builder's special. In addition to making us comfortable, we hoped our choices would assist other like-minded individuals in making wise energy use decisions. Judging from the responses received by visitors to our first solar home tour, and from the interest of coworkers, we are on the correct path.

Our hope for a new home included rural land, passive solar design, energy conserving features throughout, and electricity generation using wind and sun. We wanted the home to look and function like a normal suburban American home. We feel that we have achieved our goals. The house has no weird-looking features, and blends right in with neighboring homes. Our usage of natural gas (60 therms per month in the winter) is one-third that of a typical home in the area, and our electricity usage (120 KWH per month in the summer and 180 KWH per month in the winter) is one-fourth that of an average home.

We have all the modern conveniences, including clothes washer and dryer, dishwasher, standard refrigerator, microwave, central heat, garage door

The Stockman family's solar home and the renewable energy equipment that powers it—photovoltaic modules on a homemade rack and the 14.8 foot diameter wind generator.

opener, televisions, stereos, computers, vacuum cleaners, etc. I also like to work wood and metal with large power tools. Without the use of these tools, our electricity use would be even lower.

Home Design

Long before we began this project, I educated myself about passive solar design, energy conservation, and wind and solar energy. I knew I would get limited guidance from local building specialists. *Home Power* was a prominent source of sound information. Other sources are listed at the end of this article.

We spent five months searching for land before we found a nine-acre farm plot within a 30-minute drive of our work. After purchasing the land, fighting for wind generator approval (see companion article on page 22), and creating a site plan, we located an architect willing to tackle our passive solar project. The architect had no experience designing passive solar homes, but he listened to our suggestions and created a house based on our floorplan and dimensions.

The home is a conglomeration of Cape Cod and saltbox designs, with dormers added. From the north side, it appears to be a one-and-a-half story Cape Cod style. From the south it looks like a three-story partial saltbox. The home has a walkout basement to the south. This design allows us to reduce the exposed surface area to the north, where prevailing winter winds originate, and maximizes solar collection to the south.

Thermal Mass

The home has significant thermal mass built into the floors. The basement floor is poured concrete. The main floor decking is made of Spancrete, a prestressed concrete panel often used in the construction of parking garages. Thermally, the 8 inch (20 cm) thick Spancrete for our home is probably equivalent to 4 to 5 inches (10–13 cm) of solid concrete. The Spancrete comes in 4 foot (1.2 m) widths and almost any specified length.

The Spancrete panels arrived on a flatbed truck, and were placed directly on the block foundation wall using a crane. In about a half day, the main floor decking was completed. Because we used radiant floor heating, the Spancrete has 1-1/2 inches (38 mm) of Gypcrete on top of it.

Gypcrete is a watery concrete that is pumped into the house and poured on the floor. There is no aggregate in Gypcrete, so it is leveled with a squeegee-like tool. It expands and contracts less than concrete, which is a main attraction of the product. The home's second floor is made of the usual lumber joists with plywood decking. Gypcrete was poured directly on the subfloor, providing some thermal mass.

The nearest neighbor to the south can be seen through this window. Although the neighbors are more than 1,500 feet away, they were the most vocal opponents to the wind turbine, stating that it would be too noisy.

Windows

On the basement and second floor, south-facing window surface areas equal about 8 percent of those floor surface areas. On the main floor, south-facing windows equal about 12 percent of the main floor surface area. A number of sources suggest that if this 12 percent is exceeded, overheating can occur. For areas with less thermal mass, the magic number is 8 percent.

Of course, real life performance is never that simple. Because windows have a low R-value, it makes more sense in some locations to have fewer windows because the solar heat gained through the windows will never equal the amount lost during nonsunny and nighttime periods.

We used two types of windows. On the north, west, and east, we chose double-pane, low-E windows that have an R-value of about 3.5. For south-facing windows, we chose double-paned windows with an R-value of 2.5. Although the low-E windows have a higher R-value, they also block a significant amount of solar energy. Because we are so far north and summer is so short, we kept window overhangs to less than 1 foot (30 cm). By September, we want some solar heat gain, and will need it well into April.

We use thermal shades on all windows, except the basement. The shades have a triple honeycomb construction and an R-value of about 3.5. I had hoped to use thermal shutters or pocket-like doors over the windows with R-values in the 10 range, but we could not find commercially available products, and the cost to custom make them was prohibitive. For the basement windows, I made simple, hinged, thermal shutters. They have plywood faces in wood frames, sandwiched over 2 inch insulation with an R-14 value.

Insulation
The task of insulating and sealing the house was taken seriously. Two inches (5 cm) of extruded polystyrene panels are under the basement slab. These sheets are rated at about R-12. The 12 inch (30 cm) wide basement block walls were injected with expanding foam to give an estimated R-20 value. All exterior walls are made of structural insulated panels (SIPs). They are also called stress skin panels, and have an R-value somewhere between R-23 and R-40. More on SIPs later.

The roof has R-33 fiberglass in the eaves and R-45+ blown-in insulation in the rest of the attic. After the insulating crew came through, I spent a good eight hours sealing leaks that they felt were too small to care about. In addition, anywhere an electrical box was installed in an SIP wall, I filled the defect with expanding foam.

Some sources suggest a house is tight against air infiltration when less than 35 percent of a home's volume of air leaks out each hour in a simple pressure test. Air escapes through doors, windows, and gaps in the building envelope. Older homes often leak one to three times their volume per hour at elevated pressures. Using a blower door test, only 25 percent of our home's volume of air leaks out each hour. This number is probably lower now because I have further reduced some known leaks.

SIPs
The SIPs we used have 5.5 inches (14 cm) of styrofoam sandwiched between two sheets of 1/2 inch (13 mm) oriented strand board (OSB). The SIP manufacturer is given a set of blueprints from which panels are custom made. For the builder, the construction is similar to putting together a jigsaw puzzle. Each panel from the factory is labeled and belongs in a certain location. The panels are lifted into place with a crane. For experienced crews, SIP construction goes much faster than stick-frame construction.

Spancrete forms the main floor decking and offers significant thermal mass.

Structural insulated panels (SIPs) form the entire house structure. A small crane sets the SIPs into place.

Basement during construction, showing 2 inches (5 cm) of insulation on the floor and radiant floor tubing. The repaired holes in the cement block are where expanding foam insulation was injected inside the 12 inch (30 cm) blocks.

The R-value of our SIPs lies somewhere between 23 and 40. The huge range in R-value is because of how R-values are measured. In actual measurement, the SIP has an R-value of 23, but it performs as well as a wall containing R-40 fiberglass insulation.

In normal stick-frame construction for our area, R-19 fiberglass insulation is placed between 2 by 6 stud walls. The studs are not very good insulators, and many times insulation is not installed behind electrical boxes, wires, pipes, some corners, etc. Still, the walls are said to be R-19 walls. The SIP has none of the listed shortcomings, so our SIPs perform about as well as a stick-frame wall that has R-40 fiberglass batts between studs.

HVAC
We use radiant floor heating as one of our heating sources. An Ocean model Luna 24Fi, natural-gas-fired boiler, with an efficiency of about 83 percent, provides all the hot water for backup space heating and domestic hot water. The boiler does not use a pilot light.

Most heating is done using a Vermont Castings Encore woodstove. Our third heat source is the passive solar design. On a sunny day, which is rare during the winter, the house stays about 72°F (22°C) without any other heat source. Due to the tightness of the house, we installed a Kanalflakt, model SE2000 heat recovery unit. A heat recovery unit expels warm stale air from inside the house to the outside, and replaces it with fresh, but cold, outside air. Before the warm inside air is discharged, the heat from that air is used to warm up the cold outside air. We run this unit during bathing and certain cooking activities to remove excess moisture from the home.

The natural-gas-fired boiler (left) and heat recovery unit (right). Note the basement ceiling is Spancrete.

Upstate New York summers are generally beautiful. Maybe only a week of each summer has temperatures over 90°F (32°C). I like it hot, so we chose not to install central air conditioning. The lack of air conditioning does not mean we suffer on hot days. The huge thermal mass in the floors keeps temperature swings to a minimum.

During the typically cool nights, we open the windows to cool down the thermal mass. To further assist the entry of cool night air, we have a small whole-house fan in the second story ceiling that is infrequently used. During the day, we close the windows to keep the hot air out. On really hot days, we have an attic fan that uses a thermostat switch as well as a separate on/off switch. Last summer, the inside temperature never went above 78°F (26°C).

Lighting & Appliances

We made the decision early on to use fluorescent lighting throughout the house. We had some concern that fluorescents would not be bright enough, and that they would not fit in the fixtures we liked. Our fears were unfounded. The home is very bright and we like the fixtures.

When we found a fixture we liked, we tested it with compact fluorescent bulbs before purchase. In addition to using fluorescents, we designed the home to allow many levels of light intensity. For example, in the kitchen/eating area, we have five separate switches that each control a different bank of lights. We can choose as little or as much light as we need.

We wrestled a bit with appliances. The main issue was refrigerator selection. A Sun Frost refrigerator uses much less energy than a typical refrigerator available at the local appliance store. But a Sun Frost does not have auto-defrost, lacks all of the neat design concepts for maximizing interior usage, and costs up to three times more than a typical refrigerator.

We decided to purchase the most efficient conventional refrigerator available at a local appliance store. It's an Amana, bottom-freezer model, and uses 550 KWH per year. So far, we are happy with our purchase, and generate more than enough electricity using wind and sun to power the electricity-loving refrigerator.

Our dishwasher is an energy efficient Asko, model 1385. We cannot say enough good things about the Asko, and recommend it to everyone who can afford the higher initial investment. Our clothes washer is a Frigidaire Gallery front loader, and the dryer is its natural-gas-fired companion.

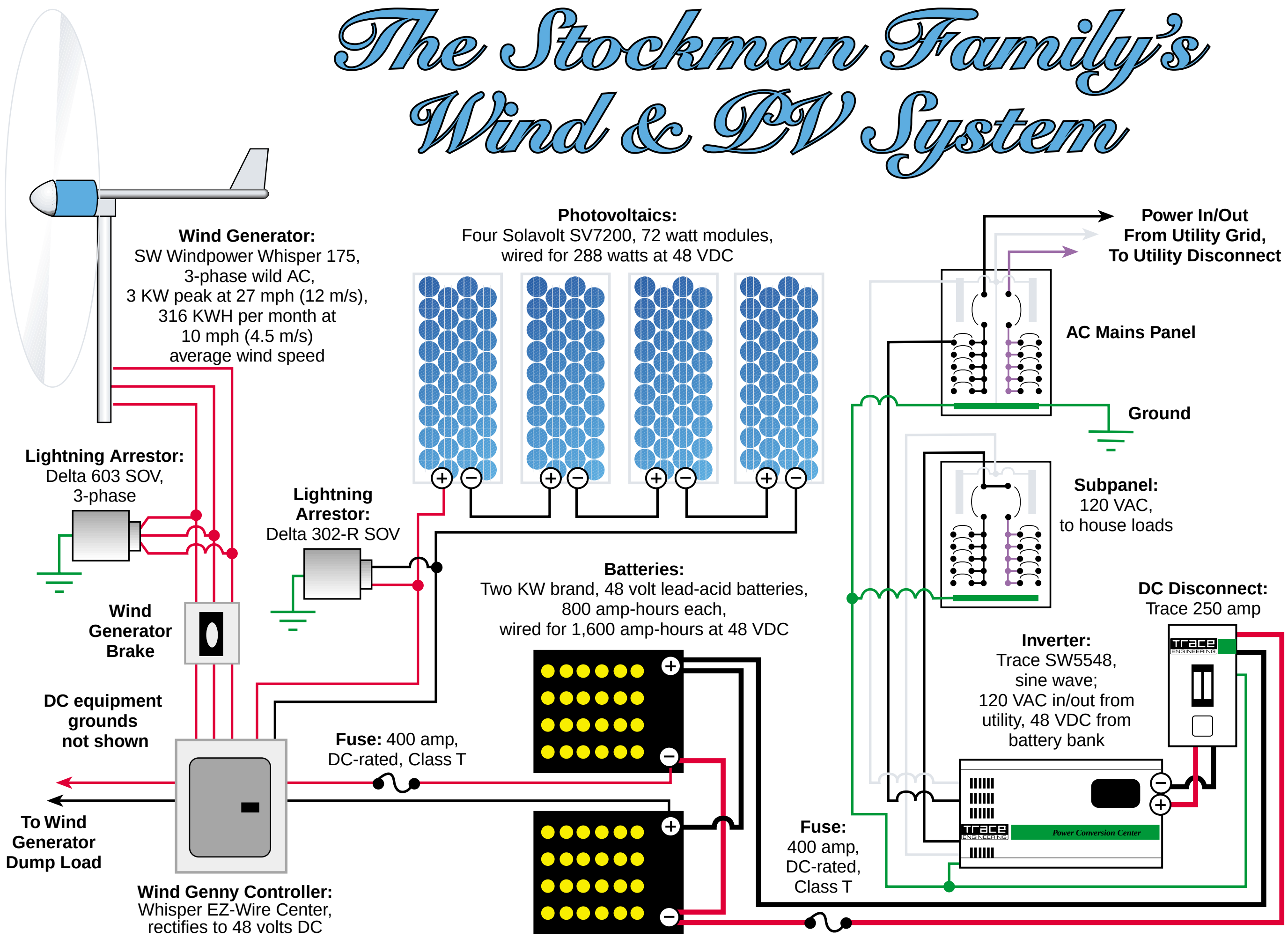
The Jenn-Air convection oven saves gas by reducing cooking times.

The efficient Amana refrigerator consumes 550 KWH per year.

The natural-gas-fired stove with a convection oven is a Jenn-Air (model JGR8855ADS). The convection aspect of the oven really does shorten cooking times by 20 to 35 percent. The microwave is a typical 1,200 watt machine (GE model JE18605B). All appliances were purchased at a local appliance store. By wise appliance selection, we have probably reduced our energy consumption by 30 percent or more.

Phantom Loads

We have reduced the number of phantom loads, but more remains to be done. Both the microwave and the stove are on separate electrical



switches that we turn off when the appliance is not being used. All televisions, stereos, and computers have on/off switches in their cords or are plugged into a switched power strip.

Four main phantom or always-on loads remain: the baby monitor, answering machine, garage door opener, and smoke alarms. By local code, all eight smoke alarms must be directly hardwired to the home's electrical system. We purchased AC smoke detectors that have battery backup. This allows us to still have functioning smoke alarms if we choose to place the inverter in search mode.

Stamping out the phantom loads of baby monitor and answering machine requires similar forethought. The house is wired with 12 volt DC outlets in the master bedroom, baby room, and living room. Once I install the small 12 volt system, we will use 12 volt DC power converters to power the baby monitor and answering machine. The garage door opener will be placed on a switched outlet, so we can turn it off when we are home. Once these conversions are complete, we can switch the inverter to search mode.

Electricity from Wind & Sun

The main electricity producer is a Southwest Windpower Whisper 175 wind turbine. It sits on top of a 105 foot (32 m) tall Lake Michigan Wind and Sun tilt-up tower. The turbine has a 14.8 foot (4.5 m) rotor diameter and produces its maximum output of 3 KW when winds are 27 mph (12 m/s). With a 10 mph (4.5 m/s) average wind speed, the turbine produces about 316 kilowatt-hours per month.

Wind generated electricity is supplemented by four Solavolt SV7200 PV panels that produce 72 peak watts each. This coming summer will determine if we need to add more panels. Summertime in Rochester generally brings more sun and less wind. To date, we have had more energy than we know what to do with, and have not had to use the grid. If we are having wind gusts significantly above 30 mph (13 m/s), I generally turn the turbine off once the batteries are full to reduce the stress on the wind turbine.

Both the wind turbine and PV output are fed into the Whisper's control box, which is located in our garage. The panels are 70 feet (21 m) from the control box and the wind turbine is 200 feet (61 m) away. The wire runs from both the wind turbine and PV array use #2 (34 mm^2) aluminum USE wire. To meet code, the cable has to be at least 2 feet (60 cm) underground, either in conduit or with 6 inches (15 cm) of sand around all sides. The simplest and least costly option for me was to use conduit.

Batteries & Inverter

From the control box, the wiring goes to two forklift batteries located in the attached garage. I initially placed an order for sixteen L-16 deep-cycle batteries, but then I heard about these used batteries from a friend. Each battery weighs 3,500 pounds (1,600 kg), is a 48 volt pack, and has a capacity of approximately 800 amp-hours. The two batteries are wired in parallel to provide about 1,600 amp-hours worth of capacity at 48 volts.

Although the batteries were used, they were tested extensively and found to have almost full functional capacity compared to a new battery. Each battery generally sells for more than US$4,000 new, but I was able to get both for US$2,200. So far, these batteries have performed beyond my expectations, and should last close to twenty years.

From the batteries, the wiring goes through a wall and into our basement where the Trace SW5548 sine wave inverter lives. Although the batteries are in an insulated box, I wanted to reduce any chance that the inverter would be damaged by the caustic fumes batteries can give off.

The inverter is set in its LBX (low battery transfer) mode. This means that when the battery voltage reaches a user-selected minimum voltage (47.4 for my system), the house is powered by the grid until the batteries are recharged to a higher, user programmable voltage (50 volts for my system) using a combination of the grid and the renewable energy sources.

We have experienced no problems with the purity of electricity produced by the inverter. One hurdle I have yet to clear is the fact that the inverter often shuts off due to overcurrent when I turn on my 1.5 HP table saw. It took Trace six weeks to reply to my two e-mail pleas for help. I am still attempting to discuss the problem by phone with their technical support people.

The battery box is made from leftover structural insulated panels (SIPs). The two, 48 volt battery packs weigh 3,500 pounds (1,600 kg) each and have a capacity of 800 amp-hours each.

The DC disconnect box, inverter, and two subpanels are located in the basement, and the batteries are in the garage above.

Do-It-Yourselfer

I installed all the equipment and wiring myself. I would not recommend doing this unless you really do your homework and are very handy. The tilt-up tower kit, wind turbine, and inverter come with decent instruction manuals for their respective devices. Creating a safe and *NEC* compliant system is not discussed specifically. So you need to learn about *NEC* regulations from other sources.

The wind generator tower kit is from Lake Michigan Wind and Sun. It comes with almost everything except the 5 inch diameter, schedule 40, steel pipe, which I purchased locally. Each 21 foot (6.4 m) length of pipe weighs about 300 pounds (136 kg), so getting them into position with only one person can be tricky. There are five sections of pipe for the tower and two sections for the gin pole. I purchased a winch from Surplus Center that I adapted to run off one of my tractor's power take off (PTO) shafts. My 60-year-old restored tractor does not even labor raising the tower.

Eight foot (2.4 m) ground rods were driven into the ground next to each anchor and the center base (total of five). Copper grounding wire then connects to each of the twenty guy cables and to the base of the tower. I also grounded the PV panel frames with a grounding rod. The negative pole of the batteries is connected to ground for the main system ground. I have SOV lightning arrestors at the base of the turbine (Delta LA 603) and at the PVs (Delta LA 302-R).

Stockman System Costs

Item	*Cost (US$)*
Tower kit with optional pulley kit	$4,300
Whisper 175 LV48 wind generator	3,900
Trace SW5548 inverter	3,300
2 KW brand batteries, 48 V 800 AH, used	2,200
4 Solavolt SV7200 modules, 72 W peak each	1,400
Wiring, conduit, connectors, etc.	1,100
7 Pipe lengths, 5 inch, schedule 40, galvanized	1,030
Concrete for footings	800
PTO-driven winch 315-B; 8,000 pound, worm gear	600
Conduit/wire cable excavating	400
Trace DC250 DC disconnect	250
Footing excavation	200
Wind generator special use permit	100
2 Fuses, Class T 400 A	52
PV rack, homemade	75
Lightning arrestor, Delta LA 302-R	40
Lightning arrestor, Delta LA 603, 3-phase	60
Wind generator building permit	35
Total	$19,842

I built a rack for eight PV panels. The rack can be adjusted for the sun's seasonal changes. The angle of the panels can also be changed to match the season. Throughout the winter, the PV panels contributed almost nothing to energy production. As spring approached and the cloud cover decreased, the output from the PV source finally began contributing several hundred watt-hours a day.

Load Analysis

Most renewable energy installers correctly recommend performing a load analysis to match the energy producing capacity of RE sources to expected energy consumption. A typical load analysis involves estimating how much electrical energy every appliance, light, television, etc. in the home uses, and adding the results up to estimate the amount required. The renewable energy system is then designed to meet the expected need.

I did not perform a load analysis before building our system, but instead estimated electrical usage in our new home based on past usage. After a year of use, I believe my guesses were correct and the system is sized correctly.

Problems

I experienced some minor difficulties with the Whisper 175, but I am, for the most part, very happy with the machine's performance. When the turbine kit arrived, there were no instructions for assembling parts for a beefed up tail assembly and a stronger blade mounting system. The parts were in the kit, but the manual made no mention of using them. I assembled and raised the turbine as described in the manual. Afterwards, I called Southwest Windpower about the spare parts, and was told to stop using the machine until the instructions arrived.

It took over a month for me to get the instructions. I suggested that the manufacturer extend the warranty for the time I could not use the turbine. They refused. Although I had to lower the tower to install the redesigned parts, I was able to find a day where there was only a foot of snow on the ground and the temperatures were just below freezing.

One other problem delayed the use of the wind generator a few more months. A circuit in the control box was burned out. This part of the circuit diverts excess electricity to the dump load when the batteries are full. I replaced the part two separate times, and the new part promptly burned out. The manufacturer redesigned the part, and the third try was a charm. The turbine has performed flawlessly since then.

I did become frustrated with the time it took to correct problems, but the manufacturer was responsive to my inquiries and worked with me to solve problems. I think we were just on a different time clock. I found it helpful to remember that this wind turbine is not a simple appliance like a toaster, and is, in a sense, custom fit into each site and situation. I do hope the company will consider rewriting the assembly manual to reflect the new changes.

Coming Home with a Smile

Although my commute from work is a bit longer than I like, I smile every time I approach home and can see the wind turbine spinning in the distance. As I walk up the drive, I hear the faint "whoosh, whoosh, whoosh" of the turbine. I look out over the nine acres and take in the wildlife as the burdens from work slip away. I enter a warm inviting home that uses much less energy than its neighbors. Everything is as it should be, and I again smile.

Access

Douglas Stockman, MD, N2ZYE • dstockman@pol.net
www.windzone.mkeis.org

The Passive Solar House, James Kachadorian, 1997 ISBN 0-9300-3197-0, 210 pages, US$24.95 from Chelsea Green Publishing Company, PO Box 428, White River Junction, VT 05001 • 800-639-4099 or 802-295-6300 • Fax: 802-295-6444 pbuskey@chelseagreen.com • www.chelseagreen.com

Passive Solar Design Strategies: Guidelines for Home Building, 1990, 85 pages plus software and guide, US$50, SBIC (Sustainable Building Industry Council), 1331 H Street, NW, Ste. 1000, Washington, DC 20005 202-628-7400 • Fax: 202-393-5043 sbic@sbicouncil.org • www.sbicouncil.org

Wind Power for Home and Business, Paul Gipe, 1993, ISBN 0-930031-64-4, 413 pages, US$35 from Chelsea Green Publishing Company, PO Box 428, White River Junction, VT 05001 • 800-639-4099 or 802-295-6300 Fax: 802-295-6444 • pbuskey@chelseagreen.com www.chelseagreen.com

Photovoltaic Power Systems and the National Electrical Code: Suggested Practices, Sandia Report SAND96-2797*UC-1290 • Available in PDF form at www.nmsu.edu/~tdi/pvandnec.htm or from Connie Brooks, Sandia National Laboratories • 505-844-4383 cjbrook@sandia.gov

Consumer Guide to Home Energy Savings, Wilson, Thorne, & Morrill, 1999, ISBN 0-918249-38-4, 225 pages, US$8.95 (plus US$5 shipping for the first book and US$1 for each additional) from American Council for an Energy Efficient Economy (ACEEE), 1001 Connecticut Ave. NW, Suite 801, Washington, DC 20036 • 202-429-0063 • Fax: 202-429-0193 ace3pubs@ix.netcom.com • http://aceee.org

Surplus Center, PO Box 82209, Lincoln NE 68501 800-488-3407 or 402-474-4055 • Fax: 402-474-5198 Winch

Xantrex Technology Inc., Distributed Residential and Commercial Markets, 5916 195th St. NE, Arlington, WA 98223 • 360-435-8826 • Fax: 360-435-2229 inverters@traceengineering.com • www.xantrex.com Inverter

Lake Michigan Wind and Sun, 1015 County Rd. U, Sturgeon Bay, WI 54235 • 920-743-0456 Fax: 920-0466 • info@windandsun.com www.windandsun.com • Wind turbine tower

Southwest Windpower, 2131 N. First St., Flagstaff, AZ 86004 • 800-946-3313 or 520-779-9463 Fax: 520-779-1485 • info@windenergy.com www.windenergy.com • Whisper 175 wind turbine

Delivered Solutions, PO Box 891240, Temecula CA 92589 • 800-429-7650 or 909-698-1700 Fax: 800-929-0238 or 909-698- 5758 sales@deliveredsolutions.com www.deliveredsolutions.com • RE equipment supplier

Delta Lightning Arrestors, PO Box 750, Big Spring, TX 79721 • 915-267-1000 • Fax: 915-267-1035 deltala@msn.com • www.deltala.com

McMaster-Carr, PO Box 440, New Brunswick, NJ 08903 732-329-3200 • Fax: 732-329-3772 nj.sales@mcmaster.com • www.mcmaster.com General hardware, connectors, etc.

SwiftLift, PO Box 299, Pittsford, NY 14534 716-248-2120 • Fax: 716-248-2505 • lmm@swiftlift.net www.swiftlift.net • Batteries

NORTHERN ARIZONA WIND&SUN
Electricity From the Sun

Serving Customers Around the World Since 1979
FEATURING: SIEMENS SOLAR PANELS – 25 YEAR WARRANTY – OVERSTOCKED IN:

SP-75 Solar panel $389.00* SM55 Solar Panel $319.50* RV-KIT 50 Watt $400.00*
ST-5 Solar panel $60.00* SM50H Solar Panel $298.00* RV KIT 75 Watt $580.00*

Also featuring quality products from: Kyocera - Unisolar – Siemens – BP Solar -Direct Power Mounts – Zomework Mounts – Two Seas Mounts – Morningstar Controllers – Iota Battery Chargers – ThinLite – Exeltech Inverters – TriMetric Battery Monitors – Dankoff Solar Pumps – Crown Industrial – Coleman Power Station - Trojan - Surrette - Concorde - SunExtender AGM Batteries – Xantrex (Formerly Trace Engineering) – Delta Lightening Arrestors. See our online store for complete pricing.
See our online store at www.solar-electric.com and our technical info website at www.windsun.com

2725 E Lakin Drive, Flagstaff AZ 86004 – 800-383-0195, 928-526-8017, FAX: 928-527-0729

Does the PV industry picture sometimes
seem a little fuzzy?

At AstroPower, we see our role very clearly.

PV is our livelihood, so we concentrate exclusively on producing better solar electric power products for our customers. Our unique focus is the product of the most dedicated and capable team in the industry. They work at AstroPower because they want to make a difference, and they take pride in the company because they all own a part of it.

When selecting a PV supplier, consider not only the products, but also the company behind the products.

Make your choice count.

Choose AstroPower.

ASTROPOWER

Independent. Clean. Focused.

www.astropower.com

AEROMAG STEALTH-ACOUSTIC™
AEROSPACE ENGINEERED
SPACE GRADE CARBON FIBER BLADES™

- Lowest noise emission high performance home power wind turbine available.
- When it comes to "quiet" smooth running turbine operations in residential communities, AEROMAG Stealth - Acoustic is the right choice for good neighbors!
- Number one for safety and structural integrity, AEROMAG Stealth Acoustics is the world leader in low rotational inertia high tip speed ratio " home power safe", blade technology.

WIND TURBINE GENERATOR FEATURES

- Anodized Aluminum body with all stainless steel hardware
- Rare Earth Neodymium Iron Boron Permanent Magnets
- Lowest cost per Watt GUARANTEED
- High Power Density Generator Technology
- Rated 900 Watts Power Output at 28.8 mph
- Peak Output Power at 1300 Watts
- Start-up wind speed at 6 mph
- 12, 24, 48 Volt available
- Lightweight 34 lbs. [17kg]

LAKOTA Land 12, 24, 48 V including Control	List Price:	$1429[1]
LAKOTA Land 12, 24, 48 V including Control with Extended Warranty add	List Price:	$179[2]
Add a tower: 2 inch 47 ft with the turbine	Add:	$369
Add a tower: 2 inch 25 ft with the turbine	Add:	$319

[1] Includes 5 year warranty on Wind Turbine Operating System and 7 year warranty on AEROMAG Stealth-Acoustic™ Carbon Fiber Blades
[2] Includes 7 year warranty on Wind Turbine Operating System and 10 year warranty on AEROMAG Stealth-Acoustic™ Carbon Fiber Blades

Exclusively sold by AEROMAX

NOW ACCEPTING APPLICATIONS FOR DISTRIBUTORS NATIONWIDE

AEROMAX CORPORATION "Revolution in the Wind"

DB1KW Available Soon !

TOLL FREE: 1.888.407.WIND (9463)
PHONE: 520.775.0085 9520 EAST LORNA LANE, PRESCOTT VALLEY, AZ 86314 FAX: 520.775.0803
E-MAIL: SALES@AEROMAG.COM WEBSITE: WWW.AEROMAXWINDENERGY.COM


See electricity in a whole new light.
When you look at BP Solar, you'll see a company that's more than solar power. We're the power of experience, with 30 years of industry leadership and reliable solar electric systems installed worldwide.
Generating electricity from sunlight, solar electricity provides the "greenest" electricity available, and is so simple, you hardly know it's there. No sound, no smoke, no CO_2 — just pure power. And by choosing solar electricity, you can help reduce carbon dioxide emissions, a major cause in producing harmful greenhouse gases.
BP Solar offers photovoltaic systems that provide complete independence from the power grid, or you can select a back up system that provides electricity during power outages. Either way, clean, reliable power is available for your family when you need it.
bp solar
The natural source for electricity™
Take a closer look at BP Solar by visiting our website at
www.bpsolar.com

THE HARD PART ABOUT WIND TURBINES

Douglas Stockman

©2001 Douglas Stockman

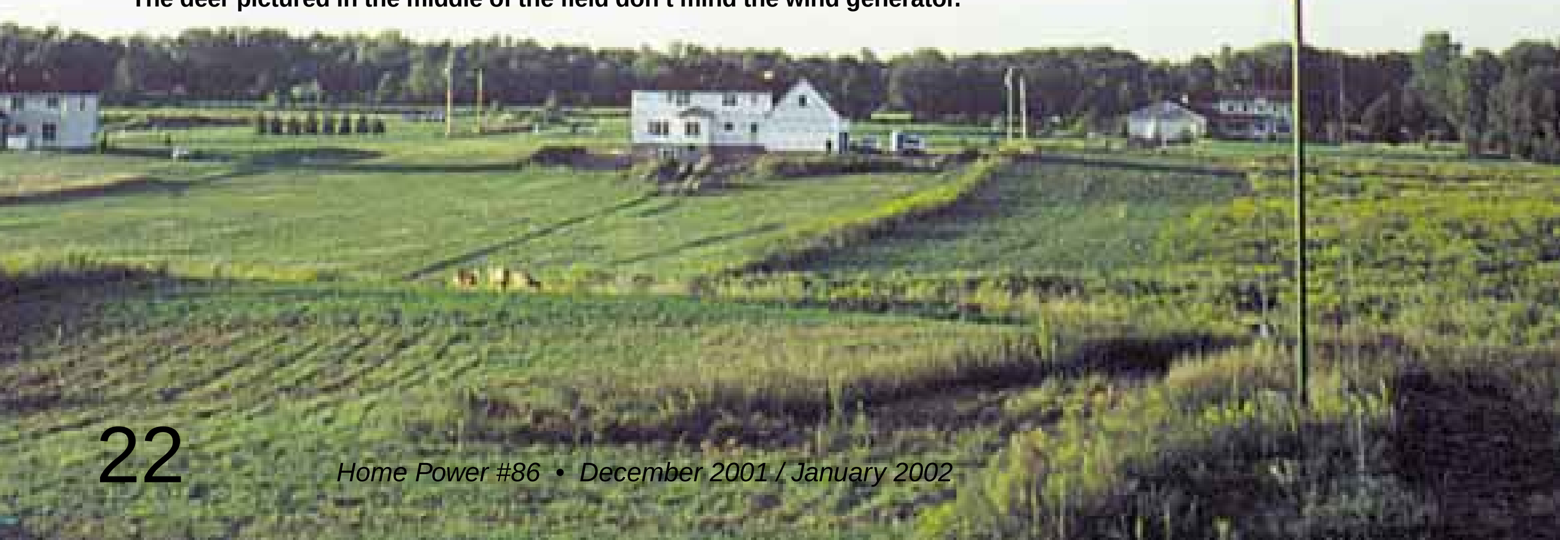
After we identified the nine-acre piece of ground that we wanted for our dream home, we started to look into the feasibility of putting a wind generator on it (see page 10). The nearest neighbor to the north was 300 feet (91 m) away behind a tree line. In all other directions, houses were at least 1,000 feet (305 m) away. It seemed like a reasonable place to locate a wind turbine.

Before placing an offer on the land, we met with the building and planning representative of the local township. We informed him of our plans to erect a wind turbine for energy generation. The planning representative said that the town already had requirements for wind turbines in their regulations. Our plan met those regulations, so there should be no problem. He anticipated that we could even skip going before the town planning board because our plan already met the regulations of the town. We did not know it at the time, but the representative was very wrong.

Irrational Fears

The land was purchased and our odyssey began. We did not know our neighbors, but the officials anticipated no problems. So we did not meet with neighbors to discuss our plans. Because we changed the location of the house from an approved site, the town had to place placards on the land announcing our proposed change. The wind turbine was mentioned in the town notice. People's hackles were raised, and multiple complaints about the plan were received. An open planning board meeting was then mandatory.

The view looking south, away from the author's home, shows the houses of neighbors who opposed the wind turbine. The deer pictured in the middle of the field don't mind the wind generator.



Having never been to a town meeting, I really did not know what to expect. I could not foresee what complaints the future neighbors would have. About fifty concerned people attended the planning board meeting, along with my site engineer, a renewable energy installer I paid to attend, my wife, and me. We presented the new site plan, an idea of what the house would look like, the wind turbine location, and details about the turbine and the tower. After my talk, the concerned neighbors had a turn at the microphone.

We were dumbfounded by people's often irrational fears and their inability to keep an open mind or consider a view different than their own. The most commonly heard complaints were:

- The wind generator, aka "bird guillotine," would kill many birds.
- The wind generator would make constant noise, upsetting the peace of the neighborhood.
- The wind generator would lower property values.
- The wind generator would ruin the character of the neighborhood.
- Trespassing children would attempt to climb the wind generator's 5 inch metal pipe tower and kill themselves.
- The local utility already provided electricity, so we should not be allowed to have a wind generator because it is unnecessary.

A number of small verbal arguments broke out between the renewable energy installer and a lady who was on a "save the wildlife crusade." The planning board decided that a further investigation had to occur before a decision on the wind turbine could be rendered. I was asked to provide evidence that all the fears of the neighbors were unfounded.

The following sections summarize some of the information we presented to the planning board. For those who want all the gory details, visit the Web site I created entitled "Windmills and Zoning Boards" at www.windzone.mkeis.org.

Wildlife

Significant concern exists regarding wind generators killing birds. The highest recorded bird kills come from Altamont Pass in California. This wind farm has over 7,000 industrial-sized wind turbines on lattice towers. Altamont Pass is on a raptor migration route. Raptors land on the crossbars of the lattice towers. When they spot prey, they at times do not notice the spinning blades when taking flight, and hit the blades. Recent studies suggest that if smooth monopole towers are used, the raptors have nowhere to land and do not go near the wind generators.

The situation in Altamont Pass does not apply to most small residential turbines. A report compiled by the California Energy Commission demonstrates that wind generators kill no more birds than any other manufactured structure. Radio towers, cars, electrical wires, and even picture windows are more deadly to birds than are small residential wind generators.

Anecdotal evidence from a nearby lattice-towered, 30 foot (9 m) diameter rotor wind turbine supports this study. In the three-plus years of operation, not a single bird has been found dead near the wind generator. An excellent article by Mick Sagrillo in *HP46,* page 30, provides more background for the interested reader.

Noise

Almost every machine that humans have made creates some level of noise. Wind generators are no exception. They produce sound when turning. Most of the noise is created by air moving over the wind turbine's blades. The sound produced is not mechanical. It is more like a "whoa, whoa, whoa" natural sound. Some turbines use a drive train. This collection of gears can produce machine-type noise.

Wind turbines do not produce sound until the wind is moving fast enough to turn the rotor (usually 6–10 mph; 2.7–4.5 m/s). This means that the peace of a quiet summer morning will not be shattered by the sounds of a wind generator. When the wind is strong enough to generate electricity, trees, bushes, and other objects are also making noise.

Noise has both character and intensity. The character issue is very listener specific. A leaky faucet dripping water does not produce much sound, but that noise can drive people crazy if they choose to listen to it. The same is true of a wind generator. Because character is too difficult to measure, the intensity of wind generator noise is often measured. Sound intensity meters exist. Even this measurement is difficult to perform accurately when outside.

My Web site provides specific numbers for sound levels of generic machines. There were no published reports on the machine we proposed using, the Whisper 175. The manufacturers of the Whisper machine suggested that their turbine was the quietest on the market of any similarly sized turbine, and that the noise output from their machine would reach ambient noise level about 200 feet (61 m) from the turbine.

Property Values

To the best of my knowledge, wind generators have never been shown to decrease property values. We

The Stockman family home with wind and PV systems.

were unable to locate any scientific studies that addressed this issue. This is probably in part due to the huge number of variables that cannot be controlled in the real estate market.

Anecdotal information from the building and planning office representative suggests that similar studies were conducted on cellular telephone towers. These studies did not demonstrate reduced property values for homes near cell towers.

Character of the Neighborhood

When other concerns of the neighbors were refuted by facts, the next argument against the wind generator was based on "ruining the character of the neighborhood." Because the character of a neighborhood is hard to quantify, we had to attack this problem differently.

We gathered information about the neighborhood. This included narrative and photographs. We showed utility poles with wires near every house in the neighborhood, antenna and water towers in residential areas, and propane tanks in our neighbors' front yards.

We also turned to the town's own documents regarding the neighborhood's zoning rules and the town's master plan for the area. These revealed that we were in a rural agricultural area. We could put in a pig farm and a 100 foot (30 m) tall silo without a question. The master plan book said that the town was supposed to encourage uses that would keep the area rural, not residential. The wind generator fit right in with this directive.

Danger to Children

This seemed like the strangest fear to us. The neighbors suggested that children would climb the tower and injure themselves. How could a child climb a 5 inch diameter metal pipe, and why would anyone attempt to climb such a structure? Using their logic, every utility pole in the town should be removed because it poses a danger to children.

In addition, within 1/2 mile (0.8 km) of the proposed wind generator tower are two huge water towers that have ladders for climbing. These are much better structures for climbing, but no one is suggesting that the water towers be removed. Fortunately, after my initial reply to this fear, the planning board did not bring the issue up again.

Redundant Energy Source

We received a letter of support from one of our neighbors we do not know. He nicely refuted the claim that the wind turbine was not necessary because electricity was already available from the utility. He said that just because local grocery stores provide fresh produce, does not mean people should be banned from having home gardens. The redundant energy source argument was also quickly ignored by the planning board.

Biweekly Meetings

Every two weeks, we attended closed planning board meetings. This went on for a few months. We would submit documents addressing previously raised concerns. The seven board members would then discuss the topic. Each meeting ended with a request for more information, and the wind generator issue would be tabled until the next meeting.

By the third or fourth meeting, it became clear that most of what we submitted was never reviewed by any of the board members. In addition, only one of the seven board members ever took enough interest in the case to visit a nearby wind generator.

Within 5 miles (8 km) of the planning board meeting location is a 20 KW, 30 foot (9 m) diameter rebuilt Jacobs on a 95 foot (29 m) freestanding lattice tower. This wind generator is four times larger than our proposed wind generator, based on power output and swept area. The interested board member stated that singing birds were louder than the Jacobs wind generator. Even with this internal report, noise remained an issue.

A Political Process

The entire process was an education in local government and politics. Even with all the evidence we submitted, two board members remained opposed to the wind generator, but had no legitimate basis for their opposition. After the final vote, we realized that these two board members knew one of the opposing neighbors personally. It was then clear that political outcomes are often based on who you know, and not the law. If it were not for a sympathetic building and planning office representative, our tenacity, and threats of a lawsuit if they had no legal basis for denying the permit, we would have lost.

The final vote was four in favor and three opposed. Our special-use permit to erect a wind generator barely passed. It had taken four months, hundreds of hours, and a few sleepless nights to get to this point. The ruling of the planning board consisted of a four-page document outlining exactly what we had to do to comply with their rules.

The final approval letter, copies of letters from concerned neighbors, supporting documents, and photographs are available on my Web site. My goal in placing the supporting data on the Web is to spare others the time and effort of locating facts about wind generator siting.

The wind generator has been operating for about eleven months now. I have not done sound measurements yet. In winds less than 27 mph (12 m/s), I cannot even hear the turbine at about 300 feet (91 m) from the tower. When standing closer than 300 feet, the only sound heard is a faint “whoa, whoa, whoa” that you must strain to hear.

The turbine noise does increase significantly in winds over 27 mph. This is when the turbine governs its speed by moving the blades partly out of the wind, which creates turbulence that can be heard. This increased sound output has not been a problem to date. In winds that strong, most people are not outside, and the batteries fill quickly. Once the batteries are full, I usually turn the wind generator off to decrease stress on the machine. Even in high winds, the turbine is quieter than nearby snowmobiles or lawnmowers.

I have called the town engineer three times to come out and measure the noise from the turbine. So far, no one has bothered to come. We have asked a number of neighbors if the wind turbine bothers them, and every one has said they do not mind it.

What Was All the Fuss About?
One neighbor asked why we did not tell people it was so quiet. We could only shake our heads in disbelief as we thought about the four months of planning board meetings. We have even had people come up our driveway and not notice the turbine spinning over the house. After three calls to the town without a response, we have stopped calling, and consider the wind generator a permanent part of our home.

Installing the wind genny was the easy part. Getting approval from the town planning board was the real challenge.

The final outcome was well worth the political and legal struggle. I just hope this article and my Web site provide others involved in similar struggles with the facts they need to quickly ease the concerns of neighbors.

Access
Douglas Stockman, MD, N2ZYE • dstockman@pol.net
www.windzone.mkeis.org

Need a High Efficiency Refrigerator for a Harsh Climate?
SUN FROST
P.O. Box 1101, Arcata, CA 95518-1101
Phone: 707-822-9095 • Fax: 707-822-6213 • www.sunfrost.com

BOOST YOUR SOLAR OUTPUT

With Patented SOLAR BOOST ™ MPPT Charge Controllers

- Our most popular SB50L and SB3048L controllers are now ETL listed to UL1741, and CSA/CE requirements

Solar Boost 50 Shown

- Featured in Home Power Magazine "Things That Work" issue #73 and #77.

- Stop throwing away that extra power and use a Solar Boost Maximum Power Point Tracking (MPPT) charge controller.

- Solar Boost charge controllers can deliver up to 30% more power to your batteries over conventional controllers.

Available in 12/24/48 volt.

RV Power Products– The recognized leader in quality MPPT charge controllers.

RV POWER PRODUCTS
PROVIDING ELECTRICAL INDEPENDENCE

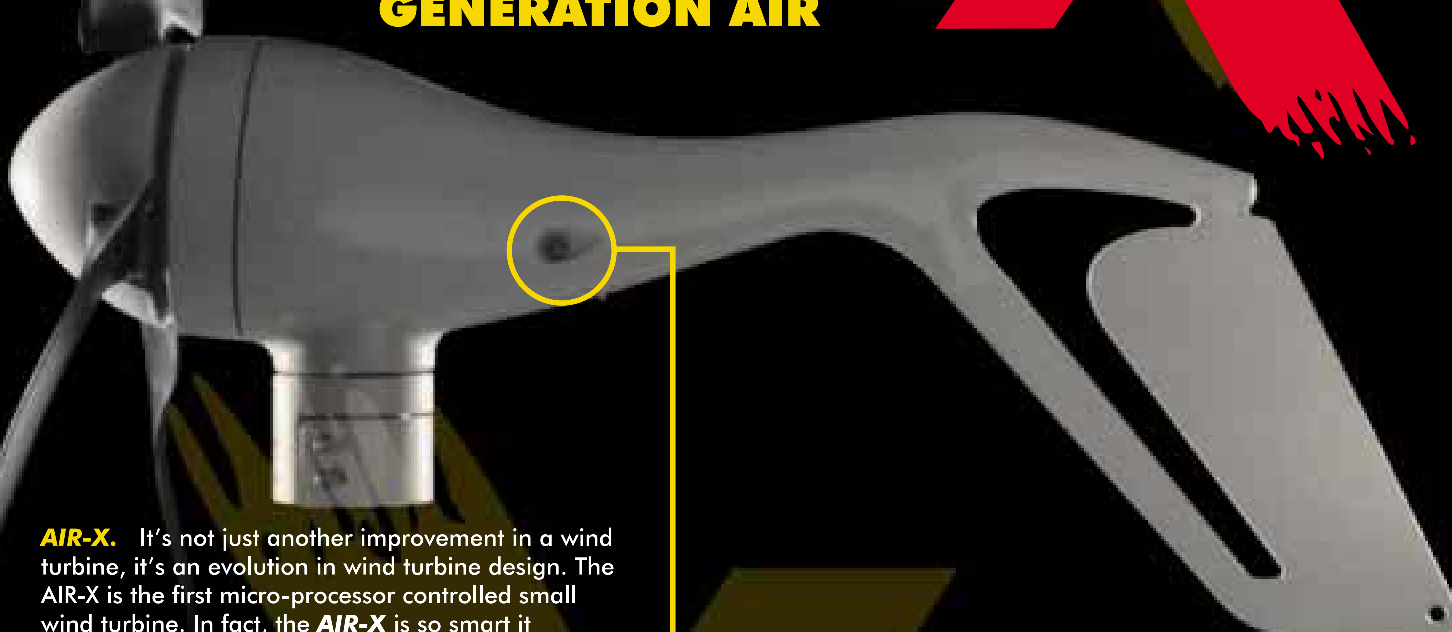
Manufactured by RV Power Products and offered by a large network of quality distributors and dealers. Call us today for information or a dealer near you

800-493-7877 or 760-944-8882
1058 Monterey Vista Way, Encinitas CA 92024

Visit our web site at www.rvpowerproducts.com or e-mail to info@rvpowerproducts.com

AIR-X

THE REVOLUTIONARY NEW GENERATION AIR



AIR-X. It's not just another improvement in a wind turbine, it's an evolution in wind turbine design. The AIR-X is the first micro-processor controlled small wind turbine. In fact, the ***AIR-X*** is so smart it continuously adjusts the alternator to maximize performance and minimize noise.

LOWER STARTUP: *AIR-X* incorporates "peak power tracking" which allows it to begin producing electricity at half the RPM of the AIR 403 meaning more energy for your batteries.

GREATER OUTPUT: *AIR-X's* controller delivers maximum power to the battery by continuously adjusting the alternator loading to maximize alternator and blade efficiency. This ensures the highest possible output at all wind speeds and at all states of battery charge.

SMART CHARGE: It's not just another charge controller. As the battery approaches charge state, the ***AIR-X's*** controller will momentarily stop charging to accurately sense battery voltage. Charging stops automatically when the batteries reach the set point.

QUIET OPERATION: No more flutter control in high winds. One of the most amazing features of the ***AIR–X*** is its ability to control RPM to prevent blade flutter in high winds. This feature allows the ***AIR-X*** to operate quietly in virtually all wind speeds.

AIR X

Southwest Windpower

Renewable Energy Made Simple

2131 N. First Street • Flagstaff, Arizona 86004 USA
Tel 520-779-9463 • Fax 520-779-1485
www.windenergy.com • E-mail info@windenergy.com

WORK FOR PEACE

Trials & Tribulations of Self-Generation

David Sweetman

©2001 David Sweetman

We recently retired to a remote location in Nevada to enjoy the later years of our life. It is 85 miles (140 km) to the nearest town and 230 miles (370 km) to any city. One of the reasons Donna and I chose this location was the availability of wind, sun, water, and land.

I was a reactor operator in the Navy (submarines), a commercial power plant operator (coal, gas, nuclear), and was eventually a vice president in Silicon Valley integrated circuit manufacturing companies, with an education in physics. I thought I had a reasonable background to easily start building my own electric generation capability.

My primary motivation in building this system was the satisfaction of generating my own energy. This article will recount some of the lessons I learned. Some of these were because I was much more ignorant than I originally thought. Others were because of some improvements that are needed in the renewable energy industry.

In general, I have found the equipment in this industry to be well made, and the technical support to be excellent. Unfortunately, the equipment documentation for installation, operation, and troubleshooting varies from poor to terrible. As a first-time installer, my expectations were that the documentation would allow me to easily and quickly install and troubleshoot equipment. This was not the case.

Fortunately, our local general contractor (and all-around good person to do nearly anything) is quite ingenious when putting things together. But often we had to discuss various alternatives in order to choose what was the most practical.

System Description

We purchased a seventeen-acre property with seven existing buildings on it, and built two more buildings at some distance apart. Since the existing buildings were wired for AC already, it made sense to continue using AC distribution and equipment. For ease of operation and due to availability, we planned only to install new items that are AC powered. We would need 240 VAC, 60 Hz inverters to power critical loads like water pumps, electronics, active solar heating, and elevator, which I need because of my disability. (I have muscular dystrophy, a genetic, degenerative neuromuscular disorder for which there is no treatment or cure. But I have not let that stop me.)

We are tied to the grid, but had been told there would be frequent and lengthy blackouts. This meant that the battery bank should be large. Since we had both wind and sun, we set up the system to use both. Combined rated output of the solar and wind electric systems is about 15 KW, but actual usable output is less.

We built our first garage for our existing vehicles and to contain a power room, sized for the initial system setup. The initial garage became too small for our needs, so we added another garage. We also found that we needed more energy.

We decided to add a second system in the second garage, because the line runs were shorter, which meant less trenching and power loss. We built power rooms in each garage to house the batteries, power panels, and breaker boxes. Both the power rooms are insulated and heated to help with the cold. The battery boxes are insulated enclosures inside each power room.

The local electrical cooperative did not understand why we wanted to generate our own electricity, given the 5.9 cents per KWH price of electricity then. But they worked with us anyway. They had no experience with home generation, but followed the Public Utility Regulatory Policies Act (PURPA) and other regulations.

Nevada passed net metering legislation in 1997. But we could not convince the utility to use our original bidirectional meter. We had to purchase a two-channel meter that tracks both grid and RE generated electricity separately. The meter has proven very useful to us to track our energy usage. But the cooperative now wishes that they had stuck with the original meter, because of the additional paperwork to record and bill for both buy and sell.

Wind & Sun

The first system combines PVs with a World Power H4500 wind generator. The turbine has a rotor diameter of 15 feet (4.6 m) and was rated at 4,500 W at 25 mph (11 m/s). In a 10 mph (4.5 m/s) average wind regime, it should produce about 325 KWH per month. This turbine is no longer manufactured. The wind generator's output is 240 volt, 3-phase variable frequency that is transformed and rectified to 48 VDC using a Whisper EZ-Wire Center.

Thirty-two Kyocera 120 watt solar-electric panels complement the wind generator's energy production. PV output is regulated by two Trace C40 charge controllers. We opted for a Trace Power Panel

After some initial difficulties, the modified World Power Whisper H4500 is a viable addition to the system.

containing two SW4048 inverters, two C40 charge controllers, and all DC breakers for overcurrent protection. The panel is prewired, which made installation simple. This system has a 48 VDC input. The two inverters are wired in series to produce 60 Hz, 120/240 VAC output.

The battery bank is made up of eight Concorde Sun XTender PVX-12105, 12 VDC batteries (210 AH total at 48 VDC). The batteries are wired in two series strings of four batteries each. The two series strings are then wired in parallel.

The second system is similar, except that the wind generator has been replaced with 32 additional Kyocera 120 watt solar-electric panels. This system uses Wattsun dual-axis PV trackers instead of fixed mounts, and one series string of batteries.

Thirty-two of the ninety-six PV panels are on stationary mounts.

Wind Generator Issues

Since we are in a windy area (class 5 or 6 on the map), a wind generator makes good sense. Traditional water-pumping windmills are still present in the valley. We purchased a World Power H4500 wind generator with a 70 foot (21 m) tower kit. The first problem was figuring out how to install the tower in our sandy soil.

Fortunately, a retired civil engineer lived nearby. He suggested that the guy wires should be attached to steel rods embedded in concrete. He specified a pyramid (tetrahedron) 6 feet by 6 feet (1.8 x 1.8 m) on bottom, 3 feet by 3 feet (0.9 x 0.9 m) at the top, and about 6 feet (1.8 m) deep. Each pyramid contains more than 5 cubic yards (3.8 m^3) of concrete for the four, guy wire pedestals and the center support pedestal.

The Whisper H4500 manual gave no instruction about the tower other than to consult a civil engineer. The manual should have contained more general information on approximately what support system is required for various tower heights and soil conditions. Why is this important? Putting the concrete in and getting the schedule 40 pipe cost nearly the same as the wind generator.

Using the tables from the *National Electric Code (NEC),* we calculated that #12 (3.3 mm^2) wire was required to run the 300 feet (91 m) from the wind generator to the power room. This seemed undersized to me, so I used #6 (13.3 mm^3) wire, just to be safe. Given the complexity of the *NEC* tables, the installation manual should have included a table for the specific wind generator, by power output, voltage, and amps per phase, listing what gauge wire should be used for the length of the run from the wind generator.

Various tests must be performed before installing the wind generator. These tests even had to be repeated after getting repairs on the generator at the factory. As noted previously, the H4500 had many design and material problems, and we experienced them all. World Power (later bought by Southwest Windpower) has been most cooperative in the repairs. After repairs, the wind generator is essentially derated to a 3000 watt wind machine (plus a little).

Photovoltaic Issues

Photovoltaic panels are much easier to install than a wind generator, although the cost per watt is still higher. The construction cost for schedule 40 pipe, concrete, etc. is still significant for a PV mount. Trackers can be a worthwhile investment, because over time, the increased output can more than recover the initial cost of the tracker.

Sandy soil necessitated large concrete footings for the 70 foot tall tilt-up tower.

The Whisper EZ-Wire Center, step-down transformer, and diversion load heater box in the power room.

Sweetman Load Estimates

Year Round Loads

Load	Watts	Hours/Week	KWH/Week
Pool cleaning & circulation	2,000	35	70
Electric gate	2,000	10	20
Vehicle battery chargers	100	150	15
Entertainment (TV, stereo, radio)	500	20	10
Battery chargers (tools, shavers, etc.)	200	50	10
Computers	400	20	8
Communications (phones)	100	10	1
		Total Year Round	134
Summer Loads			
Well pumps (home & irrigation)	3,000	56	168
Cooling (fans, coolers)	3,000	49	147
Lights (mostly fluorescent)	1,000	100	100
Utility cart chargers	1,000	42	42
Power tools	2,000	20	40
Solar heating pumps	300	63	19
Elevator	1,500	10	15
Cooking (microwave, oven, cooktop)	1,500	10	15
Appliances (freezers, refrigerators, etc.)	1,000	10	10
Washing (washer, dryer, dishwasher)	1,000	10	10
		Total Summer Loads	566
		Total Summer Plus Year Round	700
Winter Loads			
Heating (fans, heat pump)	4,000	50	200
Lights (mostly fluorescent)	1,000	150	150
Well pumps (home & irrigation)	3,000	14	42
Cooking (microwave, oven, cooktop)	1,500	20	30
Solar heating pumps	500	42	21
Elevator	1,500	10	15
Power tools	2,000	5	10
Appliances (freezers, refrigerators, etc.)	1,000	5	5
Utility cart chargers	1,000	5	5
Washing (washer, dryer, dishwasher)	1,000	5	5
		Total Winter Loads	483
		Total Winter Plus Year Round	617

We used #1 (42 mm^2) copper wire to carry the approximately 30 amps per subarray of sixteen panels the 200 feet (61 m) to the power room. It would have greatly simplified the installation to have a chart in the documentation for wire sizing for the distance, voltage, and amps.

The combiner boxes had to be put together, but there were minimal instructions and recommendations for materials or components. Using the correct size of components for voltage and current requires numerous calculations and comparisons of specifications. There is also the difficulty of getting all the components to mechanically fit together.

Battery Issues

The batteries were the most frustrating and expensive component to work with. My first error was miscalculating the total battery backup that would be required. I seriously overestimated the amount. The reality is that the local grid is rarely down, and then only for short periods of time.

I originally used eight, large, 425 amp-hour, 465 pound (210 kg), lead-acid batteries in two, 48 volt banks. We eventually found out that these required frequent (quarterly or more) addition of distilled water and regular equalization. Since we were away from home a lot, we did not meet the necessary battery watering schedule. After a little over three years of operation, the batteries died and had to be replaced.

We now use maintenance free batteries. I also contacted the battery manufacturer to get detailed instructions on operation and maintenance. Using the correct bulk and float voltage set points is critical for long battery life.

Power Panel Issues

The Trace Power Panel consists of two SW4048 inverters and two C40 charge controllers. Also included is an inverter bypass switch and an enclosure with all the necessary DC overcurrent protection. The inverters and charge controllers come with separate operation manuals. However, the systems interact. Float voltage must be set for each, but there were no clear instructions about that.

These settings must also be compensated for the voltage bias between the two pieces of equipment. The SW series inverters' bulk and float battery charge set points are programmed using the inverter's LCD display. The C40 charge controllers use potentiometers to set these parameters. Since it's a little hard to tell exactly where the potentiometers are set, a digital voltmeter

Power panel #1 for 64 PV panels.

Power panel #2 for 32 PV panels and the wind generator.

should be used to double-check the set points. This way the inverters and charge controllers are regulating based on identical set points.

The inverters offer great flexibility in how they may be used, but examples of typical setups in the manual would greatly help. The manual contains virtually no troubleshooting instructions or test modes to verify correct operation.

Two additional C40 charge controllers were added to match the output current of the photovoltaic panels. Actually that is more controller capacity than is required. Two 60 amp controllers would have probably worked, but adding two more C40s was easier. In any case, the power panel should have had all components matched in capacity or clearly identified otherwise.

Tracker Issues

Although mechanical assembly of the panels and racks was relatively simple, putting the combiner boxes together required a great deal of figuring out. Also, the trackers require extensive grounding to work reliably. With our initial setup using "standard" grounding, some trackers would occasionally not track (especially with some clouds), or would not reset to the correct position.

The tracker manufacturer explained that we needed to add additional grounds (rods sunk into the earth and tying connected metal structures together with additional ground wires). Once this was done, the problems disappeared.

Lessons Learned

My expectations for the adequacy of documentation were not met. I had to rely on significant verbal communication with the manufacturers. In general, the installation and operation manuals were incomplete. At worst they were inaccurate and inconsistent. The manuals appear to be more a reference for experienced installers rather than what is needed for the first or only time installer.

All the manufacturers have excellent phone or e-mail technical support. But you must plan on several calls. I suggest that you keep a log of all calls and adjustments for review and clarification. Get the name of the technical support person and try to talk to that person each time, even for a new problem.

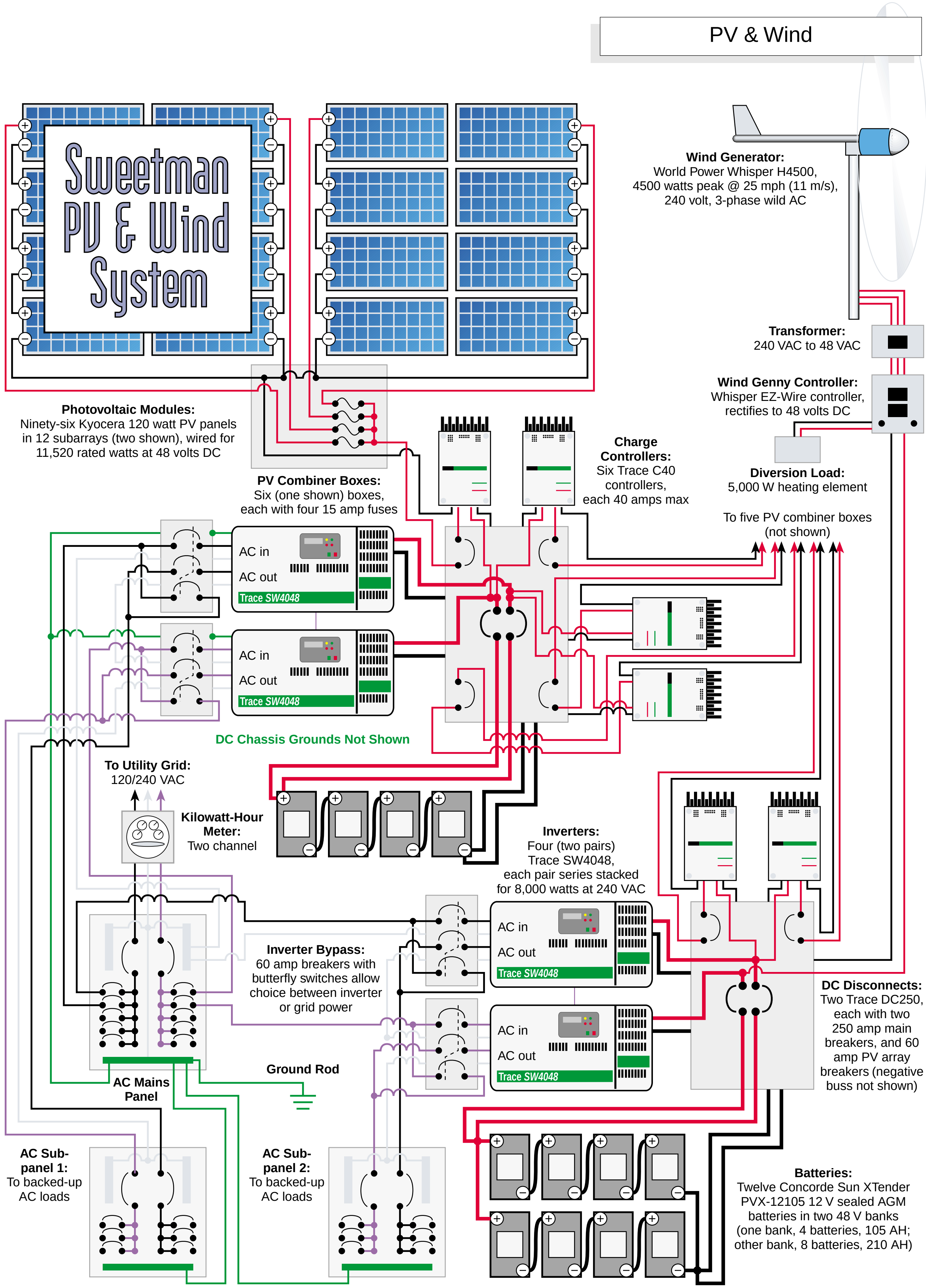
Little or no written information is readily available about how the various pieces of equipment can or should interface. So you must carefully think through how the complete system should operate and determine what interfaces are needed. Most interfaces are hardware—wire, breakers, nuts, and bolts. But others are software items—voltage and current settings.

Many of the manufacturers have recommendations on what should be used and at what values, which are only available if you call or e-mail. A system troubleshooting manual, including a flow chart, instruments required, and tools required would be a significant improvement.

Have plenty of the correct tools and troubleshooting instruments available. Minimum test instrumentation consists of a digital AC/DC multimeter capable of testing voltage, amperage (a clamp meter is handy), and frequency. The multimeter should be equipped with

Generation Capability

Summer			
Source	*Watts*	*Hours/Week*	*KWH/Week*
Photovoltaic	9,000	63	567
Wind generator	3,000	56	168
		Total Summer Generation	735
		Percent of Summer Requirements	105%
Winter			
Photovoltaic	9,000	42	378
Wind generator	3,000	63	189
		Total Winter Generation	567
		Percent of Winter Requirements	92%


Sweetman PV & Wind System
Wind Generator:
World Power Whisper H4500,
4500 watts peak @ 25 mph (11 m/s),
240 volt, 3-phase wild AC
Transformer:
240 VAC to 48 VAC
Wind Genny Controller:
Whisper EZ-Wire controller,
rectifies to 48 volts DC
Photovoltaic Modules:
Ninety-six Kyocera 120 watt PV panels
in 12 subarrays (two shown), wired for
11,520 rated watts at 48 volts DC
PV Combiner Boxes:
Six (one shown) boxes,
each with four 15 amp fuses
Charge Controllers:
Six Trace C40 controllers,
each 40 amps max
Diversion Load:
5,000 W heating element
To five PV combiner boxes
(not shown)
AC in
AC out
Trace SW4048
AC in
AC out
Trace SW4048
DC Chassis Grounds Not Shown
To Utility Grid:
120/240 VAC
Kilowatt-Hour Meter:
Two channel
Inverters:
Four (two pairs)
Trace SW4048,
each pair series stacked
for 8,000 watts at 240 VAC
Inverter Bypass:
60 amp breakers with
butterfly switches allow
choice between inverter
or grid power
AC in
AC out
Trace SW4048
AC in
AC out
Trace SW4048
DC Disconnects:
Two Trace DC250,
each with two
250 amp main
breakers, and 60
amp PV array
breakers (negative
buss not shown)
AC Mains Panel
Ground Rod
AC Sub-panel 1:
To backed-up
AC loads
AC Sub-panel 2:
To backed-up
AC loads
Batteries:
Twelve Concorde Sun XTender
PVX-12105 12 V sealed AGM
batteries in two 48 V banks
(one bank, 4 batteries, 105 AH;
other bank, 8 batteries, 210 AH)

Sweetman Estimated Costs

Item	*Cost (US$)*
64 Kyocera PV modules & 8 Wattsun dual-axis trackers	$50,000
32 Kyocera PV modules & 4 fixed mounts	20,000
2 Trace Power Panels, with 4 inverters & 6 charge controllers	16,000
Wind generator tower pipe, tube, concrete, labor	8,000
World Power H4500 wind genny, tower kit, transformer, rectifier	7,500
PV array installation; pipe, concrete, labor	5,000
Wiring in conduit and trenching between facilities	5,000
Power rooms construction and materials	2,500
12 Concorde Sun XTender batteries	1,000
Total	$115,000

both test probes and alligator clips. A battery load tester may be useful. A good set of tools for connecting (and taking apart and reconnecting) the equipment is necessary. This should include a variety of screwdrivers, wrenches, socket sets, pliers, wire crimper/stripper, and Allen wrenches. Heavy lifting equipment is required for installation.

My load calculations for system sizing were not exact. I underestimated the load by not recognizing how much energy irrigation would use. Actual output of the system is only about 70 percent of rating. I had thought this would be closer to 90 percent, but module temperature, line loss, conversion inefficiencies, and availability of sun and wind reduce how much energy is actually produced. The system was designed for modular expansion, which has greatly facilitated the addition of more PV modules.

Whining, or Constructive Criticism?

As a former vice president of quality and reliability, I believe the quality management practices of the renewable energy manufacturers are inadequate. A start, at least for the smaller companies, would be to comply with ISO-9001 quality management standards. All companies need to perform a quality review of their documentation to improve usability, consistency, adequacy, and accuracy.

I am very satisfied with my system, which is now finally working as expected. My frustration was with the time necessary to get all items working together and working correctly. My primary complaint is the inadequacy of the manufacturer's documentation for the first-time installer.

I came from an industry where if I had one 35 cent part in a million fail, I had to travel to explain to the customer what we (as the manufacturer) and he (as the user) were going to do to prevent a reoccurrence of the failure. I also was expected to provide detailed application information on how to use (and not use) the part for a wide number of functions.

I had to make sure the company I worked for took all reasonable actions to prevent any problems, either in the device or the application of the device. I do not see anything like this in the RE industry. This is a failure of management, both in setting corporate direction, and in having or using quality management practices.

I would like to see this industry grow rapidly. For this to happen in a way that builds confidence in the equipment and industry, companies will have to implement some quality systems to prevent the sort of frustrations and irritations that I had.

The hardware is good, and the verbal technical support is good. But the documentation for installation, operation, and troubleshooting ranges from poor to nonexistent. I hope RE companies can improve customer satisfaction by having more user friendly products and documentation. Then even people like me will be able to get a system to work easily and quickly.

Access

David Sweetman, PO Box 189, Dyer, NV 89010
775-572-3359 • d-dsweetman@att.net

Gary Fedor, GFC Sales, HC-72, Box 03515, Billy Wright Rd., Dyer, NV 89010 • 775-572-3231
Fax: 775-572-3343 • g.fedor@att.net • Installer

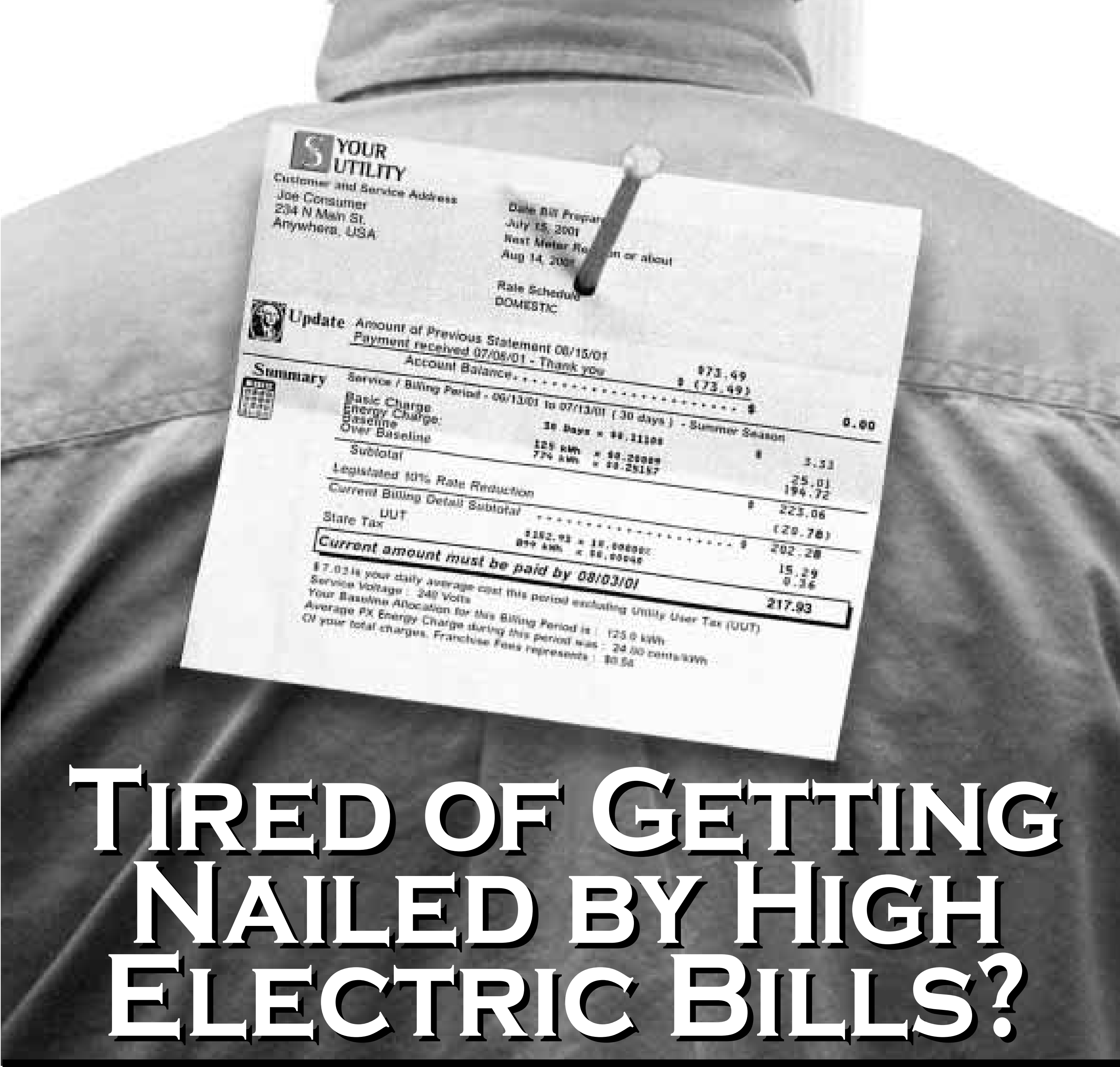
Southwest Windpower, 2131 N. First St., Flagstaff, AZ 86004 • 800-946-3313 or 520-779-9463 • Fax: 520-779-1485 • info@windenergy.com • www.windenergy.com
Whisper 4500 wind generator

Xantrex Technology Inc., Distributed Residential and Commercial Markets, 5916 195th St. NE, Arlington, WA 98223 • 360-435-8826 • Fax: 360-435-2229
inverters@traceengineering.com • www.Xantrex.com
Trace Power Panel

Kyocera Solar, Inc., 7812 East Acoma Dr., Scottsdale, AZ 85260 • 800-544-6466 or 480-948-8003
Fax: 480-483-6431 • info@kyocerasolar.com
www.kyocerasolar.com • PV modules

Array Technolgies, Inc., 3312 Stanford NE, Albuquerque, NM 87107 • 505-881-7567
Fax: 505-881-7572 • sales@wattsun.com
www.wattsun.com • Wattsun PV tracker

Concorde Battery Corporation, 2009 San Bernardino Rd., West Covina, CA 91790 • 800-757-0303 or 626-813-1234 • Fax: 626-813-1235 • conbat@earthlink.net
www.concordebattery.com



TIRED OF GETTING NAILED BY HIGH ELECTRIC BILLS?

Some utilities have increased their rates by almost 50%.
Do something about it!

Call to have a Siemens Solar earthsafe™ solar electric system installed on your home!
Generate your own electricity powered by the sun!

We'll hook you up to the sun!

Call Siemens Solar toll free (877) 777-8466 for a free brochure, "Solar Made Simple".
Or, visit our website at www.SiemensSolar.com for a free solar information kit.

esp earthsafe earthsafe solutions provider

Siemens Solar
Camarillo, CA

Dealer Inquiries Welcome

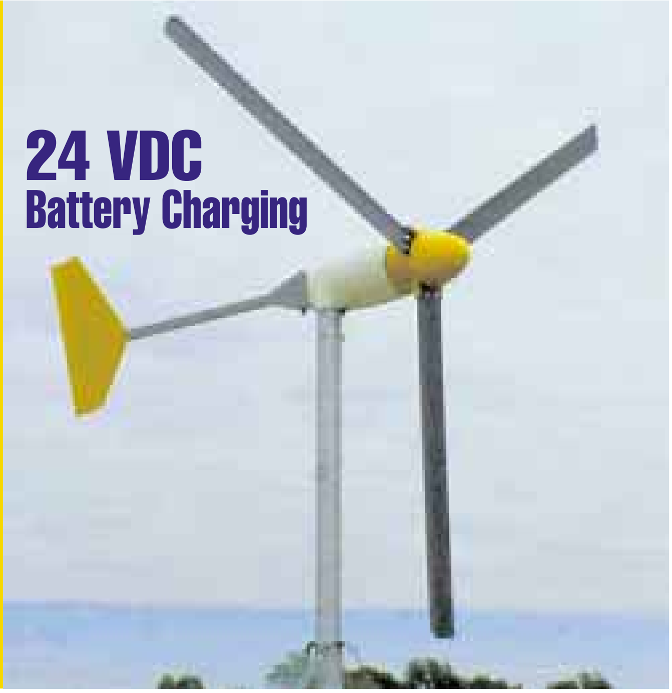
BERGEY XL.1

1000 Watt Home Wind Turbine

Features

- 5-Year Warranty (Industry's Longest)
- Maintenance Free Design
- Excellent Low Wind Performance
- Nearly Silent Operation
- Three High-Strength **PowerFlex** Fiberglass Blades, SH 3045 Airfoil*
- Neodymium Super-Magnet Alternator
- **AutoFurl** "No Worry" Storm Protection
- Fail-Safe Design, No Dump Load Required for Structural Safety
- **PowerCenter** Multi-function Controller
- **OptiCharge** Regulation for Extended Battery Life
- Easy Installation with BWC Tilt-up Towers

*Patent Pending



The all new Bergey XL.1 is the most technically advanced small wind turbine ever. It combines excellent low wind performance and the legendary Bergey ruggedness, at costs well below the lightweights. It comes from the world's leading supplier of small wind turbines and is backed by the longest warranty in the business. The XL.1 delivers on value.

Compare features, performance, price, reputation, and warranties. The new Bergey XL.1 is the clear choice for your home energy system.

$1,695

BERGEY DIRECT

WWW.BERGEY.COM

Or, Call Toll Free:
1-866-BERGEYS

Complete AC "Plug & Play" Systems from $2,995

PowerCenter Controller
- 60A Wind Regulator
- 30A Solar Regulator
- 30A Optional Dump Load
- 24 VDC DC Bus
- Battery Status LEDs

Typical Performance: 5.2 kWh DC per day

4 Times More Energy Than the Air 403[1] **1.8 Times More Energy Than the Whisper H40[2]**

1–Air is a registered trademark of Southwest Windpower, Inc.
2–Whisper is a registered trademark of Southwest Windpower, Inc.

11.2 mph (5 m/s) Average Wind Speed at Hub Height, Rayliegh Distribution.
Based on manufacturer's published power curves.

BERGEY WINDPOWER



SIMPLICITY•RELIABILITY•PERFORMANCE

2001 Priestley Ave.
Norman, OK 73069
T: 405–364–4212
F: 405–364–2078
sales@bergey.com
www.bergey.com

© 1999 Bergey Windpower

Put away THOSE TOOLS....
we
have a
simple
solution to
a complex
problem!
Solar Solutions 101
Introducing . . . .
THE POWER PARTNER SYSTEM
Simplicity at its best!
XANTREX
VANNER
• Now shipping ETL listed systems and components
• Pre-assembled, Pre-programmed, Pre-tested
• Available for most models of Trace and Vanner Inverters
ENERGY OUTFITTERS
authorized
Out Back Power Systems Integrator
Energy Outfitters, Ltd.
P.O. Box 1888 - 136S Redwood Hwy.
Cave Junction, OR 97523
541-592-6903
800-GO-SOLAR
(800-467-6527)
www.energyoutftters.com
email sales@energyoutfitters.com

Portable Solar-Electric Generator

Tom Muckey

©2001 Tom Muckey

Tom Muckey's homemade, solar-electric generator on wheels solved his outbuilding's power problem.

Last year, I built a shed in my backyard for use as a small workshop and for lawn equipment storage. The shed is about 30 feet (9 m) from the house. After completing the project, I realized that I would need to supply 120 volts AC to the structure.

I ruled out the possibility of running an outdoor extension cord from the house because my dog tends to chew on everything, whether it moves or not. Installing a dedicated power line for the shed would require a permit and electrician, not to mention the impact on my electricity bill. Since I've always had an interest in renewable energy, I decided to develop a solar solution instead.

Permanent Installation or Portable?

I determined that the electrical usage in the 10 by 14 foot (3 x 4.3 m) shed would be limited to lighting and small power tools, usually on weekends. A single 40 watt panel and a 12 volt battery would provide adequate energy for my needs. I could have easily mounted a solar-electric panel on the shed's roof with all the other components inside. Instead, I chose to make a self-contained, portable, PV powered generator, since the system requires only a few components.

The back side of the modified hand truck. Note the seasonal tilt indicators marked with yellow, green and blue.

In addition to the shed's electrical requirements, my portable system supplies electricity for many situations, including camping, boating, jump-starting a car, and the occasional California blackout.

Requirements

I came up with the following basic requirements for the portable, PV powered generator:

- Fully self-contained 12 volt output
- Easy to transport and store
- Adjustable for optimum solar panel angle
- Relatively waterproof (and dogproof)
- Modular (removable battery case)
- Battery status and module output monitoring
- Low cost

Components

I selected a Photowatt PWX400 solar panel for its good combination of durability, performance, and price. The PWX400 has a very rigid aluminum frame with tempered glass for strength. In addition, the dimensions were acceptable for a portable system. Several other panels I considered were simply too large for this application.

A close-up of the PV charge controller.

The 40 watt panel could be connected directly to the battery, but this would risk overcharging. To eliminate this risk, I chose to install a Lyncom SR7C charge controller. The controller has LED indicators for charging and low battery condition. Both the Lyncom charge controller and solar panel came from Solatron Technologies in Bloomington, California.

An Attwood battery case accommodates a Kirkland 27 series, 115 amp-hour marine (trolling) battery that was purchased from Costco. The Attwood battery case is a plastic enclosure primarily designed for marine batteries. Inside dimensions are 14 by 7-1/2 inches (36 x 19 cm).

I had difficultly finding a weather-resistant voltmeter, and ultimately purchased a Goldeneye battery gauge that is designed for boating use. A Casco 12 volt truck bed outlet and fuse assembly came from Kragen Auto.

The front of the weather-resistant battery case, showing from left to right: 12 volt outlet, test switch, and battery meter.

Inside the battery case, everything stays dry and in place.

I selected a Costco 500 pound (225 kg) capacity hand truck to serve as the base platform to support the components and provide mobility.

Mounting the Solar Panel

Converting the hand truck required some custom metalwork. I have amateur arc welding experience from classic car restoration projects, and I enjoy the challenge of joining metals without having to make too many trips to the hospital. I created four, 18 inch (46 cm) support brackets for the solar-electric panel. The top and bottom brackets were made from 1 by 1-1/2 by 1/8 inch (25 x 38 x 3 mm) angle iron, and the two center supports were flat 2 by 1/8 inch (51 x 3 mm) stock purchased from a local home improvement center.

I used a circular saw with a metal cutting abrasive blade to cut all of the metal used in the project. I drilled the brackets to match the mounting holes in the Photowatt panel, and bolted all four brackets to the panel before welding. I then positioned the panel on the hand truck, clamped down the brackets, and welded them with the panel removed. Everything lined up nicely during reassembly.

Maintaining the Correct Solar Angle

According to *The Solar Electric Independent Home Book,* a solar-electric panel in Southern California will receive maximum exposure to the sun with the following (southern) angles:

- Summer: 18 degrees
- Spring and fall: 33 degrees
- Winter: 48 degrees

To maintain the correct solar angle and allow for seasonal adjustments, I created an adjustable leg from square tubing and attached it to the back of the unit. The leg simply props up the unit and adjusts to any angle required with a locking pin. It swings into the back of the unit for transport. I labeled the predrilled holes for each angle needed for my seasonal adjustments. It's simple, but it works.

Assembling the Battery Case

The vented battery case, with a separate lid and base, was designed for boating applications. It required several modifications for the project. For starters, I permanently attached the lid to the base with hinges in the back. I then installed a Goldeneye battery gauge and a SPDT, on-off-on toggle switch to test battery state of charge and PV output. I drilled additional vent holes in the battery case lid to ensure that gases would not build up during charging.

Finally, I installed a Casco 12 volt outlet (cigarette lighter type) and automotive trailer connector for easy removal of the entire case assembly from the PV powered generator. According to the manufacturers, all of these components were designed to be weather resistant, and they have held up well being outdoors for the last six months.

The Battery Cradle

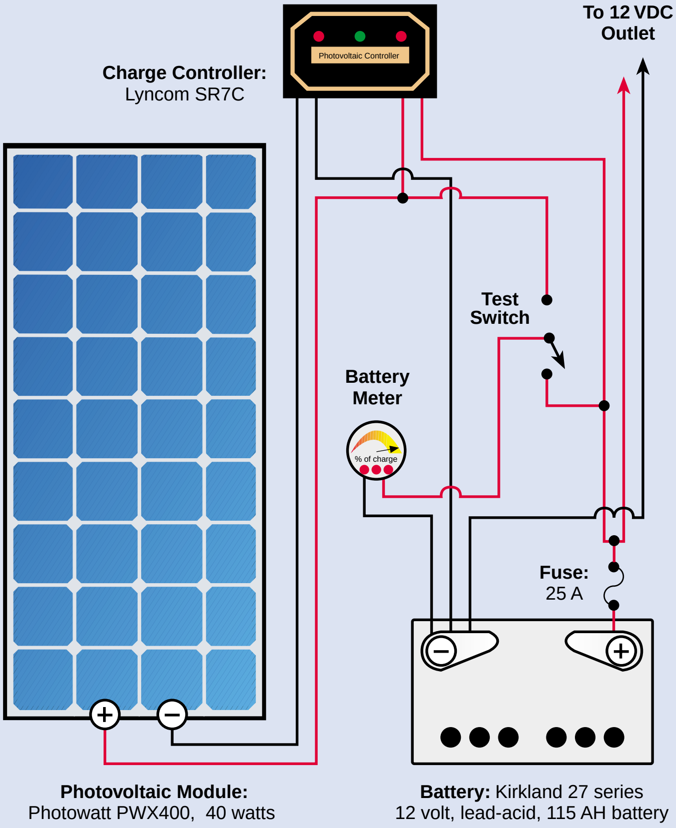
Since the entire unit is capable of tilting 0 to 90 degrees, a flooded battery would leak if mounted directly to the hand truck's original flat base plate. A design feature was needed to maintain the battery in a level position regardless of solar panel angle. I felt a cradle could provide this auto-leveling capability, and also allow for easy removal of the battery assembly as needed.

I converted the hand truck's base plate into the cradle arms, and welded several pieces of angle iron to match the battery case dimensions for the cradle base. Gravity

This homemade battery cradle keeps the flooded lead-acid battery level so electrolyte doesn't spill.

Tom Muckey's Portable Solar-Electric Generator

Tom's dog making friends with the RE generator.



keeps the battery assembly level during transport or adjustment of the panel's angle. In addition, the battery case disconnects and lifts out of the cradle quicker than the dog can run off with my favorite sneakers.

Electrical & Performance

The unit handles intermittent electricity needs without a problem. I regularly measure the battery state of charge (SOC) via the built-in gauge. The battery never falls below 60 percent SOC, and is usually around 95 percent.

To get electricity inside the shed, I converted an outdoor AC extension cord to 12 volts by replacing the end connectors with fused male and female cigarette lighter adapter plugs. I have a Statpower 300 watt inverter for the AC loads inside. In addition to electricity for the shed, I've used the PV powered generator during a blackout at my home and to jump a dead car battery.

During a blackout, the generator remains on a patio in the backyard. I simply plug the Statpower 300 inverter into the 12 VDC outlet and run a 50 foot (15 m) outdoor extension cord into the house to provide electricity to my kitchen and living room. I run two fluorescent bulbs (15 watts each) and a small TV (55 watts). This summer, I'm pretty sure that I can get my kids to go camping if we can power a laptop to play their favorite video games.

The rated output of the PWX400 module is 42 watts at 25°C (77°F). But in a warm region like Southern California, PVs typically operate at twice that temperature or higher. And PV voltage drops as temperature increases.

To better reflect real world operating temperatures at my location, PV output needs to be derated by 20 percent to reflect a realistic annual energy output. This brings the real world rating of my unit to approximately 34 watts (42 W x 0.8 = 33.6 W). Multiply this by yearly average peak sun hours per day in Southern California of 6.6 and you get 222 watt-hours per day.

Always Room for Improvement

My design certainly has room for improvement, particularly in reducing size and weight. The metal frame assembly (without PV or battery) weighs 46 pounds (21 kg). I am now working on a redesign that reduces frame weight to 26 pounds (12 kg) and requires no welding.

Instead of a battery cradle, the frame will pivot on hinges and maintain solar panel angle with an adjustable strut attached to the axle in the back. I used aluminum for the support braces and U-bolts for attachment to the frame. Perhaps a method for monitoring the load could be integrated into the unit.

Under certain conditions, the battery box casts a small shadow on the bottom of the panel. It could be fixed with some adjustment to the cradle mount design. The second generation of my solar-electric generator does not have this problem, since the battery assembly remains in a fixed position.

Portable Solar Power

In the shed, I regularly operate a fluorescent shop lamp (40 watts), a Sony CD stereo system (20 watts), and a

Muckey Solar-Electric Generator Parts List

Item	*Cost (US$)*
Photowatt PWX400 PV panel	$160
Kirkland 27 series battery,115 AH	48
Statpower 300 watt inverter	40
Hand truck, 500 pound capacity	32
Metal pieces, misc.	30
Lyncom charge controller	30
Goldeneye battery gauge	25
Casco 12 V outlet	15
Fuse, switch, misc. electrical	10
Attwood battery case	7
Total	$397

soldering gun (10 watts). During a weekend, I typically run the lighting and stereo for six hours each day along with intermittent use of the soldering gun.

I occasionally bring out a small TV (55 watts) to watch a game while I work. Most of my 110 volt AC power tools exceed the output capabilities of the Statpower 300. However, I have charged cordless batteries for lawn equipment as needed.

Overall, this project was fun, and I learned a lot about generating solar energy on a small scale. I gained a wealth of knowledge for the project from several *Home Power* magazine articles and advertisers. *Home Power* is a great resource for projects of this nature. I'm using information from recent editions in preparation for a couple of other renewable energy projects.

By the way, my dog seems to have developed a good relationship with the PV powered generator—she actually chases birds away from it!

Access

Tom Muckey, 1508 S. Jenifer Ave., Glendora, CA 91740
626-335-4026 • tmuckey@yahoo.com

Solatron Technologies Inc., aka Solar On Sale, 19059 Valley Blvd., Suite 219, Bloomington, CA 92316
877-744-3325 or 909-877-8981 • Fax: 909-877-8982
sales@solaronsale.com • www.solaronsale.com
PV and controller

The Solar Electric Independent Home Book, 1998, US$19.95 postpaid from New England Solar Electric, Inc., 401 Huntington Rd., Worthington, MA 01098
800-914-4131 or 413-238-5974 • Fax: 413-238-0203
nesolar@newenglandsolar.com
www.newenglandsolar.com

Matrix Solar Technologies, Inc., 7500 Meridian Place NW, Albuquerque, NM, 87121 • 505-833-0100
Fax: 505-833-0400 • www.matrixsolar.com
Product information

Exclusive Authorized Dealership Program

It's business…but not as usual.

Advanced Energy Group

There's no other dealership program like it.

Full Industry Product Line – Comprehensive Expert Training

Unparalleled Technical Support – Territorial Sales Protection

Optional Commercial Web Site Package

Solar4Power.com

For more information please go to our web site.

A cash investment is required. Serious inquiries only.

virtually silent

NREL's Wind Turbine Generator System Acoustic Noise Test Report for the Whisper H40 Wind Turbine indicated the difference between the turbine and background noise was between 3 and 7 dBA a difference imperceptible to the human ear

WHISPER H40

CE

MADE IN USA
up to 900 watts for only $1495 msrp

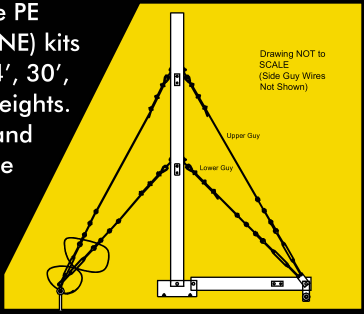
quiet easy

Certified Whisper Quiet

"The quietest turbine ever tested here" reports the NREL (National Renewable Energy Laboratory). Their acoustic test reports the sound of the Whisper H40 never exceeds background noise by 7 dBA making the H40 virtually silent. To see for yourself, download the full report at windenergy.com/SUPPORT/downloads.html

Easy to install...

...and now we have made it even easier with the revolutionary Whisper Tower Kits. Complete installation is possible in just a few hours. Kits include all hardware and easy to follow instructions. These PE Certified (in CA & NE) kits are available in 24', 30', 50', 65' and 80' heights. Visit our web site and download complete manuals at windenergy.com



Southwest Windpower
Renewable Energy Made Simple

2131 N. First Street • Flagstaff, Arizona 86004 USA
Tel 520-779-9463 • Fax 520-779-1485
www.windenergy.com • E-mail info@windenergy.com

AIR 403
400 watt rating
Over 40,000 sold
Meets IEC, NREL tested
CE

Windseeker
500 watt rating
NEW composite blades
Patented wind protection

Whisper Nautica
NEW for coastal sites
CE

Whisper H80
Perfect for low wind areas
CE

Whisper H80 WP
Low cost 3-phase AC water pumper uses conventional pump technology

Whisper 175
Over 3000 watts of power

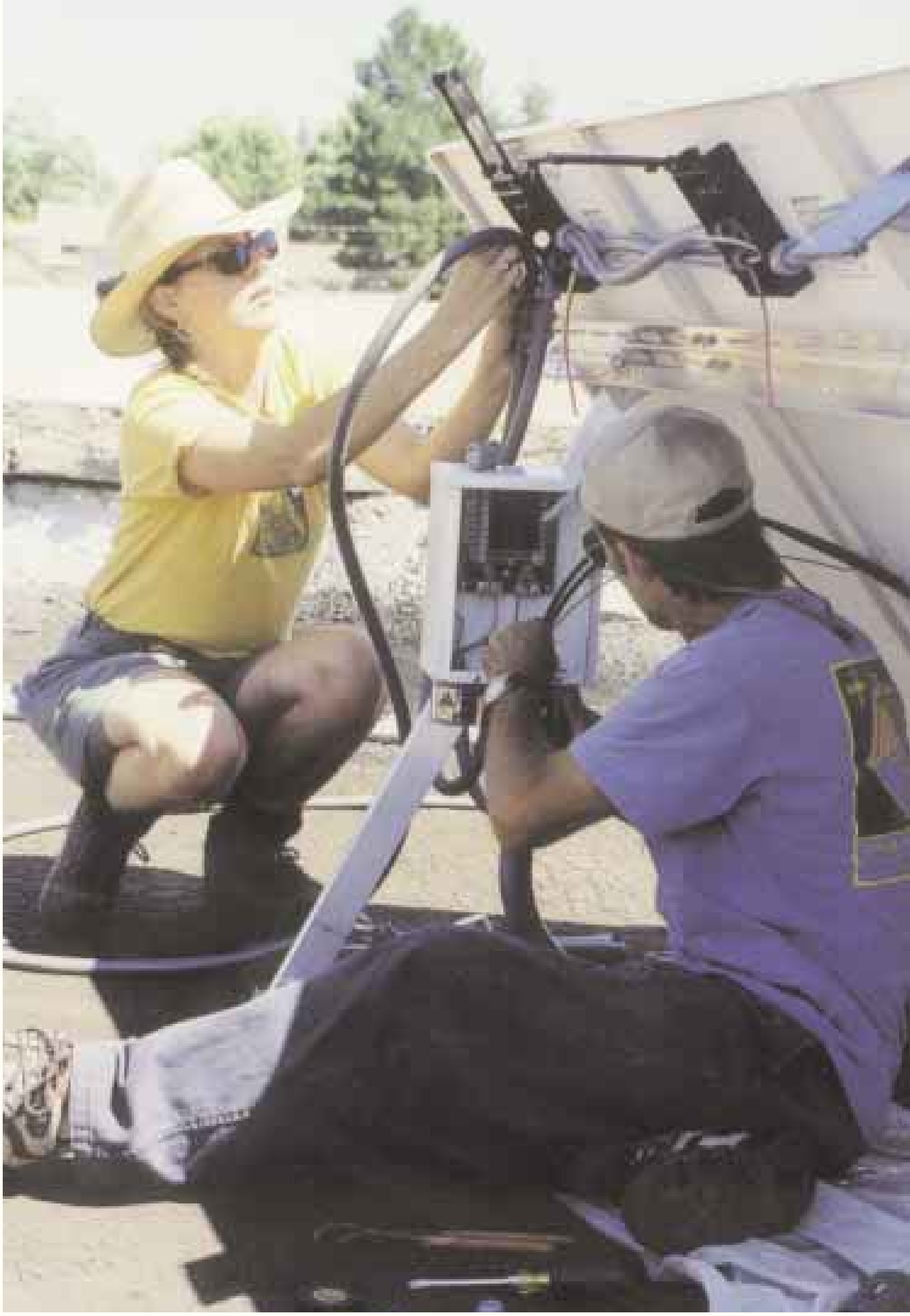
SUN ELECTRONICS
511 N.E. 15th Street, Miami, FL 33132
Fax: (305) 371-2353
Tel.: (305) 536-9917
Trace, Heart, Statpower Inverters.
Photovoltaic Modules (Solar Electric Panels):
Siemens, Kyocera, Photowatt, B.P. Solarex.
When the power goes down, the Sun comes up!
Industrial Deep Cycle Stationary Batteries, Sealed, Lead Acid.
Trojan, U.S. Battery, Rolls, Lifeline.
Southwest Wind Power, Wind Generator
Super efficient
18 Watts Lightning
and AC/DC Refrigerators
HONDA
Kubota Diesel 5kW to 550kW,
Honda Gasoline Generators.
Dealers Wanted for North and South America
www.sunelec.com
XANTREX
Smart Choice For Power

Take That Office Off the Grid

SolWest Prefair Workshop 2001

Richard Perez,
with Joe Schwartz

©2001 Richard Perez & Joe Schwartz



Workshop participants Anna Delocis and Chris Worcester wire the PV combiner box on the roof of EORenew's office in John Day, Oregon.

This year's pre-SolWest workshop snatched the office of the nonprofit Eastern Oregon Renewable Energies Association (EORenew) from the gaping maw of the local grid. That's right, the EORenew office is now on a steady diet of sunshine. And sixteen workshop attendees made it happen.

The Concept

EORenew director Jennifer Barker wanted the office to walk the talk. The EORenew office is located in downtown John Day, Oregon, and was grid-powered. We wanted to do a workshop that would teach a small group the basics of solar electricity, and also completely solar power the EORenew office.

We began planning for this workshop during July of 2000. Jennifer would do the local groundwork and solicit donations of the equipment. Joe Schwartz and I would design the system, teach the two-day workshop, and oversee the installation.

Jennifer did a thorough energy audit of her office's appliances. Joe and I ran this estimate through *Home Power's* Energy Master spreadsheet, and generated the load table you see printed below. With an estimated average daily usage of only 763 watt-hours, putting Jennifer's office on solar electricity was a snap.

Jennifer worked overtime securing donations for this project. After Joe and I did the system design, Jennifer had a specific wish list for hardware. In most cases, we received a donation of our first choice of components. I want to thank the following companies that donated their RE gear to this project—Exeltech for the inverter, Matrix Solar Technologies for the Photowatt PV modules, RV Power Products for the MPPT PV controller and remote, Solar Depot for the Dynasty AGM batteries, Southwest Solar for the evaporative cooler, UniRac for the PV mounting racks, and Xantrex for instrumentation and combiner box.

Electron Connection and Schott Applied Power donated safety gear, circuit breakers, and enclosures to the project. *Home Power* donated our time, along with conduit, wire, battery/inverter cables, and small hardware. Dennis Voigt, a local electrician, rewired the AC circuits and installed the transfer switch at a reduced charge. The cost table shows the retail dollar value of all the equipment we used in this system.

The Lesson Plan

This year's class was a heavily mixed group of sixteen people. Some were experienced enough with solar electricity to have taught the class, while others had never heard of Ohm's law. We tried to accommodate all, with classroom sessions on system design, component selection, how PVs work, wiring, batteries, inverters, and safety gear.

Joe and I like to do hands-on experiments at these classes. This year we put one of the PV modules out into the sun and plotted a current versus voltage (IV) curve on it. The class got to see first hand the effect of heat on a PV panel's power output.

SolWest Office Loads

Item	*Watts*	*Hours/ Day*	*Days/ Week*	*WH/ Day*	*Percent*
Inverter standby	10	24	7	240.00	31.5%
Solar Chill cooler	80	7	3	240.00	31.5%
Computer system	125	2	3	107.14	14.0%
Fax standby	4	24	7	96.00	12.6%
Lighting	128	1	3	54.86	7.2%
Answering machine	1	24	7	24.00	3.2%
Fax transmit	20	0.1	3	0.86	0.1%
			Total	762.86	

Co-instructor Joe Schwartz explains the finished power wall in the EORenew office closet.

We also ran a series of tests on various inverters using a Fluke 43 power quality analyzer. Several of the students were alarmed when viewing the over 40 percent total harmonic distortion (THD) of their portable modified square wave inverters.

All in all, we had about eight hours of classroom sessions. Joe was great at collecting RE equipment literature, and each student had a huge pile of materials to study after the workshop. But the real thrust here was to take Jennifer's office off the grid.

The Installation

We split up into teams. This was necessary because the PVs were to be installed on the roof, and the remainder of the system in a small closet in Jennifer's office. The office is small, with only enough room for six or eight people. The closet is even smaller, with only enough room for one person at a time.

One group headed to the roof with PV racks, drills, and wiring supplies. Another went to work in the closet installing the inverter, charge controller, and breaker panels. A third crew broke out the monster crimpers, torch, lugs, and cables. They began making up the battery and inverter cables—with flame soldered connectors and shrink tubing, no less.

Rack 'em and stack 'em—Sixteen students learned about photovoltaics while helping to install the system.

System Details

The PVs are installed on a fixed UniRac mount that is through-bolted to 2 by 6 blocking that was added inside, between the rafters. The individual Photowatt PW1000, 90 watt modules have 72 cells and can be configured for either 12 or 24 VDC. We wired the modules for 24 VDC. A positive and negative lead from each module was run to a Trace TCB10 combiner box using #10 (5.3 mm^2) THHN-2 copper wire in flexible, nonmetallic conduit.

Each module is protected with a 15 amp series fuse in the positive lead. The total rated output of the array is 360 watts at 24 VDC. But after we ran the IV curve on the modules, it was obvious that high ambient temperatures would decrease array output by as much as 20 percent.

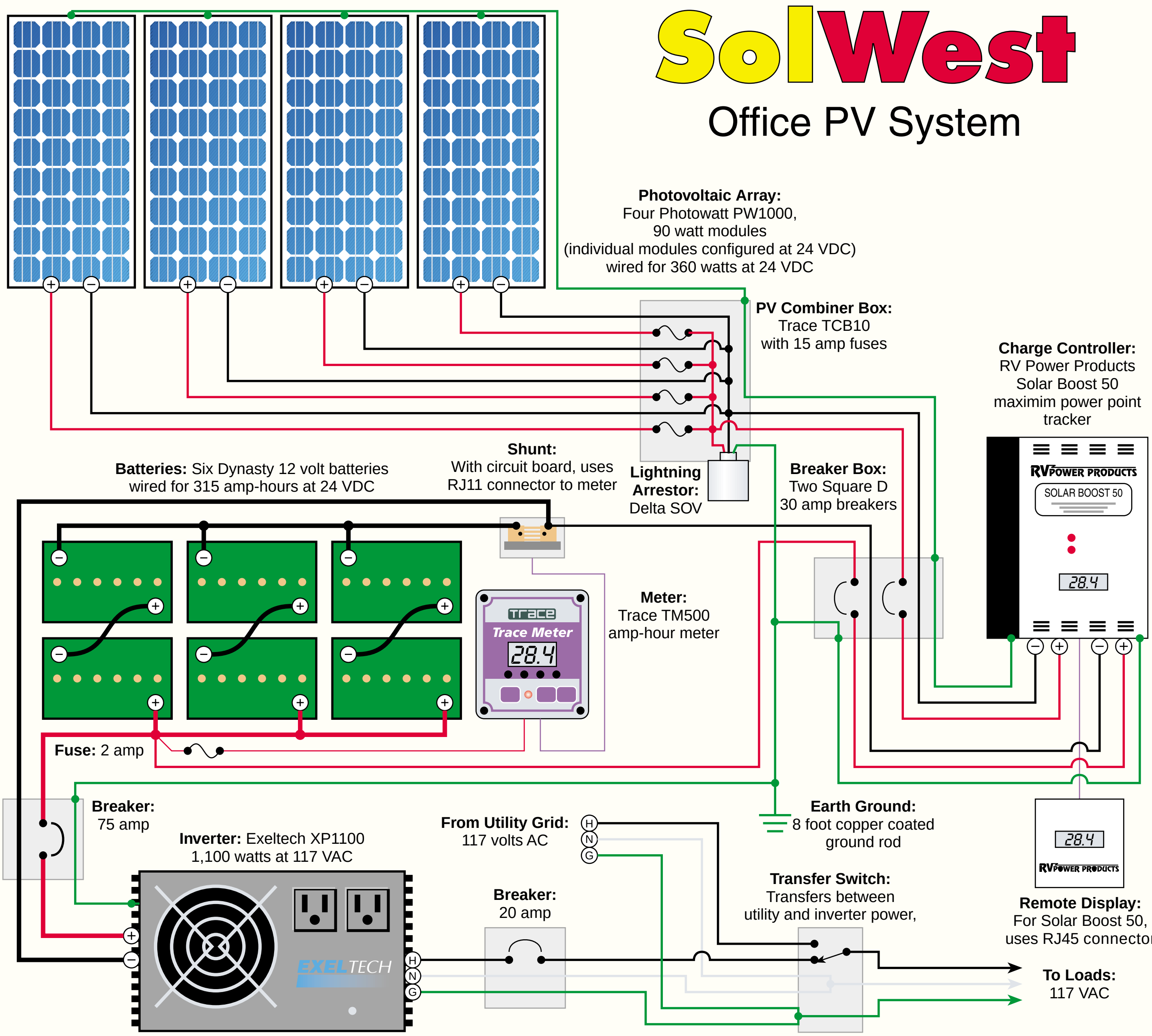
We ran 30 feet (9 m) of #2 (33 mm^2) THHN copper wire in PVC conduit between the combiner box and a two-circuit, Square D, QO breaker box located in the closet. A 30 amp, DC-rated breaker protects the wire run from overcurrent, and provides a means for disconnect. PV output is then routed to a Solar Boost 50 (SB50) maximum power point (MPPT) charge controller. Both the charge controller and wire run were oversized to allow for future expansion. The output of the SB50 is run through a second, 30 amp, DC-rated breaker and then to the batteries.

The battery bank is made up of six, 12 VDC, 105 amp-hour, Dynasty sealed batteries. Pairs of batteries were wired in series using #2/0 (67 mm^2) welding cable for 24 VDC. Then the three pairs were wired in parallel for a total battery capacity of 315 amp-hours at 24 VDC.

The Exeltech XP1100, 24 VDC inverter is connected to the battery bank using #2 (33 mm^2) welding cable. The positive leg is run through a 75 amp, DC-rated Heinemann breaker. The inverter's AC output is hardwired to a 20 amp AC breaker and then to a 20 amp transfer switch. The switch allows Jennifer to manually transfer the office circuit over to the grid when the batteries are discharged to a 50 percent state of charge (SOC), and allows the system to be operated without a battery charger. The reality is that the total office electrical load is small in comparison to the PV system output. The office will most likely never be on the grid again!

A Solar Boost remote display and a Trace TM500 amp-hour meter provide Jennifer with system information without having to get up from her desk. And a 24 VDC Solar Chill evaporative cooler keeps the office at a

Four Photowatt PW1000, 90 watt modules, in the relentless Eastern Oregon sun, should easily meet the office loads .



comfortable temperature during those hot Eastern Oregon summer days.

Training Realism at Its Best—or Worst

During the last classroom session, I delivered my standard battery safety rap. Now, Joe and I had been discussing buying all the battery safety gear (baking soda, gloves, eye protection, fire extinguisher, etc.) before the install. We'd use it as props during the workshop and leave it with Jennifer after the install was done. Well, we forgot to do this, so we were unprotected for the all too real training session that was to follow—the exploding battery.

Joe and I like doing experiments at these events, but up till now we have stopped short of exploding a battery and dealing with the mess. As fate—and our carelessness—would have it, explode a battery we did.

The battery bank is located on the floor of the closet. Joe had made a very nice plywood top for the batteries, but this wasn't installed since we were working on the batteries and their connections. The students had thrown multiple layers of plastic over the tops of the batteries. This made me slightly nervous, since hardware was continually being dropped on top of this plastic, not to mention the occasional tool. But all seemed well.

What I didn't know was that there was a disconnected series battery cable lurking beneath all that plastic. Someone must have kicked this loose cable, and it

SolWest Office Costs

Item	Cost (US$)
4 Photowatt PW1000, 90 W PV modules	$1,920
6 Dynasty batteries, Group 27	1,020
Exeltech XP1100 inverter	830
RV Power Products SB50 controller	389
UniRac PV mounting rack	265
Trace TM500 amp-hour meter	245
Trace TCB10 combiner box	229
SB50 charge controller remote	219
Inverter/battery disconnect, 70 amp	129
9 Battery/inverter cables, 2/0 CU	90
Wire, conduit, fittings (estimate)	60
2 Square D fused disconnects/enclosures	60
Delta SOV lightning arrestor	45
AC transfer switch	10
Total	$5,511

made contact with one of the 12 V batteries in the 24 VDC pack. The entire 24 V pack discharged very quickly into a single 12 V battery.

Standing 6 feet in front of the battery, I could see, underneath the translucent plastic layers, one of the batteries spurting gas and flame. I was closest to the batteries, since the hissing and foul smell had scared the students back from the closet. I could see that the layers of plastic covering the batteries had caught fire. My first reaction was to stop the fire from spreading by grabbing the flaming plastic and pulling it from atop the battery pack. No sooner had I done this than the battery exploded.

Fortunately, I was the only one even mildly injured. The acid spray put pin holes in my clothes, I got minor burns on my hand from the flaming plastic, and a permanent acid pit on my right cheek to remind me to never be so silly again.

All of a sudden, we needed all that safety gear that we'd discussed in class, but had forgotten to buy. Emergency expeditions were dispatched to secure baking soda, rubber gloves, and a plastic bucket to contain the demolished battery. Fortunately the AGM batteries don't contain very much sulfuric acid, and we successfully cleaned up the mess in less than two hours.

The ultimate responsibility for this accident lies with me. I should have made sure that the batteries were removed before anyone worked above them. I will be eternally grateful that I was the only one injured, and I will certainly be more careful around batteries in the future. While this was an entirely real and exciting learning experience for all involved, I don't plan to repeat it at future workshops.

Off the Grid!

We brought EORenew's system online at 9:30 AM on Saturday July 28, 2001. Solar energy streamed from the rooftop PV array and began charging the batteries. The inverter fed clean electricity to the office loads. Just one day earlier, the office had been powered predominantly by electricity generated by the hydroelectric dams that choke the Columbia River, and coal-fired plants that mar the western landscape, not to mention the atmosphere. But from now on, the office will be powered by the sun.

EORenew has gone solar-electric, and has a great educational tool as well. On Sunday during the fair, Joe and two of the workshop participants led a tour of EORenew's new office system. They walked into the office and flipped on the lights that were now running on solar energy. Together they described how they had installed the system and how it functioned. Another PV system was up and running. And another great group of folks are spreading the word about the power of the sun.

Access

Richard Perez, *Home Power,* PO Box 520, Ashland, OR 97520 • 530-475-3179 • Fax: 530-475-0836
richard.perez@homepower.com
www.homepower.com

Joe Schwartz, *Home Power,* PO Box 520, Ashland, OR 97520 • joe.schwartz@homepower.com

Jennifer Barker, EORenew, PO Box 485, Canyon City, OR 97820 • 541-575-3633 • info@solwest.org
www.solwest.org

Donors:

Exeltech, 2225 East Loop 820 N, Fort Worth, TX 76118
800-886-4683 or 817-595-4969 • Fax: 817-595-1290
info@exeltech.com • www.exeltech.com • XP1100 inverter

Matrix Solar Technologies • 877-2MATRIX
Fax: 505-833-0400 • marketing@matrixsolar.com
www.matrixsolar.com • Photowatt PV panels

RV Power Products, 1058 Monterey Vista Way, Encinitas, CA 92024 • 800-493-7877 or 760-944-8882
Fax: 760-634-8193 • info@rvpowerproducts.com
www.rvpowerproducts.com • Solar Boost 50 charge controller

Solar Depot, 61 Paul Dr., San Rafael, CA 94903
800-822-4041 or 415-499-1333 • Fax: 415-499-0316
staff@solardepot.com • www.solardepot.com • Dynasty batteries

Southwest Solar, 5085 S. Melpomene Way, Tucson, AZ 85747 • Phone/Fax: 520-885-7925 cuningham@dakotacom.net www.southwest-solar.com • Solar Chill evaporative cooler

UniRac, Inc., 2300 Buena Vista Dr. SE, Suite 134, Albuquerque, NM 87106 • 505-242-6411 Fax: 505-242-6412 • tracker200@unirac.com www.unirac.com • Solar panel racks

Xantrex Technology, Inc., Distributed Residential and Commercial Markets, 5916 195th St. NE, Arlington, WA 98223 • 360-435-8826 • Fax: 360-435-2229 inverters@traceengineering.com • www.xantrex.com Amp-hour meter, combiner box, array grounding

Electron Connection, PO Box 203, Hornbrook, CA 96044 • 800-945-7587 • Fax: 530-475-3401 econnect@snowcrest.net www.electronconnection.com • Heinemann 75A breaker

Schott Applied Power Corp., PO Box 339, Redway, CA 95560 • 800-777-6609 or 707-923-2277 • Fax: 707-923-3009 • info@solarelectric.com • www.solarelectric.com Enclosures for Trace products

Dennis Voigt, B&D Electric, Inc., PO Box 678, Prairie City, OR 97869 • 541-820-4144 • Wiring of AC circuits

The holidays are a time to reflect back on our good fortune and to spread joy and goodwill… let SolarTech 3000 help. For every purchase you make through the SolarTech 3000 website through January 31, 2001, we will donate ten percent to the New York Fire Department relief fund.

These items plus many more just in time for the holiday season:

Solar Charged Flashlight
P/N SFA-1, $34.95

Photon Solar Racer
P/N Photon, $24.95

Solar Powered Lantern
P/N 62601, $63.00

Solar Powered Biplane
P/N BP-2, $175.00

FreePlay S360
Human/Solar Powered Radio
P/N R3G1R1-360, $69.95

SOLARTECH 3000

SOLAR NEWS | EDUCATION | PRODUCTS

For these items as well as residential and commercial solar equipment
Go to: http://www.SolarTech3000.com or call: 877.246.8217

Trojan Maroon. Because half the day is night

Count on Trojan Battery Company for the power you need to get you through the night. You'll enjoy life more and accomplish more when your renewable energy system includes the best deep cycle batteries going. Like our breakthrough L16H with its light but strong Polyon™ case. Or the T-105, a long time favorite in PV circles. Both feature maroon cases and easy lift handles. And both benefit from Trojan's performance engineering. The great ideas we've hatched include our exclusive Alpha Plus™ high density paste formulation, which delivers the industry's highest concentration of active material. And our proprietary Maxguard® Advanced Design Separator for increased battery life and run time. Its special design cuts water consumption and maintenance needs. Not enough hours in the day? Then ask for us by name. Or by color. For the full story on Trojan deep cycle batteries, call us at 800-423-6569, fax to 562-906-4033, or visit www.trojanbattery.com. (Trojan's business hours are 7:30 a.m. to 4:00 p.m. Pacific time.)

Trojan

No Power? No Problem!

There is more to a working renewable energy system than a cheap deal on a pile of hardware.

We Provide:

Complete service. We do solar, wind, microhydro and pumping systems. Load analysis, site survey, system design, sales, installation, user training, and tech support long after the warranties expire. We live on renewable energy, have 20 years of experience, and have established over 500 systems. We specialize in NEC® compliant, safe systems that will make your Electrical Inspector smile!

Equipment for DIY. We offer reasonable deals and technical reality checks. Why settle for a packaged system when you can have yours custom designed by an expert?

Your best resource is a local pro. Tap into our network of qualified, competent Electron Connection associates across the country.

Going into the Biz? Why talk to a "sales technician" when you can talk to an electrician? We KNOW what works and how it works. We offer technical support, system design help, prompt shipment, fair pricing and NO BULL. Local referrals always. Electrical competence required.

Electron Connection

CA Electrical Lic #613554

800-945-7587 toll free

www.electronconnection.com online catalog

ipp

Siemens Solar PowerPro™ PARTNER

Trace XANTREX Brand

PO Box 203, Hornbrook, CA 96044 USA

Voice / Fax: 530-475-3401 • E-mail: econnect@snowcrest.net


Look over your shoulder. . .
we'll be there.
The new Vanner Sunlynx Interface Module. Reliable even when the grid isn't.
• 120/240Vac allows consumers to power the average house or small business with one inverter
• Produces up to 4000 watts of continuous power when paralleled
• Modular design creates clean, professional-looking installation
• Pure sine-wave output allows the use of the most difficult loads with a Vanner RE system
• Pure PV support allows the system to run when the grid is not present
• Upgradable to a battery backup system
First in loyalty, quality and support
See the complete RE family on page 59
800-AC POWER
www.vanner.com • e-mail: pwrsales@vanner.com
VANNER


For more information ask your dealer / distributor or visit us on the web at www.outbackpower.com
OutBack Power Systems
Finally ! an alternative to Brand X
PSDC
Starting At $349
Retail Price
$129
Retail Price
OBDC - GFP/2
Dual 60 Amp 12/24/48 VDC
PV Array Ground Fault Protection
250 & 175 Amp DC Breakers
$119.00
Retail Price
C60MDR 12/24/48 VDC
60 Amp Charge Controller
Shown With a few of the available options
OutBack Power Systems Inc.
19009 62nd Ave NE Arlington, WA
TEL 360-435-6030 – FAX 360-435-6019
OutBack Integrating Partners
Energy Outfitters Ltd
(800) 467-6527
www.energyoutfitters.com
Inter-Island Solar Supply
(808) 523-0711
www.solarsupply.com
Sunwize
(845) 336-0146
www.sunwize.com
OutBack Distributors
BP Solar
(301) 698-4200
www.bpsolar.com
Schott Applied Power
(800) 777-6609
www.solarelectric.com

SOL WEST RE Fair 2001

Richard Perez

©2001 Richard Perez

A fairgoer reading up on renewable energy before her next workshop.

The third annual SolWest Renewable Energy (RE) Fair was held during late July in John Day, Oregon, and it was the biggest ever. Over 2,000 folks from seventeen states, two Canadian provinces, and even from Japan attended this RE extravaganza.

A few of the fifty exhibitors participating in this year's fair.

Workshops

Perhaps the best reason to attend an RE fair is to learn RE technology at the various workshops. At SolWest 2001, you could choose from nearly three dozen workshops taught by experts in solar, wind, microhydro, energy conservation, and much more.

The variety of workshops attracted a variety of people—from ranchers learning about solar-powered water pumping to fans of hydrogen studying the latest in fuel

Kids get it—the solar panel powers the water pump!

Above: The Outback Power crew displaying their new power panels.

Above: Electrathon racing in the streets of John Day, Oregon.
Below left: Future racers check out the electric vehicle action on the track.
Below right: Don Harris, Bob Maynard, Ray Ogden, and Larry Elliott with the Electrathon racer built by Energy Outfitters, Ion Technologies, and *Home Power.*

cell technology. And not all the workshops were high tech. Some featured down-to-earth skills such as land management, solar cooking, shelter and housing, and making biodiesel.

Exhibitors

Over 50 exhibitors set up booths displaying their products and services. This brings to mind the second best reason for attending a fair—to get great deals on RE hardware. From PV modules to inverters to wind generators, it was all on sale. Since SolWest has been maturing as a fair, this year saw more manufacturers showing up to exhibit their products and to network with their distributors, dealers, and customers. The brisk business being done at almost every booth indicated the high level of interest by the fair's attendees.

New Products

An energy fair is absolutely the best place to debut new products. Not only is a new product seen by thousands of fairgoers, but also by scores of distributors and dealers. The fine fellows from Outback Power were at SolWest displaying their new line of DC and AC power panels for inverters. Don Harris of Harris Hydro was on hand showing off his new, adjustable permanent-magnet, hydroelectric generator. Steve and Elizabeth Willey of Backwoods Solar displayed a new line of ultra-low-head, affordable, microhydro turbines that are made in Vietnam.

Electrathon Racing

There is nothing like a good race to liven up any fair. SolWest had Electrathon racing two days in a row—on Saturday at the local airport and on Sunday on the streets of John Day—yes on the streets! It was quite a sight to see the microelectric racers zipping around on city streets.

The racers were greatly challenged by the long straightaways of this course. I personally saw racers hitting over 35 mph (55 kph) in 25 mph speed limit zones—all legit and legal with nary a ticket to be had. Electrathon racing is just too much fun!

A Fair Well Done!
Energy fairs don't just happen. They result from the hard work of at least one dedicated, full time person—in this case, Jennifer Barker. Jennifer's herculean labor has made SolWest a growing success.

Jennifer has successfully integrated this energy fair into her community. The folks of John Day and Grant County, Oregon are strong supporters of the fair and also of the principles it teaches—solar energy, energy conservation, and sustainability.

Tired, Hoarse, & Happy...
After two days of SolWest 2001, the *Home Power* crew was exhausted. We must have spoken with more than a thousand folks, many new to the field of RE. I particularly remember a union fellow from British Columbia with a new PV module tucked under his arm. Our conversation ranged from his upcoming guerrilla solar installation to the Wobblies. This was an eclectic gathering to say the least.

The *HP* crew schmoozed with most all of the RE manufacturers, distributors, and dealers. We got reconnected with our roots and got all the scuttlebutt at the same time. We had a great time, and we'll be back next year!

Access
Richard Perez, *Home Power,* PO Box 520, Ashland, OR 97520 • 530-475-3179 • Fax: 530-475-0836
richard.perez@homepower.com
www.homepower.com

Jennifer Barker, EORenew, PO Box 485, Canyon City, OR 97820 • 541-575-3633 • info@solwest.org
www.solwest.org

Outback Power Systems, 19009 62nd Ave. NE, Arlington, WA 98223 • 360-435-6030
Fax: 360-435-6019 • cfreitas@outbackpower.com
www.outbackpower.com

Harris Hydroelectric, 632 Swanton Road, Davenport, CA 95017 • 831-425-7652

Backwoods Solar Electric Systems, 1395 Rolling Thunder Ridge, Sandpoint, ID 83864 • 208-263-4290
Fax: 208-265-4788 • info@backwoodssolar.com
www.backwoodssolar.com

The Southern Star in Solar
SERVING THE SOUTHERN UNITED STATES & CARRIBEAN
IPP MEMBER


Tom & Shirley Lane...*ECS Owners*

SOLAR CONTRACTING SINCE 1977
4,000 REFERENCES AVAILABLE

FULL SERVICE DESIGN & INSTALLATION
SITE SURVEYS / LOAD ANALYSIS / ON-SITE TECHNICAL SUPERVISION

Energy Conservation Services

Tropical Solar Experts
(352) 377-8866

Siemens Solar PowerPro™

6120 SW 13th Street • Gainesville, Florida 32608 • USA • *www.ecs-solar.com* • *tom@ecs-solar.com*


Now Shipping...
THE NEW S-530
• 530 AH (100 hour rate), 400 AH (20 hour rate)
• Same physical dimensions as our S-460
• 1,300 plus cycles at 50% DOD
• Available wet or dry charged
• 7 year warranty
ISO 9002
Surrette Battery Company, Ltd.
S-530
530 AH (100 hour rate)
12 1/4 (L) X 7 1/8 (W) X 16 3/4 (H)
124 lbs (wet), 96 lbs (dry)
800-681-9914
sales@rollsbattery.com
Rolls
Battery Engineering


Let our family be a part of your family.
DC Control Module
RE-4500 Inverter/Charger
Sunlynx Interface Module
AC Control Module
The RE Series Inverter/Charger System and Modules.
Power for your world.
First in loyalty, quality, and support
800-AC POWER • www.vanner.com
4282 Reynolds Drive • Hilliard, Ohio 43026
VANNER

Backwoods Solar Electric Systems

For an earth restored and a world at peace. Solar, Wind, Hydro
Independent Electric Power for the Remote Home *where utility power is not available.*

When you speak with Backwoods Solar, your questions are personally answered by people using the products everyday. Our catalog / planning guide teaches the basics of installing solar electric residential power. We can refer you to skilled installers in most states. Our mountaintop business, shop, and home have been powered by equipment from our catalog for 25 years. Utility lines are still 2 miles away. We are a family business living with our products.

177 PAGE CATALOG / PLANNING GUIDE
FREE to Home Power readers

Phone **(208) 263-4290** FAX only (888) 263-4290
Website **www.backwoodssolar.com**
Email **info@backwoodssolar.com**

Visit us or write:

Backwoods Solar Electric Systems
1395-HP Rolling Thunder Ridge
Sandpoint, Idaho 83864 USA

XANTREX GOES 100% GREEN POWER

Xantrex Technology Inc., announces the purchase of Green Tags for renewable energy from the Bonneville Environmental Foundation equal to 100% of the electric energy consumed at their Arlington, Washington site.

The premium Xantrex pays supports development of renewable energy projects.

Watch for the green energy logo on all Trace brand products. Visit www.greentagsusa.org for more information.

MANUFACTURED WITH 100% GREEN ENERGY
BONNEVILLE ENVIRONMENTAL FOUNDATION
WWW.GREENTAGSUSA.ORG

Trace
A XANTREX Brand

www.traceengineering.com

Solar water pumps for every purpose

Don't throw energy down the drain with an inefficient water pump. Dankoff Solar DC pumps use 1/3 to 1/2 the energy of conventional AC pumps run by inverter.

Vertical lift to 960 Ft. (290 m)
Pressurizing to 100 PSI (7 bar)
Flows to 75 GPM (285 lpm)

Flowlight® Booster Pump
SunCentric™ Centrifugal
Solar Force™ Piston
Solar Slowpump™
Solaram™

SURFACE PUMPS
SUBMERSIBLE PUMPS

SunRise®
TSP-1000™
AND MORE . . .
Depths to 600 Ft. (180 m)
Flows to 50 GPM (200 lpm)

bp solar
Distributor

Water supply for homes, villages, agriculture, parks and recreation, and more—*since 1983*

Also a wholesale distributor of power system components

Call for a dealer referral
Toll-Free (888) 396-6611
(505) 473-3800
www.dankoffsolar.com

Dankoff Solar

Solar Hot Water for Cold Climates

Part II—Drainback Systems

Tom Lane & Ken Olson

©2001 Tom Lane & Ken Olson

Whether your climate freezes one day of the year or every day of the year, your solar water heating system must have 100 percent fail-safe freeze protection. If your freeze protection depends on either human intervention or the availability of electricity, you are living in the shadow of Murphy's law.

The heart of a drainback system—the reservoir tank stores the unpressurized water from the flat plate collectors that "drains back" whenever the circulating pump shuts off.

Two types of solar hot water systems are most appropriate for freezing climates—drainback systems and closed loop antifreeze systems. *Solar Hot Water: A Primer (HP 84)* covered the fundamentals of solar water heating systems. *Solar Hot Water for Cold Climates (HP 85)* covered the principles and components of the closed loop, antifreeze-type, solar water heating system.

In this article, you will learn the inner workings and components that make up the drainback solar water heating system. Some wrenches (system installers) of the frigid north have experienced drainback system failures due to flaws in design or installation. This article presents a culmination of knowledge and experience for freeze-free operation in cold climates. The drainback system is not to be confused with the strongly unrecommended draindown system mentioned in *HP84.*

Draindown systems rely on an electrically operated draindown valve to fill and drain the solar collectors with domestic tap water under household pressure. In general, draindown systems have had a poor performance history, with frequent freeze-related failures due to hard water, valve malfunctions, and other drain-related failures. By comparison, a drainback system uses a pool of unpressurized water that is completely separate from the pressurized domestic water in the solar storage tank.

Drainback Fundamentals

In a drainback system, the collector fluid, typically demineralized water, is circulated from a reservoir tank through the solar collectors whenever useful heat can be collected. When the pump shuts off, the water drains back by gravity to the reservoir tank. The collectors and all other piping exposed to potential freezing conditions are left empty.

The positive drain of collectors and supply/return piping is the key to the system's freeze protection strategy. This is an unpressurized closed loop—it is closed to renewed supplies of corrosive oxygen associated with replenishing water (see *Rust Never Sleeps, HP84,* page 49). Domestic water is heated by the collector fluid via a heat exchanger, which transfers the heat to water in an insulated storage tank for domestic use.

Below the drainback tank, a Ruud solar storage tank with an integral wrap-around heat exchanger stores the potable hot water.

Drainback System Components

The principle components of a drainback system include solar collector(s), circulating pump or pumps, 80 or 120 gallon (300 or 450 l) storage tank, differential control with sensors, heat exchanger, and reservoir tank. You may also include optional features such as temperature gauges, sight gauge, and flow meter.

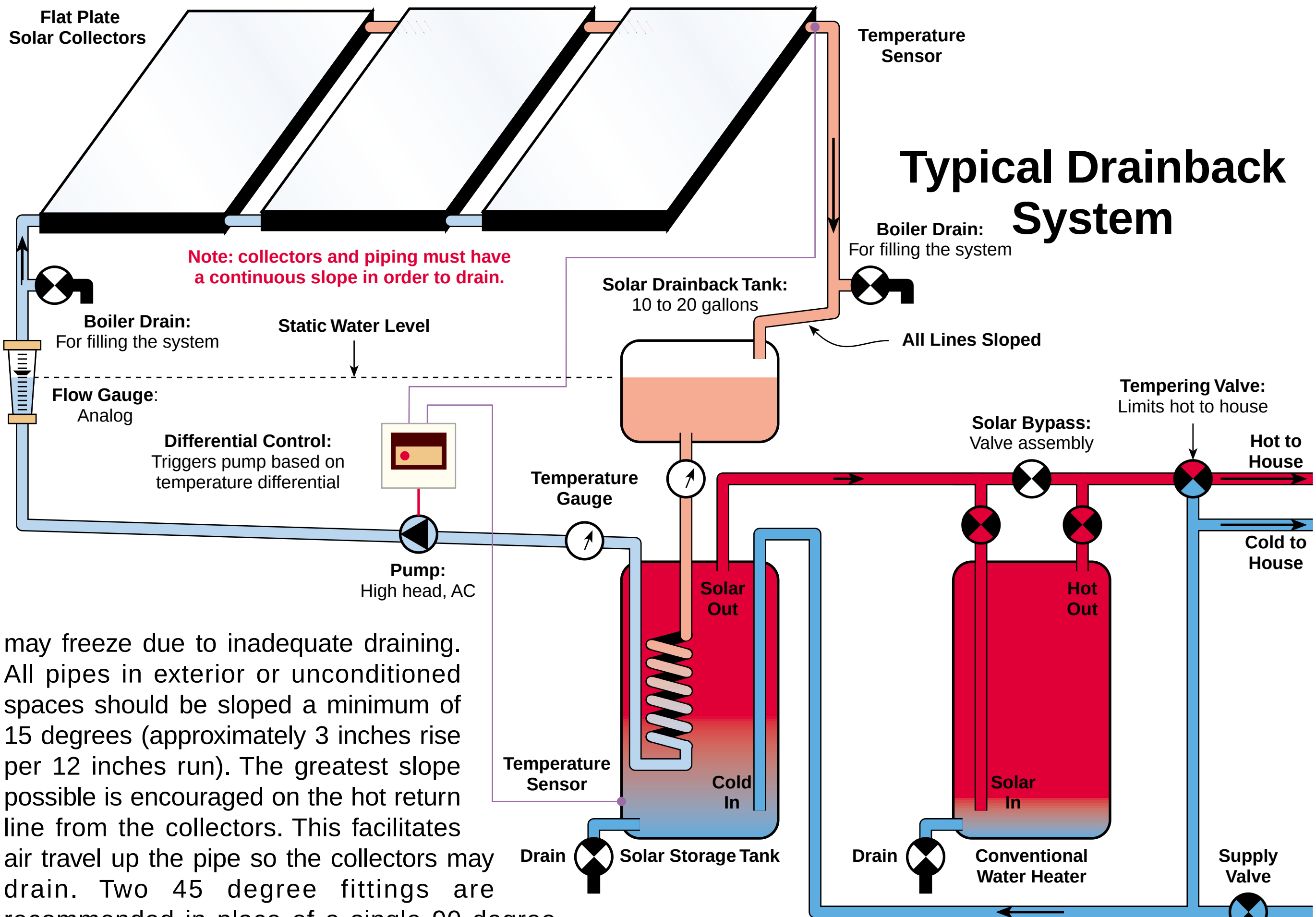
Some drainback systems do without a storage tank. Known as "whole house drainback systems," they have a very large reservoir tank that has the heat exchanger submerged inside of it. The heat exchanger is plumbed in series between the cold supply and the house DHW plumbing, and often an on-demand water heater designed to boost preheated water if needed. Frequently, large, single tank systems are used with two internal heat exchangers, one for DHW and the other for space heating. Let's take a closer look at the function, considerations, and recommendations for each of these components in a drainback system.

Collectors & Piping Must Drain

Flat plate solar thermal collectors are the most appropriate type of collector used with drainback systems. They are well suited to low temperature applications (under 150°F; 66°C), such as domestic water heating. They are constructed with parallel tubes connected at top and bottom by header manifolds. Multiple collectors are plumbed in parallel with each other. Flat plate collectors and parallel plumbing have been well described in the solar thermal articles in *HP84* and *HP85.*

The critical aspect in a drainback system is that the collectors and associated plumbing must always be able to freely drain by gravity when the pump shuts off. Collectors must be mounted facing true south (true north for locations in the southern hemisphere), with the parallel tubes (risers) of the absorber plate oriented vertically at a minimum 25 degree (approximately 5 inches rise per 12 inches run) tilt from horizontal. The risers should be a minimum of 1/2 inch ID. Never mount the collectors with the riser tubes oriented horizontally (parallel to the roof eaves). The top and bottom headers of the collector must be 1 inch. The collector's headers must be level and 1-1/2 inch headers must be used if more than three collectors are connected together in parallel.

All piping to and from the collectors must have at least a 10 degree slope (approximately 2 inches rise per 12 inches run) and must be at least 3/4 inch. Smaller pipes



may freeze due to inadequate draining. All pipes in exterior or unconditioned spaces should be sloped a minimum of 15 degrees (approximately 3 inches rise per 12 inches run). The greatest slope possible is encouraged on the hot return line from the collectors. This facilitates air travel up the pipe so the collectors may drain. Two 45 degree fittings are recommended in place of a single 90 degree elbow to assist drainage in all exterior and unconditioned spaces. All pipes should be supported at least every 4 feet (1.2 m) to prevent sagging, which may contribute to inadequate draining.

Reservoir Tank

The drainback reservoir tank holds the collector fluid. It can be installed at any height above the solar storage tank, but must be within a conditioned or freeze-free environment. The reservoir tank is typically mounted on a strong shelf above the storage tank. It may also be placed on the second floor of a two-story home to reduce static head by decreasing the distance the pump must lift the fluid to the collector.

In the tax credit era, it was possible to buy an insulated copper drainback reservoir tank with a sight glass. This is a clear glass tube on the side of the drainback reservoir that enables you to view the water level before and after the pump starts up. The sight glass allows you to monitor the level of fluid so you can ensure that the fluid is always above the circulating pump, and so you can detect fluid loss from leakage.

A collector manufacturer, SunEarth, is making a copper drainback reservoir tank that is not equipped with a sight glass. Alternatively, you can simply buy a 10 or 20 gallon (38 or 76 l) conventional water heater to serve as a reservoir. Mobile home parts distributors sell these tanks inexpensively. Install the reservoir tank on the return line from the collector above the heat exchanger and storage tank. The fluid returning from the collector must enter the airspace at the top of the resevoir tank. This allows air to move up into the collectors and piping so they can drain. Caution! If you are using a conventional water heater as drainback resevoir, it is very important to remove the dip tube from the cold inlet port. Otherwise the dip tube will impede draining of the collectors by preventing air from rising up to the collectors.

You may use a clear flow meter as a sight glass. It should be on the feed side line to the collector located at the same exact height as the top of the drainback reservoir tank. Water will seek its own level after the pump cuts off, and it should be near the top 1/4 inch of the flow meter. Flow meters are available in 2 gallon (7.6 l) per minute (gpm) to 16 gpm (60 lpm) sizes from Letro (LE-LD359B or LE-LDF359T) or Blue & White (F-450LHB). Contractor prices are about US$40 each.

A true drainback system is an unpressurized closed loop. Some early drainback system designs incorporated vacuum breakers and automatic air vents in the collector loop. These features are mistakenly borrowed from the open loop, draindown system design. This atmospheric venting of drainback systems is unnecessary, often problematic, and not recommended.

Controller & Sensors

The controller turns the circulating pump on and off. It is a differential type control, identical to that used in closed loop antifreeze systems. A thermistor-type sensor is fastened to the collector outlet pipe. Another is fastened directly to the solar storage tank wall, under the insulation, at the bottom of the tank. The sensors are wired to the controller with #18 (0.8 mm^2), two-wire, stranded PVC double jacket exterior wire.

When the outlet temperature of the collectors is 20°F (11°C) greater than the bottom of the solar storage tank, the controller activates the circulating pump. The controller shuts the circulating pump off when this temperature differential is reduced to 5°F (2.8°C), and the system drains back by gravity to the reservoir tank.

Many controls have adjustable differential settings. Differential controls are also equipped with a high limit cut-out feature. If the temperature of the solar storage tank reaches a preset high limit, usually 180°F (82°C), the controller turns the circulating pump off, and the fluid drains back to the reservoir tank. High quality differential controls are manufactured by Heliotrope Thermal and Goldline Controls.

A typical differential pump controller— the Heliotrope Delta-T.

Photo courtesy of Heliotrope Thermal.

Photo courtesy of Taco, Inc

The Taco 009BF is a typical high head AC centrifugal pump appropriate for use in drainback systems.

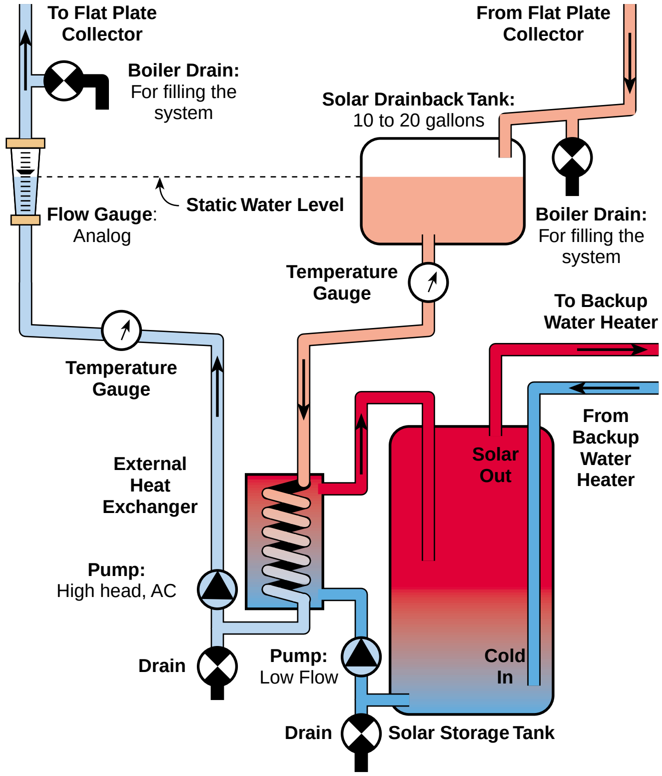
Circulating Pumps

Drainback systems use a high head, AC centrifugal circulating pump operated by a differential controller. Centrifugal circulating pumps are most commonly used in solar hot water systems and hydronic heating systems. These are appropriate because of their efficiency, reliability, low maintenance, and low energy consumption. They also permit backflow of fluid when not operating. This is a critical aspect of their function in a drainback system.

Head is the pressure that a pump must overcome to circulate the collector fluid. Static head is the pressure a pump must overcome to lift the water to the highest point in the system. The static head is equal to the vertical distance between the lowest water level and the highest point in the system. The lowest water level occurs when the pump has lifted water to the highest point in the system and before return flow has begun. Dynamic head, or friction head, takes into account the pressure a pump must develop in order to overcome the frictional resistance of the fluid moving through the pipes and fittings.

In the case of the drainback system, the circulating pump must start up at full speed and develop full head in order to lift the water to the highest point in the system and overcome the static head of the system. Once the fluid begins to fall down the return pipe, the syphon effect reduces the static head to a minimum, and the flow rate increases.

Side-Arm Heat Exchanger



This high head requirement generally precludes the use of a DC circulating pump powered directly by a PV module because the system will not fill until sufficient pressure is developed. So AC powered circulating pumps are most common. A battery powered DC circulating pump is an option, but not readily available in high head models.

The Grundfos UP 26-96BF, which can lift to a maximum head of 30 feet (9 m) of static head, or the TACO 009 BF, which can lift to a maximum head of 35 feet (10.7 m), are the two most commonly used pumps. The TACO 009 BF draws the least power. You can anticipate that these pumps should last fifteen years in a drainback system. They are lubricated by the fluid they pump.

The circulating pump should be located a minimum of 4 feet (1.2 m) below the lowest water level in the drainback reservoir to avoid sucking air into the pump. The formation of air bubbles on the suction side of the pump impeller, called cavitation, increases the load on the circulating pump. It can reduce or stop fluid movement altogether, and will burn out the pump motor. It is also preferable that the pump be mounted vertically on the cool side of the heat exchanger. Operating at a lower temperature may increase the life of the circulating pump.

Heat Exchangers & Tanks

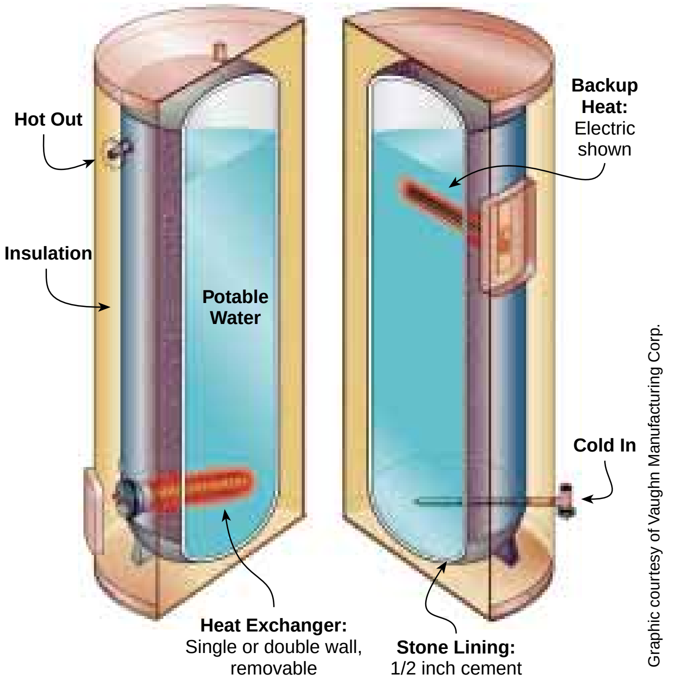
The heat exchanger transfers heat from the collector loop to the domestic water loop. A good heat exchanger will have a large surface area, and be constructed of a highly conductive material such as copper.

Heat exchangers may be integral to the tank's wall, or have a single or double wall between the two fluids. Of course, a single wall is more effective, but it may not be code compliant. Even using water as the heat transfer fluid, safety-minded mechanical inspectors recognize that a nonpotable heat transfer fluid might be used in the future. This would put occupants at risk of contamination of the potable water supply.

Heat exchangers may also be internal (within the storage tank), or external, as a separate component. An external heat exchanger, often referred to as as a side-arm heat exchanger, allows easier access for servicing (cleaning and descaling) if you add cut-off valves and a means of access.

A separate circulating pump on the water side of the side-arm heat exchanger is recommended. If you rely only on thermosyphon flow on the water side, it will be 30 to 40 percent less efficient than a double pumped system, and 20 percent less than a tank with a built in heat exchanger. When using an external heat exchanger, the two fluids should flow through it in opposite directions. This optimizes heat exchanger effectiveness by maintaining the maximum average temperature differential between the two fluids.

Cutaway of a Stone Lined Tank with Integrated Heat Exchanger



An internal, integrated (and removable), fin-type heat exchanger.

As of 2001, there are only two brands of closed loop tanks with integrated heat exchangers that wrap around the outside of the tank wall (making it scale proof), and are foam-insulated in place—Rheem and Ruud. These are both made by Rheem Manufacturing. Rheem is one of the largest manufacturers of hot water heaters, and makes an 80 gallon (300 l) tank with a wrap-around copper heat exchanger. They are commonly available nationwide and generally adequate for a family of four. Ask for the 80 gallon Solar HE (heat exchanger) model. I hope that manufacturers will bring back the 100 and 120 gallon (380 and 450 l) tanks with heat exchangers that were available during the tax credit era of the '70s and '80s.

Always bring the collector return line into the top side heat exchange opening on the Rheem/Ruud tanks, and out the bottom to return to the collectors. This configuration ensures that you are supplying the collectors with the lowest temperature possible, and is 20 percent more effective than plumbing it in reverse.

Vaughn Corp., a small company in Salisbury, Massachusetts, makes 65, 80, and 120 gallon (250, 300, and 450 l) tanks (trade name Sepco) with bolt-on, removable, single or double wall, vented heat exchangers. The heat exchanger is located at the bottom of the tank and is finned to offer greater surface area, which increases heat exchange effectiveness.

Unlike the Rheem/Ruud glass lined tanks, Sepco tanks are stone lined. These tanks typically last much longer than a standard glass lined tank. The stone (1/2 inch cement) lining makes them heavy, so you will need two people and an appliance dolly to move them into place. Do not use the less expensive, higher performing, single wall heat exchanger unless you check your local codes for compliance, even with water as the heat transfer fluid.

System Sizing & Costs

System sizing is determined by the daily volume of water usage, required temperature rise, and the local climate. Performance will be affected by the size of solar collector and the size of the solar storage tank. A solar contractor in your area may have the means of providing a detailed performance analysis, which is beyond the scope of this article. Here are some useful guidelines to get you in the ballpark.

The first step is to determine your hot water needs. Widely accepted estimates for residential hot water consumption are 20 gallons (75 l) per day for the first two people and 15 gallons (55 l) per day for each additional person. Size your tank according to your daily hot water requirement. Tanks come in standard sizes, so don't fret over trying to be too exact. Just get the available tank size closest to your estimate.

The second step is to determine the square footage of solar collector, based on the size of your solar storage tank. You can use the following generally accepted rules of thumb offered by AAA Solar, for each of four climatic regions of the U.S.

- Sunbelt: 1 square foot (0.09 m^2) of collector per 2 gallons (7.6 l) of storage.
- Southeast and Mountain states: 1 square foot of collector per 1.5 gallons (5.7 l).
- Midwest and Atlantic states: 1 square foot of collector per 1.0 gallons (3.8 l).
- New England and the Northwest: 1 square foot of collector per 0.75 gallons (2.8 l).

Here's an example. A household of four will consume an estimated 70 gallons (265 l) per day, so use an 80 gallon (300 l) solar storage tank. Based on your location, your collector area will be on the order of 40 square feet (3.7 m^2) in Arizona, 55 square feet (5.1 m^2) in Georgia, 80 square feet (7.4 m^2) in Kansas, and 106 square feet (9.8 m^2) in New Hampshire.

Typical Drainback System Sizing & Costs

Gallons HE Tank	*Collector Area (square feet)*	*Number of People*	*FSEC BTU Rating**	*WH Per Day*	*Cost (US$)*
80	2 @ 4x8 = 64	4 to 6	61,400	17,996	$3,205
120	2 @ 4x10 = 80	5 to 9	76,200	22,334	$3,558

* The Florida Solar Energy Center (FSEC) has developed performance ratings upon which the Solar Rating & Certification Corporation (SRCC) bases its solar collector thermal performance ratings.

Remember that collectors come in standard sizes too, so make your selection based on what is available. The drainback system components cost about 10 to 15 percent more than a glycol system. Current retail prices to homeowners for uninstalled equipment are shown in the table on page 67.

The watt-hours in the table come from the multiplier 0.2931, which converts BTUs to watts. This conversion may help solar-electric professionals put the savings in perspective. At US$0.10 per kilowatt-hour (KWH), the two systems will save approximately US$1.80 per day (US$657 per year) and US$2.25 per day (US$821 per year) respectively in nontaxable income, depending on specific climate and site. The equity value will last for twenty years, with simple payback less than five years.

Filling & Draining the System

Filling and draining the system is easy. It requires no special charging pump because the closed loop is unpressurized. Three boiler drains or hose bibs are sufficient to fill and drain the system. These fittings have male hose threads, which allow you to hook up a hose for draining or filling.

One boiler drain is installed above the sight glass (or visual flow meter) on the pipe feeding the collector. Another is installed above the reservoir tank in the return pipe from the collector. A third is installed at the lowest point in the collector loop.

With the two upper boiler drains open, connect a hose from a pressurized water supply (no hard water please) to the lowest boiler drain. Fill the system until the water level exceeds the sight glass, or overflows the upper two boiler drains. Close the lower drain, shut off the water supply, and disconnect the fill hose. Slowly drain water out of the lowest drain valve until it is at the correct level, which is at the top of the sight glass.

If you opt to charge the system with demineralized water or antifreeze solution, you can fill the system by pouring the fluid into a hose connected to one of the upper boiler drains. The volume of fluid required is approximately 1 gallon (3.8 l) per 40 square feet (3.7 m^2) of collector, plus 6 gallons (23 l) per 100 linear feet (30 m) of 3/4 inch copper pipe, plus 5 gallons (19 l) extra for the reservoir tank.

Advantages of Drainback Systems

The greatest advantage of a drainback system over the closed loop antifreeze type system is that overheating will not cause any problems. Once the high limit water temperature has been reached, the pump turns off, and the fluid in the collectors drains back to the reservoir tank.

By comparison, if a closed loop antifreeze system is shut off at the high temperature limit, high stagnation temperatures (up to 350°F; 176°C) will break down the heat transfer fluid, creating a sludgy, acidic deposit. Heat transfer capability is then reduced because of corrosion in the copper piping. This can be a problem if there is no flow in the system, such as when a pump fails or the grid goes down.

The significance of this advantage of drainback systems is that a system may be oversized to achieve a greater annual percentage of solar contribution without creating overheating problems in the summer months. It also permits upsizing for additional needs such as space heating or spa heating. The differential controller will automatically turn the system off in the summer when the tank sensor reaches the high limit, draining the water back into the reservoir.

An advantage of using water as a heat transfer fluid is that it never needs to be changed like antifreeze systems, which should have fluid replaced at least every ten years, or whenever overheated by stagnation conditions. Since drainback systems are unpressurized closed loop systems, they are simpler to maintain than antifreeze glycol systems. The drainback system also has fewer parts—no check valve, air vent, pressure gauge, or expansion tank.

Drainback systems are much easier to install than glycol systems. And they are immune to utility blackouts. The water drains back to the reservoir when there is no electricity to run the pump. The controller will cut power to the pump when the storage tank reaches its predetermined high limit temperature setpoint (usually 180°F; 82°C).

Water has a higher heat capacity than other heat transfer fluids, and is typically 15 to 20 percent more efficient in collecting BTUs than a 50:50 glycol/water mixture. Water's lower viscosity (it's thinner) means that it pumps more easily than glycol/water mixtures at low collector temperatures. A homeowner can easily maintain a drainback system by adding fluid when necessary. It takes proper equipment and knowledge to charge a pressurized antifreeze system.

Disadvantages of Drainback Systems

The greatest disadvantage of a drainback system as compared to a closed loop antifreeze system is that the system's collectors and piping must all be above the reservoir tank, heat exchanger, and storage tank. It is imperative that the system be installed such that collectors and piping freely drain back to the reservoir tank. Larger piping (3/4 inch copper pipe, minimum) and insulation must be used. Glycol systems often use 1/2 inch copper pipe.

Although drainback systems offer a high degree of reliablilty if properly installed, systems using water as a heat transfer fluid have little tolerance for error in freezing climates. It is, therefore, imperative that the system complies in detail with all principles of sound design and installation.

The efficient heat exchange properties of water are offset somewhat by the higher power requirements of the high head AC circulating pumps that are used with drainback systems. To run the pumps requires 140 watts for the TACO 009 BF, or 205 watts for the Grundfos UP26-96 BF. This represents about an 8 percent reduction of solar savings due to the energy required to run the pump and the differential control.

The average pump run time is about 4-1/2 hours per day. The TACO 009 is preferable due to the lower power consumption. On rare occasions, you may have to put two pumps in series if the static lift to the collector is over 30 feet (9 m) above the reservoir water level. The second pump can be turned off after startup using a timer. It is far preferable to design for single pump use, however. The second pump presents a measure of risk. If the upper pump were to fail, the lower pump may lift a static water column to a level where it may freeze. With the lower pump operating, a freeze-bursted pipe could potentially dump the contents of the reservoir.

A drainback system may also run the risk of a freeze-related failure if the controller fails to turn off the circulating pump. A damaged sensor, sensor wire, or controller failure in the "on" position could result in the circulating pump operating under freezing conditions.

These failures are quite rare, but in the interest of a 100 percent fail-safe system, you may consider either or both of the following two measures:

- Use a 30:70 propylene glycol/water mixture in place of the water. This may sound like giving up one of the advantages of a drainback system, but consider that this heat transfer fluid will be fail-safe from freezing and will not be subjected to high collector stagnation temperatures.
- An aquastat with a sensor bulb on the return side can be set to turn off the pump if the sensor bulb detects freezing water. An aquastat is a thermostat with a remote bulb type sensor. They are commonly used in the heating and cooling industry, and are readily available at any plumbing and heating contractor supply house.

Drainback systems can be a little noisy—like a coffee percolator. Make sure that the water returns through one or two 90 degree turns in a conditioned space above the water reservoir to reduce the noise of water falling into the reservoir tank. Adding a water heater insulation jacket to the reservoir can help minimize noise and reduce heat loss from the reservoir.

Variations in System Design

We have described the most common drainback system for solar domestic water heating. Of course, you can make numerous variations to this design. You may consider double pumped drainback systems, space heating to a single zone, pool heating, or PV powered circulating pumps.

Remember that double pumped systems involve using an external sidearm heat exchanger and a second pump to circulate the water loop. Although heat exchange efficiency is greater, you must also consider that the second circulating pump draws power, and increases the likelihood of maintenance and repair.

If you use a double pumped system, always pump the water in the opposite direction of the closed loop's return flow from the collector. The water side must pump slowly, so as not to disturb tank stratification (see *Maintain Temperature Stratification in Your Tank, HP84,* page 48,). You may use a 1/100 HP circulating pump with a very low flow rate, such as the March 809 oil-free model or the Taco 003.

Solar hot water and small supplemental space heating systems can be combined if the system is a drainback system. Drainback systems are ideal for supplemental space heating. Systems with AC controls with a high limit feature can use the tank sensor to turn off the pump when a preset high limit temperature is reached in storage. This prevents overheating the storage tank. Systems designed for space heating should use a collector tilt angle of latitude plus 15 degrees to optimize winter season performance. Summer performance is not compromised because the system is oversized without the space heating load.

The high static lifts required by most drainback systems do not usually lend themselves well to using PV power direct to a DC circulating pump. With conscious consideration for minimizing lift requirements, it is possible. Powering the low head, low flow circulating pump on the water loop is an easier matter. Use a five or ten watt module directly wired to the El Sid DC or March 24 volt DC circulating pump.

Simple Yet Versatile Design

We have discussed the function and design criteria for selection of each component of the system. For the collector loop, you'll need a high head AC circulating pump or pumps, reservoir tank, and heat exchanger. Three strategically placed boiler drains will allow easy filling of the system. You may choose to install a visual flow meter or sight glass to aid in filling the system. You will have to be sure that collectors and piping have fail-safe drainage back to the reservoir tank.

If you choose a solar storage tank with an integral heat exchanger, you won't need anything else for the open loop side of the system, which handles the potable domestic water. You can increase system efficiency over an integral tank heat exchanger by 15 to 20 percent if you use a double pump external heat exchanger. Beware—your system will perform 25 to 30 percent *lower* than an internal tank heat exchanger if you use a single pump, external thermosyphon heat exchanger. Your heat exchanger will also have to be descaled frequently.

A drainback solar water heating system is a straightforward design that offers reliable freeze protection for cold climates. It is a simple design, yet versatile for additional applications, such as space heating or pool applications, because it is not vulnerable to the problems of overheating. All the components are readily available, and it is an easy system to install for do-it-yourselfers with basic plumbing skills.

In future issues of *Home Power,* we'll explore the nuts and bolts of a drainback solar water heating system installation. It's not often in today's world that simplicity and reliability come in the same package.

Access

Tom Lane, Energy Conservation Services, 6120 SW 13th St., Gainesville, FL 32608 • 352-377-8866
Fax: 352-338-0056 • tom@ecs-solar.com
www.ecs-solar.com • Note: Much of the technical content of this article is based on *Solar Hot Water Systems: Lessons Learned, 1977 to Today* by Tom Lane.

Ken Olson, SoL Energy, PO Box 217, Carbondale, CO 81623 • Fax: 559-751-2001 • info@Solenergy.org
www.solenergy.org

AAA Solar Supply, Inc., 2021 Zearing NW, Albuquerque, NM 87104 • 800-245-0311 or 505-243-4900 • Fax: 505-243-0885
info@aaasolar.com • www.aaasolar.com • Distributor of solar energy components and systems

SunEarth, Inc., 4315 Santa Ana St., Ontario, CA 91761
800-978-6327 or 909-605-5610 • Fax: 909-605-5613
leslieplett@yahoo.com • www.sunearthinc.com
Flat plate collectors and drainback reservoir tanks

Vaughn Manufacturing Corp., 26 Old Elm St., Salisbury, MA 01952 • 800-282-8446 or 978-462-6683
Fax: 978-462-6497 • jvaughn@vaughncorp.com
www.vaughncorp.com • Solar storage tanks

Rheem Manufacturing, 101 Bell Rd., Montgomery, AL 36117 • 800-621-5622 or 334-260-1500
Fax: 334-260-2529 • www.rheem.com • Solar storage tanks

Grundfos Pumps Corp., 17100 W 118th Terr., Olathe, KS 66061 • 800-237-1960 or 913-227-3400
Fax: 913-227-3500 • lpetersen@us.grundfos.com
www.us.grundfos.com • Hydronic circulating pumps

Taco, Inc., 1160 Cranston St., Cranston, RI 02920
401-942-8000 • Fax: 401-942-2360 • marcha@taco-hvac.com • www.taco-hvac.com • Hydronic circulating pumps

Heliotrope Thermal, 4910 Seaport Ave., Richmond, CA 94804 • 510-237-9614 • Fax: 510-237-7018
info@heliotropethermal.com
www.heliotropethermal.com • Check valves for PV powered DC pumps, and differential controls

Goldline Controls, Inc., 42 Ladd St., East Greenwich, RI 02818 • 800-294-4225 or 401-884-6990
Fax: 401-885-1500 • sales@goldlinecontrols.com
www.goldlinecontrols.com • Differential controls

Letro Products, Inc.,1497 George Dr., Redding, CA 96003 • 800-223-1695 or 530-247-8181
Fax: 530-247-8191 • carlos@letro.com • www.letro.com
Thermometers and visual flow meters

Blue and White, 14931 Chestnut St., Westminster, CA 92683 • 714-893-8529 • Fax: 714-894-9492
sales@blue-white.net • www.blue-white.net • Visual flow meters


Solar so easy...
anyone can do it!
At Sunelco we make your purchase and installation easy.
Phone or write for our new 14th edition Sunelco Planning Guide & Product Catalog.
Regular $5 value—
Free to Home Power readers.
KYOCERA
KYOCERA SOLAR, INC.
SUNELCO
THE SUN ELECTRIC COMPANY
1-800-338-6844
www.sunelco.com
A Division of Kyocera Solar, Inc.
100 Skeels Street, PO Box 787, Hamilton, MT 59840


TRUE SINE WAVE POWER INVERTERS AND RELATED PRODUCTS
- POWER LEVELS FROM 125WATTS TO 60KW
- OUTPUT VOLTAGES OF 100,120,230
- INPUT VOLTAGES OF 12 TO 108
- 20+ YEARS MTBF
- EXPANDABLE
- MODULAR
- REMOTE CAPABLE
- "HOT" SWAPABLE
XP1100
EXELTECH
2225 East Loop 820 North Fort Worth, Texas 76118-7101 voice: 817-595-4969 fax: 817-595-1290
toll free: 800-886-4683 e-mail: info@exeltech.com website: www.exeltech.com

NORTHERN ARIZONA WIND & SUN
Electricity From the Sun

Serving Customers Around the World for Over 20 Years

SIEMENS SOLAR	PANELS	SR-100 Watt Solar$460.25*
	RV KITS	SP-75 Watt Solar$378.00*

List of Manufacturers: Unisolar – Kyocera – Siemens – BP Solar - Direct Power Mounts – Zomework Mounts – Two Seas Mounts – Morningstar Contorllers – Iota Battery Charges – ThinLite – Exeltch Invertors – TriMetric Battery Monitors – Dankoff Solar Pumps – Crown Industrial, Trojan, Surrette, and Concorde Batteries – Xantrex (Formerly Trace Engineering) – Delta Lightening Arrestors – and many more.

FLAGSTAFF, AZ 800-383-0195 FAX 928-527-0729
PHOENIX, AZ 888-881-6464

WWW.WINDSUN.COM

All in One
Inverter with Controller and Switchgear
MultiMode
PV & Wind Power Management
Grid-Tied • Backup • Stand Alone
ADVANCED ENERGY INC.
The Power of Choice ™
www.advancedenergy.com
info@advancedenergy.com
phone 603 654 9322
28 Riverview Mill Box 262 Wilton, NH 03086 USA fax 603 654 9324

PULSE
Energy/Connect

The Total System Solution

We develop leading edge technology that serves a wide range of alternative energy applications. From 8 to 800 Amps and 12 to 240 Volts, AC/DC, PWM & MPPT. These high quality products are cost effective and UL listed.

Tel: 530-271-1919 • Email: info@pulseenergy.com

greenENERGYmachine™

(renewable energy educational display)

- **Convenient Size**
  21"w. x 46" l. x 35.50 or 108"h.
- **Telescopic Pole**
  Extends to 9' for outdoor demonstration or knock-down to 7 1/2 ft. for classroom.
- **Teacher' Study Guide**
  Compatible with National Science Standard.
- **Green Energy Machine Includes:**
  35 watt solar cell, 400 watt wind turbine, sealed rechargeable battery, AC inverter, voltmeter and separate amp meters. Produces 5 amps at 110 volts AC when fully charged.

A Product of Energy Designs
285 Old Country Line Rd., Westerville, Ohio 43081
(614)882-0077 • FAX (614) 882-3189

www.greenenergymachine.com

NORTHWEST
ENERGY STORAGE

To receive information on our complete line of quality RE products and the **HuP Solar-One Battery** call
800-718-8816 or 208-267-6409 9 am-4 pm pst
6778 El Paso St. Bonners Ferry, ID. 83805
www.nwes.com batteries@nwes.com

- **HuP Solar-One** still has the best warranty in the business!
- **HuP Solar-One** positive plates are wrapped in an envelope!
- **HuP Solar-One** uses a patented recipe to achieve extra life at deeper cycles than the competition!
- **HuP Solar-One** has removable cells for easier installation!
- **HuP Solar-One** offers free shipping in the lower 48 states!
- **HuP Solar-One** uses flip top caps that make maintenance quicker!
- **HuP Solar-One** is available in 9 sizes, reducing paralleling!
- **HuP Solar-One** provides all interconnecting hardware!
- **HuP Solar-One** has over 9 sq. in. of terminal area for multiple lug connections!
- **HuP Solar-One** batteries have been in RE service for over 10 years!

HuP Solar-One Batteries!
There Is A Difference!

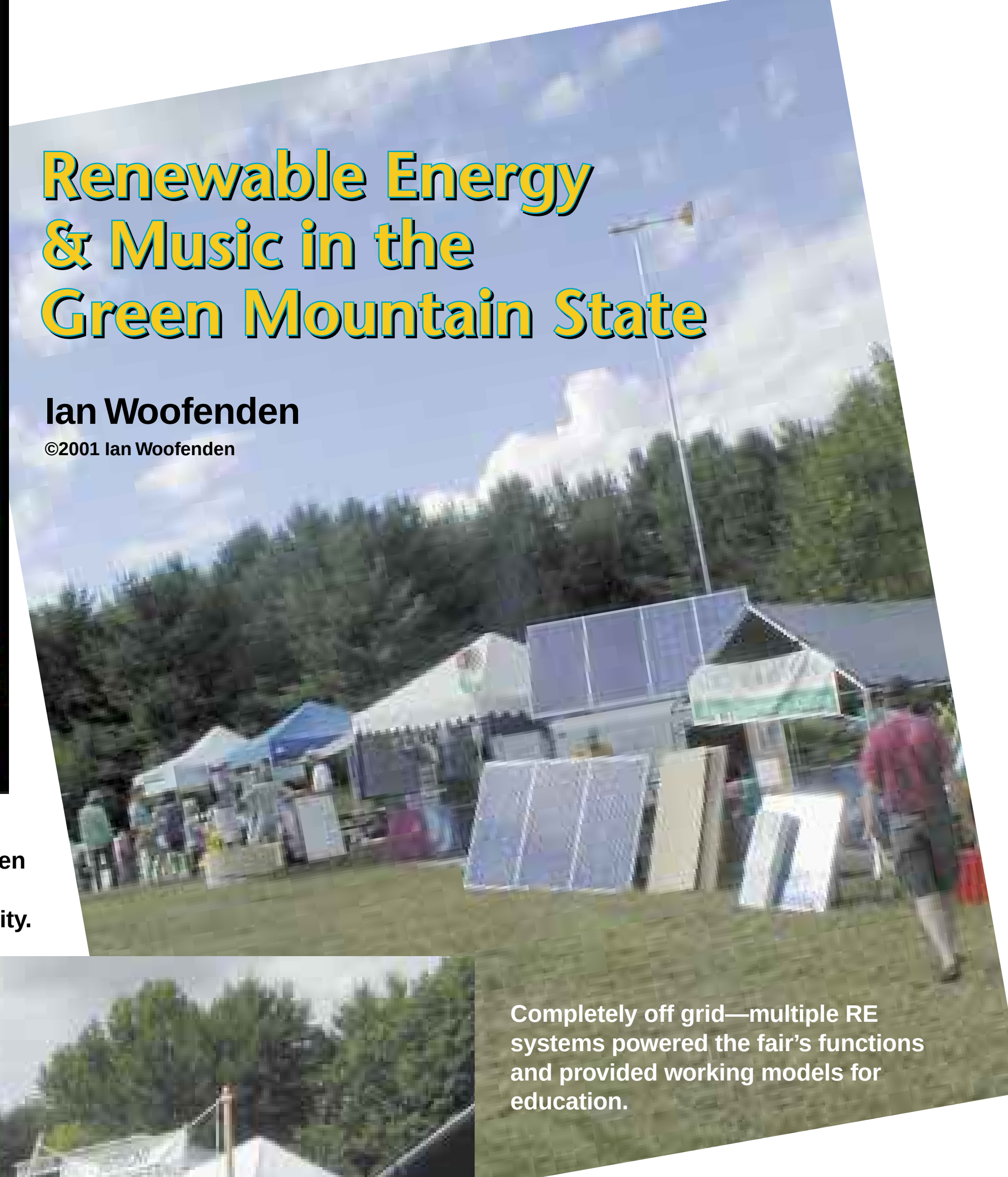
Wrench inquiries invited. Paid service calls for qualified Wrenches!

Renewable Energy & Music in the Green Mountain State

Ian Woofenden

©2001 Ian Woofenden

Forty-three vendors and twenty-seven workshops made for a great renewable energy learning opportunity.



Completely off grid—multiple RE systems powered the fair's functions and provided working models for education.

The seventh annual SolarFest was held in Middletown Springs, Vermont on July 14th and 15th, 2001. The fair was a resounding success, thanks to the hard work and support of volunteers, vendors, and sponsors. This off-grid fair is a wonderful showcase of renewable energy technology, and an entertaining weekend of music and theater.

More than 1,600 people attended the two-day fair. At the *Home Power* booth, we talked with people from all of the New England states and beyond, Canada, and even a few from abroad. The questions we fielded were educated, and we agreed with other vendors that it was a knowledgeable crowd.

Off-Grid Fair

It was especially exciting for me to see that the fair was completely off the grid. There were quite a number of renewable energy (RE) systems up and running, powering various parts of the fair. SolarFest's Solar Roller powered the main stage lights. Sixteen Solarex 60 watt panels, eight Surrette batteries, and two Trace SW4048 inverters provided an 8,000 watt continuous duty system.

Solar electricity powered the stages for this music festival, which has become a great renewable energy fair over the years.

Dave Pyles of New England Coalition on Nuclear Pollution (NECNP) brought a PV system that powered the main stage sound. The system included 960 watts of Solarex photovoltaic panels on the roof of an International Metro II step van, twenty-four deep-cycle batteries, and two Trace SW4024 inverters. This system stores 42 kilowatt-hours.

Robin Chesnut-Tangerman, trustee of SolarFest, and Bob Emery, head of SolarFest peacekeeping, built a small trailer-mounted rig called the Lightning Bug. It includes two 80 watt Kyocera panels, four Trojan L-16 batteries, and a Trace SW2512 inverter. The Bug ran the hospitality room lights for the performers, and lights for the shadow dancing screen on Saturday night.

Other systems included a small PV system that Chip Mauck set up to power the second stage. David Palumbo of Independent Power and Light powered the Chelsea Green workshop tent. Dori and Jeff Wolfe of Global Resource Options powered the RE workshop tent. John Blittersdorf of Central Vermont Solar and Wind powered the midway. A mobile system from Pam and Jeremy, students at Hampshire College, powered the gate lighting. And Ed Updike, site host and power man, set up several small systems around the grounds, powering the first aid and info house, the sales tent, and the ticket and performer parking booths.

Chip Mauck walks his talk by selling solar smoothies.

Education, Food, Crafts, & Music

There were 43 renewable energy and sustainable future vendors, and I was very impressed by the ones I talked with. These New Englanders take their commitment to renewable energy very seriously—they've done their homework and paid their dues. Two tents housed 27 workshops on renewable energy and sustainable future topics. The workshop lineup was comprehensive, and the speakers knew their stuff.

The crowds often made these workshops standing-room-only events. The speakers frequently had to cut off the discussion and questions so the next workshop could start. Most of the speakers had booths at the fair, and many workshop attendees followed them back to their booths to continue the educational dialogue.

Seven food booths kept the crowd well fed. I was especially excited to see how Chip Mauck of Sunweaver has combined food sales and renewable energy education. Chip and his crew travel all summer in a converted bus, selling "Solar Smoothies to Support Solar Energy Education," as his booth banner announces. He's serving up delicious fruit drinks, made using solar energy, while serving up RE education, system design, and equipment sales.

Josh Kerson with his prototype Spincycle, a solar-charged, human hybrid, electric recumbent tricycle. The pedals drive a generator to charge a battery. A small motor powers the rear wheel.

SolarFest prides itself on booking high-quality acts that will not overrun the specs of the solar-powered sound system. Over the past five years, the festival has hosted Dar Williams, Stanley Jordan, John Gorka, Vance Gilbert, Laura Love, and The Nields, among many others. Fifteen craft and merchandise vendors had a variety of things to sell. The fair organizers also had a tent with recordings from the performers, SolarFest T-shirts and bumper stickers, and a silent auction of items donated by vendors and others.

Over 160 volunteers make this fair possible. Many return year after year, and there are always newcomers eager to support the festival. The board of directors is a *Who's Who* of RE in the region, and the two part-time staff help pull all the threads together. Special mention goes to Nance Dean and Ed Updike, who live on the beautiful off-grid site and are key supporters of the fair.

Growing Renewable Emphasis

Melissa Chesnut-Tangerman, co-director of SolarFest Inc., the nonprofit organization that runs the festival, gave me some perspective on the fair's history:

SolarFest's seed was sown in the creative soil of a large group of friends who were oriented towards the performance arts, with a keen interest in renewable energy. It took some dancing for a few years to bring the educational aspect up to par. This year, it feels like we finally achieved that.

Kimberly Bushnell Mathewson, the other co-director, had this to say:

Of the inquiries I fielded prior to the festival, approximately eight out of ten were more interested in the energy education side of our event than the arts. This is a big switch for us, and one we have been working towards for years. We began as a solar-powered music festival, and every year since, the educational side has grown. I am so happy with this year's event and its balance, celebrating both the performing arts and a sustainable future.

The 2001 fair was a collaboration with Chelsea Green, publisher of many books on sustainable living. The company sponsored one of the workshop tents, and its publications were for sale at the fair through one of their dealers. The fair program lists more than 100 other sponsors and members who supported the fair.

Energy Consciousness

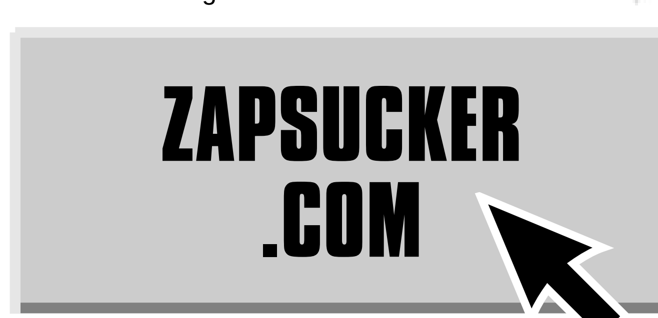
Over one-third of Vermont's electrical energy comes from the Vermont Yankee nuclear power plant. In 2008, the plant will run out of space to store its spent fuel rods, and Vermonters will have to face the reality of their energy choices. If the state's people and leaders turn to the group assembled at SolarFest this year, they'll find that they are well prepared to move Vermont toward a renewable future. For a small state, they have a surprisingly strong renewable energy industry, with quite a number of excellent spokespeople and advocates for RE. They are well poised to be an example for the rest of New England, and beyond.

We had a great time at the fair, talking RE from dawn to dusk, while seeing old friends and making new ones. If you're looking for a fun weekend of music and renewable energy education, check out next year's SolarFest—July 13th and 14th, 2002—and catch the New England RE spirit.

Access

Ian Woofenden, PO Box 1001, Anacortes, WA 98221
Fax: 360-293-7034 • ian.woofenden@homepower.com

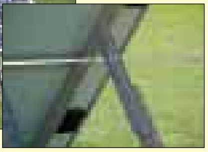
SolarFest, PO Box 1052, Middletown Springs, VT 05757 • 802-235-2866 • info@solarfest.org
www.solarfest.org



From the Manufacturers of the Track Rack™ Passive Solar Tracker

Introducing the new Universal Slotted-Channel Aluminum Rack.
Continuing 32 years of Simple, High Quality, Passive Solar Products

• Roof and Ground Mount Fixed Racks •



- Corrosion Resistant
- Competitively Priced
- Holds a Variety of Modules
- Light Weight
- Quick Turn-around
- 10 Year Warranty

ZOMEWORKS CORPORATION
1011 Sawmill Rd. NW, Albuquerque, NM 87104
(800) 279-6342/ (505) 242-5354 / Fax: (505) 243-5187
Email: zomework@zomeworks.com Website: www.zomeworks.com
Call us for a dealer near you!

INTRODUCING...

The NEW ProStar Solar Controller

- 15 or 30 amp
- 12/24 or 48 volt
- negative or positive ground

a revolution in 1995 & again in 2001
all NEW technology providing exciting NEW features!

MORNINGSTAR corporation
1098 Washington Crossing Rd., Washington Crossing, PA 18977 USA
Phone: 215-321-4457 • Fax: 215-321-4458 • www.morningstarcorp.com

Planetary Systems.com

Setting the NEW standard for Renewable Energy Systems

Our Power Package (P) will change the way you think about Solar Power.

Offering complete and exclusive power systems for off-grid, on-grid and sell-back power. Featuring state-of-the-art components, arriving at your door-completely tested, UL listed and ready to operate.

Planetary Systems is now a "Certified Trace Dealer."

Visit our website at www.planetarysystems.com
Phone 406-682-5646 Fax 406-682-5644
P. O. Box 340 262 Badger Road
Ennis, Montana USA 59729

(P) Patent Pending

Providing Sustainable Solutions for Living on Planet Earth

Visa/MC/Amex

OOPS!

. . . business slipping because your distributor sells retail?

Join the SunWize team. We support you with competitive pricing, lead distribution and technical assistance. And, we don't sell retail. Call our Dealer Sales Manager at 800-232-7652 if you are interested in becoming an authorized SunWize representative. We're partners . . . not competitors.

Siemens Solar PowerPro PARTNER

Visit us at www.sunwize.com

SunWize TECHNOLOGIES, INC.

SunEarth Inc.
Quality Solar Energy Products

THINK THERMAL-
THINK SUNEARTH

The CopperHeart Integral Collector Storage System

www.sunearthinc.com

SunEarth, Inc.
4315 Santa Ana Street, Ontario, California 91761
(909) 605-5610, FAX (909) 605-5613
Distributor inquiries welcome.

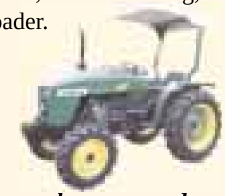
"HANZI" Chinese Diesel

China Diesel Generators
Water Cooling, Electric Start, 1800 rpm, 115V / 230V, 60 Hz, One Year Warranty. Free Parts Kit & Tools.

3 kw	$1575
7.5 kw	$2795
10 kw	$2995
15 kw	$4295

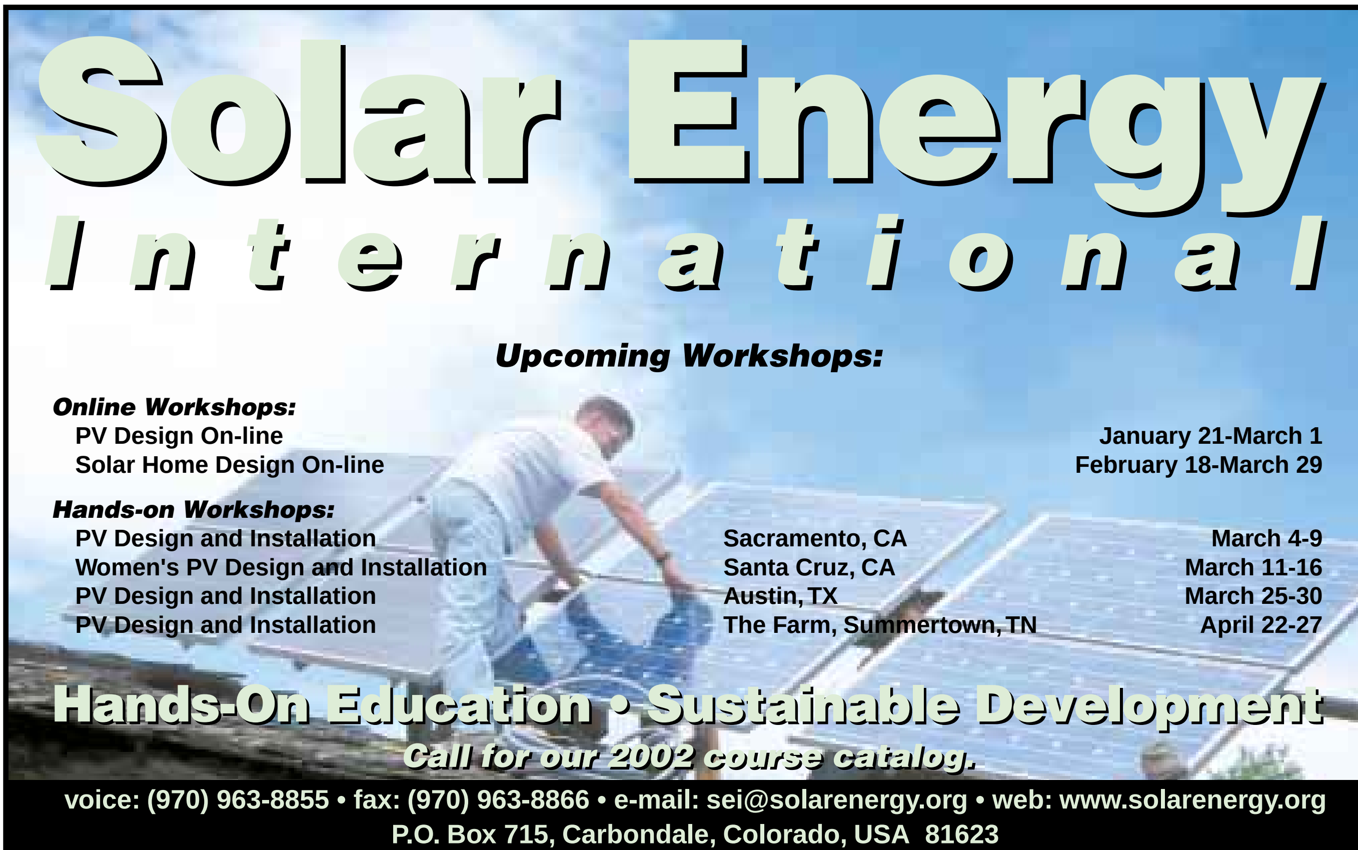
Immediate Delivery.
All China Diesel engine parts available.

China Diesel Tractors
4-Wheel Drive, Power Steering, Roll Bar, Double Stage Clutch, & Front Loader.



25 HP, 30 HP, & 50 HP.
Options: Front Loader Backhoe, Cab Turf Tires, & Implements.

Call now to place your order, or for more information
Newinli International, Inc.
1424 Arrow Hwy., Irwindale, CA 91706
Toll Free: 1-877-NEWINLI (1-877-639-4654)
Phone: (626) 357-9895 • Fax: (626) 357-9916
Web: www.dieselequip.com
Email: newinli@aol.com
Dealer Inquiries Welcome.



DEALERS WANTED

ARIZONA
CALIFORNIA
COLORADO
IDAHO
MEXICO
MONTANA
NEVADA
NEW MEXICO
OREGON
SOUTH AMERICA
TEXAS
UTAH
WASHINGTON
WYOMING

Sun Amp Power Company

800-677-6527 www.sunamp.com
email: sunamp@sunamp.com

bp solar Distributor

WHOLESALE DISTRIBUTOR
TRACE AUTHORIZED SERVICE CENTER

LARGE STOCK OF BP SOLAR MODULES BP2150, BP585, SX120 AND SX80s
COME VISIT OUR NEW 5000 SQ FT SHOW ROOM PUBLIC WELCOME

NO-HASSLE WATER POWER

If you have a reasonably fast running stream or tide nearby and 12" of water clear, Aquair UW Submersible Generator can produce 60 to 100 Watts *continuously*, up to 2.4 KWH per day. *NO TURBINES, NO DAMS, NO PIPES!* Water speed 5 mph (brisk walk) = 60W. 8 mph (slow jog) = 100W. Timber, rock, or natural venturi increases output.

Jack Rabbit Energy Systems

425 Fairfield Ave.,
Stamford, CT 06902
(203) 961-8133
FAX (203) 961-0382
e-mail: jackrabbitenergy@worldnet.att.net

The Alternative Energy STORE

"The on-line store for alternative energy products at discount prices"

www.AltEnergyStore.com

Specials

Improve Solar Array Efficiency with the SolarBoost 30A, 48V MPPT Charge Controller—Only $395

Complete Solar Water Heating Systems Starting at $1589

BP75 75W Panel Monocrystalline, high efficiency Only $345

E-mail: Sales@AltEnergyStore.com - Sales: (877)469-7026 or (207)469-7026

Harris Hydroelectric

Hydro-Power for Home Use

Introducing a new adjustable Permanent Magnetic Brushless Alternator

- 25 - 30% more efficient than Hi Output Alternator
- Marine Grade Construction throughout
- Re-connectable Stator
- Retrofittable on existing turbine

632 Swanton Road
Davenport, CA 95017
831-425-7652

NEW!

Home Power

Solstice Specials!

Deal 1

- All five Solar series CDs for $125

Shipping & Handling: U.S $8, canada $9, International $12

Deal 2

- A Solar series CD of your choice
- The New Electric Vehicles
- A Home Power Subscription or renewal

All for $60.00, S&H: U.S $6, Canada $10, International $15

Deal 3

- A Solar series CD of your choice
- The New Electric Vehicles

All for $45.00, S&H: U.S $6, Canada $10, International $15

Deal 4

- A Home Power Subscription or renewal
- The New Electric Vehicles

All for $39.00, S&H: U.S $6, Canada $10, International $15

Home Power

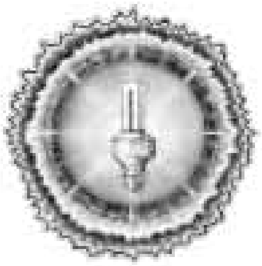
PO Box 520, Ashland, OR 97520

Phone: 800-707-6585 or 541-512-0201

Fax orders: 541-512-0343 • Email orders: hp@homepower.com

Web: www.homepower.com

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 Consecutive Insertion

	Single Insertion	*Three Insertions*	*Six Insertions*	*Ad Area sq. in.*
Full Page	$1,500	$1,350	$1,275	64.1
Half Page	$840	$756	$714	32.1
Third Page	$600	$540	$510	21.4
Quarter Page	$471	$424	$401	16.0
Sixth Page	$334	$300	$284	10.7
Eighth Page	$268	$241	$227	8.0
Twelfth Page	$188	$169	$159	5.3

Four process color (CMYK) in any sized advertisement is a flat rate of $185 per insertion. For inserts, and current subscriber/circulation demographics, please call us.

Home Power is published bi-monthly. The ad deadline for the Feb 01/ Mar 02 issue (*HP87*) is Dec 1, 2001. Call 541-512-0201 for further details.

International *Home Power* 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 — $43	Surface — $30
Mexico:	Air — $46	Surface — $30
Western Hemisphere:	Air — $48	Surface — $30
Europe:	Air — $64	Surface — $30
Asia and Africa:	Air — $77	Surface — $30
Pacific Rim:	Air — $77	Surface — $30

Surface shipment may take up to three months. All international issues are shipped in mailing envelopes. International subs are best paid for by either VISA, MasterCard, or funds from a U.S. bank.

International orders: Call: 541-512-0201
Fax: 541-512-0343

First Class *Home Power* Subscription

Get 6 issues of *Home Power* magazine via First Class U.S. Domestic Mail for $43. All First Class issues are shipped in an envelope. We start your subscription immediately with the current issue.

Second Class *Home Power* Subscription

Get 6 issues *of Home Power* via Second Class U.S. Domestic Mail for $22.50. Second Class can be forwarded for one issue (two months), so let us know immediately if you move! Please allow up to ten weeks for your first copy to arrive.

Back Issues of *Home Power* Magazine

Back issues through #20 are $6.25 each while they last. Back issues of #21–45 are $7.75 each. Back issues #46–84 are $8.75 each. Back issues #85 to present are $9.95 each. (Sorry, no more issues #1–12, 14, 15, 35, 36, 38, 40, 41, 59–61, 63–67, 79, 81, & 82.) Back issues are shipped First Class mail to U.S., Air to International. See the listing under Ad Index on the last page for details and current *Home Power* back issue specials.

Issues #1–42, 43–60, 61–70, 71–76, & 77–82 are on CD-ROMs for $29 each (Shipping: $2 in US; Canada $3; International $4).

MicroAds

MicroAd rates are 15¢ per character. Characters include numbers, spaces, and punctuation. $20 minimum per insertion (includes both print and web). Send a check with your ad. We do not bill MicroAds.

Home Power Magazine for Resale

Quantities of *Home Power* magazine are available for resale by distributors, newsstands, bookstores, energy businesses, and others. Please call, email, or write for rates and shipment specifics.

ACCESS ➠ *Home Power*, PO Box 520, Ashland, OR 97520 USA
800-707-6585 or 541-512-0201 Subscriptions and Back Issues
541-512-0201 Advertising and 530-475-3179 Editorial • www.homepower.com

TOP SECRET

GUERRILLA SOLAR: The unauthorized placement of renewable energy on a utility grid.

PROFILE: 0017

DATE: October 2001
LOCATION: Classified
OWNER NAME: Classified
INSTALLER NAME: Classified
INTERTIED UTILITY: Classified
SYSTEM SIZE: 60 watts of PV
TIME IN SERVICE: 3 months

Since we are urban dwellers, we have been mulling over how to make a solar difference. Due to historic preservation regulations, we cannot put PVs or solar thermal panels on our roof. But we have had a few solar-electric panels on our deck for several years to keep an assortment of batteries charged.

The batteries are commonly available, deep-cycle batteries that we rescued. We use them for ham radio field days (extra points are awarded to stations that run on “emergency” power), and backup power for lights and refrigeration here.

Our focus changed a bit when at Solwest 2001 in John Day, Oregon, we saw a distributor with Trace MicroSine inverters on closeout for a fraction of the original price. We bought two and took them home.

This got our guerrilla solar juices going. Why guerrilla? Because we are committed to a cleaner environment, have an aversion to red tape, and happened to have spare PV panels just looking for something to do.

One of the MicroSines is hooked up and pumping PV power into the grid right now. The other one is for future expansion. That will be awhile, since the MicroSines have a 100 watt capacity. Number one is currently only a little over half capacity. More PVs are in the cards. The MicroSine requires a 24 VDC input. So I wired two 12 VDC PVs in series for 24 volts. The AC output of the inverter is plugged directly into one of our household receptacles. Inverter output is protected by the original breaker for this circuit, which is located in the mains panel. The inverter is designed to go off-line in a matter of milliseconds if the grid fails.

We can tell the MicroSine is working, since it makes a small buzzing sound. But that wasn’t enough proof. We wanted to see that grid meter go the other way. So we turned off all circuit breakers in the mains panel, until the only active circuit was the one with the MicroSine on it. Then we made sure all the loads on this circuit were turned off.

And yes, the utility meter did spin backwards. It went very, very slowly with only our 60 watts of PV driving it, but it DID go backwards. Seeing that reverse power meter spin has us hooked. The search for more PVs to fully supply the first MicroSine, and equip the second is underway. What a great feeling!

After the MicroSine install, a technologically savvy neighbor was walking by while we were having dinner on the deck. He asked, “Are those solar cells?” He got the whole lecture, and is now a PV proponent himself. Just a small installation is all that’s needed to spread the word!

Why Guerrilla Solar?

Energy is freely and democratically provided by Nature. This century’s monopolization of energy by utilities both public and private threatens the health of our environment. Solar guerrillas believe that clean renewable energy should be welcomed by utilities. But utilities and governments continue to put up unreasonable barriers to interconnection, pushing common citizens to solar civil disobedience.

Guerrilla systems do not endanger utility line workers (see *HP71*, page 58). They share clean, renewable energy with others on the utility grid, and reduce the need for polluting generation plants. When interconnection for small-scale renewables becomes fair, simple, and easily accessible to all, there will be no more need for guerrilla action.

T-SHIRTS

Guerrilla Solar

Install by Night—Power by Day

On Black: $15, or Camo: $18
International orders add $5 for air shipping
Call, see our web site, or send check or money order
800-707-6585 (541-512-0201 Outside USA)
www.homepower.com
Home Power, PO Box 520, Ashland, OR 97520

100% Cotton
Good Shirts!

T-Shirts

Full Color on Natural Shirt
$15.00

Sizes:
S, M, L, XL, XXL

HOME POWER

Shipping:
$5 USA,
$8 Canada,
$10 International

To Order Call: 800-707-6585
(541-512-0201 Outside USA)

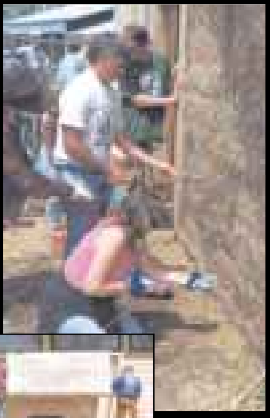
Or see our web site:
www.homepower.com

Or send check or money order to:
Home Power Magazine
PO Box 520, Ashland, OR 97520

got solar?...we do!

Upcoming Workshops Include:

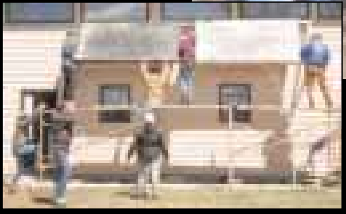
Green Building Technology



Solar Space Heating • Wind Systems Installations
Photovoltaic Installations • Straw Bale Construction
Masonry Heaters • Sustainable Living Workshops

Photovoltaics, Wind, Hydro

2002 Energy Fair
June 21–23



Solar Hot Water

Call or write for more information and course descriptions.
Midwest Renewable Energy Association, 7558 Deer Rd., Custer, WI 54423
phone (715) 592-6595 • fax (715) 592-6596 • mreainfo@wi-net.com • www.the-mrea.org

Guerrilla Solar— One Step at a Time

Solar Guerrilla 0008

©2001 Solar Guerrilla 0008

If you're interested in going solar, but your local utility isn't so keen on the idea, do the right thing—go guerrilla! A little solar civil disobedience is good for the planet and good for your head. Connecting a small photovoltaic (PV) system to the grid can be easy and safe. So here's a step-by-step approach to building a small, safe, and effective guerrilla solar-electric system.

All guerrilla solar-electric systems rely on inverters that are capable of synchronizing their AC output with utility power in order to feed renewable energy (RE) onto the grid. Every inverter capable of doing this is designed to disconnect from the grid in a matter of milliseconds when the grid fails. These inverters can't feed electricity onto the grid during a power outage. Regardless of utility approval, all utility interactive (UI) systems are inherently safe as far as utility workers are concerned.

So far, thirty-four U.S. states have enacted net metering legislation. This requires utilities to offset retail KWH rates to customers feeding renewably generated electricity onto the grid. Sixteen states have yet to implement similar legislation.

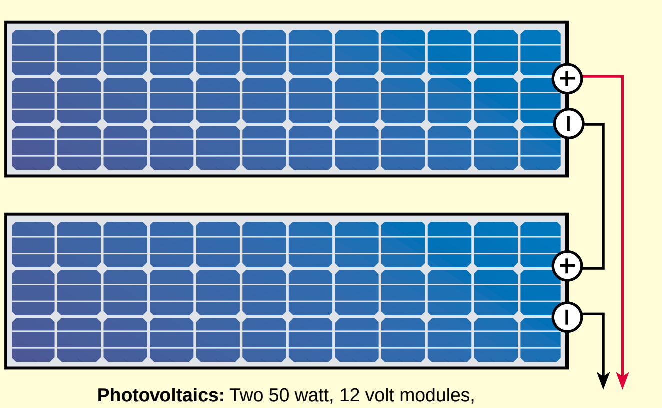
But even in states with net metering legislation, utilities often bypass laws governing the interconnection of utility intertied RE systems, in an effort to stunt the growth of distributed power generation. As a result, many clean energy advocates are operating clandestine RE systems with the simple, utilitarian goal of greening up the grid.

We've been operating a small, unauthorized, UI PV system for almost two years. Check out *HP75,* page 74. We estimate that we've put about 250 KWH of pollution free, solar electricity onto the grid since we installed the system. And every sunny day, it quietly keeps making more!

After reading the article in *HP85* about the whacky portable guerrilla solar-electric system, I thought that folks ought to check out my guerrilla rig. Our installation uses an OK4U inverter and a 130 watt Sanyo PV. I hope to inspire some people to get active and install their own UI PV system—utility approved or otherwise.

Our barn has a shed roof that faces true south and gets full sun all day long—a perfect place for PVs. Ideally, you want to install your PVs in a location that receives full sun throughout the day. Any shade on the PVs will radically reduce their output. In the northern hemisphere, orient your PVs toward true south. Then they'll produce the most energy on a daily basis.

Our OK4U inverter has a 24 VDC input and a 100 watt, 120 VAC output. Trace Engineering was importing these inverters and selling them under their MicroSine brand name. Trace is no longer importing them. But the OK4U inverter is still available through the manufacturer, NKF Electronics in the Netherlands. Many U.S. RE equipment resellers still have OK4 series inverters in stock under the Trace MicroSine brand name.



Photovoltaics: Two 50 watt, 12 volt modules, wired in series for 100 watts at 24 VDC

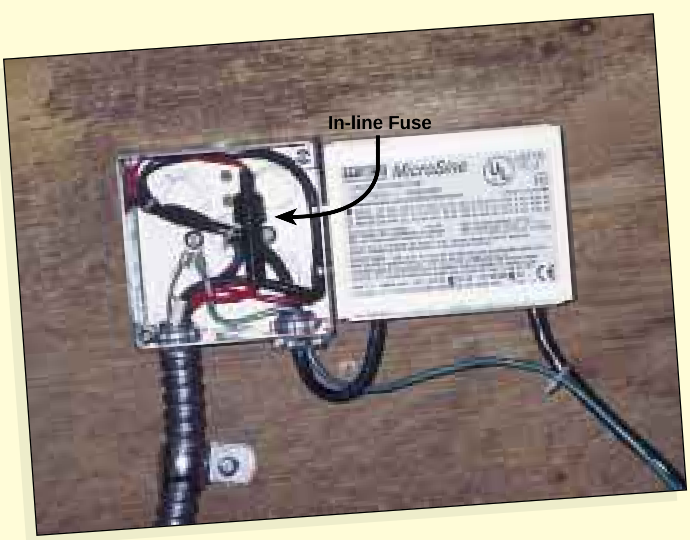
Our Sanyo PV has a 24 VDC nominal output. But most PVs have a 12 VDC nominal output. If you wire two 12 VDC, 50 watt PVs in series (positive from one PV to negative on the other), you get 100 watts output at 24 VDC, which meets the OK4U's DC input requirements.

You'll need a rack to mount your PVs. We made mounting feet using 1-1/2 by 1-1/2 inch (3.8 x 3.8 cm) galvanized steel angle. We mounted the feet to the roof framing, using 3 by 3/8 inch (7.6 x 0.95 cm) lag screws. The module frame is connected (bonded) to the main system ground at the inverter using #12 (3.3 mm^2) solid copper wire.

Two types of wire are commonly used between the PVs and the inverter. You can use copper USE wire, which is rated for UV exposure (direct sunlight). You can also use copper THHN-2 wire, run in flexible, liquidtight, nonmetallic conduit. THHN wire needs to be installed in conduit because the insulation will eventually break down if exposed to direct sunlight. We used USE wire in our system.

The inverter has two wires for DC input. Connect the positive PV output wire to the red (positive) DC input wire on the inverter. Connect the negative PV output wire to the black (negative) DC input wire on the inverter. Make sure to double-check the polarity of the PV output wires before you connect them to the inverter!

Low voltage systems move more current (amps) than if the same system was configured at a higher voltage. As the current moving through a wire increases, the voltage drop increases too. This means some energy is lost. So I'm a big fan of soldering low voltage connections to keep the resistance and voltage drop as low as possible. Properly applied solder ensures a solid electrical connection. I cover the soldered connections with heat shrink tubing to insulate them from one another.



Make sure to include a DC-rated fuse in the positive wire between the PVs and the inverter. This will protect the DC wiring from a short circuit, and allow you to electrically disconnect the PV from the inverter.

To figure out the correct fuse size, multiply the PV short circuit current (Isc) by 1.56. This is the constant used for sizing PV overcurrent fuses or breakers. The Isc rating is usually listed on the back of the PV module. If you are using two 12 volt panels wired in series for 24 VDC, you still only multiply one module's Isc by 1.56. A series connection increases voltage, but not current.

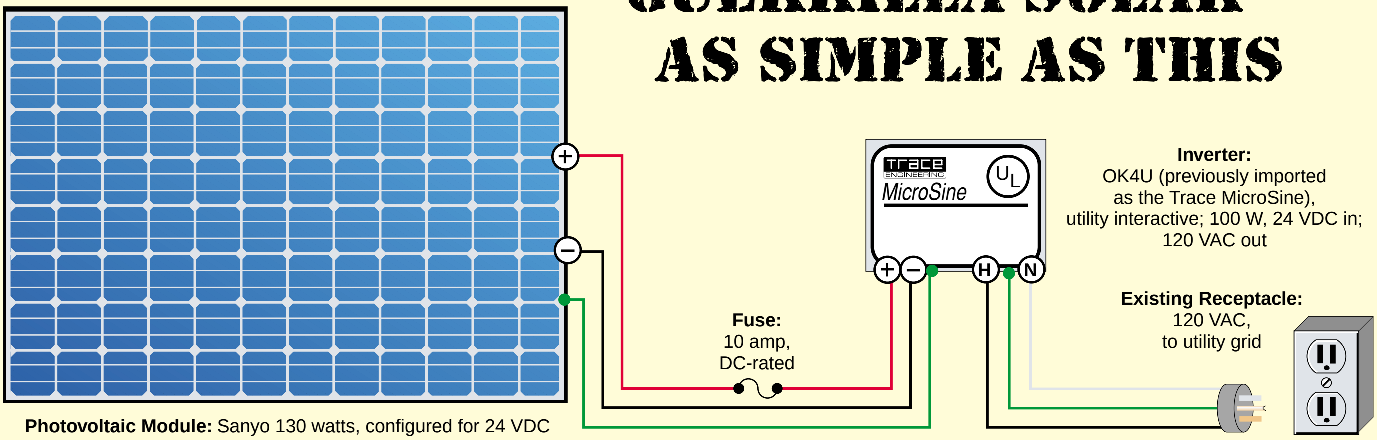
In our case, the Isc of the Sanyo PV is 3.27 amps at 24 VDC nominal. So 3.27 amps x 1.56 = 5.1 amps. We rounded up and installed a 10 amp fuse. Remember that the fuse size always needs to be smaller than or equal to the ampacity rating of the wire you're using and the series fuse rating of the module.

The OK4U inverter is designed to be mounted directly on the back of a PV module. But we decided to play it safe and install the inverter inside to keep it at a lower operating temperature. It gets very hot on our barn roof. Besides, PVs often operate at temperatures above 50°C (122°F) because they absorb the sun's heat, while only using its light.

The distance between our inverter and the PV module is only 48 inches (122 cm). I used #10 (5.3 mm^2) copper wire, so the voltage drop is really minimal at 0.1 percent. If you decide not to install your OK4U inverter on the PV module, make sure to size the PV to inverter wire run for the specific distance between your PV and inverter. You can get a wire sizing spreadsheet from the "Promised" section of the Downloads page of *Home Power's* Web site at: www.homepower.com.

I mounted the inverter to the side of a 4 by 4 by 2 inch (10.2 x 10.2 x 5 cm) metal handibox using hardware

GUERRILLA SOLAR—AS SIMPLE AS THIS



that was included with the inverter. This hardware can also be used to attach the inverter directly to the module frame if you're installing it on the back side of the PV. The inverter has cooling fins that will accept 1/4 inch (6 mm) bolt heads. Position the inverter on the inside edge of the module frame near the J box.

Locate and drill two holes so the inverter is not up against the substrate (back of the PV module). This will allow both the PV and the inverter to operate at lower temperatures. Use a nut and a star washer to hold each bolt tight to the inverter. A second nut and star washer is used to secure the bolts to the module frame. Then the fins of the OK4U will be set off a bit from the frame.

The inverter's AC output has four wires. Two of the wires (the blue and orange ones) are for an optional communications adapter that allows you to monitor system performance via a PC. We didn't purchase this adapter, so these two wires are not being used in our system.

The hot inverter AC output wire is black. The neutral inverter AC output wire is white. These wires can simply be wired to a standard 15 amp, male cord cap (plug). The hot wire goes to the gold terminal screw in the cord cap and the neutral goes to the silver one. Take a look at the detail photo of the cord cap wiring.

To eliminate the possibility of electrical shock, I ran a separate #12 (3.3 mm^2) ground wire from the cord cap's green ground terminal screw, and connected it to the inverter mounting hardware. This means that the inverter and handibox are bonded to the AC ground system.

The OK4U inverter won't generate AC electricity unless it senses acceptable grid voltage, current, and frequency conditions. But it's a good idea to get in the habit of electrically disconnecting all generation sources when you work on your system. In my case, I just have to remove the 10 amp fuse on the DC side and unplug the inverter.

The inverter output can safely be plugged directly into any standard AC receptacle (plug-in) in your home, as long as the circuit is protected by an existing breaker. This breaker will provide overcurrent protection for the AC side of the PV/inverter system. Double-check all your wiring and plug it in! The AC output of our inverter is plugged into a receptacle located right below the inverter. The inverter makes a slight buzzing sound when operating.

OK4U inverters have internal data acquisition capabilities. The inverter tracks real-time DC module voltage, AC output voltage, current, watts, and total watt-hours. It also measures inverter temperature. An optional serial port computer interface module is available with special software to access the data (see *HP67,* page 34).

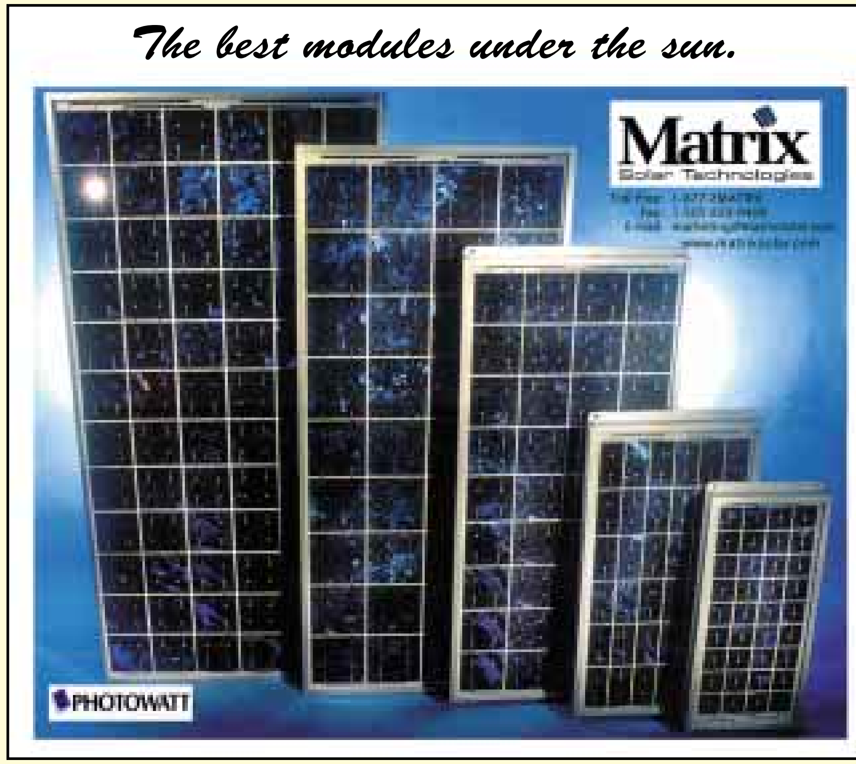
Spin the Meter Backwards—Safely

Getting approval from a stubborn utility has absolutely no bearing on the safety of a grid intertied RE system. Inverters that are capable of interfacing with the grid are designed and certified specifically for this application. And it's just common sense that you should follow safe wiring, overcurrent protection, and installation practices to protect your investment.

So install your system right, kick back, and watch the meter spin the *right* direction. If you disconnect all your household loads except the circuit that the inverter's plugged into, you'll be able to see your utility meter spinning backwards, ever so slowly. No doubt you'll want to make it spin faster. Luckily, all you have to do is add a couple more PVs and another OK4U inverter! One step at a time...

Access

OK4U manufacturer: NKF Electronics B.V., PO Box 415, NL-2800 AK Gouda, The Netherlands • +31 182 592 333
Fax: +31 182 592 123
electronics@nkf.nl
www.nkfelectronics.com



HOME POWER on CD-ROM

Original Magazine Layouts & More

Color • Indexed • Searchable • Exportable • Printable
Adobe Acrobat PDF® format (reader included)

Solar6: two CD set, same price

Issues #77 (June '00) through #82 (May '01)

Over 6,000 pages of renewable energy information: spreadsheets for load analysis, wire sizing, and the Energy Master for system design; classic basic articles from the *HP* archives; 30 years of solar insolation data, wind data for 900 sites in the U.S.; manuals and spec. sheets of popular RE equipment; energy related government publications; the *current* In Biz database; and a searchable index.

Energy Pathways video CD

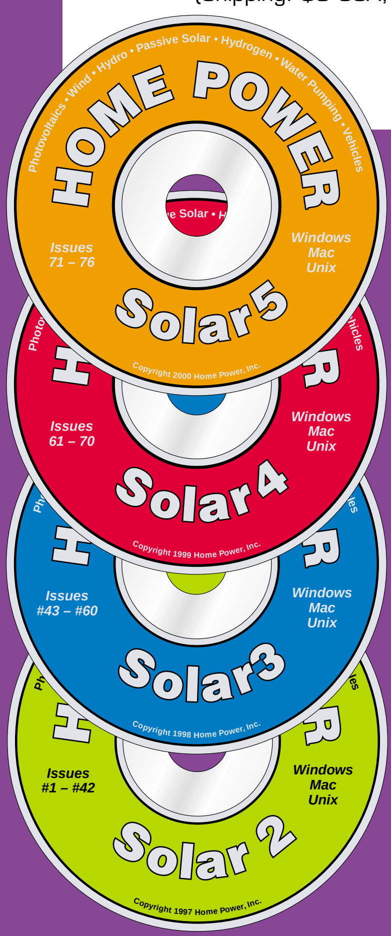
The basics of renewable energy, including solar, wind, hydro, and solar thermal energy sources, energy storage, and energy use. All in 37 minutes of digital QuickTime video format.

$29

Shipping: $2 in US
(Canada $3; International $4)

Special Deal: All five CDs for $125
(Shipping: $8 USA, $9 Canada, $12 International)

SunWorld, the official magazine of the International Solar Energy Society says, "Together these CDs offer the largest collection of useful and practical information on achieving energy independence ever available."



Solar5: Issues #71 (June '99) through #76 (May '00)

Over 1,400 pages of *Home Power;* guerrilla solar video clip; 5 hours of audio lecture (MREF '99) on batteries, inverters, ram pumps, RE system Q&A, and solar cooking; spreadsheets for load analysis, wire sizing, and system design; 30 years of solar insolation data; and the In Biz database.

Solar4: Issues #61 (Oct. '97) through #70 (May '99)

Over 1,200 pages of *Home Power;* 3 hours of audio lecture (MREF '98) on batteries, inverters, and RE system Q&A; video clips from the "RE with the Experts" series; spreadsheets for load analysis, wire sizing, and system design; and the In Biz database.

Solar3: Issues #43 (Oct. '94) through #60 (Sept. '97)

Over 2,000 pages of *Home Power;* 2 hours of audio lecture on batteries and inverters (MREF '97), spreadsheets for load analysis, wire sizing, and system design; an interactive tour of *Home Power* (Funky Mountain Institute); and the In Biz database.

Solar2: Issues #1 (Nov. '87) through #42 (Sept. '94)

Contains the original magazine layouts (text & graphics), over 3,900 pages of *Home Power.*

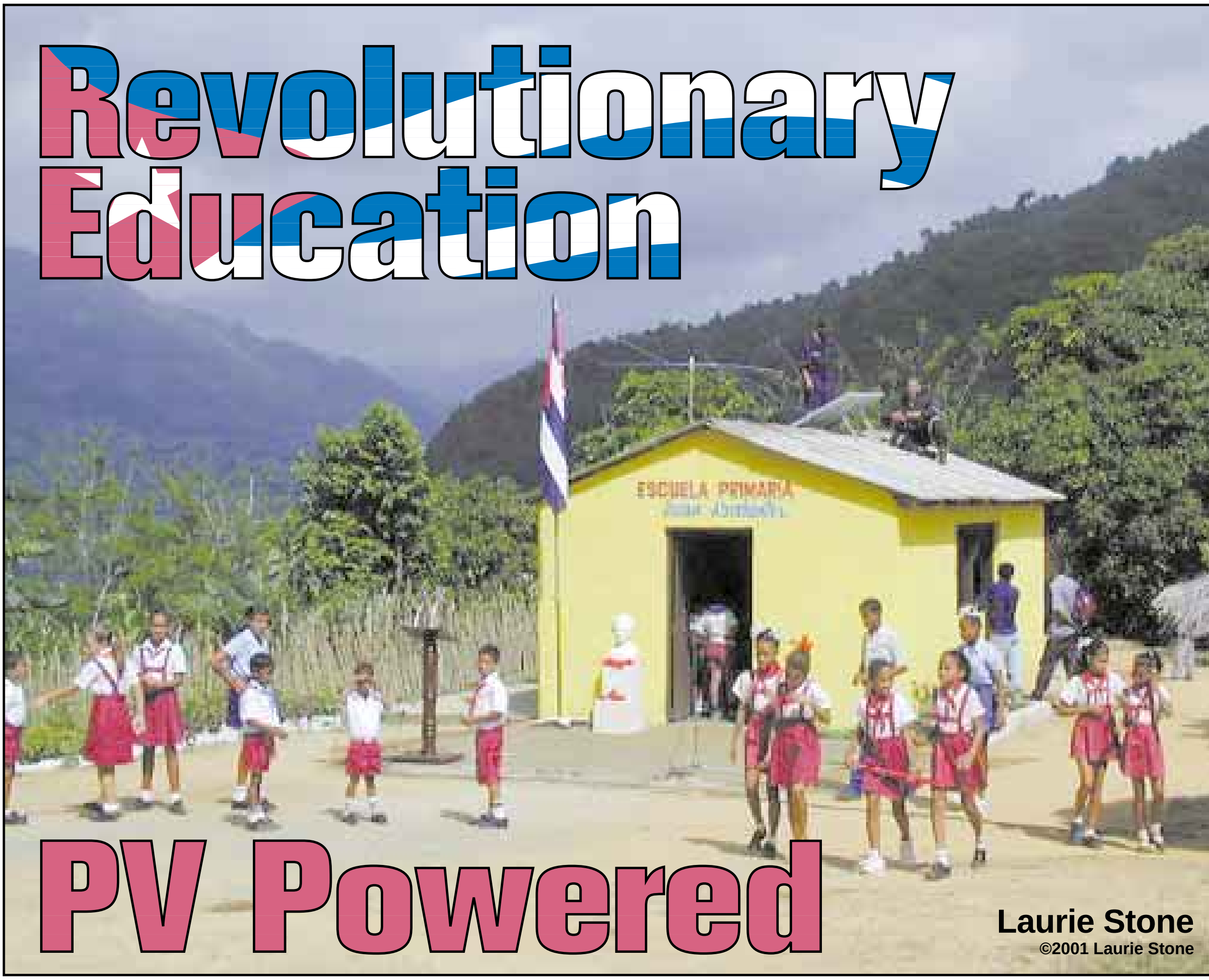
Call 800-707-6585

Home Power, PO Box 520, Ashland, OR 97520
541-512-0201 • fax 541-512-0343 • www.homepower.com

Revolutionary Education PV Powered

Laurie Stone

©2001 Laurie Stone



Juan Abrahantes School, Imias Municipality, Guantanamo Province.

Travel around rural Latin America and you're sure to see schools without basic educational tools, let alone electricity. Not in Cuba. More than 34,000 children in rural areas of this small Caribbean island are reading, writing, and watching educational videos using the power of the sun.

Cuba's commitment to education is astounding. Although many countries have obligatory schooling, Cubans take mandatory schooling to mean that they are required to provide the best educational opportunities possible for their children.

They also take family seriously. In order to allow small children to remain close to their homes, every rural community, no matter how remote or how small, has a primary school. And every primary school in these remote areas is now powered by photovoltaics (PVs).

Before 1959, Cuba had 800 MW of electrical generating capacity, and the majority of it was in the large cities. After the Cuban revolution in 1959, the government made rural electrification a priority. In the next thirty years, 95 percent of the country was electrified with over 3,000 MW of capacity.

Recovering from Soviet Oil Dependency

Cuba had been buying oil inexpensively from the Soviet Union. The 1989 collapse of the Soviet Union, along with a tightening of the U.S. enforced economic blockade, led to the bottom falling out of the Cuban economy.

From 1989 to 1993, the island's gross domestic product (GDP) fell by half, from US$19.3 billion to US$10 billion. Since Cuba couldn't trade sugar for oil with Moscow, the country lost most of its petroleum supplies overnight. Imports fell by 75 percent—much of that was food, spare parts, agrochemicals, and industrial equipment.

Without oil, industrial production fell, factories closed, public transport collapsed, blackouts became common, and agriculture and food production were paralyzed. In

1993, at the height of the crisis, Cuba was spending 60 percent of its import bill on food and oil.

The years since 1989 are known as the "special period," a time when the Cuban people have had to figure out a way of coping with their grave economic problems. The state moved dramatically to restructure the economy. For the most part, Cubans sympathize with the state's efforts to distribute available food as fairly as possible. The special period has been a time of belt-tightening. But the consensus is that the problem is a national one, which all Cubans need to work on together to solve.

Cuba had to begin buying oil on the international market, which their fledgling economy could not afford. This led to a desire to decrease their dependence on fossil fuels and use more renewables.

Rural primary school in Pinar del Rio Province.

Cuba is now using biogas, biomass, solar, wind, and microhydro energy. The residue from sugarcane, Cuba's main export crop, is used to power the 156 sugar mills in Cuba. The excess electricity is put into the grid. Over 220 microhydro systems, from 8 KW to 500 KW, supply 30,000 Cubans with electricity. Besides the 9,000 mechanical windmills in Cuba, the island now has a 0.45 MW wind farm to supply electricity to the national electricity grid.

Students watch an educational video in the Giralda Baldoquin School, Jobabo Municipality, Las Tunas Province.

2,000 School PV Systems

Even during the special period, social programs, such as education and health care, were not cut, but remained a high priority of the Cuban revolution. To better the quality of education for their children, in the year 2000, the Cuban government financed a program to electrify all of the primary schools in the country that had no electricity. The program was carried out by PV distributor Ecosol Solar.

Ecosol Solar is a division of Copextel, a private Cuban technology company that specializes in computers, electronics, telecommunications, and other high technologies. Ecosol Solar sells, services, and installs photovoltaics, solar thermal, wind, biomass, and hybrid systems.

In less than one year from the time the first PV panel was installed on a primary school, 1,994 schools had photovoltaic systems. Each system consists of a 165

Students in PV Powered Cuban Schools

Student Population	*Number of Schools*
1	21
2 – 5	357
6 – 10	483
11 – 20	518
21 – 40	385
41+	180
Total	1,944

Antonio Guiteras School, Union de Reyes Municipality, Matanzas Province.

School System Costs

Item	*Cost (US$)*
PV module, 165 W	$970
Charge controller, 20 A	200
2 Batteries, 6 V, 220 AH	160
Inverter, 250 W	80
2 DC lights, 15 W	70
Total	$1,480

watt module, a 20 amp controller, a 250 watt inverter, and a 220 amp-hour battery bank. Three of the systems also include small wind generators.

Each school has two 15 watt DC lights, and an AC television and VCR for educational programs. The systems are designed to run five hours a day if students watch a video. Without the video, the systems can run for eight hours a day.

PV *Brigadistas*

To carry out such an ambitious project, the nongovernmental organization (NGO) Cubasolar and Ecosol trained brigades in each of the provinces on the installation of PV systems. The brigades were made up of representatives of Ecosol, university professors, students, teachers, and other volunteers from the provinces.

Cubasolar was founded in 1994. Its mission is to promote renewable energy, energy efficiency, and environmental education. Every two years, Cubasolar holds an international renewable energy conference in Cuba. The organization has introduced renewable energy into the national education system, and publishes books and magazines promoting the use of renewables.

Twenty-five brigades went to the rural areas, installed the systems, and trained local people in the maintenance of the systems. A maintenance video was shown to the teachers at each school. The teachers are in charge of monitoring the battery level, and occasionally cleaning the panels.

Every ninety days, each school receives a maintenance visit from a technician. There is also a repair shop in each province, and a minor repair shop in each territory (the provinces are made up of numerous territories) set up by Ecosol. An Ecosol technician also does a periodic inspection of the entire system.

No problems have been reported with any of the school systems so far. Even with the PV electrified health clinics program, which began in 1987 (see *HP66*), there have been very few system failures. Many of these systems have actually survived three hurricanes with no damage. Ecosol credits the lack of failures to user training.

Students at the environmental education classroom in Ciudad Libertad show drawings of renewable energy at work.

The PV electrified schools bring the total number of PV systems in Cuba to more than 2,400. These include 320 health clinics, 100 social centers, 4 rural hospitals, and numerous houses.

Cuba is importing part of their photovoltaic hardware. But they now build their own charge controllers, and they also have a PV manufacturing plant in Pinar del Rio where they are producing PV modules with 14 percent efficiency.

Due to their economic situation, the factory is not producing panels for public use yet. They just do not have the money to mass produce the PV modules. Right now, they are only being produced in a laboratory setting. With financing, the factory could produce 1 megawatt of PV panels a year. Their hope is that in the future, systems can be made completely with Cuban parts.

Computers for the Countryside

In June of 2001, Cubasolar received the United Nations' Environmental Program (UNEP) Global 500 award for this remarkable PV program. But the school electrification program is not finished yet.

The Cuban government wants every child in Cuba to have access to a computer. They plan to put a computer in every primary school by March of 2002. In the next few months, Cubasolar and Ecosol are committed to adding one more panel to each primary school, so that each system can also run a computer.

Environmental Education

Children in Cuba not only learn using PV technology, but also learn about PV technology. In the middle of Havana, young children learn about renewable energy in the environmental classroom in Ciudad Libertad. Ciudad Libertad (Freedom City) was an army barracks in prerevolutionary Cuba. After 1959, it was converted into a school complex. It now contains preschool through university classrooms.

Children from schools all over Havana use the environmental education classroom in Ciudad Libertad. They learn about environmental issues, including energy conservation, recycling, and renewable energy. On World Environment Day (June 5) alone, 1,340 students visited the classroom. On a recent visit, young children were drawing pictures of PV powered hospitals and schools.

Renewable energy education is integrated into other schools as well. The Basic Industry Ministry financed a book on environmental education for teachers. Cubasolar estimates that 98 percent of all Cubans know that PV panels produce electricity.

Cuba takes its commitment to education seriously. Their economic hardships and lack of access to fossil fuels do not deter them from providing high-quality education to every child in Cuba. Jose Martí, a Cuban hero who fought against Spain for Cuban independence said, "People can't be more perfect than the sun. The sun

Cubasolar Conference: Solar and Renewable Energy in Cuba

March 29 through April 7, 2002

We traveled for three hours by bus, open-air truck, and on foot to get to a remote PV installation in the Sierra Maestra, the mountains of eastern Cuba. This was no ordinary solar conference. This was a conference organized by Cubasolar, a nongovernmental organization that promotes renewable energy in Cuba.

Cubasolar has been organizing international renewable energy conferences since 1994. Every two years, scientists, engineers, and solar enthusiasts from around the world travel to Cuba to learn about what this small island is doing with renewable energy.

Unlike other solar conferences I have attended, the majority of the conference was not held in lecture rooms, but was spent visiting PV, micro-hydro, and biomass sites. During the 1996 conference, we visited a remote community powered entirely by photovoltaics, witnessed the grand opening of a remote PV powered health center, spent time in two communities electrified with microhydro systems, and visited a sugarcane factory run on biomass from the sugarcane stalks.

During the adventurous trips to these remote regions, we talked with our Cuban counterparts and with solar advocates from Europe and throughout Latin America.

Although it is illegal for U.S. citizens to travel to Cuba for tourism, there are certain licensed travel providers to Cuba. I traveled to Cuba with Global Exchange, a licensed provider that offers trips to learn about Cuba's programs in sustainable development, music, art, and culture. Global Exchange also obtains specific educational travel licenses from the U.S. treasury department for their trips to the Cubasolar conference.

The Cubasolar 2002 conference will be held in Pinar Del Rio province of western Cuba from March 27 to April 7. For information on the Global Exchange delegation, contact Pam at Global Exchange listed in the access section at the end of this article.

burns with the same light that it heats. The sun has spots. The unfortunate speak only of the spots. The fortunate speak of the light."

Cubans are using the light of the sun to combat their oil shortage, and to ensure a superior education for their children. Now every rural Cuban primary school proudly displays a Cuban flag, a bust of Jose Martí, and a photovoltaic system.

Access

Laurie Stone, Solar Energy International, PO Box 715, Carbondale, CO 81623 • 970-963-8855
Fax: 970-963-8866 • sei@solarenergy.org
www.solarenergy.org

Cubasolar, Calle 20, #4115 Esquina a 47, Playa, Havana, Cuba 11300 • 537-29-6691
Fax: 537-24-1732 • sol@cubasolar.cu
www.cubasolar.cu/instituciones/cubasolar.html

Ecosol Solar, Calle 29 #2610 Miramar, Playa, Havana, Cuba • 537-24-0239 or 537-24-3731
Fax: 537-24-1732 • ecosol@solar.copextel.com.cu
www.cubasolar.cu

Global Exchange, 2017 Mission St. #303, San Francisco, CA 94110 • 800-497-1994 or 415- 255-7296
Fax: 415-255-7498 • info@globalexchange.org
www.globalexchange.org

RENEWABLE ENERGY with the EXPERTS
An Instructional Video Series on the Basics of Residential Renewable Energy

$39.95 each

Residential Solar Electricity with Johnny Weiss, 48 min. Johnny Weiss is one of the founders and teachers at Solar Energy International, in Carbondale, CO.

Residential Wind Power with Mick Sagrillo, 63 min. Mick Sagrillo has installed and repaired over 1,000 wind turbines.

Residential Microhydro Power with Don Harris, 44 min. Don Harris has designed and manufactured over 1,000 microhydro power plants.

Reviewed in HP56

Batteries with Richard Perez, Editor in Chief and founder of *Home Power* magazine.

Solar Water Pumping with Windy Dankoff, 59 min. Windy Dankoff has been designing and installing solar-powered water pumping systems for 15 years.

Shipping $5 USA, $6 Canada, $10 International

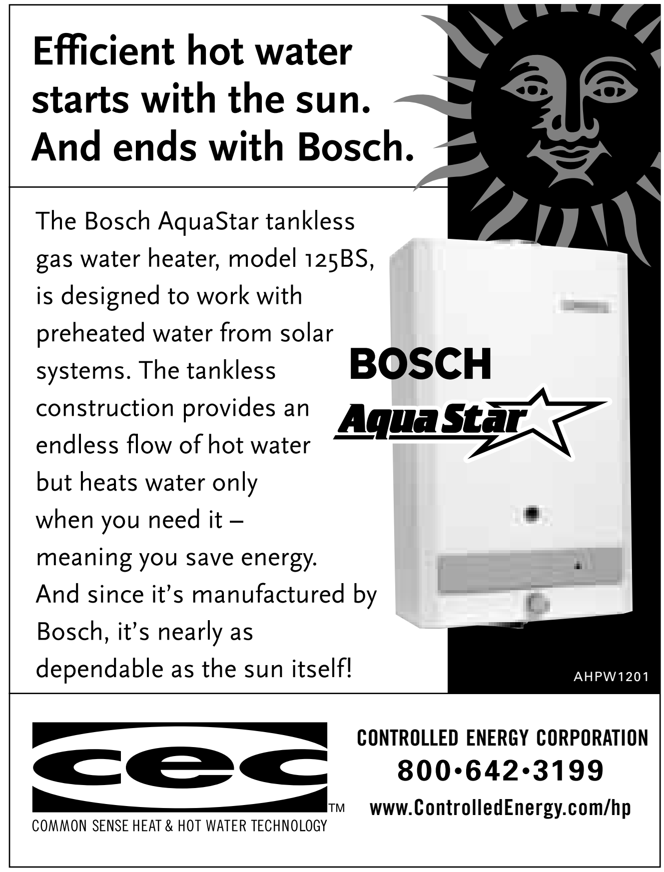
Home Power, Inc., PO Box 275, Ashland, OR 97520
toll free in USA: 800-707-6585 • 541-512-0201
Fax: 541-512-0343
Web: www.homepower.com

SOLARHOST
Solar-Powered Web Hosting
& Applications Service Provider
The official Web host of Home Power magazine.
www.SolarHost.com
Toll Free 866-SUN-HOST
703-934-9245 • FAX 703-934-9264
SolarHost, technology as nature intended.

Solar Wind Works
CA Contractor's License: #796322
Renewable Energy Power Systems
• Sales—PV, Wind, & Microhydro
• Design—Off-Grid or On-Grid
• Full On-Site Installation
Chris Worcester
Toll Free! 1-877-682-4503
530-582-4503 • fax: 530-582-4603
PO Box 2511, Truckee, CA 96160
www.solarwindworks.com
off the grid since 1977!
Proven Energy Solutions for Self-Reliance or Utility Buy-Back

Solar Village
Independent Renewable Power
We will design, install and support a Professional - quality power system for you. Choose from micro-hydro, wind and photovoltaic systems or combine any of these to meet your needs and fit your lifestyle.
Plus you get trained so you know how it works!
Call us. Tel 800-376-9530
Fax 336-376-1809
Visit our web site
www.solarvillage.com
Located in North Carolina


GotSolar.com
Everything you need under the Sun!
Free Shipping
In the continental US
No Sales Tax!
GotSolar.com brings you the BEST equipment, at the BEST price!
Stop by our web store
www.gotsolar.com
Email: sales@gotsolar.com
Phone:541-412-7276

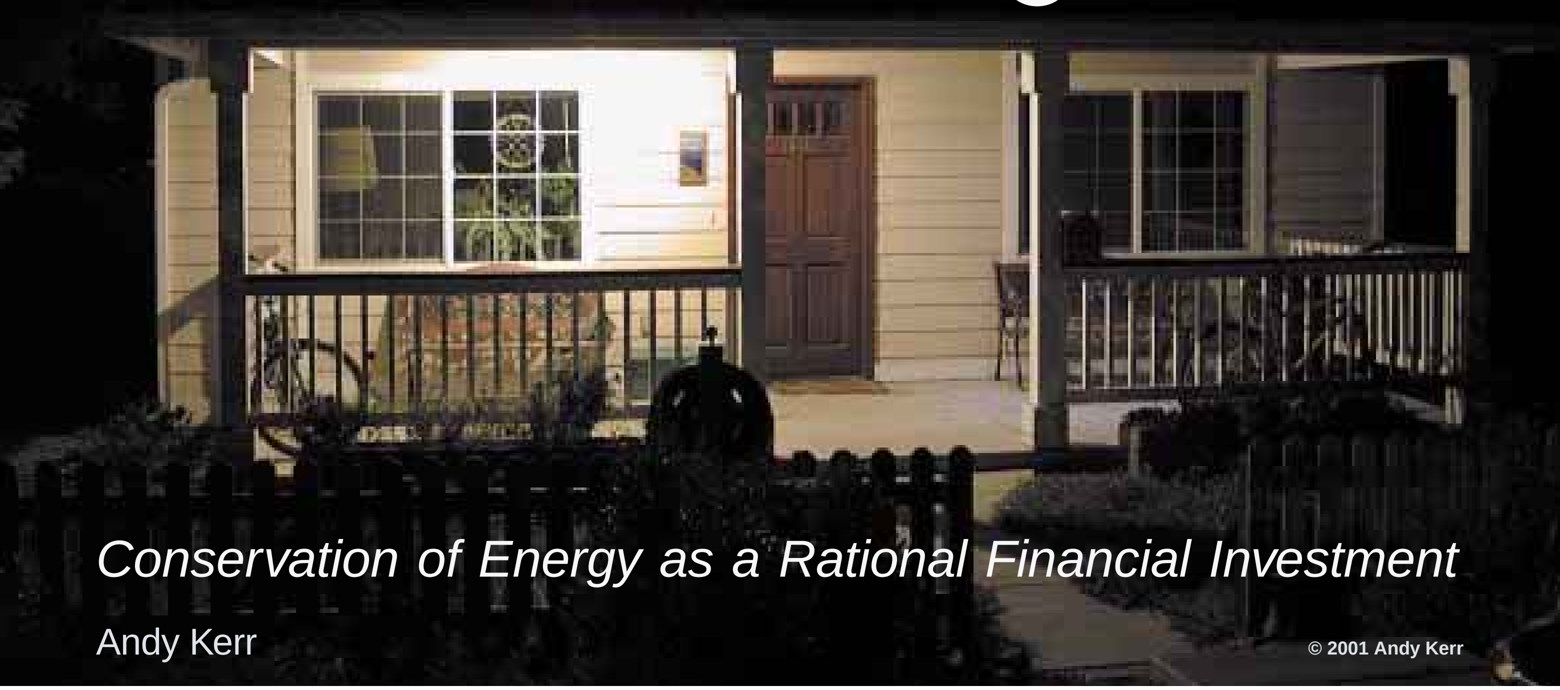

Efficient hot water starts with the sun. And ends with Bosch.
The Bosch AquaStar tankless gas water heater, model 125BS, is designed to work with preheated water from solar systems. The tankless construction provides an endless flow of hot water but heats water only when you need it – meaning you save energy. And since it's manufactured by Bosch, it's nearly as dependable as the sun itself!
BOSCH
Aqua Star
AHPW1201
cec
COMMON SENSE HEAT & HOT WATER TECHNOLOGY
CONTROLLED ENERGY CORPORATION
800•642•3199
www.ControlledEnergy.com/hp


Learn about Cuba's award-winning renewable energy program & other projects in sustainable development in Cuba
April 1 to April 6 2002
Fifth International Renewable Energy Conference
US Delegation March 29 - April 7
Contact: Pam Montanaro, Global Exchange
510-486-1050 or pam@globalexchange.org
www/.globalexchange.org/campaigns/cuba/sustainable/index.html
Hosted by Cuba Solar
Pinar del Rio, Cuba
www.cubasolar.cu

Doing Well While Doing Good

Conservation of Energy as a Rational Financial Investment

Andy Kerr



© 2001 Andy Kerr

Warm, inviting, and energy efficient—a bright compact fluorescent (left) and not so bright LED (right) light the porch.

Many years ago, I installed compact fluorescent lightbulbs (CFs) because of "personal virtue." They weren't very good, and they were darn expensive. Now their economics put the recent booming stock market to shame. Measured by either simple payback in years or return on investment, investing in CF lightbulbs is an extremely rational investment for the consumer.

I became interested in financial rates of return, not so much because of the money, but because people often use "payback" as an excuse for not switching to solar energy. While there are compelling environmental arguments to convert to solar energy, environmentalists and solar energy advocates must address the economic issues as well.

Many people I've talked to don't consider the financial costs of operating an electrical device, whether they are buying a lightbulb, a refrigerator, or a furnace. They tend to go for the lowest initial price. Such behavior is not just environmentally insensitive, but also economically irrational.

This malady is not just limited to uninformed consumers, but often to business types, who spend each working minute trying to make money. Energy philosopher Amory Lovins has noted the disconnect in many businesses between capital costs and operating expenses. When a new plant is designed, most often the lowest-cost motors are bought to keep construction costs down. But purchasing more efficient motors, albeit twice as expensive, may have a payback in one or two quarterly reporting periods.

Most people who do consider operating costs will only purchase the more expensive, albeit more efficient, device if it has a payback of no more than three years. They want the additional capital cost to be recouped in energy savings (both measured in dollars, of course) within three years. In other words, roughly a 33 percent return on investment. It doesn't seem to matter that the device may well last several times the payback requirement.

Do these same people insist that their saving accounts, certificates of deposit, bonds, stocks, and mutual funds have a similar return on investment? Of course not. Even the tremendous run-up of the stock market these last few years was between 20 and 30 percent, and that was an anomaly.

It turns out that the compact fluorescent (CF) bulb, depending on how it is used, can have a rate of return that is still illegal for most financial institutions to charge. Any energy consuming device should be considered, not only for environmental impact, but also in terms of pure, simple, capitalistic economic efficiency. If they were, both consumers and the environment would generally be better served.

Simple Payback & Return on Investment

Many consumers can grasp the concept of simple payback. Say you buy something that costs X instead of Y and the Y device saves you Z amount each year. How many years must pass to recover the increased capital cost (Y - X) resulting from saved annual operating costs (Z)? While this approach is not financially elegant, since it doesn't factor in the time value of money (interest), it's close enough for consumer work.

Since capitalists and governments all live and die using return on investment (ROI), shouldn't you at least factor it into your purchasing decisions? You probably already do in your own personal financial planning. Why not also in your consumption planning?

In calculating ROI, the variables are:

- Capital cost (of a lightbulb, for example), and
- Operating cost (in dollars used per year).

For electricity operating costs, two additional variables are:

- Cost of electricity (per kilowatt-hour), and
- Amount of time operated.

In the context of energy consuming devices, ROI is calculated by using four simple steps:

1. Determine the price difference between the lower cost item and the higher cost item.
2. Estimate the annual operating savings of the higher cost versus lower cost item.
3. Divide the annual operating savings by the difference in capital cost.
4. Multiply by 100 to get a percentage return on investment.

Classic styling and conservation can mix.

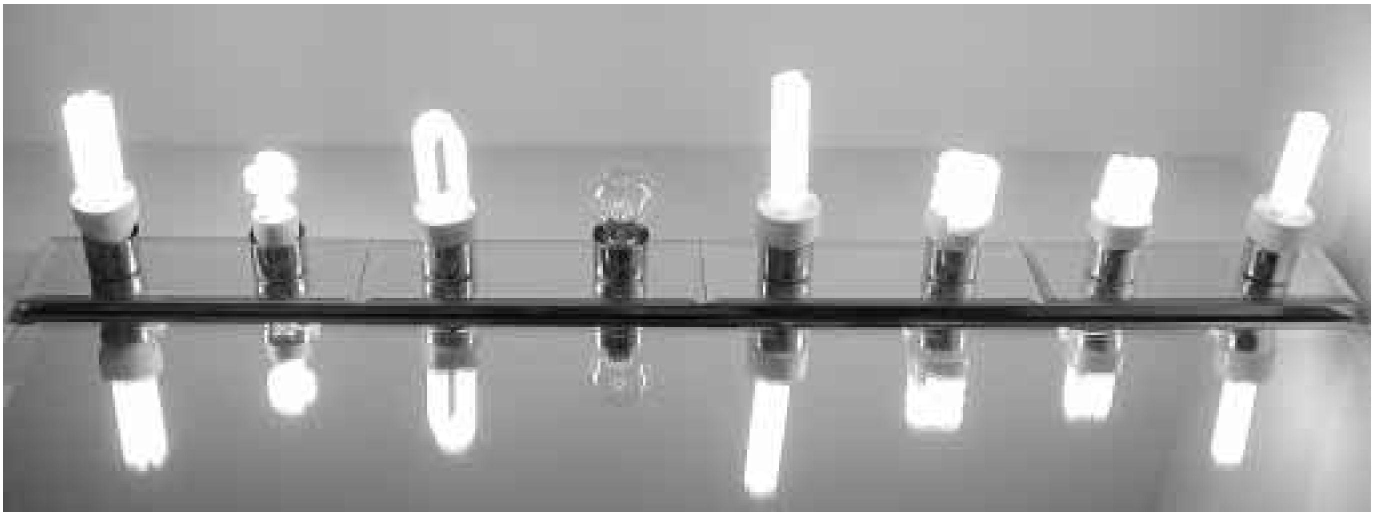
This article evaluates the ROI for five examples: compact fluorescent lightbulbs, solar water heating, the Toyota Prius, home solar-electric energy generation, and LED lightbulbs. I have invested in all of these items in the past year, so the examples are based on my own experiences.

Compact Fluorescent Lightbulbs

Every woman I've ever lived with wanted to leave the porch light on at night. It didn't make sense to me, since I am asleep then. I finally learned that it makes sense to her, because she is asleep then. So I bought my first CF, although they didn't work well in very cold weather back then. Until recently, on my porch, two 15 watt CFs ran an average of eleven hours a night, 365 days a year.

A CF bulb that produces the same amount of light as an incandescent lightbulb uses a quarter of the energy. Light intensity, by the way, is measured not in watts, but in lumens; watts are a measurement of power drawn. Lumens good; watts bad.

Assuming eleven hours of on-time per night, my US$8.99 CF saves me US$10.84 (181 KWH at US$0.06 per KWH) of electricity annually, compared to a typical US$0.40 incandescent bulb. I live in a region of "cheap" electricity, based on hydropower (which is only



Compact fluorescent lightbulbs (left to right): General Electric (25 watt), FEIT Electric (13 W), Phillips (23 W), LEDtronics (0.7 W, the narrow focus of the LED beam makes it difficult to see in this photograph), Osram (20 W), Lights of America (15W), Phillips (15 W), Osram (15W).

cheap if you are not a salmon). That works out to an annual return on investment of 121 percent over a one year period. Do you have any (legal) investments that pay over 100 percent annually?

The table below shows various returns on investments for investing in a US$8.99 compact fluorescent lightbulb versus buying a US$0.40 incandescent lightbulb. It all depends on how much the light is used and how much you pay for electricity. According to the U.S. Department of Energy, Idaho has the lowest electricity rates in the nation, with a statewide average of US$0.04 per KWH. Hawaii has the highest average rates, at US$0.12 per KWH. And rates have been increasing rapidly in many parts of the country.

The table covers costs for grid-produced electricity and off-grid electricity, which may cost more. A perversion in return on investment analysis is that the more you use the bulb, the greater the ROI and the shorter the payback period. Imagine leaving it on 24 hours (like all those exit lights). You'd have a fantastic rate of return, but you would be wasting money (not to mention wasting energy and harming the environment).

Long-lasting compact fluorescent bulbs save money. It takes time (aka money) to change lightbulbs, especially if the bulb is in a hard place to reach. CFs are normally rated at 10,000 hours of average use; incandescent bulbs at 1,000 hours. CFs are also a hedge against higher electricity costs.

Annual Percent Return on Investment
$8.99 Compact Fluorescent Bulb Over 40¢ Incandescent Bulb

Rate ¢/KWH	*0.5 Hrs./Day*	*1 Hrs./Day*	*2 Hrs./Day*	*4 Hrs./Day*	*6 Hrs./Day*	*8 Hrs./Day*	*10 Hrs./Day*	*12 Hrs./Day*	*24 Hrs./Day*
4¢	4%	7%	14%	29%	44%	58%	73%	88%	175%
6¢	5%	11%	22%	44%	66%	88%	110%	132%	263%
8¢	7%	15%	29%	58%	88%	117%	146%	175%	351%
10¢	9%	18%	37%	73%	110%	146%	183%	219%	438%
12¢	11%	22%	44%	88%	132%	175%	219%	263%	526%
14¢	13%	26%	51%	102%	153%	205%	256%	307%	613%
16¢	15%	29%	58%	117%	175%	234%	292%	351%	702%
18¢	16%	33%	66%	132%	197%	263%	329%	395%	789%
20¢	18%	37%	73%	146%	219%	292%	365%	438%	877%
22¢	20%	40%	80%	161%	241%	322%	402%	482%	965%
24¢	22%	44%	88%	175%	263%	351%	438%	526%	1,052%

Compact Fluorescent Return On Investment Spreadsheet

ENTER THESE VARIABLES	UNITS	ENTER HERE	EXPLANATION
Bulb use	Hours/day	*10*	Enter your estimate of how many average hours the bulb is on each day.
CF bulb size	Watts	*13*	Enter wattage size of CF bulb (not what the packaging says in the incandescent equivalent).
Brightness	Lumens	*805*	Enter lumens rating from packaging. Brightness is measured in lumens, not watts.
Rated CF bulb life	Hours	*8000*	Enter rating from packaging.
Cost of electricity	$/KWH	*0.060*	Enter your cost per kilowatt-hour for electricity.
Wattage of incandescent bulb replaced	Watts	*60*	Enter wattage of incandescent bulb replaced.
Lumens of incandescent bulb replaced	Lumens	*865*	Enter lumens rating from packaging.
Rated incandescent bulb life		*1000*	Enter rating from packaging.
Cost of incandescent replaced	$	*$0.40*	Enter the price of incandescent bulb being replaced.
Cost of CF bulb (before any rebates)	$	*$6.47*	Enter cost of CF bulb. First, subtract any rebates from utilities or government.
Rebates	$	*$0.00*	Enter amount of any rebates or kickbacks for buying the bulb.
Combined federal and state tax rate	%	*35*	Enter your combined federal and state tax rate as a percent.
Cost of CF bulb (after any rebates)	$	*$6.47*	
Marginal increase in cost for CF bulb	$	*$6.07*	The cost of your “investment instrument.”
Power used	KWH/year	47.45	This is the amount of electricity the bulb uses in a year.
Money spent on electricity consumed	$/year	$2.85	This is how much money you will spend annually with a CF bulb.
Money saved on electricity not consumed	$/year	$8.54	Three times what is spent. A comparable CF bulb uses 1/4 the energy of an incandescent.
Brightness efficiency of CF bulb	Lumens/watt	61.92	The amount of brightness per unit of energy consumed. Lumens good; watts bad.
Brightness inefficiency of incandescent bulb	Lumens/watt	14.42	Brightness is measured in lumens, not watts.
Number of incandescent bulbs you don't change	Pains in ass	7.00	
Simple payback on intial investment	Years	0.76	This is simple payback in years.
Return on investment (tax-free)	%/year	140.71	This is a tax-free figure as a percent of the cost of the CF bulb.
Return on investment (taxable)	%/year	216.47	This is the equivalent rate of return of a taxable investment. Money saved need not be earned.

Working spreadsheet available in the Downloads section of www.homepower.com

The returns on investment depicted in the table for investing in a CF lightbulb are far in excess of what you can get in a money market checking account, passbook savings account, certificate of deposit, mutual fund, or stock market index fund. Investing in compact fluorescent lightbulbs is safer than a federally insured account as well. Even if you have the cheapest grid power and use a bulb just over an hour per day, it’s a better return than a historic stock market yield. The stock market has averaged about 8 percent return on investment over the very long term.

The New Champion

Compact fluorescent bulbs have steadily improved. They are now brighter, smaller, less expensive, and have great light quality. However, until recently, no one produced a CF bulb with comparable brightness that was not larger than a standard incandescent bulb. In light fixtures with tight tolerances, anything larger than a bad old regular lightbulb won’t fit.

A new entrant in the market is FEIT Electric’s ECOBulb. It’s no larger than a standard incandescent, and emits 825 lumens, just 5 percent less than a standard 60 watt incandescent at 865 lumens. A comparable Lights of America 15 watt bulb puts out 860 lumens, but is somewhat bigger than the standard bulb. FEIT’s bulb draws 13 watts, but only has an average life of 8,000 hours, rather than the more typical 10,000 hours. Even with the shorter lifespan, it pencils out economically to be the best replacement CF for the 60 watt standard incandescent bulb.

You can download an Excel spreadsheet to easily determine your own capital and operating costs for lightbulbs. You enter the variables (bulb cost, energy cost, lumens, etc.) and the spreadsheet determines the rest. It’s available in the downloads section of *Home Power’s* Web site—www.homepower.com

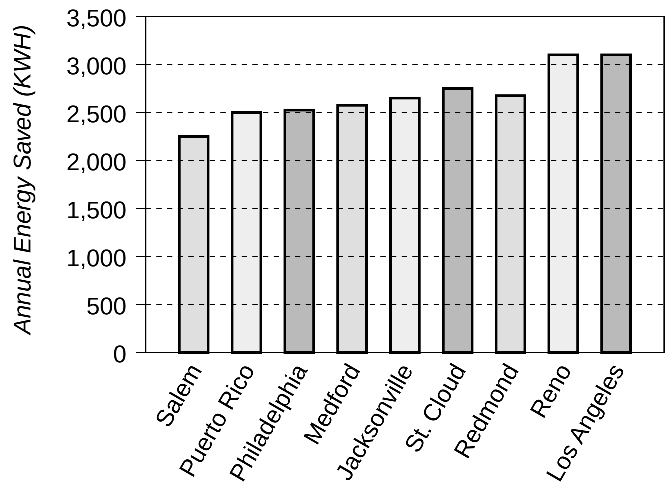
Solar Water Heating

Only after my third solar water heater in three different houses did I get around to doing a return on investment analysis. The table on page 100 depicts the costs of my new system. It is sized for a family of four. It was obviously very nice to have the government pay for about half of the cost of the system. But what about payback or return on investment? Running the numbers tells the story.

According to the Oregon Energy Office, a typical solar domestic water heater provides between 50 and 60 percent of a home’s water heating needs. The graph on page 100 depicts annual energy saved in kilowatt-hours for various locations in the nation, with a bias toward Oregon. Though where I live in Ashland is sunnier than Medford, let’s use the 2,600 KWH of annual energy saved noted in the graph.

Hot water panels on the front porch roof and the 30 watt PV panel that runs the circulation pump.

Solar Water Heater Performance



But what about maintenance costs, and how long will the system last? It should last decades with little maintenance. Ashland's water is pure, so scale buildup isn't an issue. In about five years, the antifreeze may discolor (indicating breakdown due to excessive heating), and need to be replaced, at an estimated cost of US$100. You can also install a drainback solar thermal system, but it uses more electricity to circulate the fluid.

If you have more maintenance, the ROI will go down a bit, and simple payback will go up some. If electricity rates increase, the opposite will occur. Even without the government assistance, the ROI is 4.7 percent, or still a respectable, long-term, tax-free investment. (To learn more about my system, see www.andykerr.net/energy/hotwater.)

Iowa Street Solar Water Heating

System Cost

Item	*US$*
Cost of system (parts and labor)	$3,650
City of Ashland Electric Department rebate, paid to installer	-500
Initial capital cost to homeowner	$3,150
State of Oregon Energy Income Tax Credit	-1,500
Actual capital cost to homeowner, after next tax filing	$1,650

ROI & Simple Payback of Supplemental Solar Over 100% Electric

Item	*Amount*
Annual cost savings (2,600 KWH x $0.06 KW)	$156
Payback time	10.6 years
Return on investment (tax-free)	9.4%
Green bragging rights	Priceless

Toyota Prius

If you are in the market for a new four-door sedan (not everyone is buying SUVs), what's the return on investment of buying one of those new Toyota hybrids? (See my article in *HP85.*)

If gas prices continue to rise, you may be able to economically rationalize additional cost through anticipated fuel cost savings. It depends on how much you are spending on fuel annually. Compare a new state-of-the-art Prius and a conventional Toyota Echo, which has the same body (sans rear spoiler) as the Prius.

The difference in the manufacturer's suggested retail price between the Prius and the Echo is US$9,455 (before any government rebates). Assuming you are "average" as defined by the EPA and drive 15,000 miles (24,000 km; 45 percent highway, 55 percent city) per year, the average annual fuel cost (US$1.70 per gallon for regular gas) is US$531 and US$729 respectively. Dividing this US$198 marginal savings by the marginal cost difference yields a return on investment of 2.09 percent (tax-free). If you drive more, you save more money, and the ROI is greater.

At least two states (Oregon and Maryland) offer US$1,500 tax credits for purchasing a Prius. (Go ahead, figure the ROI with such a credit.) With special plates in Virginia, you can drive solo in the high-occupancy

Andy and the Prius make 2.09%.

vehicle lane (a priceless intangible). And one of the bright spots in President Bush's tax plan is a proposed federal tax credit for hybrid vehicles.

Solar-Electric Production

I recently installed a 3 KW solar-electric system at my home. A full report is being prepared for *Home Power,* after working out the system kinks and getting good data on production and costs. The report will include return on investment and simple payback numbers.

I can only report now that from a purely financial standpoint, my solar-electric system appears to be a very marginal economic investment. Although I qualified it for as much government assistance as possible, certain site-specific costs conspired to drive up the price of the system.

I also bought the Lexus version of a PV system rather than the Neon version. It provides other hard-to-quantify variables such as being able to offer my neighbors a cold beer or cup of hot tea as may be required during a blackout. Of course, now that I've invested a boatload of money in fixed costs for my electricity, I'm hoping that electric rates go through the roof. It would help my ROI...

3.2 KW of photovoltaics power the Kerr household.

LED Lightbulbs

OK, I confess: I paid US$123 for a lightbulb. Obviously, this was not just any lightbulb, or even a gold-plated compact fluorescent bulb. It is a light emitting diode (LED) bulb. These are quite possibly (but certainly not quite yet) the next generation of lighting, though most of this generation hasn't yet graduated to CF bulbs. I must have personal virtue coming out the wazoo.

Many years ago, I swallowed hard when I bought my first CF for US$30. CFs are much less expensive today and are much better in quality. Like most new products, quality improves over time. Organic foods, recycled paper, store-bought bread, microbrewed beer, computers, automobiles, and washing machines come immediately to mind. CFs today are the same quality (and just about the same size) as incandescent bulbs.

The AC LED—Very efficient, but not quite bright enough for the front porch, and still expensive.

Marketers describe me as an early adopter. I'm rarely among the very first to buy something new, but I usually am first among my friends and colleagues. I just had to try one of those new, 120 volt AC, light emitting diode lightbulbs.

An LED is a semiconductor device that works by electroluminescence, and very efficiently converts electrical energy to light. Very little heat is produced. In contrast, an incandescent bulb is 90 percent heat and 10 percent light.

Some new LED lightbulbs on the market look just like "normal" incandescent lightbulbs. They screw into a standard Edison socket. Unfortunately, though the bulbs are unbreakable and will last 100,000 hours, the light quality is comparable to the early compact fluorescents—lousy.

For my porch light application (11 hours per day), at my price of electricity (US$0.06 per KWH), my return on investment for the LED lightbulb is 12 percent, compared to an incandescent bulb. Fifty percent better than the historical stock market, but very different from the 121 percent ROI for a compact fluorescent lightbulb.

Unfortunately, the LED lightbulb failed a more important test—usability. My wife couldn't work the combination lock on her bicycle at night with the puny output from the LED. Money isn't everything.

Home Power publisher Richard Perez notes that producing an 850 lumen LED bulb is more of a financial hurdle than a technical one. One company has the patent on white LEDs and it doesn't yet see the benefits of high-volume, low-royalty per unit sales. In time, price will decrease and quality will increase, along with sales.

Richard does note that "seven to eleven of these white LEDs make a great flashlight. These flashlights are showing up everywhere now, and are bound to replace the incandescent models on battery life alone." Not to mention bulb life.

Financial Rationality

Here are my take-home messages:

- Immediately change out every incandescent lightbulb you have, except for those in appliances like refrigerators, stoves, washers, and others that get very little use.
- If you have the right site, install solar water heating now.
- If you're in the market for a new four-door sedan, the Prius can make financial sense, especially if gas prices rise.
- Solar-electric production can be a cost-effective financial investment if site conditions are right, government subsidies are generous, and electricity prices are high enough. You have to figure it out for your own situation.
- It helps to have a business where you can write off intellectual larks like US$123 lightbulbs.

Tax Consequences

The financial savings of investing in energy conservation and renewable energy is in money saved by not having to buy energy. The savings are tax-free—money you don't have to spend is money you don't have to earn.

If you want to compare and contrast your tax-free investments in energy savings with your other taxable investments, use the following formula:

$$r = f \div (1 - t)$$

Where:

r = return on taxable investment

f = return on tax-free investment

t = taxpayer's combined federal and state tax rate as a decimal

For lightbulbs, this calculation is done for you in the downloadable spreadsheet mentioned previously.

Insufficient Capital?

Some of us think we can't afford the up-front capital cost of investing in energy efficiency. This may be really true for things like cars and water heaters (even though grants, rebates, and low-interest loans are often available for both).

But lightbulbs are a different matter. The capital cost is relatively low and the return is quite high. On top of that, many utilities are now bribing the economically clueless with rebates to make the consumer reach for that initially more expensive lightbulb.

Money Is Not the Measure of All Things

Having said all this, I still believe that money is not the measure of all things. I do not fixate on return on investment. The things that we value most—self, family, community, and environment—are irrational economic investments within a capitalist system, since they have too low a return on investment. Humans may well fail to save the Earth, and ourselves, because economists say it is inefficient and accountants say it is a poor return on capital.

Consider global warming. What's it worth to not have the last of the old-growth redwood forests die out? To not have to worry about getting malaria in Missoula? To not have sea levels rise and flood out much of the developed world? If these things are important to you, it is worth considering other factors in addition to financial return on investment.

It boils down to this question: What's your internal rate of return? Many of our goods and services are provided to us at very low prices. These prices are so low that slavery (clothes), substandard wages (food), pollution (paper), and natural resource exhaustion (wood products) are necessary to do it.

For most goods and services, the moral thing to do is pay more for environmentally friendly products made by socially just companies. But in the case of compact fluorescent lightbulbs and solar hot water, anyone ought to be able to see the economic rationality of energy efficiency.

Access
Andy Kerr, The Larch Company, 1213 Iowa St., Ashland, OR 97520
541-201-0053
Fax: 541-201-0065
andykerr@andykerr.net
www.andykerr.net

FEIT Electric Company, 4901 Gregg Rd., Pico Rivera, CA 90660
800-543-FEIT or 562-463-BULB
Fax: 562-908-6360 • info@feit.com
www.feit.com

Lights of America, 611 Reyes Dr., Walnut, CA 91789
800-321-8100 or 909-594-7883
Fax: 909-594-6758
webmaster@lightsofamerica.com
www.lightsofamerica.com

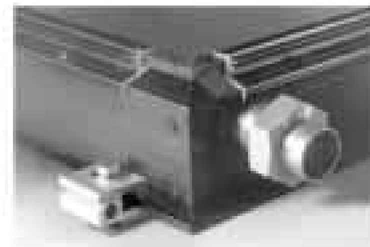
Oregon Office of Energy, 625 Marion St. NE, Salem, Oregon 97301
800-221-8035 or 503-378-4040
Fax: 503-373-7806
energy.in.internet@state.or.us
www.energy.state.or.us

LEDtronics, 23105 Kashiwa Ct., Torrance, CA 90505
800-579-4875 or 310-534-1505
Fax: 310-534-1424
webmaster@ledtronics
www.ledtronics.com

For every $1 spent on energy efficiency, $3 to $5 are *saved* on PVs and system components

The Solar Heating Company
Specializing in solar hot water, home heating, pool heating, and combined systems

Gobi Collectors
Three convenient sizes
High performance rated
Rugged, lasting construction
Easy hardware for any tilt
SRCC OG-100 certified.



Helix Pump Station
Powers solar hot water heating systems in direct water circulation or in glycol systems. Handy heat exchange package available with thermosiphon on the water side for cold climates.

Helio-Pak 16
Heat exchanger appliance external to tank and for use with any tank. Compact, modular, easy to install, it is also available with solar powered pumps for remote locations.
SRCC OG-300 system certified.

Sensible Technology since 1976
HELIODYNE, INC.
4910 Seaport Ave., Richmond, CA 94804
Tel: 510-237-9614 Fax: 510-237-7018
e-mail: info@heliodyne.com
web: www.heliodyne.com

PC Software for Trace Sine Inverters
WinVerter™ Setup for installers
• Save time programming
• Record setup of multiple customers
• Easy reprogramming
WinVerter™ Monitor for users
• See status at a glance
• Control inverter from local PC & via remote modem
• Log meter data to file
We also sell SW communications & memory adapters
www.RightHandEng.com / (425) 844-1291

Renewable Energy Products
Education, Solar Panels, Wind, Hydro, Charge Controllers, Batteries, Inverters and a lot more.
• Online Convience
• In-Person Service
• Great Prices
410-391-2000
Mr Solar.Com

Things *That* Work!

Tested by Home Power

C. Crane's QuickCharger

Richard Perez

©2001 Richard Perez

This smart battery charger quickly recharges, tests, and conditions the most common sizes of nickel-cadmium (NiCd) and nickel-metal hydride (NiMH) cells.

C. Crane's QuickCharger is not your average battery charger. It contains a number of technical features that make it different from other chargers on the market. Most chargers recharge two or more cells in series, which means that one or more cells are always either undercharged or overcharged. The QuickCharger charges each cell in parallel to the same level. This leads to better battery performance and longer life.

The QuickCharger is microprocessor controlled using a recharge algorithm that is based on change in voltage versus change in current versus change in time. This algorithm assures a full recharge every time, without overcharging the cell and reducing its life.

The QuickCharger also is capable of using the onboard microprocessor to evaluate the condition of older cells. It can exercise NiCds and rid them of the dreaded memory effect caused by shallow cycling.

Manual & Shipping

The QuickCharger arrived here via UPS in fine shape—it was packaged well. It came with a sixteen-page, comprehensive operating manual. I had to give the manual a thorough reading to understand the various symbols on the unit's LCD display. As complex as it may sound, there are really only two buttons necessary to operate the QuickCharger—the discharge override button and the analyze button.

Using the QuickCharger

The QuickCharger I tested uses a 120 VAC wall cube power supply, but it can also be powered directly from 12 VDC with the optional car cord. The first step in operating the QuickCharger is to plug it in. This gives the microprocessor time to boot and become operational before the user inserts any cells.

Lifting the plastic cover reveals the four charging stations, and signals the microprocessor that the user is adding cells to the charger. At this point, you can insert between one and four cells. These may be AAA, AA, C, or D sized cells, but they must all be of the same size for any particular charging run.

The charging stations are accessed by sliding a contact back and inserting the cell. The springs used on these sliding contacts are much stronger than on any charger I've ever used. This assures good electrical contact. After the cells are inserted into the charger, closing the lid initiates a charging cycle.

The microprocessor determines the state of charge of the cells, and decides if they need a discharge cycle before being recharged. In most cases, the cells are not fully discharged when you remove them from your flashlight or other device. The QuickCharger fully discharges them, in parallel, at the 1.2 VDC level, not in series. This is important, since when two or more cells are fully discharged in series, it is almost certain that one of them will be overdischarged and reverse polarized. This can lead to greatly reduced cell capacity and premature failure.

During discharge, the QuickCharger takes the cells down to 1.0 VDC and then terminates the discharge process. The discharge override button allows the user to skip the discharge process and proceed immediately to recharging.

During recharging, the QuickCharger uses four distinct sequences—soft-start charging, fast charging, top-off charging, and finally trickle charging. Each of these stages has a particular purpose.

Soft-start charging controls the amount of current flowing into a fully discharged cell, which reduces cell heating. Fast charging recharges the cell as quickly as possible until it is almost full. Top-off charging finishes the job at a reduced current rate. The cells can then be left in the charger for a trickle charge, which keeps them fully charged until you remove them from the charger.

All these various steps in the recharging process are designed to fully recharge the cell as quickly as possible without damaging the cell from overheating. In every other fast charger I have used, the cells come out of the charger very warm or hot. With the QuickCharger, the cells come out at room temperature. This means less cell wear and longer cell life.

This LCD display tells you at a glance where in the recharge process the cells are. It even has a real voltmeter that displays cell voltage in real time. When the cells are finished, the charger's extensive LCD display signals the user.

QuickCharger Performance

Over the years, we've accumulated quite a few NiCd and NiMH cells of various sizes. We use them in flashlights, radios, tape recorders, remote controls, cameras, and instruments. I hate using disposable cells—they are expensive, and are real polluters if not disposed of properly. Currently we have twelve AAA cells, over three dozen AA cells, about ten C cells, and six D cells.

I began giving our cells a routine recharge with the QuickCharger, and many of our old ones have shown new life. The QuickCharger is restoring lost capacity by exercising the cells.

All of these cells are rechargable, and overall they must have cost us somewhere around US$300. Some of them are over eight years old and still functioning. We've saved hundreds of dollars over the last ten years by using rechargable cells. And they are convenient—no trip to town required, just pop them into the charger.

While the QuickCharger is super sophisticated in its handling of the recharge process, it is still very simple to use. You just plug it in, insert the cells, and the charger does the rest. Forget to take them out when they are done? No problem—the QuickCharger will not overcharge them, but instead keeps them at peak charge.

When run on the AC power supply (wall cube), the unit is a phantom load. We have ours on a plug strip. Power consumption depends on how many and what size cells are being charged. Maximum power consumption is 14 watts while charging four fully discharged D cells.

Simple, Effective Charger

C. Crane's QuickCharger is the best battery recharger I've ever used. It's simple to use, effective, and protects cells from the damage inflicted by most commercial chargers. At only US$49.95, it's worth much more than it costs. Considering the hundreds of dollars that most folks have invested in rechargable cells, this is a small price to pay for keeping them in peak condition, ensuring their long lifetimes.

Things That Work! Criteria

The products reviewed in *Things that Work*! must meet three criteria:

1. The product must meet its manufacturer's specifications.
2. The product must be durable and last in actual service.
3. The product must offer good value for the money spent on it.

The reviewed equipment is not necessarily the best product for all applications.

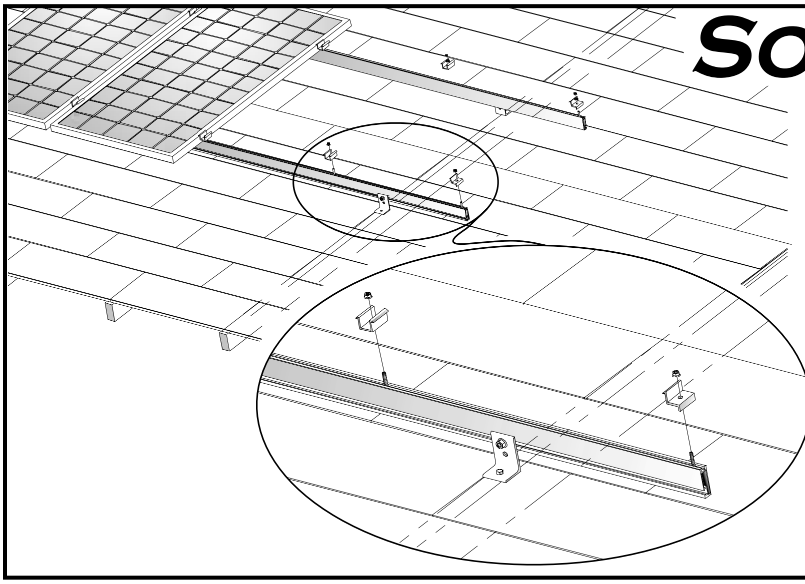
Access

Richard Perez, *Home Power,* PO Box 520, Ashland, OR 97520 • 530-475-3179 • Fax: 530-475-0836
richard.perez@homepower.com
www.homepower.com

C. Crane Co., 1001 Main St., Fortuna, CA 95540
800-522-8863 or 707-725-9000 • Fax: 707-725-9060
ccraneco@aol.com • www.ccrane.com
QuickCharger

Ready to buy your PV system now? Expert information and "better than best" prices on quality PV modules, inverters and complete systems. For details visit our web site at http://www.solarsolar.com For faster reply send email to solar@solarsolar.com or send a self addressed stamped envelope to SOLutions in Solar Electricity, P. O. Box 5089, Culver City, CA 90231 or call us at 310-202-7882

IPP MEMBER



SolarMount™

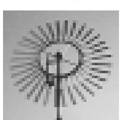
The easiest, fastest, and safest way to install a PV array on virtually any roof.

Call today for details
(505) 242-6411
or E-Mail: info@unirac.com

UniRac®

UniRac, Inc.
2300 Buena Vista, SE, Suite 134
Albuquerque NM 87106 USA
Phone: 505.242.6411 • Fax: 505.242.6412
www.unirac.com

Learn to store hydrogen power
www.hydrogenappliances.com



Hornet Power!

We sell PMA's and turbine parts

Stealth ***Wind Turbines***

"Best dollar per Watt value on the market today" Produce up to 6000 Watts for **only $929.95**

Call today 661-724-1919

Fiber Optic Products, Inc.

Your Source For Solar & Fiber Optic Lighting

- ICP
- KYOCERA
- UNI-SOLAR
- MORNINGSTAR
- TRACE

We carry all brands of Panels, Controlers, Inverters, and Trackers for Home, RV, Marine, Office, Landscape or Back-Up Power. Plus check out our Fiber Optic line and Electronics Section.

303-637-0102

ON-LINE ORDERING AVAILABLE

www.fiberopticproducts.com

Contact:
Earth Solar, LLC
4504 S. Georgia Street
Amarillo, TX 79110
806-359-9005
Fax 806-355-0585
www.earthsolar.com
E-mail contact@earthsolar.com

Earth Solar

Powerful Solutions Trace Engineering

1-800-329-3283

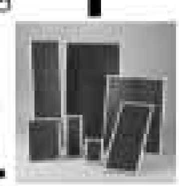
We carry the full line of Trace products at blowout sale pricing!!!
Call for your low quote.

Lowest prices in the nation!!!

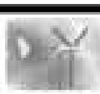
KYOCERA | UNI-SOLAR

Bekaert ECD Solar Systems LLC

Solar Modules Blowout Sale
KC120 - 120 Watts $535
KC80 - 80 Watts $365
KC60 - 60 Watts $286
KC40 - 40 Watts $214
KC35 - 35 Watts $189



US64-64Watts $319
US42-42Watts $219
US32-32Watts $182
US21-21Watts $146
US11-10.3Watts $107
US5-5Watts $58
US3-2.8Watts $48



Bergey WindPower

XL 1-$1595

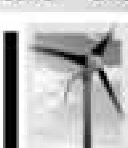
Bergey has units up to 10 Kw for everything from water pumping to grid intertie. Call us for all your wind generator needs.

Dedicated to a cleaner "greener" earth.

Statpower

(modified sinewave inverters, model indicates power in watts)
Notepower 75-$61
Prowatt 150-$62
Prowatt 250-$90
Prowatt 800-$371
Prowatt 1500-$532
Prowatt 2500-$815

(true sine wave inverters, model indicates power in watts)
Prosine 1000W 12V -$645
Prosine 1800W 12V -$916
Prosine 2.5Kw 12V -$1876
Prosine 2.5Kw 24V -$2028
Prosine 3.0Kw 12V -$2199
Prosine 3.0Kw 24V -$2355



Southwest Windpower
Renewable Energy Made Simple

Air 403-$490
Air 403 Industrial-$797
Air 403 Marine-$685
Whisper H40-$1525
Whisper H80-$2250
Whisper 175-$4578
Windseeker 502-$742
Windseeker 503-$890

UNIRAC heart interface bp solar

The Good Neighbor

Neighborhood Electric Vehicles

Shari Prange

©2001 Shari Prange

The Th!nk Neighbor is Ford's entry into the NEV market.

There's a new kid on the block in the automotive community. He's a different sort from the swaggering SUVs and muscular four-wheel-drive pickups that have become tiresomely common in recent years. He's a little bitty guy, kind of quiet. His name is NEV.

What Is It?

According to the National Highway Transportation Safety Authority (NHTSA), a neighborhood electric vehicle (NEV) is defined as any four-wheeled electric vehicle with a top speed not greater than 25 miles per hour (40 kph). For regulatory purposes, NEVs are included in a category called low-speed vehicles (LSVs). Many states have adopted standards that allow these vehicles to be licensed for use on public streets where speeds are limited to 30 or 35 mph (48–56 kph). (The National Alternative Fuels Hotline recommends contacting the department of transportation for your state to learn what NEV regulations may apply.)

It sounds a lot like a golf cart, doesn't it? Well, the golf cart is one evolutionary ancestor of the NEV. Most golf carts have a top speed of 10 to 15 mph (24 kph). Somewhere along the line, people discovered that golf carts are often more convenient, economical, and pleasant to use than a regular gas car. They are clean, quiet, cheap to run, and easy to park. They are perfect for short, low-speed trips in the immediate neighborhood.

The Alternative Fuels Data Center, a project of the Department of Energy, reports that 50 percent of all car trips in the U.S. are under ten minutes in duration. This is exactly the kind of driving that is the worst for gas cars. In a five-minute run to the grocery store or post office, a gas car doesn't even get a chance to get warmed up. This is the most polluting and inefficient part of its driving cycle. This kind of driving is bad for the air, bad for the wallet, and bad for the engine, too. Layers of crud (that's a technical term) build up in the engine and never get burned clean.

In recent years, some planned communities began to design for golf cart use within the confines of the neighborhood, and residents loved the idea. However, some people started to want something a little more car-like. Golf carts became more deluxe, and began to evolve into a new species of vehicle for people who have never picked up a golf club in their lives.

NHTSA has strict definitions for NEVs and LSVs. But the term NEV is often broadened to include very small three and four-wheeled vehicles intended for short range local use. They are also sometimes referred to as “city cars,” especially when they have enclosed bodies and can attain higher speeds.

What’s It Good For?

We’ve already mentioned the idea of using the car within a limited community, or as an in-town commute car, but there are other possibilities as well. One is the shared community car. In this situation, the cars are owned by a neighborhood co-op or an independent company, not by individuals. A ratio of homes per shared car is established, and the cars are stored in various places throughout the community. Users subscribe to the service, and reserve the cars in advance for specific times.

This means that the driver only pays for the time he or she actually uses the car. You don’t have to worry about owning it, insuring it, garaging it, or maintaining it, and it’s more economical and convenient than a conventional rental car. It’s perfect if all you need to do is pick up your child from preschool every afternoon. It may mean that some families can own one car instead of two, which reduces the parking density in the neighborhood.

An example is Boulder CarShare in Boulder, Colorado. This co-op aims to maintain a ratio of one vehicle per ten members. At the moment, this includes two “normal” gas cars, a Saturn and a Subaru, and one EV, a Sparrow. (Read more about Sparrows in the next issue and *HP67,* page 76.) CarShare has just added a GEM to its fleet in North Boulder. Reservations for cars are made through a 24-hour telephone reservation system.

A similar concept is the station car. In this case, instead of basing the cars in the neighborhood, they are based at natural hubs of transportation, such as a commuter train station. When you get off the train near your job, you find a row of ready station cars. You check out the first one in line and drive it to work. At the end of the day, you return it and get on the train. Or, at your home station, you can check out a similar car for the drive home, and return it to the station the next day. This system also works by subscription.

Because these cars are smaller than normal, specially designated parking areas can be created for them, fitting more of them into the space than would be possible with even compact cars. Also, if the station cars are lined up in a queue, nose to tail, they can take even less space. They can be packed bumper to bumper, and users just take the first one in the line.

The station car concept is becoming reality in Fremont, California. In a test program with good prospects for expanding to other locations, Hertz operates a fleet of Th!nk City vehicles based at local Bay Area Rapid Transit stations.

Incentives

There are some financial reasons for building and driving NEVs. Incentives vary from state to state, and even from one city or county to another. Some generous incentives are taking shape at the state level in California. However, the biggest incentive is federal. A 10 percent income tax credit is available for the purchase of a pure electric vehicle. This means you can deduct 10 percent of the purchase price from the amount of federal taxes you owe.

The wording of the tax law itself is ambiguous. It specifies “four-wheeled vehicles built primarily for use on public streets, roads, and highways.” Does it apply to NEVs or not? A strict reading might indicate that NEVs do not qualify, since they cannot travel on highways. And how is “primarily” defined? Some NEV owners have been filing for this credit, and have not been denied so far.

An even bigger incentive applies to the manufacturers, which explains why Detroit is suddenly interested. The California zero emissions vehicle (ZEV) mandate has been under attack since its inception, and has been greatly diluted. Originally, manufacturers were supposed to provide ZEVs (which, with today’s technology, means electric vehicles) for 2 percent of their total sales in the state starting in 1993, 5 percent in 1998, and 10 percent in 2003.

Intense lobbying got the first two deadlines dismantled to the point where a few hundred test vehicles satisfied requirements. The final deadline is rapidly approaching. The manufacturers are still required to meet the 10

The ElectraKing was not a speedy car, but it did inspire good-humored affection.

The GEM car is a useful local runabout.

Once again, Detroit does the right thing for the wrong reason, proving that the Robert Heinlein character, Lazarus Long, was right when he said, "Never appeal to a man's better nature. He may not have one. Invoking his self-interest gives you more leverage."

It Started Small

The rest of the world learned to appreciate very small cars long before Americans caught on. The most famous small import was the VW Beetle, but the German Isetta, British Mini, Japanese Honda 600, and French 2CV "Duck" made the Beetle look like a family car. These were known as minicars and microcars.

percent minimum—sort of. There are formulas whereby several hybrid or super low emission vehicles (SULEVS) are considered the equivalent of one ZEV. This is very interesting math, where a small amount of pollution, multiplied several times, equals zero pollution...

However, the California Air Resources Board is holding a hard line requiring at least 2 percent of the vehicles from the "Big Six" (GM, Ford, DaimlerChrysler, Toyota, Honda, and Nissan) to be actual ZEVs. If they fail to meet this standard, they will be fined US$5,000 for each vehicle they are short. Since the six companies together sell about one million cars in California each year, the potential is close to US$100 million in fines if they fail to produce them.

Enter the NEV, which qualifies as a ZEV. Even better, each NEV sold now, two years before the mandate takes effect, qualifies as four ZEV credits, which can be applied against 2003 production and sales. This was part of the agreement negotiated with the California Air Resources Board when their original, more strict requirements were loosened. An NEV that sells for US$5,000 today is worth US$20,000 in ZEV credits usable two years from now. Manufacturers could give them away and come out ahead.

Manufacturers can also buy and sell ZEV credits among themselves. So a small manufacturer who makes only NEVs might actually make more money selling credits to gas car manufacturers than he makes selling NEVs. Depending on the mix of vehicle types that manufacturers choose to make, the mandate could require anywhere from 4,450 to 15,450 electric vehicles on the road in California in 2003.

For a long time, an entire class of these tiny cars has been known as the A class in Europe and the K class in Japan. They have been zipping around the streets of other countries, but are virtually unknown in the U.S. Due to the lack of market interest in the U.S., it has not been economically worthwhile for manufacturers to meet the standards necessary for sales in this country. Historically, these little foreign cars have been powered by gas engines much like those in larger cars.

American history also has recorded a number of very small cars, but there were two differences between these and the cars in the rest of the world. The American tiny cars came from small independent companies, not major car manufacturers. And they were electric. These were the first NEVs.

It's worth taking a moment to talk about some of these older vehicles, because many of them are still on the road. The people who have them are generally quite attached to them. But they do turn up regularly on eBay.

Orphans

If you are looking for a frugal and clean form of personal transportation, these can still be very viable. You need to know, however, that they are automotive orphans. They were built by small companies, in small quantities, and their builders are long gone. You will have to be your own maintenance and service person, and locating parts can sometimes be challenging.

The most successful and well-known of these early NEVs was the Sebring-Vanguard CitiCar. This car was only built from 1974 to 1976. It was a response to the gas crisis of 1973. Approximately 3,500 CitiCars were built, and many are still in service. Some have been upgraded with newer control systems. Numerous CitiCar resources are on the Internet.

This four-wheeled, wedge-shaped car ran at 36 volts DC initially, and then was upgraded to 48 volts. It had a top speed of over 30 mph (48 kph), and a range of about 40 miles (64 km).

The company was sold in bankruptcy in 1977, and reborn in 1978 to produce the ComutaCar. This version looked much the same, but had a larger motor and many improvements to the amenities. It was also required to meet more stringent crash standards. For this reason, the batteries were incorporated into the bumper to double as a crush zone. More than 4,000 of these were sold. By 1980, the costs of certifying the cars to new NHTSA standards became prohibitive.

Another small electric of yesteryear was the B & Z ElectraKing. It came in three-wheeled and four-wheeled versions, and ran at 24 or 36 volts. Due to its very boxy, cartoonish shape, it is often described as a Fred Flintstone car or a Mr. Magoo car.

Today, several companies are venturing into the electric minicar market again, and this time some of them are major manufacturers. There are upscale golf carts that may never set their treads on manicured turf, and cars that may only occasionally masquerade as golf carts. Let’s look at these first and most cart-like links in the progression from cart to car.

GEM
Global Electric Motorcars of North Dakota, a subsidiary of DaimlerChrysler, makes the GEM. Since 1998, the company has produced more than 7,000 vehicles. Their car started life as the Trans 2. Like the Sebring-Vanguard CitiCar, it died when the original company folded, and was revived under a new name. When it was reborn as the GEM, it maintained a visual resemblance to its predecessor, but the drive system had been upgraded and improved.

This is an open-sided, bubble-shaped vehicle, although soft and hard “weather enclosure accessories” are available. However, it has no heat, which limits it to mild weather driving. It does have three-point seatbelts, as well as automotive-type headlights, taillights, brake lights, and turn signals. It comes in two-seat and four-seat versions, as well as a two-seat utility model with either a long or short cargo bed.

All the dimensions of the GEM are on a small scale. The vehicle is only 55 inches (140 cm) wide. Depending on the model, it may be from 96.5 inches (245 cm) long for the two-seater to 144 inches (366 cm) long for the long utility version. All the models are between 69.5 and 71 inches (177–180 cm) tall, so the driver has better visibility than in most sports cars. The tires are mounted on 10 or 12 inch (25 or 30 cm) wheels. The combination of all these small numbers makes it very maneuverable, with a 10 to 12 foot (3–3.7 m) turning radius.

The Gorilla is small and sweet tempered, but powerful.

The curb weight of the vehicle ranges from only 940 to 1,200 pounds (426–544 kg). Despite its small size, it’s relatively husky. The cargo capacity ranges from 600 pounds (272 kg) for the two-seater to 1,100 pounds (499 kg) for the long utility model. A few different styles of truck beds and cargo carriers are available as options.

The GEM runs on a 72 volt pack of six, 12 volt, deep-cycle, lead-acid batteries. The batteries are recharged from standard household 120 VAC by an onboard charger. The top speed for the GEM is 25 mph (40 kph), and it can travel for 25 to 35 miles (40–55 km) before needing to recharge. The various GEM models sell for about US$8,000 to US$10,000.

Th!nk Neighbor
The Th!nk car was originally developed by the Norwegian company, PIVCO. It was then bought by Ford and brought to the United States. Th!nk is actually an umbrella name that includes an electric bicycle, an NEV, and a city car.

The Th!nk Neighbor is the NEV of the family. It has many similarities to the GEM. It has a front body panel that rises nearly straight into the windshield, which then curves back to join the roof, all in one continuous line. It comes in two-seat and four-seat versions.

The Neighbor has all of the usual basic automotive amenities, including lights, horns, mirrors, windshield wipers, and the option of an AM/FM/CD sound system. It is open-sided, but the luxury option offers weather enclosures and heat. The heat system runs off the battery pack and will decrease the vehicle's range.

Its top speed is 25 mph (40 kph). Like the GEM, its 72 volt battery pack certainly could carry it to much higher speeds, but it has been designed to fit the NHTSA limits for neighborhood and low-speed electric vehicles, so it is artificially restricted to 25 mph maximum. It will travel up to 30 miles (48 km) on a charge.

The Neighbor is just slightly larger than the GEM, at 57 inches (145 cm) wide, 104 to 114 inches (264–290 cm) long, and 68 inches (173 cm) high. Cargo capacity ranges from 600 pounds (272 kg) for the two-seater to 1,000 pounds (454 kg) for the four-seater. The vehicle itself weighs 980 to 1,280 pounds (445–581 kg). The Th!nk Neighbor is just becoming available in the fall of this year. The retail price is approximately US$6,000.

Gorilla PUV

For contrast, there is also the Gorilla PUV, or "personal utility vehicle." It's a very large name for a small vehicle. This is a four-wheeled, two-wheel drive NEV with some differences. For one thing, it is made by a small independent manufacturer, Gorilla Vehicles.

Another difference: it is more ATV-like than golf cart-like. It carries two passengers, who sit one behind the other in a tandem configuration, instead of side-by-side. They straddle the vehicle, and steering is with handlebars instead of a steering wheel.

However, the Gorilla fills a similar niche. It comes in different versions, with options for windshield, canopy, and a second passenger seat or various styles of cargo beds. The 24 volt model uses three, 8 volt, golf cart batteries, and has a top speed of 12 to 14 mph (19–23 kph). The 36 volt model uses three, 12 volt, deep-cycle, lead-acid batteries, and reaches 20 to 25 mph (40 kph). One version of the 36 volt model meets all the standards to qualify as an NEV.

Being only one seat wide and having no roof, the Gorilla is much smaller than the GEM or Th!nk Neighbor, at only 72 inches long, 34 inches wide, and 36 inches (183 x 86 x 91 cm) tall to the handlebars. When it comes to performance, you can see where the Gorilla gets its name. It is rated to carry 600 pounds (272 kg) of driver and cargo, and can tow up to 4,000 pounds (1,800 kg). The vehicle itself weighs only 530 pounds (240 kg) including batteries, proving that big power can come in small packages.

The Gorilla is equally at home on neighborhood streets going for a few groceries, or as a working beast on a farm or industrial site. Manufacturer's suggested retail price is US$4,495 for the basic vehicle.

The Next Link

This has been an introduction to the concepts of neighborhood electric vehicles and city cars. These little electric cars tread more gently on the earth in many ways: energy efficiency, pollution, noise, economy, as well as the actual physical footprint. In many situations, they're more convenient for the user, too.

There have been minicars and microcars in the past, and even electric ones, but they never really caught on in America. This time, though, with some legislation focusing the attention of major manufacturers, the small EV may finally come into its own.

In this article, I looked at the neighborhood electric vehicles (NEVs). These have to meet a strict federal definition, which limits them to 25 mph (40 kph) top speed, and requires four wheels. They tend to resemble golf carts, with an open style of architecture.

Next time, I'll look at some "city cars." This is a less rigidly defined group, but it fills a similar niche. These cars have higher speeds and more enclosed, car-like bodies, although some have only three wheels. Both types of cars prove that size does matter—and sometimes, smaller is better.

Access

Shari Prange, Electro Automotive, PO Box 1113-HP, Felton, CA 95018 • 831-429-1989
shari.prange@homepower.com • www.electroauto.com

Global Electric MotorCars, 3601 7th Ave. NW, Fargo, ND 58102 • 888-871-4367 or 701-232-2500
Fax: 701-232-0600 • global@gemcar.com
www.gemcar.com

Th!nk Mobility, 5920 Pasteur Ct., Carlsbad, CA 92008
800-252-4221 • www.thinkmobility.com

Gorilla Vehicles, 5672 Littler Dr., Huntington Beach, CA 92649 • 714-377-7776 • Fax: 714-377-6667
info@gorillavehicles.com • www.gorillavehicles.com

Sebring-Vanguard CitiCar & ComutaCar History & Links
www.econogics.com/ev/citicar.htm

Alternative Fuel Vehicle Buyer's Guide
www.fleets.doe.gov/fleet_tool.cgi?$$,atv,1

USDOE National Alternative Fuels Hotline, 9300 Lee Hwy., Fairfax, VA 22031 • 800-423-1363 or 703-934-3069 • Fax: 703-934-3183
hotline@afdc.nrel.gov • www.afdc.doe.gov

ELECTRIC VEHICLE

COMPONENTS, CONVERSION KITS, PUBLICATIONS, VIDEOS, AND ENGINEERING DESIGN SERVICES FOR THE EV HOBBYIST AND MANUFACTURER...All components selected with safety and reliability foremost in mind....We stock and sell the largest variety of the very best:

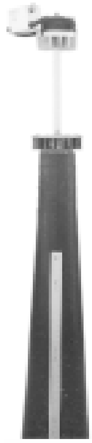
- ADVANCED DC Motors in 12 variations from 2 HP to 28.5 HP
- CURTIS-PMC Controllers, Throttle Potboxes, Footpedals
- ALBRIGHT & KILOVAC Main & Reverse Contactors in 6 models
- GENERAL ELECTRIC & HEINEMANN Circuit Breakers
- BUSSMAN Safety Fuses from 200 to 800 amps
- DC-DC Converters from 48 to 336 V input
- K & W ENG. & BYCAN Battery Chargers from 48 to 144 V
- Full line of CURTIS, WESTBERG, & KTA Meters & Gauges
- DELTEC Meter Shunts from 50 to 1,000 A
- EVCC Adapter Plates, Couplings, Clamps, & Brackets
- PRESTOFLEX Welding Cable, MAGNA Lugs, Assy. Tools
- CONVERSION KITS for vehicles from 300 to 10,000 lbs.
- Complete ELECTRATHON Drive & Instrumentation Pkg.
- 4 Complete GO KART kits...for up to 90 mph..

KTA SERVICES INC.

COMPONENTS & PUBLICATIONS CATALOG........$5.00
Electric Vehicle components and systems since 1984

944 West 21st Street – Upland, CA 91784 USA
Tel: (909) 949-7914 – FAX: (909) 949-7916
Web: www.kta-ev.com

Breakthrough Product from the makers of the STREAM ENGINE


LH1000

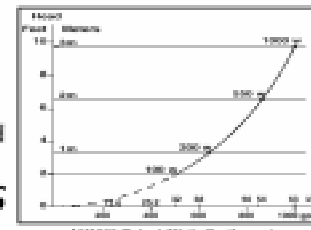
The New LH1000!

- Operates at heads of 3 to 10 feet
- Adjustable for maximum power
- Multiple output voltages
- Output over 1KW
- Easy Installation

"This is a very cool machine. It represents a major breakthrough in microhydro design." -Bob-O Schultze on the Stream Engine, Home Power #67

Epoxy Encapsulated Alternator
Waterproof, Water Cooled, Neodymium Permanent Magnets, Brushless, Reconnectable Windings

Also Available:
Hydro components including turgo & pelton runners, system design and tech support.


LH1000 Output (Watts Continuous)

ENERGY SYSTEMS & DESIGN

P.O. Box 4557, Sussex, NB E4E 5L7 Canada
Tel.: (506) 433-3151 • Fax: (506) 433-6151
Website: www.microhydropower.com
Email: hydropow@nbnet.nb.ca

Renewable Energy Products

Education, Solar Panels, Wind, Hydro, Charge Controllers, Batteries, Inverters and a lot more.

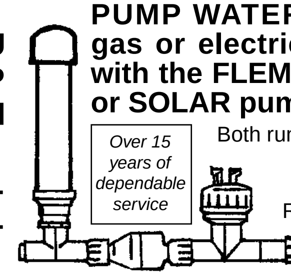
- **Online Convience**
- **In-Person Service**
- **Great Prices**

410-391-2000

Mr Solar.Com

U P H I L L

PUMP WATER uphill with no gas or electricity. It's possible with the FLEMING HYDRO-RAM or SOLAR pump.



Over 15 years of dependable service

Both run on Free Energy—Sun or Gravity.
Water your Garden or Livestock.
For INFO send $5.00 to:
Ram Company, 512 Dillard Hill Rd.
Dept. HP, Lowesville, Va 22967
1-800-227-8511

POLAR POWER INC

See the Latest Solar Technologies!

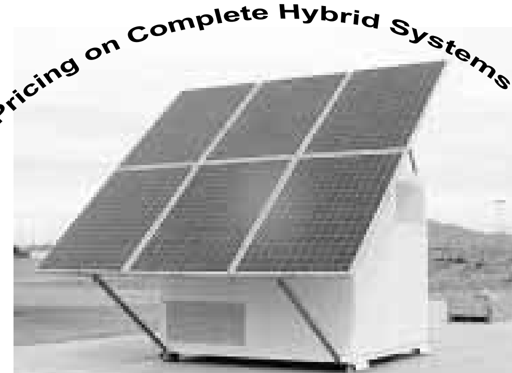
Visit our web site at www.polarpowerinc.com

Find new products, ideas, and detailed technology discussions.

- **DC Generators** in propane, natural gas, and diesel
- **Micro-Cogeneration** for your home or office
- **Charge controllers** for every application
- **Solar Refrigeration and Air-conditioning**

Polar Power has been manufacturing reliable energy systems for over 20 years. Satisfied customers include telecommunication, oil field, residential, and military. **Dealer inquiries welcome!**

Low Pricing on Complete Hybrid Systems



Phone: 310 830-9523 22520 Avalon Blvd., Carson, CA 90745

Installing EV Gauges, Part 1

Mike Brown

©2001 Mike Brown

In my last column, I discussed the types of gauges needed for the operation of an electric vehicle (EV), as well as optional gauges you might want to install. In this column, I'll cover the installation of the gauges in the dashboard or other locations of an EV.

All automobile manufacturers spend a great deal of time designing the instrument panels of their cars and trucks. Much attention is paid to details like how the information is presented, gauge size, visibility under all conditions, and positioning the gauges to minimize the time spent looking at the dashboard and not watching the road. All of these concerns apply as you look for places to put the specialized gauges needed in an EV.

Replacing Original Gauges

Since the manufacturers have optimized the positioning of their instrument panels, is there still a place left in the dash for an ammeter and state of charge (SOC) meter? The answer to this question depends on the original dash layout, which is often determined by the age of the car or truck.

Older cars and trucks often had one or two big gauges, such as a speedometer and tachometer, flanked by two or more smaller gauges. This type of layout is ideal for us. You can replace the no longer needed fuel and temperature gauges with an ammeter and SOC meter, and you're ready to go. Most of the time, the smaller gauges you are replacing are 2 inches (5 cm) in diameter, just like the meters you are replacing them with. If they are larger or smaller, you will have to figure out a way to make them fit.

The next stage in the evolution of instrument panels was the gauge cluster. This configuration has all of the vehicle's gauges built into one instrument panel or "cluster." In a cluster, the individual gauges have all been integrated into a single complex mechanism. They come out of the dash as a single unit. This was a space and cost saving move, and it has become the standard type of instrument panel for the kinds of cars and trucks we convert, which are mainly the small, economy models. Replacing some of the existing gauges in one of these clusters with EV gauges can be challenging.

Since modifying the cluster means removing it from the car, it is a good idea to see if there is room for your gauge before you start removing the dash unit. The easiest way to do this is to draw a circle the same size as the largest diameter of the gauge (which is usually the bezel, the metal rim that holds the glass or plastic cover of the gauge to the body) on a piece of paper. Hold this circle over the gauge you are thinking of replacing, and see if there is enough room for the EV gauge to be in the cluster without interfering with the faces or needles of the other instruments or any of the warning lights.

If this method is made difficult by the cover of the cluster or its position in the dash, a phone search of the local wrecking yards for price and availability of an instrument panel like yours might be in order. If you find one (out of the car), a trip to the dismantler would give you a closer look at the amount of room available, not only for the diameter of the gauge, but also the distance from its face to its back.

If there seems to be enough room for the gauges you want to install, and the price is reasonable, you might want to purchase the used unit to practice on, or even to use for the finished EV gauge cluster. I've seen this done successfully several times, but from my experiences with many different makes of cars, removing and modifying an instrument cluster is not something I recommend.

Other Gauge Locations

The automotive aftermarket industry, which includes racing and hot rod companies, offers many types of accessory gauge mounts. They can hold the gauges necessary to monitor a high performance engine. These mounts are made to hold standard 2 inch (5 cm) automotive gauges, so they are compatible with standard automotive-style EV gauges. They can accommodate different numbers of gauges arranged in different configurations.

These mounts can be installed either under the dashboard or on top of it. If you decide to install them on top of the dashboard, you will want to fabricate some kind of cover to protect the gauges from the sun and hide all the wires involved. Look for mounts at auto parts houses, speed shops, or ads in the car hobbyist magazines.

Another possibility for gauge installation is somewhere in the vehicle's dashboard other than the instrument panel. This could be a storage bin for tape cassettes, space provided for a CD player that isn't being used, or a heater or air conditioner outlet that can be sacrificed to provide a place for an ammeter and an SOC meter.

To use one of these spaces, you have to make a plate of metal or plastic that will hold the gauges and fit in the available space. Then you must figure out how to attach this assembly to the chassis of the vehicle.

This mounting option usually involves removing the outer dashboard cover, but this isn't too bad a job with the help of your factory service manual. This method gives you more of the original equipment look than the accessory mounts do, with less work than mounting them in an instrument cluster.

On Top of the Dash

Mounting gauges on top of the dashboard in either an aftermarket mount or one you have built yourself is a good idea, but you need to consider some possible problems. The first is line of sight. While this position is great for viewing the gauges, you must be careful to keep the gauges and their housing from obstructing your view of the road from the driver's seat. Place your add-on instrument cluster or a mock-up where you think you want it. Then sit in the driver's seat to make sure that it doesn't block your view of either front corner of the car, interfere with the rearview mirrors, or narrow your forward view of the road.

View problems or the shape of the top of the dash may make it necessary to position the gauge package closer to the center of the car instead of directly in your line of sight. If so, the instruments might be hard to read. Then you can see whether it helps to angle the housing assembly or the gauges in the housing toward the driver.

Mounting your EV instrument cluster on the top of the dash could also be complicated by the safety padding that has been installed on dashboards of cars and trucks since the late 1960s. Finding solid metal to bolt the gauge mount to can be a challenge.

From one of the footwells of the passenger compartment, use a flashlight to look up at the underside of the dash in the area you want to bolt the gauge mount. Can you see your chosen mounting location? Is there metal to bolt to? If you can't see your mounting spot from the footwell because the heater is in the way, does removing the radio give you a view and access to your mounting spot?

If you can't see the underside of the dash at the spot where you want to fasten your mount, or you can't reach it to install fasteners, the top-of-the-dash gauge mount is not an option for you. If you have metal to fasten to and access for installing fasteners, the next thing to check is if there is enough room between the top of the dash and the windshield for a power drill to make the necessary mounting holes. This possible problem could be overcome by a power drill with a right-angle head.

If everything is still a go for the top-of-dash mount plan, the next step is to determine the thickness of the dash padding where you want to drill. Decide exactly where you are going to drill your mount holes, and push a long, thin, straight pin of known length through the padding until it is stopped by the metal part of the dash. Measure from the top of the pin to the top of the padding, and subtract that distance from the length of the pin to determine the thickness of the padding.

The reason for taking this measurement is that the layer of crushable foam between the metal of the dash and the metal or hard plastic mount is not a firm enough base for the gauge mount assembly. Tightening the mounting screws will crush the foam and probably damage the plastic skin of the dash.

You can build spacers out of pieces of tubing with an inside diameter just big enough to slip over the mounting bolts for the gauge mount, and as long as the thickness of the foam. These will give you a firm mount for the EV instrument cluster. I have made spacers out of old VW pushrods and table lamp parts, to give just a couple of examples. You might also try plumbing and heating supply houses. Be creative.

The process for using spacer pipes goes like this. First, center punch holes for the mounting bolts through the foam and into metal at the chosen bolt locations, using a thin center punch. Then drill the holes for the mounting bolts through the padding and through the metal. Finally, drill holes the same size as the outside diameter of the pipe spacers through the foam only. A hole big enough for all the wires needed to hook up the gauges should also be drilled in a suitable location.

The finishing touch for the top-of-the-dash gauge mount is a cover for the back of the gauges. This cover hides the backs of the gauges and all the wires running from the drive system to them, and protects those gauges and wires from the sunlight pouring through the windshield. You can make this cover out of a plastic, such as ABS, that will withstand high temperatures and has good UV resistance.

In the Dash

The next location to consider for your EV gauges is in the dash of the car or truck in the same horizontal plane as the instrument cluster or a little lower. This mounting option takes partial advantage of the factory's work in locating the original instrument package for visibility, and gives a factory look to the EV gauge installation. As mentioned previously, if the gauges are located closer to the centerline of the car than they are to the driver, angling them toward the driver will make them easier to read.

The thing to look for with an in-dash location is room. You will need space enough for the largest diameter of the gauge, times the number of gauges used, plus about a 1/2 inch (13 mm) space between each gauge and on either end of the row of gauges. In addition, you will need enough room behind the face of the dash to accommodate the depth of the gauge, plus at least 1 inch (25 mm) to allow clearance for the mounting studs and wiring.

Installing your gauge mount will probably require removal of the face of the dashboard. But if you follow the directions in your factory service manual and label any wires you have to remove, you should be OK. If you are using a space previously occupied by a heater or air conditioner outlet, be sure to block off the ducts that connect the outlet to the main airbox.

Under the Dash & in the Console

Two other locations for EV gauges are on the bottom edge of the dashboard in an aftermarket mount, or in a console installed in the vehicle. Both of these options are less than ideal due to poor visibility and their distance below the driver's view of the road.

The more the line of sight to the gauges veers to the side and down, the more problems you have with readability. When the gauges are mounted to one side, the driver gets only a narrow angled view instead of seeing the full face of the gauge.

Once again, this can be partially solved by tilting the gauge mount and gauges toward the driver, but there are often limits to how much tilt can be used. Interferences with the gearshift, other parts of the vehicle's interior, or parts of the driver's or passenger's anatomies can restrict the amount of tilt used.

I discovered another problem when mounting gauges on the lower dash of an early model Rabbit. The numbers and graduations of the gauges were in an arc across the top half of the gauge, and the needle's pivot was at the bottom, which is the normal gauge configuration. But from the driver's seat, the bezel of the gauge hid the numbers because the face itself was recessed behind the glass. All you could see was the needle moving back and forth.

Since we were having gauges custom made, it was easy to have them made upside down, with the numbers and graduations along the bottom of the gauge and the needle pivot at the top. The new configuration made a big difference in the early Rabbits. Since we knew that other models would have the same problem, we made it the standard configuration for our gauges.

If your car or truck has a console built into it, it probably contains a clock and one or two other gauges that give less important information than the gauges in the instrument cluster. Replacing these with your EV gauges makes sense, and because this was a factory installation, visibility problems should be minimal.

Despite our efforts to make all the gauges visible, one of the gauges, due to its position, will be easier to read. The ammeter should be the gauge in that position because it is used as an energy consumption gauge and is more closely watched while driving. The SOC meter should have the next most visible place in the gauge cluster. The auxiliary battery voltmeter, if you are using one, could be in the least visible position.

Now you have the gauges physically installed in the car. Next time I'll talk about wiring them, with details about the appropriate shunts, wire sizes, wire run locations, and other details. Stay tuned.

Access

Mike Brown, Electro Automotive, PO Box 1113-HP, Felton, CA 95018 • 831-429-1989 • Fax: 831-429-1907
mike.brown@homepower.com • www.electroauto.com

Reduce Your Energy Consumption

STABER

***Commercial-Quality* Washers at a Residential Price**

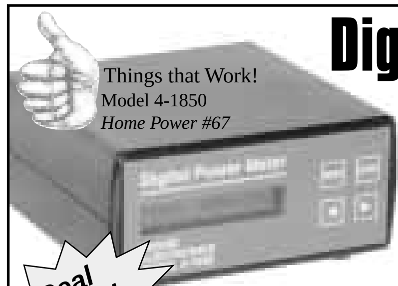
- Does not void warranty if used on solar power
- **Save 30 gallons of water per load** *(great for wells & septic systems)*
- Less hot water to heat
- Uses an average of just 135 watt-hours per load
- Patented stainless steel tub design can clean more effectively than circular tubs
- Can hold 16 full-size bath towels because of no agitator
- Reduce your drying time with faster spin speeds
- Made in the U.S.A.

CALL 1-800-848-6200
or 614-836-5995 today!
www.staber.com

Staber is the only 'top loading front loader' made in the U.S. and is currently named as a 'Best Buy' in *Consumers Digest*

The Symbol for Energy Efficiency

Home Power
Things that work!



Digital Power Meter

Measures Watts & Watt-hours (kW-hr)

Real Plug n' play!

Simple to use.
Plug the Power Meter into any AC outlet, and plug the appliance to be measured into the Power Meter. That's it!

- Measure REAL (true) power 1 to 1850 Watts
- Measure power used, 1 Watt-hr to 9999 kilo-Watt-hrs
- Measure cost ($), just enter cost per Kilo-Watt-hr
- Calculates average monthly cost
- Compare appliances for energy savings
- Find parasitic loads
- NEW backlit LCD display now standard!

NEW: Model 20-CTR...
measures any supply/load 100-250 vac, up to 40 amps, 1 or 2 phase. Perfect for grid tied inverters. See our website, or call for details.

Prices start at $149.95 Model 4-1850 **Many models available.**

To order, call toll free
1-888-433-6600
www.brandelectronics.com

Brand Electronics
421 Hilton Rd.
Whitefield, ME 04353
For information only, call 207-549-3401
info@brandelectronics.com

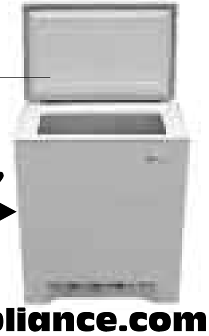
MORE PROPANE POWER

Dynamx, Inc. is your source for off-grid living appliances. Refrigerators, Freezers, Ranges, Hoods, Washers, Coolers, Heaters

Peerless Premier
Several sizes / models
20", 24", 30", 36" widths
AGA / CGA Approved

Peerless Premier - Zephyr - Staber - Danby - Conserve
Williams - Equator - Consul - Zero - Frostek - Crystal Cold

Zero GEV-70 Portable Chest Freezer. 3-way Power. 2.2 Cu. Ft.
AGA / CGA Approved



"CAMPERS FAVORITE"

Dynamx, Inc.
(928) 636-1955
www.warehouseappliance.com
Dealer inquiries welcome

NORWOOD
INDUSTRIES INC.

LUMBERMATE™ 2000

PORTABLE BAND SAWMILLS

- Handles logs 31" diameter.
- Saws 24" wide boards & beams.

9hp - $3,895
13hp - $4,255
15hp - $4,495
20hp - $4,995

Call today for more details!
***800-661-7746** Ext.408*

www.norwoodindustries.com

Norwood Industries Inc. • 252 Sonwil Drive, Buffalo, NY. U.S.A. 14225

Renewable Energy Terms

Alternating Current (AC): Two-Way Electron Flow

Ian Woofenden ©2001 Ian Woofenden

Derivation: From Latin alternare, *from* alternus, *by turns, and Latin* currere, *to run.*

Direct current is relatively simple to understand (see *Word Power, HP85,* page 118). Electrons (charged particles or "charges") flow in one direction through a circuit. The charge flow is from the negative terminal of the battery through the circuit wiring, to the positive terminal, through the battery, and back around. Alternating current (AC) is different.

In an AC circuit, the electrons flow one way and then the other. They move back and forth, and don't travel down the wire from the source to the load. This can be confusing to people new to electrical concepts. I remember when I first tried to wrap my brain around the idea. I thought, "If the electrons move a little one way and then a little the other way, don't they cancel each other out? How does anything get done?"

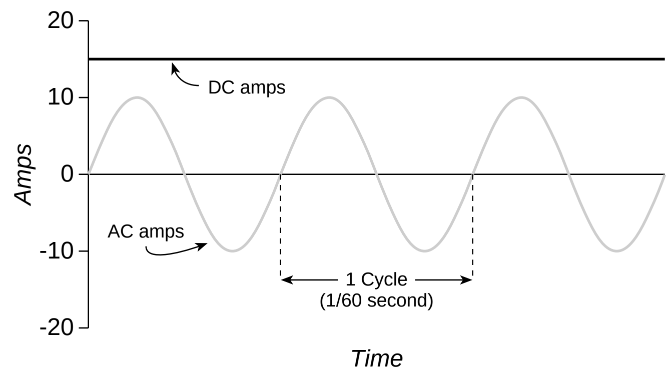
This misconception is probably rooted in the assumption that the electrons are "energy," and that they move down the wire and are "used up" by your appliances. But electrons are not energy; they are matter—part of the wire in the circuit. Electrons, or charges, are one of two things that flow in electrical circuits. The other is energy. Energy is the capacity to do work. Electrical energy is in the form of electromagnetism—an electromagnetic field.

Energy flows from source to load on a one-way trip. Its flow can be facilitated by direct current (roundtrip unidirectional flow of charges) or alternating current (back and forth flow of charges). To help you understand how this back and forth, alternating current can perform work, think about an old, crosscut saw. My wife and I used one of these to cut firewood years ago. If you focus on the saw blade, and have the goal of it "going" somewhere, you'd think that my wife and I were doing nothing when she pulled one way and I then pulled the saw right back to where it started.

But with each pull, a bit more wood got cut. The saw blade is like charges flowing back and forth, and the wood getting cut is the work being done. The energy flowed from the muscles in our arms and backs into the cut in the wood. The saw blade, like the charges in alternating current, just goes back and forth.

The diagram here shows direct current and alternating current graphs. The vertical axis shows amplitude—in this case, amps. The horizontal axis shows time.

AC and DC Waveforms



The direct current graph is not very exciting. Once you turn the switch on to a single, constant load, the charge flow is constant and in one direction. Your flashlight batteries, PVs, automotive batteries, and RE system batteries put out this steady, unidirectional type of charge flow.

In the alternating current graph, you can see that the amplitude is constantly changing. The center (zero) line of the graph represents no charge flow. The upper extreme of the "wave" shows the charge flow at its peak in one direction (10 amps in this case). The lower extreme shows the peak in the other direction.

In alternating current, the amplitude goes from the peak charge flow in one direction, through zero charge flow, to the peak in the other direction. By convention, we call the peaks "positive" and "negative." This reversing of direction happens many times a second. In North America, the standard is 60 hertz (Hz), which means 60 complete cycles per second. In many other places, it is 50 Hz. A cycle is from zero to the positive peak, through zero again to the negative peak, and back to zero.

Understanding alternating current is not simple. And the nature of this form of charge flow makes for a lot of complication and nuances in the design of electrical wiring systems and electronic components. The basic thing to remember is that the electrons are moving back and forth in the wires, and all that motion is moving energy along to your appliances.

Access

Ian Woofenden, PO Box 1001, Anacortes, WA 98221
Fax: 360-293-7034 • ian.woofenden@homepower.com

ZAPSUCKER .COM

Renewable Energy Products

Education, Solar Panels, Wind, Hydro, Charge Controllers, Batteries, Inverters and a lot more.

- **Online Convience**
- **In-Person Service**
- **Great Prices**

410-391-2000

Mr Solar.Com

Need GIFTs for CHRISTMAS? Choose SOLAR!

neatsolarstuff.com

Call Toll Free: 1-866-247-6527
Email: gifts@neatsolarstuff.com
Shop: www.neatsolarstuff.com

Radios & Flashlights - Educational Toys - Nifty Stuff - Lights

Solar products since 1979

AAA Solar Supply Inc - (800) 245-0311
Photovoltaics - Solar Hot Water
Space Heating - Pool Heating
New, used & rebuilt for the do-it-yourselfer

www.aaasolar.com

LOWEST PRICES UNDER THE SUN!

Solar Electric Inc.

5555 Santa Fe St. #D, San Diego, CA 92109-1602 USA
858-581-0051, 858-581-6440 fax, 1-877-842-5678 TOLL FREE FAX
www.solarelectricinc.com, email: solar@cts.com

1-800-842-5678

Best Selection! Lowest Prices! Guaranteed!

Trojan UNI-SOLAR PowerStar

Phoenix Composting Toilet System

Odorless • Waterless • Large Capacity
Low Energy Requirements • Owner–Friendly

Advanced Composting Systems
195 Meadows RD
Whitefish, MT 59937
Voice: 406-862-3854
Fax: 406-862-3855
phoenix@compostingtoilet.com
www.compostingtoilet.com

Sunergy Systems, LTD
Box 70, Cremona AB T0M 0R0
Voice/fax: 403-637-3973
sunergy@telusplanet.net
In British Columbia:
Voice: 250-751-0053
Fax: 250-751-0063

If you're looking for fast, expert, inverter repair performed by expertly trained technicians, using the latest state of the art test equipment, visit:

WWW.INVERTERREPAIR.COM

or call toll free

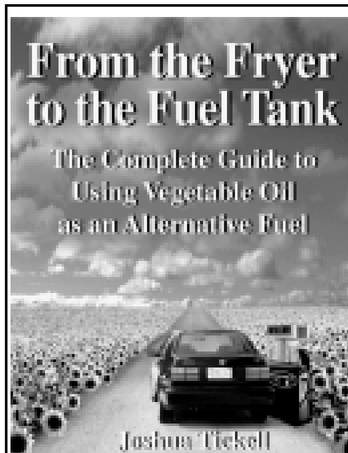
866-52-FIXIT

or

888-647-6527

INVERTERREPAIR.COM
is a division of Solatron Technologies Inc.

Bringing you the power of the sun at down to earth prices



Fuel *any* Diesel vehicle, generator, or engine with **vegetable oil**!

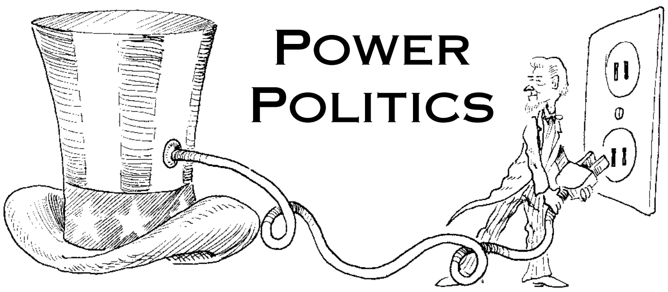
Complete instructions, photos, diagrams, parts lists, and resources for:

- Running a diesel on ***Straight Vegetable Oil***
- Making Biodiesel from Used Cooking Oil
- Building a Small Scale Biodiesel Processor
- Growing Oilseed Crops
- Diesel Vehicles

NEW! **The Veggie Fuel Video...**

Follow Joshua Tickell as he makes biodiesel from used cooking oil with easy-to-read, onscreen instructions.

Book or Video $29.95ea. (Outside USA add $5)
Book & Video Combo $46.95 (Outside USA add $7)
1-800-266-5564 or 419-281-1802 (24 hrs/day)
http://www.veggievan.org/book.html
U.S. check or money order payable to:
BookMasters, P.O. Box 388, Ashland, OH 44805



Nukespeak & the Lowdown on New Nuclear Power

Michael Welch

©2001 Michael Welch

"The nuclear power industry and its allies in government are deliberately withholding information, omitting facts, ignoring figures, thwarting investigations, promoting fallacies, hiding reality, stretching and bending the truth, obfuscating, prevaricating, committing material false statements, and outright lying in a last-ditch, no-holds-barred effort to resuscitate the deservedly-dying atomic power industry."

So reads the bold print under the even bolder title, "The Return of Nukespeak" on the June/July 2001 cover of the *Nuclear Monitor,* a newsletter of the Nuclear Information and Resource Service (NIRS). In the '70s (when I became an antinuclear activist) and well into the '80s, the nuclear industry hurt itself badly by trying to stand on the lies and half-truths that folks had believed in during the post-WW II patriotic moods that existed into the '60s.

Now the industry and its Bush administration puppets perceive a window of opportunity as the nation concerns itself with its energy future. What is the truth buried under the new round of nukespeak? I hope the American public doesn't fall for this specialized doublespeak again, and that we expose the truth before the next generation falls victim.

Too Cheap to Meter

Cheap energy was the biggest lie of all. U.S. utilities were pushing for nuclear energy by literally claiming that it would be "too cheap to meter." It was easy for the nuke industry and government to pull the wool over public eyes, at least until the world realized how hard it would be to control that little radioactive fuel pellet.

Taming nuclear energy for electricity production turned out to be more expensive than any conventional source. For example, when California utility PG&E's Diablo Canyon nuclear plant was brought on-line, its high costs were responsible for raising utility rates by about 50 percent, even though the plant provides only about 12 percent of PG&E's total capacity.

Safe

Ever since the beginning of the concept of nuclear energy, the government and nuke industry have made claims that nuclear energy is safe. There are two types of engineers. The first believes in simplicity and soundness of pure design. The second believes that no matter what the problem, there is a technological fix.

Nuclear engineers by necessity belong to the second group. The consequences of something going wrong are so potentially huge that simplicity is an impossibility. The more complexity introduced, the more room for human failing in design, manufacturing, construction, and operation. It's akin to a Catch-22. The more potential for problems, the more complex the technological fix. The more complex, the more potential for problems.

Nuke plants are not safe. They are horrible accidents waiting to happen, teetering on a knife's edge above the deepest abyss of engineering follies. Just thinking about Three Mile Island, Chernobyl, Fort St. Vrain, the lesser known Humboldt Bay, and many other reactors, with all the serious accidents in the world, should be enough to send shivers down the spines of even the most hardened "we can fix anything with technology" engineers.

But for some inexplicable reason, they see only the challenge of more engineering at the other end of the tunnel they exist in. Want more proof? How about the need for the Price-Anderson Act, which limits the liability of nuclear plant accidents to a tiny fraction of the damage they could do. Without this legislation, which is currently up for reauthorization, no utility would consider operating a nuke plant. They would not be able to get insurance, nor would they be willing to take the risks themselves.

We Need the Energy
Simply put, this country does not need more energy. It needs less consumption. It needs more efficient appliances and equipment, and more conservation. California is the shining example. With little effort, California citizens cut back their energy usage by 20 percent in just a few months after the rolling blackouts last winter. More shortages predicted for the summer just did not materialize.

Even so, California's problems were not caused by lack of generating capacity. They were caused by the inability to deliver energy where it was needed, and the fact that unreliable nuclear plants were not delivering at full capacity when they should have been.

Nukes Don't Pollute
While we enjoy the benefits of energy, we tend to ignore the drawbacks. Energy production and use account for nearly 80 percent of air pollution, more than 88 percent of greenhouse gas emissions, and more environmental damage than any other human activity.

What a joke to say, "Nukes don't pollute." Some of the dregs of nuclear energy production remain deadly to life for over a million years. Oh, you mean that nothing comes out of the smokestack? That nuclear reactors don't produce greenhouse gases like carbon dioxide, normally associated with burning fossil fuels? Wrong again.

When the entire nuclear fuel cycle and plant construction are taken into account, nuclear energy produces four to five times the emissions of renewable energy. You need to look at uranium mining and milling, processing, enrichment, fuel fabrication, transportation from centralized manufacturing sites, reactor construction, and nuke waste disposal. All these things are energy intensive.

For example, the Paducah, New York, uranium enrichment plant uses so much energy that it has a dedicated coal-fired electricity generating plant to meet its needs. Further, the plant is the nation's largest contributor of chloroflourocarbons (CFCs), which destroy the ozone layer that protects our fragile environment from harmful rays of the sun.

CFCs are pretty much banned from consumer products these days, but the nuke industry uses more than their share. Sure, maybe there is less CO_2 produced over plant lifetimes than with a coal burner, but let's not hold nukes up to be the solution to pollution-induced climate change.

Nuclear Waste
Nukespeak tells us that nuke waste is not a problem, that it will be solved by burying it in the Nevada desert. Another technological fix, spiralling into economic and environmental disaster. Much of that dangerous waste will still be around after a million years, long after it has escaped its containment and entered the environment.

Nuclear waste is still the Achilles heel of the nuclear industry. There is no good place to put it. There is no safe way to store it. The nukespeak mantra of the '60s was, "Don't worry, we will find something to do with it by the time it becomes a problem." Well, the waste has filled up the temporary storage systems originally set up, and new temporary ones are being devised. There still is nothing final or permanent that can be done with nuclear waste.

The industry would like you to think that its irradiated, spent fuel can be reprocessed. Of course, the first tries at this resulted in billions of dollars wasted, and our government is still trying to clean up the environmental mess. "Britain does it—why can't we?" They do it, and they do a really bad job of it. The fact is that there has never been a workable way to reprocess nuke waste. Everybody that has tried it has made an environmental mess.

France Does Nukes Big Time: Why Can't We?
We've all heard about France's nuclear energy capabilities, right? If you mean the urban myth that their nuclear systems are safe, and that they have no waste storage problems, then yes, I've heard about it. The truth is that they are no better than anyone else at this stuff. It is just that for decades, goings-on at French nuclear facilities were considered state secrets. That is the *only* reason why France has been able to build their nuclear program to provide nearly 80 percent of their electricity.

The public was not allowed to find out about their problems until recently. French accidents caused radioactive releases that citizens were not warned about. Their nuclear fuel reprocessing program is famous for polluting the beaches and ocean along its coast. Contamination levels were found up to 17 million times above background levels. Their radioactive waste disposal research program is less than half completed, and the now informed public is strongly opposed to the rest. The French energy program is not building new reactors, but looking to diversify its sources. France is not a successful nuke story, contrary to what we have heard in the nukespeak.

The Public Will Keep Us in Check
Yes, the public has kept the nuke industry in check, but by opposing the building of plants, not by participating in making sure that they are run safely. But all this may end. The Nuclear Regulatory Commission (NRC) is supposed to regulate nuclear energy on behalf of the

citizens of the U.S. But the reality of the situation is that it has become an instrument of the industry.

Now the NRC is trying to limit public participation in reactor licensing hearings. The public has just been too successful for the industry's liking, and now something must be done. The public right to due process may be eliminated. Then the public wouldn't be allowed to participate in evidentiary hearings with weight behind them, but would be stuck with a process of "informal" hearings with little legal recourse.

Second Generation Nukespeak—PBMR

Now we are being promised a new variety of "cheap" nuke energy—the pebble bed modular reactor (PBMR), which manufacturers claim can compete economically with fossil fuel powered electricity generation. One thing that makes it potentially cheap is that it is modular in nature. It provides for the ready addition of more modules to meet demand rather than building a single, huge, thousand megawatt reactor, which had previously been the practice. But, how cheap would it be if it didn't work, or if it let loose its poison into the environment?

Another thing that makes the PBMR appear cheap is the industry claims that it is inherently safe, getting rid of the need for reactor containment. Inherently safe? That sounds like still more nukespeak left over from the '70s. Back then, they just promised "safe." Now they are adding the new qualifier "inherent" to persuade us that nuclear energy is an innocuous technology.

The pebble bed reactor relies on a constant flow of fuel balls (pebbles) through the reactor and back to a storage vessel. In proposed designs, there are more than 300,000 balls total, and about 3,000 pebbles cycle into and out of the reactor each day. Each pebble makes about fifteen round trips through the core before it is discarded. Fuel is constantly being circulated through the reactor and out again. So new fuel can be added without shutting the plant down for refueling, as is required in conventional nuclear plants. Conventional nuke plants keep the fuel pellets in rods that remain stationary in the reactor.

Unlike most nuclear plants, water is not used to cool the PBMR reactor and create steam for generating turbines. The coolant is naturally convected helium gas that drives turbines to make electricity. After the turbine, the residual heat is extracted from the gas before it is returned to the reactor. It is designed as a passive cooling system for the core. The containment is not in the design because it could hinder the natural flow of coolant, and because an unwieldy containment would get in the way of the modular character of the design.

PBMR is merely a new form of an old, bad idea, the high-temperature, gas-cooled reactor (HTGR), which has been considered and abandoned numerous times over the decades. A PBMR reactor was built and operated in West Germany in the early '80s. In 1986, just a few days after the Chernobyl nuclear disaster, a fuel pebble got lodged in the fuel cycling system. Efforts to get it unstuck caused damage to other pebbles in the system, which released radioactive helium and other fallout into the atmosphere.

At first, officials tried to cover up the release by blaming the contamination on Chernobyl. But it was discovered that it was a different type of radiation than that released by the ill-fated Ukranian reactor. Two years later, the West German reactor was closed due to radiation-induced failures in the helium gas channels, and because the pebbles were difficult, if not impossible, to manufacture without defects.

Nuclear Terrorism

One of the things that NRC hearing participants have raised time after time to no avail in NRC licensing hearings is the possibility of terrorist attacks on nuclear plants. There is speculation that September's fourth hijacked plane might have been heading for the Three Mile Island nuclear plant.

A jumbo jet fully loaded with fuel and hitting the reactor containment at a modern nuke plant could be a catastrophe with the potential to be much worse than that of the World Trade Center towers. Imagine what could happen to any city downwind from a compromised reactor and containment, burning with jet fuel. After the September terrorist attack, security at nuke plants was tightened considerably throughout the world. Scheduled radioactive waste shipments were halted until further notice.

In early October, the NRC announced that they would study the possibility of jumbo jet crash attacks on reactor containment buildings. This was two weeks after they announced that the plants were safe from such attacks. But activists still expect no less than a full-scale whitewashing and continued nukespeak.

In the same October press announcement, the NRC boldly stated that such attacks were never considered as a possibility, and that no such threat had ever occurred. But in 1972, hijackers threatened to crash their plane into a reactor at the Oak Ridge National Labs in Tennessee if the airline did not meet their demands for money. The hijackers were not political terrorists, however, and so were satisfied to get the money. They were arrested upon touchdown in Cuba.

NIRS

For years, the Nuclear Information and Resource Service has been keeping folks informed about nuclear energy from the environmental standpoint.

Headlines in recent NIRS newsletters include:

- “Texas Again Stops ‘Low-Level’ Waste Dump”
- “Russia Approves Nuclear Waste Imports”
- “Price-Anderson Act Renewal”
- “Global Warming Agreement Excludes Nuclear Power”
- “Licensed to Kill” (about how reactor operation warms water and kills marine life)
- “German Waste Shipment Delayed by Protests”

Thanks go to NIRS for their hard work, and for giving me the seeds for this issue’s column. Please join them and subscribe to their excellent newsletter.

Access

Michael Welch, c/o Redwood Alliance, PO Box 293, Arcata, CA 95518 • 707-822-7884
michael.welch@homepower.com
www.redwoodalliance.org

Nuclear Information and Resource Service (NIRS), 1424 16th St. NW, #404, Washington, DC 20036
202-328-0002 • Fax: 202-462-2183 • nirsnet@nirs.org
www.nirs.org

Science for Democratic Action, a publication of The Institute for Energy and Environmental Research, 6935 Laurel Ave., #204, Takoma Park, MD 20912
301-270-5500 • Fax: 301-270-3029 • ieer@ieer.org
www.ieer.org • Info on PBMR nuke plants

AUTOMAGIC BATTERY WATERING

WE MAKE WATER FROM YOUR GAS

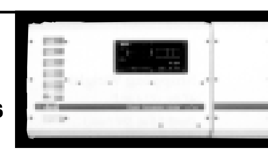
Hydrogen and oxygen battery gas catalytically recombined into pure water and returned to each battery cell. Keeps battery topped off for extended periods of time and reduces maintenance costs. Explosive hydrogen gas is virtually eliminated from the battery area. Corrosive spray and fumes are contained and washed back into each battery cell. Electrolyte kept strong longer, extending the useful power and life of the battery. HYDROCAP Vents simply replace the battery’s caps. Battery maintenance is greatly reduced. Write or call for more information.

Things that Work!

Hydrocap

305-696-2504
975 NW 95 St.
Miami, FL 33150

Marysville Marine Distributers



Inverter Service Center

127 Industrial Dr
White House TN 37188
615-672-1142

P.J. Gonzalez
615-672-5459
pgon@bellsouth.net

Very large parts inventory for inverter repairs.
New and used inverters at low prices.

Sinewave inverters
- X-SW4024MC/2 $ 1800.00
- X-SW5548 $ 1500.00

DR Series inverters
- X-DR3624 $ 850.00
- X-DR2424 $ 800.00
- X-DR1524 $ 750.00

RV Series inverters
- X-RV2012 $ 900.00
- X-RV2512 $ 1000.00
- X-RV3012 $ 1100.00

Batteries by Lifeline
Totally sealed glass mat technology
- Group 31 105 amp hour
- 6V 225 amp hour
- 4-D 210 amp hour
- 8-D 255 amp hour

Lightning Protection by Delta
Protect Your Precious Investment!!!!
- AC Lightning Protection $39.95
- DC lightning Protection $52.46
- AC Surge Protection $39.95

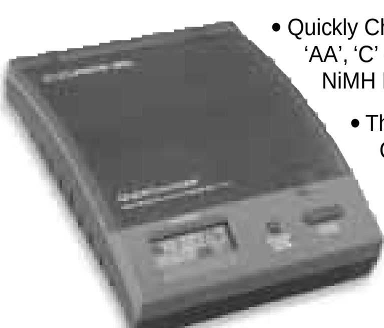
We are not limited to these models. We have a large inventory of other models in stock.

Other manufacturers include Heart and Statpower, all currently under the Xantrex name.

Our sales and service associates have been factory trained at Xantrex facilities. So if you have those difficult to answer questions, we have answers.

QUICKCHARGER
BATTERY CHARGER

The Best Charger Made Today



- Quickly Charges Up To 4 ‘AAA’, ‘AA’, ‘C’ or ‘D’ Size NiCad Or NiMH Batteries
- The Only Charger To Fully Charge All Sizes Of New High Capacity NiMH And NiCad Batteries
- Intelligent Discharge Revitalizes NiCad Batteries
- Also Works On 12V DC

Call for FREE Catalog

C. CRANE COMPANY

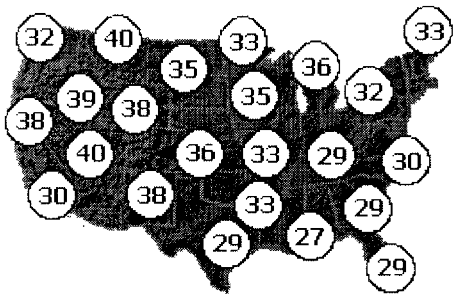
$49.95
Shipping Incl.

800-522-8863 • CCRANE.COM

WATTSUN™
SOLAR TRACKERS

The Dual Axis Tracking Advantage

***as compared to a fixed mount tilted at latitude**



Percent Annual Power Increase

More Power...Less Money

ARRAY TECHNOLOGIES, INC. WWW.WATTSUN.COM
3312 STANFORD NE, ALBUQUERQUE, NM 87107
TEL: (505) 881-7567 FAX: (505) 881-7572

Want more power & life from your batteries?

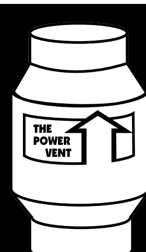
Then get the IES DeSulfator® battery conditioner.
Call your dealer or visit
www.InnovativeEnergy.com

Not only the original, but the most powerful

DS-500 up to 350 amp hours
DS-1000 up to 1,000 amp hours

INNOVATIVE ENERGY SYSTEMS, INC.
9351-J Philadelphia Rd., P.O. Box 70060, Balto., MD 21237
410-686-3120 FAX: 410-686-4271

BATTERY BOX VENTILATOR
& BACK DRAFT DAMPER



- Positive hydrogen venting
- Stops back drafts
- Keeps batteries warmer
- Minimal power consumption
- Available in 12, 24 or 48 VDC

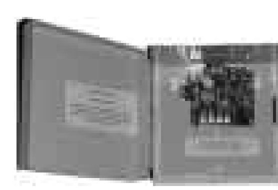
* Trace SW Inverter or controller required to switch fan on/off automatically

POWER VENT
12v & 24v – $79
48v – $104
+ $8 S&H (cont. U.S.)
CO residents add 3%

THE POWER VENT
Zephyr Industries, Inc.
POB 52, Salida, CO 81201
719.530.0718
www.zephyrvent.com

BZ Products Model MPPT 150-12
12 VOLT 150 WATT
MAXIMUM POWER POINT TRACKING CHARGE CONTROLLER

- Boost charge current up to 30%
- Up to 15 amps output current
- High efficiency 95%
- PWM control with temperature compensation
- Weather proof powder coated metal enclosure with 1/2" conduit knockouts
- Maximize your small system's performance
- Five year warranty
- Cost about the same as regular PWM charge controllers
- Industrial packaging available

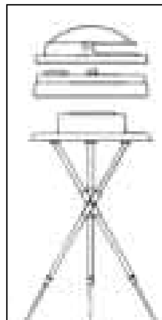


BZ Products, Inc.
314-644-2490 • bzp@brick.net
7614 Marion Ct., St. Louis, MO 63143, USA

With the MacCoupler you can now safely refill small propane cylinders for under 35¢!

Legal and safe for lanterns, heaters, stoves, barbecues, torches, etc.
ONLY $14.95
US Pat. No. 4,807,848
CALL TODAY!
888-493-4517

Solar Pathfinder



The Best Tool For Solar Site Analysis

- ✴ Easy to Use
- ✴ Fast & Accurate
- ✴ Diagrams from 0–66° N & 0–49° S
- ✴ Pathfinder with metal case & tripod $245, Handheld $165 (+ shipping)

3680 Hwy 438, Dept HP
Pleasantville, TN 37147
Phone & Fax 931-593-3552
www.solarpathfinder.com

Our website has free information on "Using a battery monitor to help maintain your battery system, conserve energy and troubleshoot problems."

The **TriMetric** TM-2020

For beginning or intermediate level, our website explains the basics of "volts", "amps", and "amp-hours" for people who are new to electricity. We have information on maintaining your batteries and hints on minimizing your generator usage. The website also describes how the TriMetric measures the energy content of your batteries. We list complete TriMetric instructions, information on shunts, and trouble-shooting meter installation problems. Some files are in "Adobe Acrobat" format. Or mail us $1 for postage and we'll send you (the old fashioned way!) the information on "Using a battery monitor..."

Measures: battery volts, amps, % full (based on amp-hours), battery lifetime total amp-hours, highest and lowest battery voltage, days since fully charged, and days since equalized. Mounts in standard "double gang" box (optional).

Under $200 including shunt.

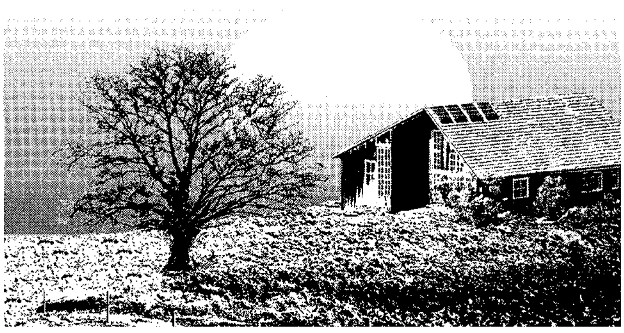
BOGART ENGINEERING

19020 Two Bar Road, Boulder Creek, CA 95006

(831) 338-0616

www.bogartengineering.com

SIEMENS



Solar Power Your Dream.

You've finally found just the right spot. A little out of the way, but good water, good soil, and even a little view. You're going to build.

Siemens can help turn your plans into reality. An economical Siemens solar system can give you year after year of trouble-free electricity. And do it silently, without fuel, waste or pollution.

Find out now just how easy it is to have a solar system to meet all or part of your electrical needs.

See Your Siemens **SolarPower**Pro™

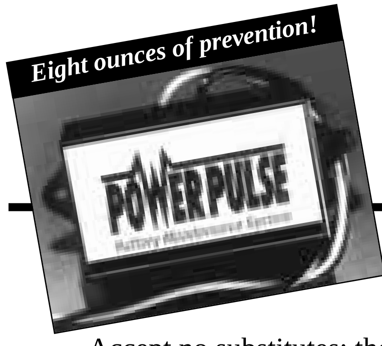
Office (520) 636-1001
Fax (520) 636-1664

P.O. Box 365, 2655 N. Hwy 89
Chino Valley AZ 86323

IPP MEMBER

HITNEY SOLAR PRODUCTS, INC.
Harmony with Nature

"I consider (the PowerPulse® devices) to be standard equipment for a lead-acid battery system…"
Richard Perez, Home Power magazine



Extend the life of your batteries!

12 Volt	24 Volt
$69.95*	$119.95*

Accept no substitutes; the cost effective **PowerPulse**® units are patented, approved by the U.S. Military, and have a 5-year limited warranty.

***Manufacturer's suggested retail price. Other voltage units available.**

■ Free delivery to 50 States. ■ Major credit cards OK.
■ Bulk/Dealer inquiries invited.

Abraham Solar Equipment

800-222-7242 ■ 970-731-4675

124 Creekside Place ■ Pagosa Springs, CO 81147

©1999 Abraham Solar Equipment. All rights reserved.

THE POWER BROKERS!™

Don Loweburg ©2001 Don Loweburg

The Right Path

Last issue, I reported on the booming California PV market. How things change so quickly! I don't know how it goes for other companies, but I have noticed a marked decrease in new calls during the last two months. This is, no doubt, related to the apparent "solution" of California's energy problem.

I say apparent because little has actually changed here except that the generators got the price increases they were demanding and the lights stopped going out. After the price increases, the generators made more capacity available. In other words, they were holding back supply until they got the price they wanted. In this country, renewables and especially the solar-electric industry, have been on a constant roller coaster ride. Each crisis precipitates a mini boom followed by a decline of interest.

On a positive note, each peak or crest of the wave establishes a new beachhead of increased use of renewables. But the ebb tide that follows is disruptive to the orderly development of the RE industry.

Speaking of disruption, I am writing this less than one week after the New York and Pentagon attacks. The collective consciousness at the moment is preoccupied with grief and anger. Little public analysis has been directed at the energy ramifications arising out of a widespread U.S. military action in the Middle East. Huge issues loom.

We Must Choose the Right Path

Long-term energy sustainability receives little government attention in this country compared to in Europe and Japan. Americans would have no way of knowing this unless they were to read offshore publications. One consistent source of very broad-range RE information is *Renewable Energy World,* published in England. The recent *Review Issue 2001–2002* provides a comprehensive global overview of the state of renewables.

The U.S., once at the forefront of wind development, is now far overshadowed by Europe. In just four years, the U.S. has slipped from number one producer of PV modules to third ranking, behind Japan and Europe. In terms of installed PV, the U.S. accounts for only a small fraction compared to that installed in Japan and Europe.

In Europe and Japan, strong national programs promote the installation of RE. No such national programs are present in the U.S. Instead, the national government seeks increased "supply," meaning more drilling and pumping, and correspondingly increased consumption of hydrocarbons. The government's (ultimately our own) blindness is heading us into a dark corner.

From the Horse's Mouth

Carl Weinberg, once head of R&D at Pacific Gas & Electric (PG&E) and now an independent energy consultant, has written an article, "Keeping the Lights On—Sustainable Scenarios for the Future." It appears in the July/August 2001 issue of *Renewable Energy World.* His perspective and thoughts are especially interesting in that they come from firsthand experience as a utility executive. In fact, while at PG&E, Carl is credited with coining the term "distributed utility."

It is from the perspective of distributed generation as the new generation paradigm that he analyzes the future of electric generation. It is a global picture, well embellished with much detail, including a succinct and accurate history of the development of the regulated utility industry in this country.

Mr. Weinberg, though cognizant of renewables as a component in the new scene, deals with a wide range of what he calls distributed resources. These include efficiency measures and distributed generation technologies. But ultimately he asserts that the struggle is not one of technology but of "business models."

In the article, he states, "Distributed generation poses a serious problem to traditional utilities. All of these technologies are a threat to the revenue of utilities, since most utility revenues are derived from the sale of electricity." This means that the application of these technologies will be bitterly opposed by traditional utilities.

This battle is in full swing in the U.S. in the establishment of interconnections to the distribution grid. Interconnection standards fall into two categories—technical and administrative. Weinberg quickly dismisses the technical standards (UL 1741 and IEEE 929, for example) as a done deal and goes on at length to focus on the administrative issues, which he terms "contentious."

Carl establishes a gradient to measure utility responses. At one end is a "plug and play" policy, and at the other end "hesitate and hassle." He, somewhat cryptically, states, "It is an interesting exercise, and in some ways amusing, to place various utilities along this scale." Is this in any way an allusion to his former employer?

In closing, he proposes two scenarios or paths. On the one hand is tradition, or "teaching old dogs new tricks." He outlines some of the difficulties involved in transforming the existing utility structure and concludes, "All these problems could be overcome, but not easily. It would require political will and patience to face a snarling dog while trying to teach it new tricks."

The other path Carl outlines is innovation, or "the supermarket of choices." It has its problems, which he enumerates. He then concludes, "To achieve this scenario requires the fashioning of a variety of markets and assuring a host of competitors, along with the capability to oversee these markets for some time."

Carl Weinberg's article is especially recommended for those who have wondered why we at *Home Power* "hate the utilities." It is not hate. It is simply knowing what the game is. What better source for that information than the words of someone with utility experience.

System Ratings

Important distinctions between module output and system output were covered in the last two columns. In *IPP, HP84,* Sandia Lab's work on module output ratings and expected yearly energy production as related to geographic location and mounting orientation was reviewed. In addition to the many important detailed findings, it was concluded that if the manufacturer's STC (standard test conditions) output wattage ratings were accurate, this rating could be used to compare different modules. It is, however, only a reference number and in no way can it be used to characterize system output.

In *IPP, HP85,* the discussion moved to system output and the way component efficiencies interact determining system output. Using a simple mathematical approach, it was shown that system output as measured in AC watts may be typically 70 percent of the array STC rating for batteryless grid systems, and even lower for stand-alone systems.

Though these realities have been known for years, they have not been widely discussed among manufacturers, wrenches, and their customers. Early customers and their installers were so thrilled with the fact that electricity could be made from sunshine that efficiency was not the main concern. Imagine an off-grid customer freed from a howling generator. Efficiency was usually not even measured. Clearly, a pattern of denial has been perpetrated over the years. What rhinoceros in the living room?

Telling the Truth

The home-based, grid-connected market changes things. First of all, these customers already have electricity, and look to PV as a way of lowering their utility bill. System output now must be accountable. A second change involves the presence of standard metering on the inverters. Both power and energy output can easily be tracked. Manufacturers, dealers, and installers who over-promise are going to be held accountable.

This issue has come to the surface here in California due to the expansion of the grid-connected market. Some customers and installers have been disappointed with system performance. Initially, focus was on the hardware and installation quality. These are, of course, crucially important issues, and there have been problems on both fronts. However, after site-specific factors are accounted for, we must conclude that the expectations for system performance are too high.

It is time to proactively get the story right. Though it may seem dismal to "lower the bar" of expectations, the truth is crucial to the future success of the PV industry. If we don't get it right, expect to hear a litany of tales to the effect that solar electricity does not work. We have been there once before, and I don't want to go there again. Remember, many are just waiting to prove this point!

Whose Job Is It?

Though this veil of "efficiency denial" is borne by all elements of the PV industry, the task of setting the record straight falls squarely on the reputable installing dealers and designers of PV systems. Manufacturers of components (modules and inverters) are liable only for the performance of their product. It is the system integrator/installer who must stand behind the system's performance. We are holding the bag, so to speak. That is why we must break the silence.

What Watts?
The least accurate rating system is based on the STC module output. For example, twenty-four, 120 watt modules would have an STC rating of 2,880 watts DC. An unscrupulous vendor might market these modules and an inverter as a 2,880 watt PV system. Moving closer to the truth, we have the California Energy Commission (CEC) rating. This rating includes about a 10 percent module derate based on temperature and other factors, and an inverter efficiency derate factor (a still overly optimistic value based on the inverter's peak efficiency). The CEC rating for this system would be just under 2,400 watts.

Many of the kit systems offered by companies like Siemens, BP, and Kyocera are marketed using this rating, as are many systems designed by independent dealers or distributors. From a marketing perspective, this may make sense, since the CEC watts determine the California rebate. Referring to the CEC rating may also imply some degree of state sanctioned credibility. However, the real world output of this system, using the best inverter on the market and an ideal open-air rack for the modules, is about 2,000 watts, as measured at a central California location in the summertime.

This output, "real world system peak AC watts," is about 70 percent of the array STC rating. Customers and installers must keep in mind that this is still a "ballpark" number. It assumes that the sun's rays are perpendicular to the array's surface when the measurement is made. If this is not so, then a lower number would be appropriate. In cooler climates, a higher number. On a hot roof, a lower number. And so on.

Paying for Energy
Though actual peak system AC output power is a good starting point for determining expectations of system performance, yearly energy output is what a customer should be most interested in. As a start, that number depends on system peak AC output watts. Other factors affecting yearly energy output are local climate, installation integrity, appropriate component matching, shading and site issues, racking methods, and geographic location.

It is the interplay between these factors that will determine yearly system energy output. This can be quite complex. Experienced installers/designers have the benefit of a knowledge base of past projects. Coupling this knowledge with computer design tools like Solar Design Studio enables them to make reasonably accurate assessments.

The customer purchasing a kit system from a local hardware chain or over the Internet does not receive this kind of support. In fact, they are mislead by manufacturer statements to the effect that "the system can be easily installed by any local licensed electrician." Manufacturers and outlets that are pushing product this way are doing a disservice to the customer and the PV industry.

Buyer Beware
Recently I received an e-mail titled "Intertie Installation Schlock." The note was written by someone with long-time experience in the industry. It seems a relative of this person had questions about a grid-intertie system recently installed by a local electrician who "specializes" in intertie. The customer felt that his fifty-one, 120 watt modules should be making the meter go backwards, and they weren't.

Among the problems found by our PV colleague on a site visit were: loose battery cables, inverters with the utility power connected to the generator input on both inverters (the system would never be able to "sell," or put energy into the grid, wired like this), the inverter's float voltage (that's the sell voltage) set higher than the charge control (again the charge controller would not allow the inverters to sell), and the modules wired three in series (should have been four in series). Like that, the array voltage would always be less than the sell voltage.

Any *one* of these problems would have kept the system from functioning properly. This is an example of how standard quality components, all UL listed—a good system on paper—can be completely botched with incompetent installation. Systems should be designed and installed by experienced PV professionals. And customers should thoroughly check the background and track record of any prospective installer. They must have verifiably happy past customers.

Access
Don Loweburg, Independent Power Providers (IPP), PO Box 231, North Fork, CA 93643 • 559-877-7080
Fax: 559-877-2980 • don.loweburg@homepower.com
www.i2p.org

Renewable Energy World, James and James, Ltd., 35-37 William Rd., London, NW1 3ER, UK
+44-20-7387-8558 • Fax: +44-20-7387-8998
rew@jxj.com • www.jxj.com/magsandj/rew/index.html

Sandia National Laboratories, David King
505-844-8220 • dlking@sandia.gov • For document downloads: www.sandia.gov/pv

Maui Solar Software Corporation, 810 Haiku Road #113, Box 1101, Haiku, HI 96708 • 808-876-1859
michael@mauisolarsoftware.com
www.mauisolarsoftware.com • Solar Design Studio software

ABS Alaskan, Inc.

Alternative Energy & Remote Power Products for Alaskans

- Solar Panels
- Wind Turbines
- Micro Hydro
- Generators
- DC Lighting
- Inverters
- Controls
- Meters
- Batteries
- Accessories

And all your other home power needs!

Fbks: **ABS Alaskan** 2128 Van Horn Rd. (907) 452-2002
Anch: **AK Battery Mfg.** 166 E. Potter #2 (907) 562-4949

Or visit us on the internet at:
http://www.absAK.com/

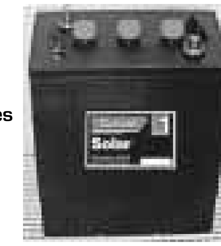
Do You Need Batteries?…

RAE Storage Battery Company

Since 1943… Quality & Service

Surrette Solar 1, 400 Series, Type CH 375 - L16

Engineered under careful guidelines by Dave Surrette - Family owned business Est. 1935



Dyno Batteries

Custom Built Superior Deep Cycle Batteries from M. Knowlton family Since 1933. Seattle, Washington

If you need Competitive Pricing & Prompt Delivery call:
860-828-6007

Fax 860-828-4540
51 Deming Rd., POB 8005,
Berlin, CT 06037

Rolls

Dyno

SIMMONS Natural Bodycare

Make every day special

The natural ingredients of our products get their energy from the sun

simmonsnaturals.com
42295 Hwy. 36, Bridgeville, Ca 95526

Off the grid since 1980

DEALERS RETAILERS HOMEOWNERS

~ Quality Professional Service ~

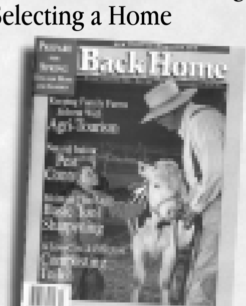
Serving the Eastern US & Atlantic Islands with:
PHOTOVOLTAIC CONTRACTING, INSTALLATION, TROUBLESHOOTING & REPAIR

CURRENT ELECTRIC / MOONLIGHT SOLAR
3451 Cameo lane Blacksburg VA 24060
540-953-1046 moonlightsolar.com

BackHome MAGAZINE

Your Guide to Self-Reliant Living

Take control of your own life. Thousands of people have gone BACKHOME to enjoy less complicated, more rewarding lives . . . and you can join them. In each bimonthly issue, find articles on topics such as: Alternative Home-Building Techniques, Organic Gardening, Selecting a Home Business, Living Mortgage Free, and much, much more!



Subscribe to BACKHOME for just $18.97 per year.
Call us at 800-992-2546,
write to us at P.O. Box 70HP,
Hendersonville, NC 28793
or visit our Web site

www.BackHomeMagazine.com

WE WROTE THE BOOK ON ELECTRIC CAR CONVERSIONS

CONVERT IT **How-To Manual**
by Michael Brown with Shari Prange

Expanded & Updated 3rd Edition
$30.00 tax & postage included

"We built Mr. Brown's car, and we won."
Bruce Burk,St. Johnsbury Academy,
1991 American Tour de Sol Open Class Winner.

ELECTRO AUTOMOTIVE
POB 1113-HP, FELTON, CA 95018

www.electroauto.com

2002 NEC

John Wiles

Sponsored by the Photovoltaic Systems Assistance Center, Sandia National Laboratories

The 2002 *National Electrical Code* has been published by the National Fire Protection Association, and will be enacted into law by many states and local jurisdictions on January 1, 2002. The 2002 *NEC* has been significantly revised in both content and format. Article 690 on photovoltaic power systems received some attention, and the significant changes will be presented in this column, and in my column in *HP87.*

About 40 people in the PV industry worked on a set of 32 submissions to the 2002 *NEC.* Others inside and outside the industry proposed changes, as can anyone who takes the time to properly fill out the required form.

Many of these other proposals were not well substantiated, and were rejected on the first cycle of the three-year process. Several changes were made during the public comment phase. The Code Making Panel (CMP-3) had their say, and then the NFPA Technical Correlating Committee made the final revisions and edits.

The exact contents of Article 690 for the 2002 *NEC* will not be repeated here due to space restrictions. Everyone designing and installing PV systems is encouraged to get a copy of the complete 2002 *NEC,* and better yet, the 2002 *NEC Handbook.*

690.2 Definitions
Note the new decimal format instead of the old 690-2. The definitions for “Bipolar Photovoltaic Array,” “Photovoltaic Systems Voltage,” and “Stand-Alone System” were slightly revised for clarity. A new definition was added for “Diversion Charge Controller,” and it covers diverting excess energy to DC or AC loads. Those installations using diversion controllers face some new requirements; see the next *Code Corner* in *HP87.*

690.3 Other Articles
Article 690 still dominates when it conflicts with another article (but not over the local inspector). Reference is made to sections 705.14, 705.16, 705.32, and 705.43, which require additional markings and some other restrictions when there is more than one source of power. These other articles generally won’t affect PV installations other than requiring some system labels that are required by Article 690 anyway. The UL-listed inverters used in PV systems are generally more robust, and exceed the hardware requirements listed in the 700 series articles.

690.5 (B) Disconnection of Conductors
This section on ground-fault protection equipment was reworded to correct a grammatical error and to better match the actions of existing equipment. There are no changes from the detailed requirements established back in the 1987 *NEC* for this fire protection device that must be used in PV systems mounted on the roofs of dwellings. It still must detect the ground fault, indicate that a ground fault has occurred, interrupt the fault current, and disconnect the faulted PV array.

690.7 (E) Bipolar Source and Output Circuits
A new section was added to allow the DC voltage-to-ground to be defined as the system voltage on certain types of bipolar systems that meet specific grounding requirements. Only a new type of inverter will ever use this type of bipolar system. Currently no available inverters use bipolar PV arrays, although the recent vintage Omnion inverters did. Most bipolar systems require that the system voltage be measured not-to-ground, but between the two highest voltage conductors.

690.8 (B) Ampacity and Overcurrent Device Ratings
Wording was added to designate that PV currents are to be considered continuous (lasting more than three hours). This is important to the PV design process because the solar irradiance usually exceeds the standard test conditions of 1,000 watts per square meter for three hours or more around solar noon. This is the reason for the 125 percent multiplier on current that has been discussed in other *Code Corner* columns. The section was revised and reformatted for clarity.

690.8 (D) Sizing of Module Interconnection Conductors
This section was added to ensure that the module cables have sufficient ampacity when only one overcurrent device is used to protect two or more strings of modules. This is a complex subject (covered

in some detail in previous *Code Corner* columns) and is oversimplified in the *NEC.* Normally, an overcurrent device will be needed for each module or series string of modules. The conductors and overcurrent devices will be sized as discussed in other Code *Corner columns.*

690.9 (C) Photovoltaic Source Circuits
This section was modified to indicate that supplementary overcurrent devices are available in 1 amp increments up to 15 amps. Both DC listed fuses and circuit breakers are available in these values. Some of the new thin-film modules may require overcurrent protection as low as 1 to 2 amps.

690.9 (E) Series Overcurrent Protection
It is now permitted (note that the language is permissive and not mandatory) to use only a single overcurrent device in a series string of modules. This sounds trivial, but some inspectors were asking for one fuse per module or a module fuse and a conductor fuse in a series string. PV installers have, for the most part, always known this common sense item.

690.14 Additional Provisions
In an attempt to remove a misleading reference to Article 230, CMP-3 (the Code Making Panel) revised this section to put the requirements of Part 230F into Article 690. There are no real changes in the requirements, but now 690.14 requires that the PV disconnect be readily accessible outside the building or immediately inside the building at the point of first entry. Also, this disconnect must be grouped with the disconnects for other sources of power for the building.

This will restrict the current practice of running PV conductors through the roof inside the attic and house to a first disconnect near the batteries. The PV source circuits must now be run outside the building to a readily accessible point outside the building or immediately inside the building to the first disconnect. Readily accessible means that it must not be necessary to use ladders to get to disconnects mounted on the roofs or other high locations, or to move parts of the building to get to the switches. PV disconnect switches cannot be mounted in bathrooms due to the obvious shock hazards.

Grouping the disconnects is a very old requirement and means that the disconnects for the PV, wind, utility, hydro, generator, etc. shall all be grouped in the same location and not spread throughout the facility. The *NEC* does not consider a battery bank as a source of power. But most inspectors and electricians correctly consider it to be. The battery disconnect should be grouped with the means of disconnect for other source circuits. Good luck if you have more than six sources of power, since you are only allowed a total of six disconnects. A label will need to be installed on the outside of the building indicating where the disconnects are located if they are not readily visible.

All of these requirements have been in the code for years, but they are now specifically spelled out in Article 690. They allow quick and ready access to power disconnects in the event of emergencies such as fires or gas leaks.

Summary
Most of the changes in Article 690 of the 2002 *NEC* make it somewhat clearer. The revisions to the comments in the 2002 *NEC Handbook* should also make it easier for the people to understand the rationale behind the code requirements. The remainder of the 2002 *NEC* changes in Article 690 will be addressed in *HP87.*

Questions or Comments?
If you have questions about the *NEC,* or the implementation of PV systems that follow the requirements of the *NEC,* feel free to call, fax, e-mail, or write me. Sandia National Laboratories sponsors my activities in this area as a support function to the PV industry. This work was supported by the United States Department of Energy under Contract DE-FC04-00AL66794. Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy.

Access
John C. Wiles, Southwest Technology Development Institute, New Mexico State University, Box 30,001, MSC 3 SOLAR, Las Cruces, NM 88003 • 505-646-6105
Fax: 505-646-3841 • jwiles@nmsu.edu
www.nmsu.edu/~tdi/pv.htm

Sponsor: Sandia National Laboratories, Ward Bower, Department 6218, MS 0753, Albuquerque, NM 87185-0753 • 505-844-5206 • Fax: 505-844-6541
wibower@sandia.gov • www.sandia.gov/pv

National Electrical Code® and *NEC*® are registered trademarks of the National Fire Protection Association. The 1999 *NEC* and the *NEC Handbook* are available from the NFPA, 11 Tracy Drive, Avon, MA 02322
800-344-3555 or 508-895-8300 • Fax: 800-593-6372 or 508-895-8301 • custserv@nfpa.org • www.nfpa.org

EPOWER®

Charger / Booster

Prices start at **$599.95**

- 12V–50, 100, 200 Amp
- 24V–25, 50, 100 Amp
- 38–64 lbs.
- Overload Protection
- Regulated Output
- Safety On/Off Switch
- Extended run LP option available–some models
- OHV engine option available–some models
- We also make a high quality OHV, all copper winding, brushless, 3KW AC generator, 120V or 120/240V

EPOWER
1346 W– 400S, Albion, IN 46701
Phone 219-636-2099
www.epowerchargerboosters.com

SOLAR COOLING
WITH
SOLAR CHILL

ULTRA LOW ENERGY – 25 TO 80 WATTS!

The most efficient coolers on the planet.
12 & 24 Volt DC Evaporative Coolers
For Your Home or Vehicle (KAR KOOL)

Call SOUTHWEST SOLAR
(520) 885-7925 Tuscon, Arizona, USA
southwest-solar.com

AC/DC Inverters, Solar Electric Modules

Batteries, Charge Controllers

DC/Propane Refrig, Track Rack

1-888-SOLARNOW
Toll Free

HORIZON INDUSTRIES

BBB MEMBER SAN DIEGO

CAL SEIA

We Sell The Best
& Service The Rest

Send $4.00 for a catalog
2120 W Mission Rd (# L), Escondido, CA 92029
(760) 480-0403
www.horizonsolar.com

Water Pumps, DC Lights, DC Appliances

Meridian
energy systems, inc.

Solar-electric system design, installation, and service.

Austin, Texas
512-477-3050

www.meridiansolar.com

Back Issues of Home Power!

Good Info! Good Deal!

in USA 800-707-6585

Check out our Web site: www.homepower.com
It contains an index of all articles back to issue #1.

You can buy back issues individually:
- $6.25 each for 13 and 16 through 20
- $7.75 each for 21 through 45 (except for 35, 36, 38, 40, 41)
- $8.75 each for 46 through 84 (except for 59–61, 63–67, 79, 81, 82)
- $9.95 each for 85 through current

(Shipping included)

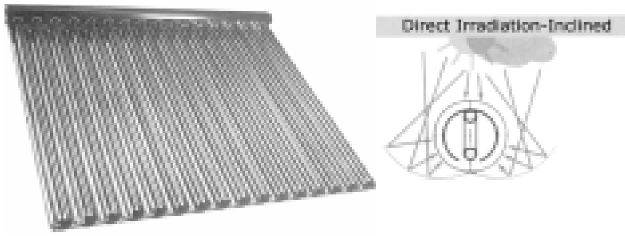
- OR -

Special Deal: All available back issues for $125
Shipping: $20 USA, $30 Canada, $40 International

Check with your local library—through interlibrary loan you can get back issues.
The Jackson County Library in Oregon and the Alfred Mann Library at Cornell University have all issues.

Or, get the CD-ROMs for $29 each   Special Deal: $125 for all five
Solar2 (1–42), *Solar3* (43–60), *Solar4* (61–70), *Solar5* (71–76), and *Solar6* (77-82)
Shipping for single CDs: $2 USA, $3 Canada, $4 International   *Shipping for all five CDs: $8 USA, $9 Canada, $12 International*

Home Power, PO Box 520, Ashland, OR 97520 • 800-707-6585 • 541-512-0201



Powergen Solar Ltd

(where clean energy costs less)

Seeks U.S. investor partners.

(Vacuum tube collectors from $560.00 U.S.)

British solar thermal design company seeks partners to launch a proven, low cost vacuum tube CPC collector across the USA in order to reduce America's energy consumption. Contact principal Eric Hawkins at erh@solar.org.uk

www.eco-shop.co.uk

RENEWABLE ENERGY SOLUTIONS!

WIND POWER

PHOTOVOLTAIC

MICROHYDRO

HUMAN POWER GENERATOR

WINDSTREAM POWER SYSTEMS INC.

PO Box 1604 HP, Burlington, VT 05402 Tel 802 658 0075 Fax 802 658 1098

info@windstreampower.com • www.windstreampower.com

Independent Power Systems Throughout the World – Our 26th Year

NEW FRONTIER

SOLAR & SATELLITE

PHOTOVOLTAICS • WIND POWER • MICRO HYDRO
PASSIVE SOLAR • HOT WATER • REFRIGERATORS
COMPOSTING PRIVIES • ELECTRIC VEHICLES
TITLE 24 CALCS. • POWER SUPPLIES
SATELLITE PHONES • SATELLITE INTERNET
SATELLITE T.V. • SATELLITE MUSIC
RADIO PHONES

18 years experience in design, sales, installation, repair, and maintenance.

Todd G. King, M.A., Proprietor
106 East St., Alturas, CA 96101
(530) 233-5219
newfrontier@starband.net

Window Quilt™

Insulating shades can add R-4.5 to your existing windows.

Control your comfort at skylights, solariums and vertical windows.

Automation and motorization available for quilts and sunscreens.

For an estimate, fax, call or send your window measurements to:

SOLAR INTERIOR DESIGN

Ray Pokorny, 242 NE 61st Ave., Portland, OR 97213
Fax: 503 238-9995 • Toll Free: 888 765-2741
email: solarint@mail.imagina.com

Adopt a Library!

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

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

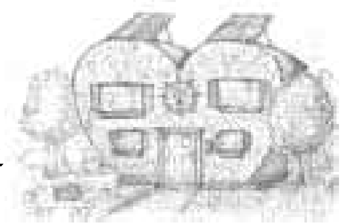
You may want to do the same for your local public library. We'll split the cost (50/50) of the sub with you if you do. You pay $11.25 and Home Power will pay the rest. If your public library is outside of the USA, then we'll split the sub to your location so call for rates.

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

To Adopt a Library write or call

Home Power®
PO Box 520, Ashland, OR 97520 USA
1-800-707-6585 or 541-512-0201 or FAX 541-512-0343
hp@homepower.com • www.homepower.com

Home & Heart



Kathleen Jarschke-Schultze

©2001 Kathleen Jarschke-Schultze

"Whiskey's for drinking, water's for fighting." Mark Twain said this, and he was in California when he said it. The drought here continues to parch everything in our county and many others. Our creek is long dried up. Our well is putting out water in the morning and empties by early afternoon.

I have lost two rose bushes, a Brother Cadfael and a Barbara Bush. We also lost a cherry tree. I let all the strawberries die. We only water the tomatoes and corn in the garden. Soon the corn will be over for the season and we can stop watering it.

Everything is on drip irrigation: all the fruit trees, all the lavender plants, the grape arbor, and the rose bushes. There are a few potted plants in the front yard that I water by hand with dishwater. I never thought it would be hard to keep comfrey, mint, and horseradish alive.

We have a small, battery-powered kitchen timer that we use when watering. All watering is timed. All the drippers are on a rotating schedule. Our yard is an oasis of green in a dry, brown and gold landscape.

It became dry so fast this spring that even the star thistle did not grow. My bees have suffered a dearth of nectar. I found them sucking the juice out of the ripening grapes in the arbor. I am feeding them syrup (2 to 1 sugar and water) to prepare them for winter. This is not going to be a good year to evaluate my solar hive ventilator. (See *Home & Heart, HP85*.)

The weather has been very hot. With our downslope, down canyon winds every day, you can see the leaves curl on the trees in the afternoons. The hot air sucks the moisture out of any leaves open to the breeze. I planted two climbing Cecile Brunner roses on the north side of our garden as a windbreak, to protect the plants there.

Brown Goats

This year we finished putting in a 6 foot (1.8 m) fence around ten acres of property surrounding our house. This kept the deer out until now. We call them brown goats, since they are browsers like goats, and will strip any plant of its foliage in a night if they can stand on their hind legs and reach it.

We returned from a trip to find all the grapes that had been hanging down in the arbor gone. I heard a noise the other night, and went out on the porch and saw a four-point buck stepping delicately from the arbor, heading toward our big, old apple tree. All the fallen apples under the trees were gone. Our apple trees have had a dramatic fruit drop due to drought. I narrowly saved a Kaffir lime tree by bringing it into the house. It had just few leaves nibbled on.

Water-Sipping Washing Machine

The second summer after moving to the creek, we experienced our first drought. The creek dried up, the spring that fed the house water system dried up, and we had to haul water. That was the year we drilled a well.

Since water could so obviously be an issue at this house, we did everything we could to cut our water usage. We bought and installed a one pint flush toilet made by SeaLand. We did not take baths, only showers. And I began a search for a water efficient washing machine.

A few years later, I bought a Staber washing machine. At the time, it was the only super efficient washing machine on the market. There is a full review of this machine as a *Things That Work!* in *HP47.* I have run my machine since 1995 without problems. Once a belt broke, and Staber immediately sent a replacement.

Washed Up

Well, just recently, we were leaving on a ten-day trip. I thought I would do several loads of laundry, since the water system would have time to recharge while we were gone. The first load I did was a quilt. Not a thick quilt, but a queen-sized quilt, nonetheless. I have washed quilts many times before without a hitch.

When I went to the basement to take the quilt to the clothesline (solar powered clothes dryer), the tub still had water in it. The tub was not full because a horizontal-axis washer uses less than half the water of a regular washer.

I thought, "Oh, no. I've broken it this time." I took the quilt out and laboriously rinsed it in the deep cement sink next to the washer. Then I hung it on the line to dry. I dipped as much water as I could out of the tub. After I had done that, the tub would "fill" again but the pump that drains the tub simply would not work.

One of the things I really like about the Staber is that the front panel easily comes off and you can work on the machine without having to move it from the wall. I unplugged it and opened the front by removing three screws. One thing my dad taught me was that if something doesn't run, the first thing you do is lift the hood (or remove the panel) and see if all wires are connected and not loose. I did that. Everything looked good.

The next morning, I called Staber and explained the symptoms. A really nice guy at the other end had an answer. You see, the pump safeguards itself. If any foreign object gets to the pump, it will not run, thereby saving its life. The guy told me how to remove a hose connected to the pump and reach my finger in there. It should turn a quarter turn, pause, and then turn a quarter turn again.

I returned to the basement. Since I could not get all the water out of the tub by dipping with a plastic cup, I put a large bedspread under the pump to catch the inevitable water. About a gallon came out after I disconnected the hose.

I reached my finger into the pump and pulled out a three-and-a-half-inch long, sixteen penny nail! I couldn't believe it. How did that get in there? I stuck my finger in again and came out with a shiny dime. That must have been my tip.

I put the hose back on and replaced the front panel. My Staber washer has worked flawlessly since then. I was happy to be able to work on my machine and fix it myself without bothering Bob-O about it. I think it was very smart of Staber to design a pump that can defend itself. I can be pretty tough on appliances and watches, so I just love anything that can stand up to life with me, including Bob-O.

Rats!

I have just heard that the Vermin-X electronic pest repellers that I wrote about in *Home & Heart, HP84* do not work on modified square wave power. The insidious thing is that they work for about a day and then choke. Weitech has received several calls confirming this. They had no idea that this would happen, since they weren't really aware of a market for their product in the renewable energy sector until after my review. There's another good reason to get a sine wave inverter if you can afford it.

Access

Kathleen Jarschke-Schultze is waiting for rain at her home in Northernmost California, c/o *Home Power* magazine, PO Box 520, Ashland, OR 97520
kathleen.jarschke-schultze@homepower.com

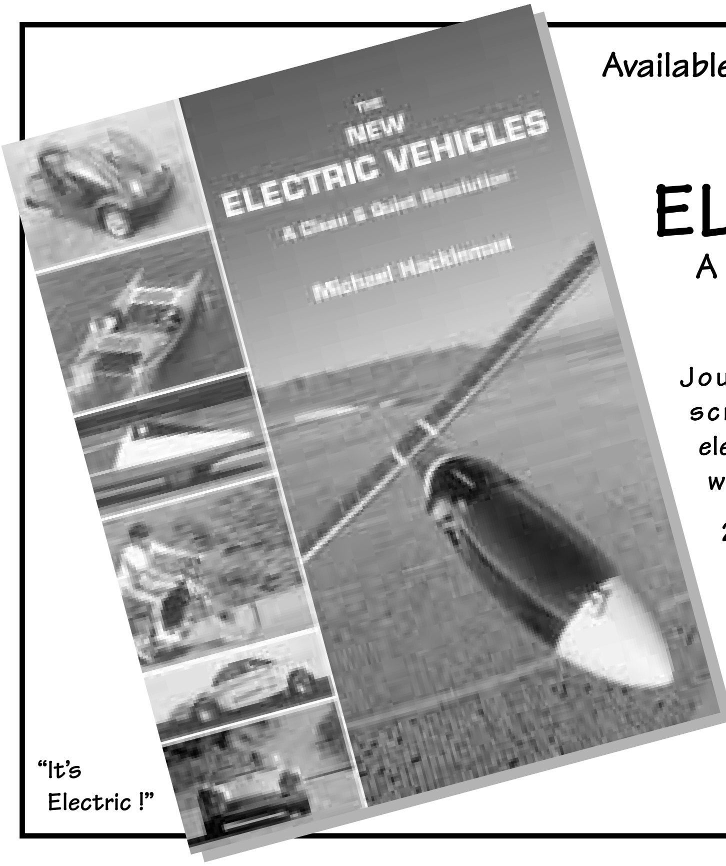
Staber Industries, Inc., 4800 Homer Ohio Ln., Groveport, OH 43125 • 800-848-6200 or 614-836-5995
Fax: 614-836-9524 • info@staber.com
www.staber.com • Staber washing machine

Weitech, Inc., PO Box 1659, Sisters, OR 97759
800-343-2659 or 541-549-0205 • Fax: 541-549-8154
info@weitech.com • www.weitech.com
Vermin-X pest repellers

SolarRoofs.com
Complete Solar Water Heaters starting at $995!
FIREBALL 2001
PV Options
Color Options
Patented Design
Dealer Inquiries Welcome

Check out these Architecturally Attractive, Very Easy to Install, & Affordable Systems!
We are Web based: **www.solarroofs.com**
SolarRoofs.com, Carmichael, CA • New (916) 481-7200

Statement of Ownership, Management, and Circulation (Required by 39 U.S.C. 3685). 1. Publication Title: HOME POWER 2. Publication #00-8699. 3. Filing Date: September 19, 2001. 4. Issue Frequency: Bi-Monthly. 5. Number of issues published annually: 6. 6. Annual Subscription Price: $22.50. 7. Mailing address of known office of publication: P O Box 520, Ashland OR 97520-0018 (312 N. Main St., Phoenix, OR 97535),. 8. Headquarters of general business office of the publisher: P O Box 275 (10,000 Copco Rd.), Ashland, OR 97520. 9. Names and addresses of Publisher, Editor, and Managing Editor: Publisher and Editor-in Chief, Richard A. Perez, P O Box 931 (10,000 Copco Rd.), Ashland, OR 97520; Publisher and Managing Editor, Karen L. Perez, P O Box 931 (10,000 Copco Rd.), Ashland, OR 97520. 10. Owner (if owned by a corporation its name and address must be stated immediately there under the names and addresses of stockholders owning 1% or more of the total amount of stock: Richard and Karen Perez, PO Box 931, Ashland, OR 97520, Dale and Marilyn Hodges, 1525 S Ivy, Medford, OR 97501, Scott and Stephanie Sayles, 163 Kingswood Dr, McMinnville, OR 97128, Virginia Deano, 3853 Arrowhead, Medford, OR 97501 . 11. Known bondholders, mortgagees, and other security holders owning or holding 1% or more of total amount of bonds, mortgages or other securities: None. 13. Publication Name: Home Power. 14. Issue date for circulation data: Issues 80–85. 15. Average no. of copies each issue during preceding 12 months — a. Total no. copies (net press run) 30,083. b. Paid and/or Requested Mail Circulation; (1) paid/ requested outside-county mail subscriptions (include advertisers' proof copies/exchange copies): 7,741 (2) Paid In-County Subscriptions: 54 (3) Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and other non-USPS Paid Distribution: 15,884 (4) Other Classes Mailed Through the USPS: 4,120 C. Total Paid and/or requester circulation: 27,799. d. Free distribution by mail (samples, complimentary, and other free) (1) Outside-County: 159 (2) In-County: 8 (3) Other Classes Mailed Through USPS: 820. e. Free distribution outside the mail: 57. f. Total free distribution (sum of 15d and 15e): 1,044. g. Total distribution (sum of 15c. and 15f.): 28,843. h. copies not distributed: 1,240. i. Total (sum of 15g. and h): 30,083 j. Percent Paid and/or Requested Circulation: 96.4% No. of Copies of Single Issue nearest to filling date — a. Total no. copies (net press run) 34,500. b.(1) Paid/Requested Outside-County Mail Subscriptions (include advertiser's copies and exchange copies): 9,675. (2) Paid In-County Subscriptions: 60 (3) Sales Through Dealers and Carriers, Street Vendors, Counter Sales, and other Non-USPS Paid Distribution: 17,270. (4) Other classes Mailed Through the USPS: 3175 c. Total Paid and/or requester circulation: 30,180. d. Free distribution by mail (samples, complimentary, and other free): (1) Outside County: 64. (2) In-County: 6. (3) Other Classes Mailed Through the USPS: 862. e. Free distribution outside the mail (carriers and other means: 65. f. Total free distribution: 997. g. Total distribution: 31,177. h. Copies not distributed: 3,323. i. Total (sum of 15g. and h.): 34,500. Percentage of paid and/or requested circulation: 96.8%. 16. This statement of ownership will be printed in the December 2001/January 2002 issue of this publication.
17. I certify that the statements made by me above are true and complete. Karen L. Perez, Publisher and Business Manager 9/19/01.



Available Now! Only $25 (U.S. S&H $6; Canada $10; international $15)

THE NEW ELECTRIC VEHICLES

A Clean & Quiet Revolution

by Michael Hackleman

Journey into the world of conversions, scratchbuilts, human-electrics, solar cars, electrathon racers, planes & boats—all powered with electricity.

272 pages of EV technology, 465 photographs (over half in color), and detail on 65 vehicles. Includes 115 technical design and construction sidebars.

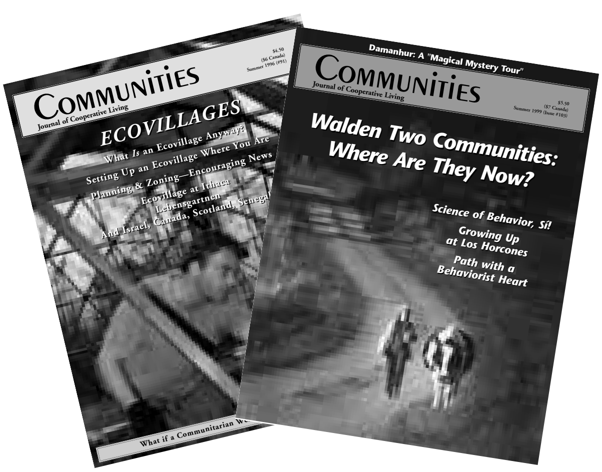
To order call: 800-707-6585

Outside USA call 541-512-0201 • Fax: 541-512-0343

or write to:
Home Power Publishing
PO Box 520 • Ashland OR 97520

"It's Electric !"

Intentional **Communities**



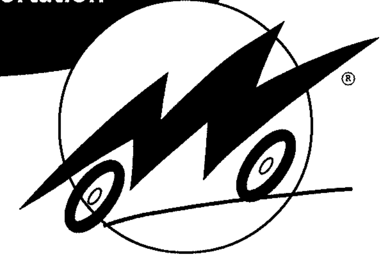
Dedicated to communicating the experience and wisdom of intentional community.

Each issue features a different theme such as Appropriate Technology, Decision Making, plus ongoing columns.

1 year subscription $20 ($24 Canada)
Sample issue $6 ($8)

800-462-8240 http://fic.ic.org/cmag

Tour de Sol -
The Great American Green Transportation Festival



MAY 2002
NYC - DC
Festivals &
Road Rally Competition

NORTHEAST SUSTAINABLE ENERGY ASSOCIATION

50 MILES STREET • GREENFIELD, MA 01301
(413) 774-6051 nesea@nesea.org www.nesea.org

Please send me more information on:

- ☐ **Entering**
- ☐ **Attending**
- ☐ **Volunteering**
- ☐ **Exhibiting or Sponsoring**

Name
Company name
Address
City, State, Zip
Phone Fax

NEW ENGLAND SOLAR ELECTRIC, INC.

401 Huntington Road, PO Box 435
Worthington, MA 01098
1-800-914-4131

$16.95 plus $3 PPS
(includes our $3 catalog)

This is the most popular book for PV remote homes. It is written and published by New England Solar Electric Inc.

"Best all around book on wiring your PV system."
Real Goods Sourcebook

"Our favorite book for Do-It-Yourselfers."
Windy Dankoff, Dankoff Solar Products

"This should become the bible for alternative energy users."
Ken Cox, Trace Inverters

Send $3 for our 80 page catalog and product guide

Servel/Dometic Gas Refrigerators. Trace Inverters. Trojan Batteries.
Siemens & Solarex PV modules, Osram Bulbs. Thinlite Fixtures
Aquastar Hot Water Heaters. AIR 403 Wind Generators

Best book, most user friendly catalog, & best kits in the business.

Lake Superior Renewable Energy

A.D. & P.C. Jasmin, Proprietors – A. Durst, Associate

Wind Generators • Towers • Batteries
Charge Controllers • Inverters • Backup Generators
Battery Chargers • Site Evaluation
Complete Systems Troubleshooting and Repair Service
Surplus Military & Computer Grade Electronics

We also do: Custom Computer Building / Upgrading / Networking
Custom and Classic Motorcycle Electrical System Rewiring

819 Maple Grove Rd., Duluth, MN 55811
(218) 722-6749

e-mail: slakjaw@aol.com • web: http://members.tripod.com/~LSRE

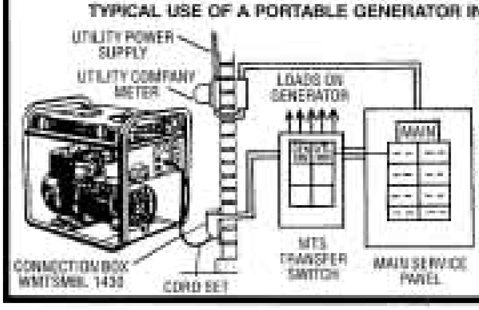
WHEN YOU HAVE AN ELECTRIC POWER OUTAGE

NO ONE LIKES TO BE LEFT IN THE DARK!

And your Lights, Refrigerator, Freezer, Water System and Heat will not work

You can avoid this dilemma with your portable generator and Manual Transfer Panel made by Eylander Electric. The MTS enables you to access generator power and transfer it to utility power with the flip of a switch.

TYPICAL USE OF A PORTABLE GENERATOR IN AN EMERGENCY POWER APPLICATION



- Panelboard doubles as transfer switch for portable power!
- Suitable for use with portable generator.
- Alternate mains, only allowing power from one source to be on at one time!
- Plug-in circuit breakers can be installed with spaces for up to 36 circuits for 120/240V thru 277/480V.
- Main Breakers are rated from 30 thru 600 AMP
- Available through most electrical distributors.

Listed **Eylander Electric** Certified

3301 Everett Ave., P.O. Box 1479 • Everett, Washington 98206
Phone (425) 259-1601 • Fax # 1-425-252-2486
800-932-8986

HELIOTROPE THERMAL

DELTA-T
SOLAR HEATING CONTROLS

For automatic operation of solar heating systems

DTT-84 and DTT-94 controls established the standard over twenty years ago and their reliability has been proven in nearly a million installations.

SOLAR CHECK VALVE
Low resistance spring check valve ideal in PV pumped systems

HELIOTROPE THERMAL
4910 Seaport Ave.
Richmond, Ca. 94804
Tel: 510-237-9614
Fax: 510-237-7018
e-mail: info@heliotropethermal.com
web: www.heliotropethermal.com

HAPPENINGS

INTERNATIONAL
Free instructions, photos, drawings, & specs to build solar cookers & water systems with local materials, purchased with local currency. Sunstove, www.sungravity.com

Green Empowerment finances microhydro & other RE projects in Nicaragua, the Philippines, & Borneo. Volunteers needed. www.greenempowerment.org

Solar On-Line Internet courses. Year-round. PV Technology & Opportunities; Systems Design Basics; PV Systems Design: Professional; Solar Homes: Healthy Buildings; Solar Energy for Global Development. SóL, PO Box 217, Carbondale, CO 81623 • Fax: 559-751-2001 SoL@SoLenergy.org • www.SoLenergy.org

CANADA
Microhydro Courses: Assess site, determine feasibility, & design & install a system. Apr. 26–28, ’02; Nelson, BC, Selkirk College—250-352-6601. May 10–12, ’02; Kamloops, BC, Univ. College of Cariboo—250-828-5039. US$80 to US$160. Info: www.energyalternatives.ca/mhcourse.htm

Alberta Sustainable House; open house 3rd & 4th Saturdays, 1–4 pm. Cold-climate features & products for health, environment, conservation, RE, recycling, efficiency, self-sufficiency, appropriate technology, autonomous & sustainable housing. Free. 9211 Scurfield Dr. NW, Calgary, AB T3L 1V9 Canada • 403-239-1882
Fax: 403-547-2671 • jdo@ucalgary.ca
www.ucalgary.ca/~jdo

The Institute for Bioregional Studies demonstrates & teaches ecologically oriented, scientific, social, & technological achievements. IBS, 393 University Ave., Charlottetown, PEI C1A 4N4 Canada
902-892-9578

Vancouver Electric Vehicle Association. Call for meeting info. PO Box 3456, 349 West Georgia, Vancouver, BC V6B 3Y4 Canada
604-878-9500 • info@veva.bc.ca
www.veva.bc.ca

NEW ZEALAND
Feb. 2-3rd ’02; Canterbury Sustainability Expo, Christchurch. Alternative energy, building and construction options, heating options, energy efficient housing and appliances, home products, Gov. info, new & emerging technologies, composting toilets & greywater, alternative transport, education, speakers, demonstrations, exhibits. John, 025-576527

NICARAGUA
Jan. 7-18, ’02; Managua. Intro to PV for developing countries. Lectures, field experience, & eco-tourism. Taught in English by Richard Komp & Susan Kinne. US$850. Contact Barbara Atkinson
215-942-0184 • lightstream@igc.org
www.grupofenix-solar.org

NATIONAL U.S.
Pollution prevention video series. Appalachia: Science in the Public Interest offers 42 videos, incl. Solar Dry Composting Toilets, Solar Hot Water Systems, PV, Solar Space Heating, Solar-Powered Automobiles, Quilted Insulated Window Shades, & more. US$25 + S&H, broadcast-quality tapes available. ASPI Publications, 50 Lair St., Mt. Vernon, KY 40456 • 606-256-0077
Fax: 606-256-2779 • aspi@kih.net
www.kih.net/aspi

American Wind Energy Association. Info about U.S. wind industry, membership, small turbine use, & more • www.awea.org

State financial & regulatory incentives for RE: reports. North Carolina Solar Center, Box 7401 NCSU, Raleigh, NC 27695
919-515-3480 • Fax: 919-515-5778
www.ncsc.ncsu.edu/dsire.htm

Energy Efficiency & Renewable Energy Clearinghouse (EREC): Insulation Basics (FS142), New Earth-Sheltered Houses (FS120), PV: Basic Design Principles & Components (FS231), Cooling Your Home Naturally (FS186), Automatic & Programmable Thermostats (FS215), & Small Wind Energy Systems for the Homeowner (FS135). EREC, PO Box 3048, Merrifield, VA 22116 • 800-363-3732 • TTY: 800-273-2957 • energyinfo@delphi.com
www.eren.doe.gov

Energy Efficiency & Renewable Energy Network (EREN): links to gov. & private internet sites & “Ask an Energy Expert” online questions to specialists.
800-363-3732 • www.eren.doe.gov

Green Power Web site: deregulation, green electricity, technology, marketing, standards, environmental claims, & national & state policies. Global Environmental Options & CREST, www.green-power.com

National Wind Technology Center. Assists wind turbine designers & manufacturers with development & fine tuning. Golden, CO
303-384-6900 • Fax: 303-384-6901

Sandia’s Stand-Alone Photovoltaic Systems Web site: design practices, PV safety, technical briefs, battery & inverter testing, www.sandia.gov/pv

Solar Energy & Systems. Fundamentals of Small RE: Internet college course. Weekly assignments reviewing texts, videos, WWW pages, & e-mail Q&A. Mojave Community College • 800-678-3992
lizcaw@et.mohave.cc.az.us
www.solarnmc.mohave.cc.az.us

Federal Trade Commission (free pamphlets): Buying an Energy-Smart Appliance, Energy Guide to Major Home Appliances, & Energy Guide to Home Heating & Cooling. Energy Guide, FTC, Rm 130, 6th St. & Pennsylvania Ave. NW, Washington, DC 20580
202-326-2222 • TTY: 202-326-2502
www.ftc.gov

Solar Curriculum for schools. 6 wk. science curriculum or individual sessions. Free! 30 classroom presentations & demos using free or low-cost materials. Susan Schleith, Florida Solar Energy Center • 321-638-1017
www.fsec.ucf.edu

ALABAMA
Centre, AL. The Self-Reliance Institute of NE Alabama seeks people interested in RE, earth-sheltered construction, & other self-reliant topics. SINA, 6585 Co. Rd. 22, Centre, AL 35960

ARIZONA
Apr. 19–21, ’02; AZ RE Expo; Prescott Valley, AZ. For consumers, educators, contractors, youth, and public. Info: Prescott Valley Economic Development Found., 888-240-4256 • www.pvedf.com

Info on tax credits for solar in AZ. ARI SEIA, 602-258-3422

Scottsdale, AZ. Living with the Sun free lecture series, 3rd Wed. each month, 7-9 PM, City of Scottsdale Urban Design Studio. History & current concepts, design, applications, solar heating & cooling, architecture, landscaping, PV & cooking. Dan Aiello, 602-952-8192, or AZ Solar Center • www.azsolarcenter.org

ARKANSAS
Sun Life Constr. by Design: Seminars 3rd Sun. of month. Hands-on, incl. ferro-cement, building dwellings for minimal materials expense. Loren Impson, 71 Holistic Hollow, Mt. Ida, AR 71957 • 870-867-4777
loren@ipa.net • www.Sun4Life.com

CALIFORNIA
Dec. 11–14, ’01; Sacramento. EVAA Electric Transportation Industry Conference. Battery EVs, hybrids, path to commercialization.
650-365-2667 • www.evaa.org

Arcata, CA. Campus Center for Appropriate Technology, Humboldt State University. Ongoing workshops & presentations on alternative, renewable, & sustainable living. CCAT, HSU, Arcata, CA 95521
707-826-3551 • ccat@axe.humboldt.edu
www.humboldt.edu/~ccat

Rebates for PV & wind. CA Emerging Renewables Buydown Program, CA Energy Comm., 800-555-7794 or 916-654-4058
CallCntr@energy.state.ca.us
www.energy.ca.gov/greengrid

Energy Efficiency Building Standards for CA. CA Energy Comm. 800-772-3300
www.energy.ca.gov/title24

Solar e-Clips, free weekly email newsletter. CA news & info solar energy. To subscribe email with "Subscribe" in subject to solareclips-request@californiasolarcenter.org

COLORADO
Carbondale, CO. SEI: hands-on workshops. 1–2 week sessions. PV Design & Installation, Advanced PV, Wind Power, Microhydro, Solar Cooking, Environmental Building Technologies, Solar Home Design, & Straw Bale Construction. Solar Energy International (SEI), PO Box 715, Carbondale, CO 81623 • 970-963-8855
Fax: 970-963-8866 • sei@solarenergy.org
www.solarenergy.org

IOWA
Prairiewoods & Cedar Rapids, IA. Iowa RE Assoc. meets 2nd Sat. every month at 9 AM. All welcome. Call for schedule changes. IRENEW, PO Box 355, Muscatine, IA 52761
319-288-2552 • irenew@irenew.org
www.irenew.org

KENTUCKY
Livingston, KY. Appalachia: Science in the Public Interest. Projects & demos in gardening, solar, sustainable forestry, more. ASPI, Rt. 5, Box 423, Livingston, KY 40445
Phone/Fax: 606-453-2105 • aspi@kih.net
www.kih.net/aspi

MASSACHUSETTS
Greenfield Energy Park needs help preserving the historic past, using today's energy & ideas, creating a sustainable future. Greenfield Energy Park, NESEA, 50 Miles St., Greenfield, MA 01301
413-774-6051 • Fax: 413-774-6053
nhazard@nesea.org • www.nesea.org

MICHIGAN
Tillers International, classes in draft animal power, small farming, blacksmithing, & woodworking. 5239 S 24th St., Kalamazoo, MI 49002 • 616-344-3233
Fax: 616-344-3238 • TillersOx@aol.com
www.wmich.edu/tillers

MONTANA
Whitehall, MT. Sage Mountain Center: one-day seminars & workshops, inexpensive sustainable home building, straw bale constr., log furniture, cordwood constr., PV, more. SMC, 79 Sage Mountain Trail, Whitehall, MT 59759 • Phone/Fax:
406-494-9875 • cborton@sagemountain.org

NEVADA
Jun. 15–19, '02; Solar 2002: Sunrise Sustainability Expo. Reno, NV. Annual American Solar Energy Society conference. ASES, 2400 Central Ave. #G-1, Boulder, CO 80301 • 303-443-3130 • Fax: 303-443-3212
ases@ases.org • www.ases.org

NEW HAMPSHIRE
Spinning a Web of Solar Spirits; workshops on living with the sun. 1st Wed. every month. Sunweaver, 1049 1st, NH Turnpike, NH 03261 • 603-942-5863
Fax: 603-942-7730 • fonature@tiac.net

NORTH CAROLINA
Saxapahaw, NC. How to Get Your Solar-Powered Home: Seminars 1st Sat. each month. Solar Village Institute, PO Box 14, Saxapahaw, NC 27340 • 336-376-9530
Fax: 336-376-1809 • solarvil@netpath.net

NEW YORK
Apr. 27, '02; North Country Sustainable Energy Fair, Canton Middle School, Canton, NY. Workshops, activities, vendors, exhibitors, and presenters. Home tour Apr. 28. Scott Shipley, 315-386-4928
cobbship@northnet.org • www.ncenergy.org

Tax credits. Info on grid connection & tax credits: NY State PSC,
www.dps.state.ny.us/photovoltaic.com

RE Loan fund. Low interest financing: NY Energy $mart Program, NY State Energy R & D Authority, 518-862-1090 ext. 3315
Fax: 518-862-1091 • rgw@nyserda.org
www.nyserda.org

OREGON
Sep. 21, '02; Seneca, OR. Solar Cookery Equinox Extravaganza. EORenew, PO Box 485, Canyon City, OR 97820
541-575-3633 • info@solwest.org
www.solwest.org

Cottage Grove, OR. Adv. Studies in Appropriate Tech., 8 wks., 4 interns per quarter. Aprovecho Research Center, 80574 Haxelton Rd., Cottage Grove, OR 97424
541-942-0302 • dstill@epud.org
www.efn.org/~apro

RHODE ISLAND
Energy Co-op provides RE, energy efficiency & conservation services, & group purchases of "Energy Star" products. Erich Stephens • 401-487-3320
erich@sventures.com

TENNESSEE
Summertown, TN. Kids to the Country: nature study program for at-risk urban TN children. Sponsors & volunteers welcome. The Farm, Summertown, TN 38483
931-964-4391 • Fax: 931-964-4394
ktcfarm@usit.net

TEXAS
El Paso Solar Energy Association bilingual Web site. Info in Spanish on energy & energy saving. www.epsea.org

El Paso Solar Energy Association: meetings 1st Thur. each month. EPSEA, PO Box 26384, El Paso, TX 79926 • 915-772-7657
epsea@txses.org • www.epsea.org

Houston Renewable Energy Group: meets last Sun. of odd months at TSU Engineering Building, 2 PM. HREG, PO Box 580469, Houston, TX 77258 • jferrill@ev1.net
www.txses.org/hreg/HREGhome.htm

VIRGINIA
Info & services on practical solar energy apps in VA. VA Solar Energy Assoc., the VA Solar Council, and the VA chapter of SEIA. Info: VA Div. of Energy, 804-692-3218

WISCONSIN
MREA Workshops: Solar Space Heating, Wind Systems Installation, Photovoltaic Installation, Straw Bale Construction, Masonry Heaters, Sustainable Living Workshops, RE for the Developing World. Significant others half price. MREA, 7558 Deer Rd., Custer, WI 54423 • 715-592-6595
Fax: 715-592-6596 • mreainfo@wi-net.com
www.the-mrea.org

To have your event included in the *Home Power Happenings* listing, send e-mail to happs@homepower.com or snail mail to: Happenings, c/o *Home Power*, PO Box 520, Ashland, OR 97520

the Wizard speaks…

Theory Time

Expansion
The expansion of the material universe may be explained by considering a higher dimensional object passing through a three-dimensional space. This object would necessarily have a three-dimensional cross-section that is essentially spherical in form.

As the higher dimensional object passes through the three-dimensional space, its spherical cross-section would appear to expand, as viewed from three-dimensional space. Consider a cone passing through a plane as a reduced example. From the point of view of the plane, the circular cross-section of the cone appears to expand from a point to an ever larger circle.

Drum Theory
The space-time continuum can be considered to be a medium that is similar to a drum head. Wave patterns in this medium could form very complex structures, due to the existence of non-integer harmonics. The peaks and valleys in these structures would then define the form and structure of both matter and space-time itself.

Gravitational Theory
Basic gravitational theory is still incomplete. It does not yet explain quantum gravity, accelerated expansion, and other observed anomalies. A possible solution is to return to the Newtonian form of the gravitational equation with one addition. The gravitational parameter G would no longer be considered constant. It would be a function of a set of variables, defined by the event space under consideration.

Vortex Theory
Consider space as a continuous medium with properties similar in some ways to a super fluid. Material particles could then be explained as complex vorticular flows within this medium. The flows would be of the same basic nature as the medium, but differ in motion, structure, and density. These vortices would produce complex wave-like motion in the medium, resulting in the appearance of forces and interactions.

Clean Air.
Clean Water.
Clear Conscience.

Join ASES Today.
For only $70 per year, you can support the American Solar Energy Society (ASES), the oldest and largest national organization dedicated to advancing the use of solar energy for the benefit of U.S. citizens and the global environment. Your membership includes a subscription to SOLAR TODAY magazine.
For more information, contact ASES, 2400 Central Avenue, Suite G-1, Boulder, Colorado 80301, (303) 443-3130, ext. 2, FAX (303) 443-3212
e-mail: ases@ases.org, web site: www.ases.org.

Be part of the solution.
Go
SOLAR TODAY
a publication of the American Solar Energy Society (ASES)
www.solartoday.org • (303) 443-3130 ext. 2

OFF LINE
Independent Energy Systems

CA Lic. #661052

Our 17th Year Offgrid!
We provide excellent service
and technical support.

Residential Power • Water Systems • Communications
Wind • PV • Hydro • Custom Design • Installation • Mail Order

All Major Brands

SIEMENS Trace Engineering SunFrost

ZOMEWORKS Corporation **California Rebates!** KYOCERA

(559) 877-7080

e-mail: ofln@aol.com
http://www.psnw.com/~ofln
located in the central Sierra, near Yosemite

ipp MEMBER

OFFLINE
P.O. Box 231
North Fork, CA
93643

CATALOG AVAILABLE

ELECTRIC CAR COMPONENTS & KITS

***Reliable, Affordable Components**
***Large Library Of Adaptors**
***Most Experienced Tech Support**
***Design Assistance**

Conversion Kits:

****Basic & Deluxe Universal Kits***
Contain all drive system components. You add mounts, boxes, etc. to fit your model.

****Complete Custom Bolt-In Kits***
Voltsrabbit for VW Rabbit, and *Voltsporsche* for Porsche 914. Completely prefabbed. No design or welding necessary. Kits include everything except donor car & batteries.

For Catalog, Send $6.00 To:

ELECTRO AUTOMOTIVE
POB 1113-HP
FELTON, CA 95018

(Outside the U.S. & Canada, add $5.00)

www.electroauto.com

ipp

NEED A WRENCH?
(your local solar expert)

Go to IPP'S national list of qualified installing dealers.

WWW.I2P.ORG

Earn a degree in Renewable Energy

with a concentration in Photovoltaic Design and Installation in two years or less at

San Juan College, Farmington, NM
Classes start August 2000

- Prepare for a career with job opportunities in renewable energy businesses, equipment supply companies, remote power field service, utilities or international agencies.
- Learn about solar electric (photovoltaic), solar thermal, wind, micro hydro, and hydrogen energy conversion.
- Earn a 2 year AAS degree or 1 year certificate. Both emphasize full NEC compliance.
- Combine science with hands-on learning.

San Juan College . . .

- Is a progressive community college located in the Four Corners.
- Tuition $300/semester maximum out-of-state and $180 in-state. Housing assistance available.

Information:
Carl Bickford, (505) 566-3503 or (800) 241-6327
bickford@sjc.cc.nm.us
website: www.sjc.cc.nm.us/reng/index.html

Errata

In HP85*, the photo caption on page 107 mistakenly attributed North Dakota State University's entry #22 to another entrant.*

In HP84*, the caption at the bottom of page 23 read "The power room includes eight Trace SW5548 inverters capable of 22 KW at 220 VAC" It should read "capable of 44 KW at 220 VAC," since combined KW is irrespective of output voltage. Tom Davis, Backup Power Systems of Northeast Louisiana*

Safety Note

In the Guerrilla Solar article in HP85, *there are safety hazards. Any time a male plug is used at the end of an energized cable, there is the potential for accidental shock or shorting from the exposed blades.* Home Power *recommends that those wiring methods not be used.*

***Home Power* to Libraries**

Dear *Home Power*, Last year I donated three *Home Power* subscriptions to three libraries in different states on the west coast of the U.S., as a test to see if they would renew the subscription out of their own funds.

Without any suggestions, request, or input from me regarding subscription renewal, all three libraries renewed their subscription to your publication using their own library funds.

Maybe the subscriptions were renewed because of the energy crisis on the west coast of the U.S., or maybe this would have happened anyway, regardless of the energy crisis.

The point is that your readers should invest US$12.25 to make sure their local public libraries and school libraries (that are open to the public) have a chance to try your publication for one year.

Considering what is happening today in the oil exporting countries, and considering our president and his policies, it is important for your readers to take a stand and make a statement by making a contribution of an *HP* subscription to a library. Now is the time for people who believe in renewable energy to back up that belief with their money. Stand up and be a real American. Keep our energy supply and future secure by supporting locally generated renewable energy. As of today, I am donating subscriptions to five more libraries. Debra Schwartz

Hi Debra, Thank you for writing in and sharing your inspiring test. It's awesome that you put money forward and adopted three libraries. I hope other readers will be inspired to act too.

I was turned on to Home Power *at the public library in Grants Pass, Josephine County, Oregon. Now I'm living with renewables myself. I'd like to thank whoever donated the subscription to my library. I'd also like to thank you on behalf of the future* Home Power *readers and renewable energy users. You've done those communities a thoughtful service!*

Renewable energy's message continues to spread at an accelerated pace. Whether people are becoming more aware of energy because of necessity, philosophy, or whatever really doesn't matter. Best REgards, Eric Grisen

Hot Water Heat Exchangers

I would like to see a thorough article on heat exchangers for solar hot water. Types available, brands, e-mail addresses of manufacturers, etc. Some people make their own collectors, but a heat exchanger is more complicated. Also, in your recent solar DHW articles, you said that a three tier exchanger is required with antifreeze. Is that true with the nonpolluting kind used in furnaces today?

I would have liked to see an e-mail address for the Goldline pump controller manufacturer in your article also. I have had solar hot water for twenty years, and found your article very informative. Ted Vonderhorst

Hi Ted, Thank you for your suggestion regarding an article focussed on heat exchangers: types, sizes, uses, manufacturers, contacts, etc. I agree that it would be a worthwhile topic.

The double walled heat exchanger is appropriate for systems that deal with potable water. It's a safety/contamination issue.

Here is some additional contact info on Goldline controls: Goldline Controls, Inc., 42 Ladd St., East Greenwich, RI 02818 • 800-294-4225 or 401-884-6990 • Fax: 401-885-1500 sales@goldlinecontrols.com • www.goldlinecontrols.com Ken Olson

One or Two Tanks?

In *HP85*, page 142, the question of one or two tank solar DHW (domestic hot water) systems is discussed. Ken Olson has done an excellent job in his series, but this question needs some clarification. A two tank DHW system, large system or small, is the better choice over a one tank system.

One reason to use two tanks is so you can use all the solar energy available to heat (or preheat) your DHW. Most people probably have their 40–50 gallon electric or natural gas water heater set at 120°F. If this is also the only tank used for solar heated water, then solar heating is only available after the solar panels are at least 120°F. This limits the amount of solar heating to only the few hours in a sunny day when the panels are hotter than the 120°F tank of water.

A second important reason to use two tanks is that any solar heat available above ground water temperature (in Iowa about 55°F) can be used. A tremendous amount of the savings in a solar DHW system is by preheating the water up to the 120°F in the electric or natural gas DHW tank. Heating a separate tank by solar only from 55°F to 110°F is a lot of savings in fuel. Your fossil fuel DHW needs to be heated only 10°F instead of 65°F (55°F to 120°F)!

Another reason for the two tank systems is that the panels are more efficient at lower temperatures. To heat the tank of water above the setting of 120°F is not a very efficient use of solar energy. Using the panels from 60°F to 120°F is an efficient use of the solar panels. Also, using the water as it is being heated by the sun in one tank allows that hot water during the day to displace the water in the second tank. If use is scheduled to the heating of the water by the sun during the day, you can end up with two tanks of solar hot water at the end of the day, plus use of solar hot water during that same day. Thanks, Tom Snyder, Dyersville, Iowa studegh@earthlink.net

Hi Tom, Thank you for your letter and comments regarding two-tank versus one-tank storage systems. I agree with you that most solar water heating systems will use the two-tank storage system as described in the article. As you have accurately pointed out, this allows the collectors to operate most efficiently at lower temperatures. Any other source of heating of the solar storage water will drastically reduce efficiency of the solar collectors. More often this will cause the solar water heating system to not run at all, since the collectors will have to operate 20°F higher than the solar storage temperature.

As stated in the article, however, there is an opportunity for small systems with limited space to satisfy both solar storage and auxiliary water heating within a single oversized electric water heater. In order to do this, the lower heating element must be disabled so as not to heat the water at the bottom of the tank. The upper heating element will heat only the upper one-third of the tank. The lower two-thirds is used only for storage of solar heated water. As you point out, the auxiliary heating only has to operate enough to raise the temperature from where the solar left off.

This single tank strategy doesn't work with gas water heaters because they heat from the bottom only and would force the solar water heater to operate only at temperatures above the gas heater's thermostat setting. If you have a gas water heater, and only enough space for a single water tank, you might consider using a tankless water heater, often referred to as an instantaneous or on-demand water heater. Ken Olson

Vampire Phantom Loads

Dear *HP*, I work for the Minnesota State Energy Office, which promotes renewable energy, energy conservation, and alternative fuels. As one to personally walk the talk, I've been slowly addressing electricity use in my St. Paul home (along with transportation and heating).

Mike's Annual Phantom Loads

Item	*KWH/Year*	*Annual Cost ($US)*
Stereo clock	135.6	$10.17
VCR clock	104.1	7.81
Microwave clock	30.5	2.29
TV	23.1	1.73
Small radio	23.1	1.73
Total Phantom Loads	316.4	$23.73
Total Annual Household	1,918.0	

I don't use a lot of electricity for a grid-connected urbanite (average of 160 KWH per month compared to the 268 KWH per month of the last owner), but admittedly, it could be better. With assistance from a coworker, I measured most of my "phantom loads" in my house—things that don't use a lot of power, but since they are on 24 hours a day, 365 days a year, they do add up. What I found was somewhat shocking.

These five phantom loads are accounting for 16.5 percent of my electricity use! That's the difference between buying the 485 KWH per year Kenmore refrigerator I bought last year and the average new refrigerator (and the upgrade cost me money!).

How do phantom loads compare to real loads? Interestingly, the majority of power is used in phantom mode:

Mike's Phantom vs. Real Loads

Item	*Watts*
Stereo CD	31.0
Stereo radio	26.4
Stereo off	15.5
VCR play	21.7
VCR on	16.0
VCR off	11.9

What are some solutions (for me and your readers)?

- Power strips to turn phantoms off when not in use. I don't use my VCR much for recording and don't particularly care if my stereo or microwave clock is set. You can also pull the plug easily enough.
- Energy Star VCRs, TVs, and radios now address phantom loads (they benignly call it "standby power").
- Use small battery powered devices. I have a button-battery powered alarm that has lasted over ten years on the same battery. At US$10 per year for electricity for a standard clock radio, I think I'm making out pretty well.

What's the moral this Halloween season? Watch out for this spooky energy "vampire." Ha ha ha ha ha ha! (in freaky vampire voice). To view other statistics about my personal energy use (I'm letting it all hang out there): http://www.geocities.com/mtaylor12345/

I can't leave without giving a plug for our office. For information on everything about energy in Minnesota (300+ MW utility wind power and sixty E85 stations for example), visit www.commerce.state.mn.us. We have more home energy guides for building conservation than you can shake a stick at. Mike Taylor, State Energy Office, Department of Commerce, 85 7th Place E, Suite 500 St. Paul MN 55101 • 651-296-6830 Fax: 651-297-7891 • mike.taylor@state.mn.us www.commerce.state.mn.us

Solar Logging

Dear Editor, I enjoyed reading the recent article by Windy Dankoff about solar logging in the Rocky Mountains with a modified Norwood bandsaw, because I happen to own basically the very same sawmill. My saw is the Norwood Lumbermate 3, the predecessor to the Lumbermate 4 described in the magazine. After some five years of use and experience using this mill, I have a few comments and observations.

From reading the article, one is led to believe that the sawmill as supplied from Norwood is very noisy—"can be heard a mile away." This is definitely not the case! My mill, with a 13 HP Honda engine, is just barely audible at full power from 100 yards away, and at 1/4 mile, cannot be heard at all. When using the mill, the noise level is so low that no earplugs are required. I think it is the chainsaws with their screaming 2-cycle engines and poor mufflers that can be heard a mile away!

Further, the sawmill fumes are not objectionable, being roughly 1/10th to 1/15th the volume produced by the average family sedan. The problem appears to be that the reader is not quite sure whether the author is referring to gas chainsaws or the gas engine on the mill, or both. I do not find that the gasoline engine on the mill produces any stress whatsoever to the operator, in fact, the low pulsating rumble is sort of relaxing to me and others who have actually used it. I have never heard anyone who has used my mill complain about stress! Most people are impressed with the machine and usually want to know how much it costs. I could find a few nits to pick about it if I looked hard enough, but overall Norwood has done a fairly good job designing the machine.

A comment or two about sawmill blade life seems in order. There is nothing wrong with using an electric motor for power. It is quite practical actually, but there is nothing magical about it. Several mills on the market are already offered with optional electric motors. They are more dependable than the gas or diesel counterparts, but also less portable.

Cutting blades do not care what the power source is, whether it be gas, diesel, steam, electric, hydro, human power, hamsters running in a squirrel cage, or whatever. The blade wear and tear rate comes from the speed of the blade times the friction and abrasion of the material you are cutting. If blades last twice as long with an electric motor, it is because the mill is cutting lumber twice as slowly compared to the gas engine that was replaced! I don't believe that the pulsations of a gas engine have anything to do with blade wear. You could replace a gas engine with a more powerful, higher rpm electric motor, thereby increasing the speed of the cutting operation. Then the electric motor would wear the blades out faster than the gas engine, but you would cut lumber faster also, fairly plain and simple. Sorry folks, there's still no free lunch!

Overall, the magazine article was well written—Windy is to be commended for a great job. Oh, by the way, about those gas chainsaws: when are the manufacturers going to start putting a good muffler on these things! Why hasn't the EPA come down hard on the manufacturers about the 130 db+ of noise generated by these? Why are today's chainsaws every bit as noisy as those made 50 years ago? I dearly love my Stihl...but gosh is it loud! I can put up with the fumes, but the noise is something else. Sincerely, Marshall Ronne, Jr., Seward, Alaska

Dear Marshall, Thank you for your comments. Like you, the solar loggers were happy with the Norwood mill even before they did the solar-electric conversion. They are convinced that replacing the gas engines with electric motors significantly reduced maintenance of the blades and adjustments in both the sawmill and the chain saws, about equally. This is based on a year of experience using each power source. Reduced vibration remains the best explanation because their sawmill blade runs at the same speed with the DC motor, with more *power!*

At their altitude of 9,400 feet, their original 9 HP engine was good for only about 5.6 HP. (The HP of a nonturbo combustion engine is reduced by about 4 percent per 1,000 feet or 305 meters.) Engine HP is measured by a false standard that is more than two times the true shaft HP. DC motors are rated by their true HP. (We have followed this rule many times when replacing engines on water pumps and other machines).

So, the solar loggers have more power than they did originally. When the blade bites heavily or is pinched, it maintains its speed better. The emphasis of the project, and my article, is the elimination of fossil fuels, which is absolute in this case. The additional benefits are the icing on the cake. Windy Dankoff, Dankoff Solar Products, Santa Fe, New Mexico

Frankly, Dear, Some Don't Give a Damn

Dear *Home Power,* First, let me say it was a pleasure meeting you folks at the energy fair this summer at Amherst, Wisconsin. I think highly of your magazine and your contributions to society.

But the August/September *(HP84)* issue with the article on "New Tara in Georgia" greatly disturbs me. The article does not give a cost breakdown of the Davidson system. I suspect that is because just eyeballing it, their system would have to be several hundred thousand dollars. What would be the payback on a system like that—60 to 80 years? According to the article, "During hot summer days, the temporary home site uses all the power the array creates in a day." My gosh! How many amp-hours is that?

Give me a break—it is consumerism on this scale that is much more of our earth's problems than solutions. I don't care how green the electricity is from "New Tara in Georgia," it darkens the earth in the face of your other article, "Power to West Africa." Please, more articles on the latter, which I'm sure reflects the roots of this magazine. Peace and prosperity to all, Eric Kahmann, Minneapolis, MN

Hello Eric. The HP *crew agrees with you 100 percent. There is no good excuse for such rampant consumerism and abuse of resources. Truly, less is better. That said, there are folks in this world who don't share those concerns. They are going to continue using whatever energy and resources they want. Then the question becomes, is it better for them to do it with or without renewables? The resounding answer is, "With." So we must show them how to do it that way, just as we show the small and average sized system owners how to do theirs.*

Articles that appear in Home Power *are limited to what we receive from our readers. Quite honestly, one huge system is enough for us every year or so. If we don't have small system* *articles that are good or ready, we must go with what we do have. So folks, write up your small system articles and send them in. How? See* Writing for Home Power *in this issue. Michael Welch*

Optimistic Paybacks

Hi, *HP*'s published payback periods are somewhat optimistic, because they typically do not take into account the time value of money. I realize that there are concerns beyond the financial. While it would be intriguing to attempt to attribute a value to self-reliance and living lightly on the planet (perhaps there's an article there?), right now I'm taking the lazy way out and referring only to dollar payback comparing a renewable system with grid costs.

For example, the article "An Earthship RE System Grows," an excellent and informative article, assumed that US$150/month for 100 months would pay back an investment of US$15,000. For simplicity, suppose the entire system was purchased at one time, up front (I realize this is not the case, but I'm simplifying to make the calculations easy). Suppose instead of purchasing the RE system, the owner put his US$15,000 investment in the bank and continued to pay US$150 per month for grid power. Suppose he achieved a net interest rate, after inflation and taxes, of 3.5 percent, yielding US$43.75/month. This would bring the net grid electricity cost to ($150 - US$43.75) = US$106.25 per month. As a result of the interest earned on what would have been the up-front purchase cost of the RE system, the grid electrical costs take almost twelve years to grow to US$15,000 when offset by interest on earnings. Hal Lasell Horace lasellhj@navsea.navy.mil

Hello Hal, Thanks for your letter. Check out Andy Kerr's article in this issue. It's great to see Andy analyzing different energy efficient items and showing the economic benefits. I think it's good to be critical of the numbers. But to me the biggest mistake is not to factor in the full cost of nonrenewable energy. The direct subsidies, infrastructure support, and protection provided to utility companies make clean energy look "expensive" by comparison. And if you factor in the cost in blood and dollars (not necessarily in that order) of providing "cheap" Middle Eastern oil... Ian Woofenden

Still More GFI

In reading recent issues of *HP* magazine, I see the GFI debate heating up again. Everyone is worried about the plugs and how many watts each draws, and justifiably so. However, there is another solution I have seen used before. My parents have a GFI circuit breaker that feeds the receptacles in the house. If anything causes it to trip, the breaker dumps, isolating everything on the circuit. Instead of using four, six, eight, twelve or more GFI receptacles, each using energy, how about just one or two GFI breakers feeding the entire circuit(s)? You eliminate the cost of all those GFI receptacles, eliminate all the phantom loads they cause, and the protection is all nice and centralized.

GFI on any circuits that may have surge suppressors, spike suppressors, or battery backed-up UPSs on them can be a major pain. Most people have some sort of this protection on their computers and electronics. But in this situation, too much of a good thing causes more problems than it is worth.

The problem is that all of those suppressors will suppress the spike or surge by sending it right to ground! This will trip the GFI unit and of course protect your equipment from harmful voltages, by killing all power to it at the source. Unfortunately though, on a computer system, killing the power without a proper power down can be quite damaging in other ways. Aaron Scholten

Hello Aaron, Ground-fault circuit interrupting (GFCI) breakers are common in new building wiring. And as you point out, they typically save the owner a little energy and money. These GFCI breakers trip when an imbalance greater than 20 mA is present between the hot and neutral conductors, as compared to the 5 mA imbalance threshold standard for GFCI receptacles.

Your analysis of the surge suppressor/GFCI dilemma is right on. Most surge suppressors rely on a number of paralleled metal oxide varistors (MOVs) and shunt or divert excess surge current to ground. Ground wires carry no current except under fault conditions. Any current that is shunted to ground will result in an imbalance between the hot and neutral legs, and the GFCI will open the circuit.

I haven't heard from many people running into problems using surge suppressors on GFCI circuits. But this is probably because surge suppressors aren't commonly used in locations requiring ground-fault protection. Thanks for writing, Joe Schwartz

Fuel Cell Availability

Do you know of a single fuel cell installed and operating on a residence anywhere in the U.S., not including research units? I've seen plenty of articles about the things being towed around on trailers to school science fairs and public displays, but I've never seen anything written about one in private operation with some performance documentation. All the hype from the fuel cell industry is always about how they will make things better in the future. Most information, feature articles, and fuel cell advertising is written simply to keep the excitement level up without actually saying the words "available now, come and get 'em." If they were available today, even at the US$15,000 range, sales would be very brisk indeed. Fuel cell company stock would be the next Wall Street rocket if any of the hype was real. And what about operational costs?

At an installed cost of US$15,000 each, there is no way that fuel cells will reach critical mass necessary to drive the cost down to the forecast US$5,000 by 2005. My point is that if you cannot drive a reasonable distance to see one of these marvels running today, there is no way it will reach the widespread installed base predicted in the next few years. Lots of people had VCRs in their homes long (years) before they reached critical mass needed to get one in the majority of homes with the expected cost reduction. Personal computers are another example. Years of hard-won sales and lots of competition in the marketplace were in place long before the things took off. And now, ten years later, there is still a long way to go before every home has a PC.

Fuel cells are being held out as the main reason why further research and development is not going full bore on other alternative energy sources. It's often said that solar is still too expensive or wind energy simply cannot supply enough continuous power to be a considered a real solution to any energy program. The mindset is that fuel cells are the only technology that we'll need in the future, so why bother with the other stuff.

Utility companies have yet to be heard on this issue as far as I can see. Here in the Midwest, where electric rates are still US$0.07 per KWH and gas prices are still reasonable, fuel cells are not being held up as the ultimate solution. The utility company distributes electricity as well as gas in the area, holding competition at bay for the foreseeable future. Iowa is also the home of those major wind farms who are partnered with the same utility who stated in the early nineties that "wind is still not feasible for general use." In the Northwest, at least the independent power companies are at least interested enough to get involved.

Will large utilities be able to stem the fuel cell invasion? Will the fuel cells ever invade? Will they ever get the average home "off the grid?" *Home Power*, being the power house it is, might want to explore the fuel cell issue a little further. I'd like to see an *HP* style article about installed fuel cell power plants. And where in the U.S. or the world for that matter are these things being used? On a regular basis, this information would be very useful for the average alternative energy enthusiast both from a technical perspective and from a PR or customer relations angle. It would let readers judge for themselves whether or not this new technology solution is just around the corner or not. I will be interested to see if your view on the subject coincides with mine. Thanks, Dave Gross

Hello Dave, Fuel cells are still developmental, and I know of none that are actually powering homes. I don't consider them to be "off-grid" since they consume natural gas, which is why utilities are pushing them so hard. You get to trade an electric bill for a gas bill...

I can eventually see a fuel cell replacing the backup engine generator in off-grid systems, but not for at least ten years. I can only get excited about fuel cells if they are fed hydrogen made by solar and wind sources. Consuming natural gas (or propane) is not the answer. Richard Perez

Dave, I have to admit that I too was somewhat hoodwinked by the fuel cell industry back in early '99 while researching my fuel cell article for HP72. *I'd hoped to enjoy quiet, reliable, efficient, low emissions backup power for my remote cabin. Since then, I have grown tired of waiting, and have purchased a propane generator instead.*

Just because there are residential units currently in beta testing, this by no means assures the success of these tests. And cost issues provide yet another hurdle to commercialization. I'm no longer holding my breath.

On the other hand, it would be imprudent to completely ignore this technology until it hits the mainstream. A lot of the technology featured in HP *would hardly be considered mainstream. My suggestion is to relax and wait with the rest of us. As I promised in my original article, I will start writing a follow-up report just as soon as a viable system is officially slated for public release. That should give even the early adopters plenty of advance warning. Russ Barlow*

More on Fuel Cells

I read "More on Fuel Cells" in a column by Don Loweburg *(HP85),* and wanted to add a couple more perspectives on this "red herring" and "bridging technology" discussion. Mr. Loweburg states that "in a system of grid connected PV," there is no need for hydrogen storage at all. I agree with this, but only until we, as a nation, have become substantially solar powered.

At such point in the future when we have installed enough PV to have a substantial impact on the overall electricity supply, we'll need more than the grid to store excess power generated by the sun, since the sun still does not shine at night.

Until that time, hydrogen storage may very well be a reasonable alternative to storage batteries. Unfortunately, Mr. Loweburg's column did not give us enough data to compare these two technologies' monetary costs or environmental costs; I suspect this was beyond the scope of his article.

One other possibility for storage of solar generated energy may be the already accepted practice of storing energy in the form of the potential energy of water which has been pumped to an elevated location. In the early 1970s there was a rather large environmental debate about the construction of a dam which would hold water pumped from the Hudson River. The water was to be pumped from the river to the reservoir behind the dam during off-peak hours, then run back through the turbines during peak hours, generating electricity for peak demand. I believe this was known as the Storm King Mountain Energy Project, although I'm not certain, as it's been so many years ago.

At the time, many folks (myself included) thought that it was near insanity to do this, as there would have been a net power loss. But having learned lot more about the whole power generation/consumption situation, I'm thinking this might be an acceptable method to store energy produced during times of high insolation, for use during the night, or other periods where solar power couldn't meet demands.

Although I have no hard data regarding how much power is actually lost by this method, I believe it is a fairly small percentage of the total energy generated. And once the water has been pumped to the higher elevation, I'm fairly certain that there would be much less continuing loss than we have in batteries. The only losses that would occur would be evaporation or leakage through the bottom of the reservoir.

Although I'm not really in favor of building lots of large reservoirs for this purpose, it might well be be wise to consider this in comparison to other energy storage schemes. Malcolm Drake • jumpoff@echoweb.net

Hello Malcolm, Pumped storage, as in the Storm King Mountain project you mentioned, has been around for a while. Pumped storage was used in California to help justify the building of Diablo Canyon Nuclear Power Plant. Pumped storage only makes sense for utilities that have plants that are difficult to take offline or put into idle mode for off-peak hours. Essentially, that means nuclear power plants.

One of the promises that PG&E made to Californians while trying to convince us of the need for Diablo Canyon, was that by adding the Helms Lake pumped storage project, Diablo Canyon could be used as a peaking power source. The idea was that since nukes can't be shut down or throttled back readily, the off-peak power from the plant should be used to pump water up hill to be run back down again during times of peak power consumption.

Too bad we didn't invest those billions of Diablo Canyon and Helms dollars in solar panels back in the late '70s and early '80s. We would have ended up with naturally peaking power sources, and would have had a twenty year jump start for the PV industry. Michael Welch

Hello Malcolm, Michael's response pretty much covers pumped storage. My purpose was to open the conversation, and you are right—detailed analysis was beyond the scope of the article. Another purpose was to challenge some of the general concepts regarding hydrogen as a future fuel.

My belief is that we are still far from even being close to a hydrogen economy, and that we are in the middle of a marketing ploy that is essentially a bait and switch operation promoting natural gas as a fuel. A possible negative effect here could be to stall any real shift toward a hydrogen fuel economy. Thanks for reading and responding to the IPP *column. Don Loweburg*

Welding Cable Debate

To the Editor, This letter is written in response to a letter to the editor, from John Wiles, in *HP85.* In the discussions that I have had with inspectors, they do not tell me that they reject welding cable due to any particular code interpretation. They reject welding cable because they are influenced by John Wiles' seminars and publications.

Not only has welding cable proven its worth in the field, but many varieties are UL listed. It is the cable preferred for battery connections by many RE installers. Listed welding cable is not an untested product, prone to unknown failures, such as the varieties Mr. Wiles warns us to avoid in the *Code Corner* of *HP82.*

Mr. Wiles is by far the most powerful voice, both in interpreting and drafting of the photovoltaic code. If Mr. Wiles would like to help solar, he could write the regulations to match the technology, rather than forcing the technology to conform to pre-existing rules.

Sincerely, Drake Chamberlin, RE LAB/Renewable Power Installers Advocacy Program, 3138 Lyle Ct., Denver, CO 80211 • 303-477-4739 • solar@eagle-access.net http://eagle-access.net/solar

My Top Secret Guerrilla Solar Story

I have considered the possibility of net metering near Atlanta (awarded the dubious distinction by the Sierra club of being the #1 urban nightmare in the country), but I ran into the following obstacles:

- Net metering isn't allowed.
- Our meter is a ratcheting type that will not reverse the KWH counters
- There are lots of power hits in the area during storms, some lasting hours
- If the meter were a standard "net-able" type, a negative monthly reading would result in big legal trouble for me and my family.
- I don't want to accidentally electrocute a lineman who is unfortunate enough to be on the high side of the pole pig after a storm.
- Intertie inverters are really expensive, even more than my Trace 3624.

So, here's the obvious alternative: Since the "best" I can do is to reduce my dependency on the electric utility, I decided that the most efficient way to do it was to purchase a generator "transfer" box from the local Home Depot, split out four of my lighting circuits and give them to the solar-powered inverter instead of the power company!

A generator transfer box is no more than a breaker box with lines in and out connected to three-way, center-off switches. When a switch is on center, the circuit is connected to nothing. When it is down, the circuit is connected to your home breaker box (and the utility company). When it is up, the circuit is connected to your own power source that could be a generator, or a nonsynchronous (regular) inverter! Better transfer boxes also have crude watt meters built into them to help with load balancing.

This results in safe isolation of the feed lines from my power generation system, decreases my power dependency, and saves me several thousand bucks on an intertie inverter I don't have to buy. Best of all, it is entirely legal, I don't have to hide it from the "power Nazis," and I'm saving money both ways, in power saved and capital expenditure.

The only real trick is you will have to make a special extension cord to go between your inverter and the generator transfer box, and you may have to "rearrange" your home branch circuits (safely) so that your inverter only needs to feed one leg or phase of the home circuit box. This will avoid any problems with split phase 220 V devices trying to run off a 120 V inverter.

Be patriotic and minimize your dependence on foreign oil—vote with your dollar and your kilowatt-hours! Sincerely, Kenton Chun, Woodstock, Georgia • kentonchun@usa.net

Hello Kenton, With the exception of international fossil fuel based energy corporations and their political allies in the U.S., most Americans feel that energy independence should be high on our list of national priorities. Ultimately it will lead to a more peaceful world. Distributed generation using renewable resources is the obvious direction all countries need to move toward.

The majority of U.S. states allow net metering of renewable energy systems. But it's important to note that the citizens of most of these states had to resort to legislation to force electric utilities to offer net metering to their customers. Thirty-four states have been successful in implementing similar laws. There's no reason why Georgia can't be number thirty-five. All it takes is time and organization.

If the grid is available, utility interactive RE systems make sense. A well designed stand-alone PV system spends a lot of time in regulation mode. The charge controller limits the amount of energy flowing from the PVs to keep the batteries from being overcharged. So in effect, PV output is being blown off or "wasted." The beauty of net metered, utility interactive systems is that solar energy is never "wasted" during regulation. Any excess generation is put onto the grid for your neighbors to use. And the system owner is credited for this excess generation.

It's also important to point out that all inverters capable of feeding energy onto the grid incorporate safety features that prevent the inverters from energizing a failed utility grid and injuring line workers. These safety features are UL approved, just like the appliances in your home. Not a single line worker has ever been injured by an inverter backfeeding a nonenergized utility grid.

Many folks put the independence provided by a battery based system like yours on the top of the list of reasons to invest in a solar-electric system. Your system is a great example of how a person can become energy independent one circuit at a time. And using a generator transfer box is a convenient way to manage your household loads. Take it easy, Joe Schwartz

Utility Grid-Intertie Red Tape

Dear *Home Power,* First, I've been interested in renewable (solar) energy since the '70s, but only recently found your magazine. I especially enjoy the technical and hands-on aspects of your magazine. Keep up the good work—converts (from non-RE) come one at a time.

This is mainly an FYI and to make others aware. Anyone who has Excel Energy as their electricity provider and is looking to intertie to them needs to look at this link: www.xcelenergy.com/EnergyMarkets/CustInterconnectGuide/TOC.asp

I talked with one of the local Excel engineers about an intertie. I was told "no problem; let me send you a form we have." It turned out to be a 40+ page bound book!

OK, I thought, I'm an engineer, this shouldn't be a problem. After I read it from cover to cover, including the fine print, here is what I came up with:

1. Straightforward application form, three pages. Nothing unexpected.
2. I have to pay for a feasibility study done by Excel.
3. I have to submit a second application, more detail, five pages.
4. I have to pay for an engineering study done by Excel.
5. If Excel approves it, I can install my system.
6. Before intertie, I have to pay for Excel to come out and inspect the work and equipment.
7. The intertie must be accessible by Excel so they can shut it off when they deem necessary.

You probably see this a lot with all your correspondence from readers. For me, as an engineer, I was more than a little upset. Maybe I'm seeing this all wrong and this is normal, but it looks like Excel is hiding behind "feasibility" and "engineering" studies to dissuade anyone from having an intertie. On the surface, they look like they support customer owned generating equipment. Underneath, it seems like they'll bury you with paperwork and costs. This is a big, Texas based, power company that owns plants from Texas to North Dakota.

After looking at all the work and expense (on top of the PV system), I decided against any (legal) intertie. My plan now is to rewire my house with two breaker boxes, one to the PV and one to the grid. As I can afford to increase my PV output, I'll rewire more of the house to the new breaker box, gradually weaning off the utility company. Very frustrated, [Name withheld in case he decides to go guerrilla.]

Hello Frustrated, Unfortunately, your experience is a common one. It's bad enough that we have to resort to legislation to force most utilities into offering their customers net metering of electricity generated using clean energy sources. When utilities, in turn, develop net metering policies that are so convoluted that the majority of potential net metering customers throw up their hands, it's nothing short of obstructionist.

As I pointed out in my response to Kenton's letter in this issue, utility interactive (UI) systems have a higher overall system output than stand-alone systems. In an intertied system, think of the grid as an infinite battery, ready and willing to suck up any excess energy your RE system has to offer. Energy flowing onto the grid is credited against your power bill. In a stand-alone system, excess PV output is lost to regulation when the batteries are fully charged.

You mentioned two options available to you; subjecting yourself to Excel's "application" process or pulling a percentage of your loads off-grid and powering them with a stand-alone PV system. Don't overlook your third option. As long as your meter is bidirectional, you can install a UI system, choose not to notify the utility, and get defacto net metering right out of the gate. Since UI inverters cannot feed electricity onto a failed utility grid, unapproved UI systems are just as safe as approved ones when it comes to line worker safety.

Distributed generation is the direction that electric energy supplies are heading. Some utilities are forward thinking and go as far as encouraging customers to install UI RE systems by offering premium rates for RE generated electricity. Others are stubbornly determined to struggle against the tide. Joe Schwartz

Guerilla Solar

Dear HP, I am doing my best to catch up with developments in alternative energy, particularly PV. The first issue of *HP* that I read was *#83.* I ordered a subscription right away. I have since learned this technology has been around for a few decades, yet it is still a maturing and emerging technology. I appreciate that you don't seem to censor articles about individual installations, no matter what the level of sophistication.

Thanks for defining guerrilla solar. Am I naive in hoping the system shown in issue *#85* is not typical? I can appreciate the frustration with barriers expressed by the writer of the article and in the definition, yet I do not think it justifies the wiring methods shown in this case. I would be very surprised if the work shown was done by a licensed electrician. A licensed electrician knows that you do not ever wire cords so that the male cord cap is energized; they also know not to rely on a single layer of insulation to separate an energized conductor from a grounded surface.

Perhaps someday PV system components can be safely wired together without specialized knowledge and skills. Until that day arrives, I am glad there are some barriers in place because enthusiasm clearly does not make up for a lack of knowledge and skill. I am encouraging our local authorities to require electrical permits and inspections for all grid-tied systems as well as for stand-alone systems that exceed 50 volts (AC or DC) or 1,200 watts. Larry P. Meads, Master Electrician/Construction Coordinator LPMeads@cps-satx.com

Hello Larry, Many of the articles published in Home Power *are written by our readers. They're usually the same folks who designed and installed the system, and they are rarely electricians. The quality of the installation varies from homeowner to homeowner. The same is true if you compare the workmanship of two different electrical contractors.*

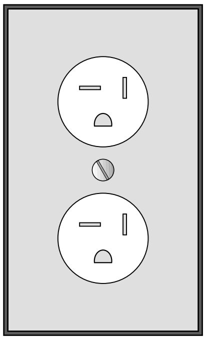
That being said, the guerrilla solar article in HP85 *is definitely atypical and sparked a lively debate among the* Home Power *crew. I'm* Home Power's *resident "conduit meister," and I cringe when I see systems installed in this fashion. But our responsibility to "publish the news" won out, and no gory detail was omitted.*

For a look at the other end of the spectrum, check out the IPP *column in this issue, or better yet, the system profiled in* HP81, *page 52. This system was installed by a licensed electrician and has a code violation list as long as your arm. Overcurrent protection wasn't even included.*

Section 690 of the National Electric Code *already specifically addresses PV systems. But not all U.S. counties require electrical inspections and permitting. This inevitably has an effect on the quality of all electrical work, not just renewable energy systems. Joe Schwartz*

Backwards Plugs

Hi *Home Power,* I have also used regular cords for connecting portable solar panels. However, for safety, I put them on backwards. That means that coming from the panels, and any added extension cords, you end up with the female end. This means you can't accidentally plug your solar panels (or other equipment hooked up this way) into a 120 VAC outlet. And it is just as easy as doing it the regular 120 VAC way. Russ Hanks, Vicksburg, Mississippi



Hello Russ. My entire home is wired for both 12 VDC and 120 VAC. But I do not like the cigarette lighter type plugs and outlets for DC. They are too unreliable, though good for readily noticing that you are using DC. I decided to wire my DC receptacles with standard 20 A outlets. These have one horizontal blade and one vertical blade, so there is no way that I could mistakenly plug AC appliances into the DC system, or DC appliances into the AC system. Careful, though, there are some types of the 20 A receptacles that will accept the twin vertical, 15 A plugs. Don't get those. Michael Welch

Calling All Guerrillas

Dear Solar Guerrilla, I'm seeking help for my documentary addressing home power and net metering issues. I've already shot an extensive interview with one of the first solar guerrillas, as well as with *HP's* Richard Perez. But to really show how large and widespread the GS movement has become, I need to create a video sequence showing lots of guerrillas! It's impossible for me to get around and film this many people, so I'm asking the GS community to help out by sending in your own guerrilla solar video declaration.

All that's required is a shot of you in your favorite guerrilla-wear, posing in front of anything RE. Arms crossed, fists raised, and other gestures (allowed by the FCC) are encouraged! Include a brief declaration of going guerrilla or yell out your favorite GS slogan. A second take just for your voice is a good idea. Any format of video will do (VHS, SVHS, 8 mm, miniDV). If you don't have access to a video camera, send a photo instead. To protect your identity, specify your GS alias to be used in the credits.

As an independent filmmaker, I'll be submitting the finished program to film festivals and public television, and will eventually make it available as an organizational tool. It's intended to raise awareness about home-produced renewable energy and advocate for fair and enforced net metering laws. I've made several other short documentaries on topics ranging from renewable energy to global climate change policy to sustainability. My latest work, "The Power of Coal," is currently touring with the NextFrame Film and Video Festival.

For more info about the documentary, have a look at http://home.earthlink.net/~jaslld/gs. Please contact me if you have any questions. Send tapes to: John Schmit, PO Box 2875, Iowa City, IA 52244 Thanks, John Schmit 319-887-9837 • john-schmit@uiowa.edu

Hello Solar Guerrillas! I've worked with John and he's doing a very interesting project. Please give him a hand if you can—send him some home video of your guerrilla systems. John is aware of the security issues surrounding guerrilla systems. You can trust him with your information. Richard Perez

More Sustainable Building Info, Please

Dear *Home Power,* The article in *HP85,* page 22, "Sun & Straw in Colorado" was wonderful. Many of the *HP* articles just focus on the renewable energy aspects at a homesite. But I'm sure a large percentage of readers are planning to build their own homes, and we're looking for ways to tie everything in: solar power, straw bale, rainwater catchment, grey water recycling, hydronic heating, solar hot water heating, etc. I think this was one of the few homes that seemed to incorporate everything. Having a floorplan layout was very helpful also. While this article was perhaps already slightly longer than average, I would encourage you to add another two or three pages to future articles in order to describe the systems above in even greater detail. Thanks, Michael Wood, Kingwood, Texas • info@freshairadventures.com

Hi Michael, Thanks for writing in and sharing your enthusiasm. I, too, appreciate reading about the sustainable building projects our RE authors are doing. RE and sustainability go hand in hand. We should consider running small features that explain, in detail, a particular home's rain catchment system (for example). Perhaps we could run drawings and photos to give folks real how-to info. Our articles rely on what our readers send us, so when folks send us new features, be sure to include plenty of info showing us your integrated building systems. Best, Eric Grisen

Add RE to Your Backup System

Dear *HP* Thank you for "Blackout Protection for Your On-Grid Home" in *HP84.* It's great to see a complete "recipe" with every detail covered. At the end, you say "there is the tantalizing possibility of adding solar, wind, or microhydro to this system." For one who is so tempted, I suggest a simple enhancement described in my article "Solar Water Pumping & Supplementary Power for a Grid-Powered Home" in *HP76.*

Instead of a subpanel, I installed a GenTran transfer panel, normally sold for transfer of circuits to a generator. Instead of switching my subcircuits on an all-or-nothing basis, I can individually transfer any or all of them to either inverter or grid power. During sunny weather, I run several of my home circuits, using the solar power as much as I can. During less sunny times, I run less, or none of them, on solar. During a power failure, I switch on more or fewer circuits, depending on our needs and the weather vs. the expected duration of the failure (keeping an eye on the battery monitor).

The transfer box takes the place of the subpanel shown in your system. It doesn't add any additional labor to the job, and it costs only a little more. If the user switches all the circuits over to inverter, it will perform the same way as your subpanel system. Windy Dankoff, Dankoff Solar Products, Santa Fe, New Mexico

Two Gripes

Dear *Home Power,* Overall, you provide very good information, and a particularly good attitude (some might call it radical, but then again, we used to think that Greenpeace was radical, too, didn't we?). I have two gripes:

1. Each presentation of technology (article), instead of a treatise on the subject, is normally a saga of every gritty detail of how "it" was solved in this particular instance. While this is very interesting (and it probably sells more magazines), it lessens the value for someone really looking for information. I normally have to look at many sources to separate the wheat from the chaff (not that that isn't enjoyable, too!) and this is hard because...

2. I really detest the PDF format. While it's great for printers, and to "exactly" preserve the "look and feel" of your page, it's horribly slow and unwieldy onscreen, and does not contain hyperlinks! What's wrong with HTML? It's faster, more convenient, and allows us to set default viewing preferences (even if it does not present the ads exactly as produced!) Also, I am not handicapped, but HTML is accessible; PDF is not. davoss@kc.rr.com

Hello, Home Power *articles are written by users and system installers, not by "experts" sitting in offices. So the articles are full of nitty gritty details about real systems, which is what we like. You are the first one I know of that has had such strong feelings about the PDF format. We have had complaints involving Acrobat formats before, but with little exception, the folks became converts. But the bottom line is that we are not in the Web publishing business, but rather in the magazine publishing business. There is not much you can do graphically with HTML—it is just not very flexible. We always present one or two articles in HTML format on our Web site, but that is mostly as a teaser for those who are not familiar with our publication.*

We are definitely concerned with accessibility for folks who are sight-impaired. Acrobat 5.0 (Windows version only) offers support for screen readers, offering the accessibility that earlier versions did not. Michael Welch

Manufacturer Kits—Good or Bad?

Dear *Home Power,* I read the brief few paragraphs about system kitting. I am not from the manufacturer. However, I continue to hear complaints about manufacturers making money and it disgusts me. Are we not in a business to make money? Being profitable means staying in business. Being profitable means spending more money on R & D. Should manufacturers be criticized for creating new ways of making money? Tell me what manufacturer in the last twenty years has made a significant profit.

It appears to me that kitting systems and marketing kits has been extremely successful. Why not go with what works? Manufacturers are attempting to create value! They have the money to do so, and they are spending the money to market these kits.

Who benefits? Everyone! Traditional dealers *are* benefiting from this. They are riding on the coattails of the manufacturers that are marketing these kits. As a technical salesperson in the solar industry, I can explain in detail each component of a system. I can explain what it does, how it works, etc. This knowledge will always be valuable to have in your arsenal. However, I see this knowledge being abused regularly. We are offering a solution, not a bill of components.

Confuse a customer and you lose a customer. We need to simplify our solution to the customer. When a consumer purchases an air conditioning system (the average customer), do you think it is important to explain what gauge of metal the ductwork is? How long is the ductwork? What is the compressor size? Who makes the blower motor? Again, we are offering a solution, not a bill of components! In addition, the systems are lending better profits for *everyone.* I am seeing 30+ percent margins for the dealers. That is on the system alone. And another US$1.25–$1.50 per watt on installation.

Expansion of marketing base? Absolutely! Why not? Furthermore, any responsible manufacturer or distributor will not sell to incompetent dealer/installers. I have personally assisted in training new re-sellers. Being an electrical contractor is a good start, but there are many other factors that go into the selection of new re-sellers. As far as competing with distribution for balance of system (BOS), traditional dealers can purchase these kits too. Including the BOS components in the kits.

We are all in this together. The solar industry is evolving. We have to be open-minded to this evolution. Dealers must support the distributors and manufacturers. If it weren't for the manufacturers, what would we sell? We need them as much as they need us. Thanks for listening. Paul

Hello Paul, Thanks for reading and responding to the IPP *column. I very much agree with your overall premise concerning the need for the various elements of the PV industry to work together and support each other. Really, I was not banging on manufacturers in a general way, but rather, commenting on a particular marketing approach that I don't agree with. I'm comfortable with disagreement while we continue to support one another.*

Your comments about manufacturers needing to make money are understandable, but your concern must be weighed in view of who these corporations are; Siemens, BP, Kyocera, etc. They can afford the long haul. My vested interest slants towards installers and dealers. They must make money now. Sincerely, Don Loweburg

Overpopulation & The Wiz
Dear Richard, With regard to *The Wizard Speaks* comments on overpopulation, and the recently published letter criticizing those comments, I just wanted to add my full support to the original note emphasizing the critical nature of human overpopulation. The proliferation of our species threatens to overwhelm the ecological balance of our fragile earth, to the detriment of humans and all other species sharing it with us. Our overuse of resources and crowding also places humans in a difficult position with regard to peaceful coexistence among nations and communities.

It is widely acknowledged that education, adequate health care promoting increased survival of offspring, and access to family planning alternatives combine to result in lower birth rates. By no means are any sort of genocidal measures implied nor required in the honest admission that human population growth must be slowed, stopped, and ultimately reversed. Nor did the column suggest any such extreme measures.

Below is a link to some good information on the subject supplied by the National Wildlife Federation, along with a note on a PBS documentary on population issues. www.nwf.org/animaltracks/current/hotline924.cfm. Best regards, Jim Taulman, Richmond, Texas

Response to the Wizard Criticism
Dear Richard and staff, My brother and I married immigrants. I am part of a multi-racial, multi-ethnic family. My family not only talks the talk on accepting immigrants, but we walk the walk as well.

I am replying to Laura Allen and her criticism of the Wizard's pointing out the problem of overpopulation. The Wizard is right on the money about the problems overpopulation is causing. I am also sick and tired of the name-calling going by anyone who opposes this view. The facts don't support them, so they resort to insinuating that anyone who is opposed to mass immigration to the U.S. is a racist.

My sister-in-law grew up in Hong Kong. She experienced firsthand the poverty, overcrowding, and disease that are part of living in an overpopulated area. She was among the first to point out to us what was going on in this country. She does not want to see these avoidable problems here. She wants better for her children!

People living in the U.S. do use more resources than anyone else in the world. This is not going to change anytime soon. In the 1970s, the environmental movement made people aware of this, and Americans responded by having fewer children so there would be a better quality of life for everyone. Adding to our population is therefore globally irresponsible. Furthermore, the U.S. open borders policy has made it easier for people to leave their countries rather than to stay and implement the social change needed for the benefit of everyone in that country. Ralph Nader even mentioned this concern during his presidential campaign last year. Ask yourself this: What would have happened to democracy in South Africa if Nelson Mandela had immigrated to America?

The U.S. is the breadbasket of the world. This forced growth is causing precious farmland to be paved over and destroyed. How can we supply food aid to the rest of the world if this continues? Our water resources are also becoming extremely depleted.

I have found that the only people who support this mass immigration and forced population explosion are the extremists. The extreme liberals support it for philosophical reasons that have nothing to do with the reality that it is unsustainable and globally irresponsible. The extreme capitalists and globalists support forced growth because the cheap labor increases their profits and the work force can be easily abused. This mass immigration is corporate welfare in the extreme.

The Wizard was right to raise the vital issue of population growth. It is the responsible thing to do. The future generations of this planet depend on us to address this rationally today. Yours truly, Kathy Nolan (long-time reader), Riverdale, New Jersey

Hi Kathy, Thank you for writing HP *and sharing. I agree that overpopulation and the sustainability of America are serious issues. The economic paradigm of what you call "forced growth" is an issue my high school economics courses explained very well. Interestingly enough, I rarely hear it brought up.*

I think that until we pay all Americans a true living wage, the prospect of slowing down our population growth, and therefore immigration, is not possible. When we eliminate cheap labor from our capitalist equation, I think we'll be able to seriously address America's overpopulation with compassion. Eric Grisen

Send us your letters by e-mail to:
letters@homepower.com

Ozonal Notes

Energy & Security

Richard Perez

©2001 Richard Perez

Energy runs as a common thread through all we do. For a simple example, consider a loaf of bread. It takes energy to grow and harvest the grain. It takes energy to ship the grain to the bakery, and energy to bake and package the bread. Then more energy is used to transport the bread to stores where it is sold. And finally we use energy to go to the store to purchase the bread.

Look at our homes. It takes energy to power them—energy for heating, cooling, lighting, and all home appliances. Nearly all this energy is generated in centralized power plants. It is transmitted on long-distance power lines spanning hundreds of miles before being distributed to homes.

Let's face it—we're strung out on energy. We cannot carry on our lifestyle without it. We consume energy in everything we do. Energy is vital to our economy and to our national security. So vital that we are prepared to go to war, and have gone to war, to ensure our energy supplies.

The recent terrorist attacks have clearly demonstrated how delicate and vulnerable we are. The United States has become hyperaware of our security. This awareness is focused on protecting what we have and maintaining our lifestyle—a lifestyle rooted in energy.

Electrical Energy

Our electrical energy infrastructure is a far more delicate and vulnerable target than either the World Trade Center or the Pentagon. Consider the tens of thousands of miles of transmission lines, most of which are located in uninhabited areas. Then there are hundreds of centralized power plants.

If a terrorist group can successfully attack New York City and Washington, DC, they can also shut the power off in large sections of this country. Terrorists have attacked the American symbols of wealth and power—the World Trade Center and the Pentagon. But much more damage would be incurred if they attacked the infrastructure that enables this wealth and power—our electric power grids.

Transportation

Our transportation system runs on energy supplied by oil. As long as a major portion of this oil comes from the Persian Gulf region, we will be vulnerable. The supply lines are long and difficult to secure, in spite of the some 60 billion dollars the Pentagon spends every year to protect our Persian Gulf oil supplies.

Added to the difficulty of securing these oil supplies is the fact that the monies we spend on this oil are being used to attack us. The terrorists may be funded by our oil dollars. In fact, every time we pull up to the gas pump, we could be aiding and abetting the very people who want to attack us.

The New War

President Bush tells us that we are now involved in a new type of war—a war that will last a very long time. A war in which we really don't know who we are fighting or where they are. A war that must be conducted in secret. In such a war-time climate, hysteria and violence may flourish.

Nowhere in all the media attention focused on this new war, do I see some simple and basic questions being asked. Why are these terrorists attacking us? Could their motives be somehow related to our military actions in the Persian Gulf over the last twenty years? Could our thirst for oil have sown some of the seeds of this new war?

What Can We Do?

If we look to governments to end this war and to ensure our security, I fear that we will be disappointed. If we are going to resolve this situation without huge loss of life and property, we must do it ourselves and for ourselves. We can help to ensure our security by eliminating one major cause of such conflicts—imported energy.

First, put your home on renewable energy and intertie it with your local grid. This will protect your home from the effects of possible terrorist attacks on our electric grid. And it will help lessen the inherent vulnerability of grid-based electricity.

The only way to make our electric grids more secure is to adopt distributed generation. Make each building an energy producer and an independent energy unit. The only way that this is practical and sustainable is to use renewable energy sources. Sunlight, wind, and falling water can neither be attacked nor eliminated. These fuels are freely delivered everywhere daily. Renewable energy is not a commodity to be fought over.

Second, use less oil. When you replace your vehicle, make fuel efficiency your prime criteria. Drive less and drive smarter. Carpool, use public transport, and eliminate unnecessary trips. And finally, keep your eye on the emerging electric vehicle technologies—these cars can be fueled with sunshine.

Peace, Please!

In the 56 years I've been on this planet, I've lived through five wars. In every case, these wars have been caused by greed and a lust for power. Energy is freely and democratically delivered to all of us every day; we just need the hardware to intercept it. When each home and business has its own renewable energy system, we'll have one less reason to wage war. I can only hope that this latest war ends quickly, with little loss of life and damage to our planet.

Access

Richard Perez, *Home Power,* PO Box 520, Ashland, OR 97520 • 530-475-3179 • Fax: 530-475-0836
richard.perez@homepower.com
www.homepower.com

Get A Job!

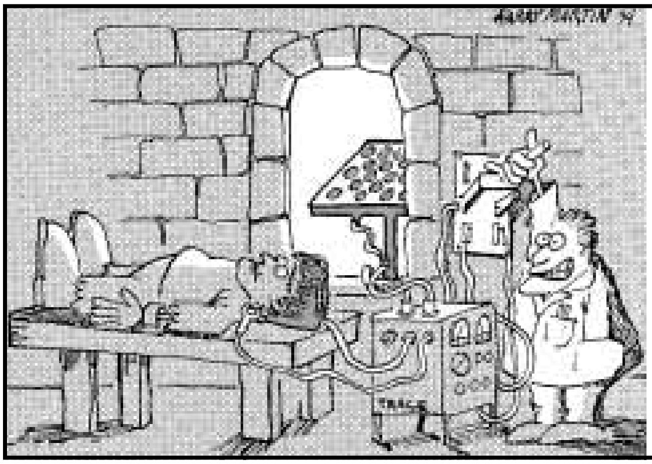
Home Power **is proud to offer a new feature on our Web site called "Get a Job!"**

Home Power **encourages businesses to post their renewable energy related jobs on our Web site at no charge.**

If you want to work in the RE industry, you can search the listings for your dream job.

Make your work part of the solution!

www.homepower.com



Need a renewable energy quick-start for the ole' brain?

Home Power Quick-Start Subscription Special

our last six available issues, plus a one year surface subscription...all for $45 inside USA
(Call for International Rates)

Home Power Magazine
P.O. Box 520, Ashland OR 97520 USA

800-707-6585 in USA, or 541-512-0201
VISA or MC

WWW.HOMEPOWER.COM

Q&A

Wind Turbine Choices
Dear *Home Power,* I am looking to purchase a house and want to install a renewable energy system. I have been considering both solar and wind power and tend to favor wind.

The Bergey systems always seem to get high praise, and are said to require no maintenance. Is this true? I am not a "handy" person, but have always been fascinated by renewable energy. I also have seen ads in *HP* for Whispers and so on, but then I heard of a Jacobs turbine produced by Wind Turbine Industries Corp. Is this brand well made? It seems that they sell a 20 KW system for the same as a Bergey 10 KW system.

The swept area for the Bergey is 415 square feet, and for the Jacobs 29-20, it is 660 square feet. The Jacobs has a predicted output of 1,644 KWH per month based on 10 mph wind, the Bergey 1,050 KWH. If the Bergey system requires a minimum lot size of one acre, what do you think the Jacobs would require?

Do the Jacobs systems require any maintenance? Which would you recommend for someone who wants little worry or maintenance? Should I consider another brand? So far I've only seen 10 KW systems by Bergey and Jacobs. Since the Jacobs puts out so much more power for about the same price, do you think that the extra maintenance is worth it? Thank you for your help. Yours, Charles E. Matoesian

Hello Charles, If you divide 1,644 KWH by 660 square feet, you get a monthly output of 2.49 KWH per square foot for the Jacobs. If you divide 1,050 KWH by 415 square feet, you get a monthly output of 2.53 KWH per square foot for the Bergey Excel. What this indicates is similar efficiencies for the two turbines. Forget about the wattage ratings for the two turbines.

From experience, the Jacobs will deliver as predicted, but the Bergey may be a bit enthusiastic in the monthly output number. However, this conclusion was based on the older version of the grid-tied inverter that they used. I do not know how their newer GridTek inverter, manufactured by Trace, is performing.

The one-acre lot size was derived from the following assumption: 100 foot tall tower to be located in the exact center of a 200 by 200 foot lot, which is roughly one acre. This allows for a "fall zone" within the lot, as required by many zoning agencies. The lot size has nothing to do with power output, and everything to do with tower height and fall zone.

As far as wind turbine reliability and longevity, it depends on the owners and their ability and willingness to maintain the wind genny. Maintenance is at least annual for all *wind generators, regardless of what the manufacturer claims. "Maintenance" can be as simple as climbing the tower and inspecting all fasteners, welds, wires, blade edges, bearing play, and looking for any wear, fatigue, or potential failure points. I call it "inspection," but it's still "maintenance."*

In terms of maintenance, the Jacobs will require more annual tower work than the Bergey. Since the Jacobs has more moving parts than the Bergey, there are obviously more parts to check for wear and tear, and potentially more parts to periodically replace. In addition, the Jacobs has a gear box with oil that needs annual changing, a messy job. Also, there are a few grease zerks that need attention—not a big deal.

The other "problem areas" that I have seen in the past are primarily the U-joints in the drive shaft between the gearbox and the alternator. But if the bearings begin to go in either machine, you'll be calling in a crane to lower the machine so that the work can be performed on the ground.

If you are willing to climb the tower and do inspections, then either machine will work fine. If you are also willing to climb and do an annual gear oil change, grease a few zerks, and replace the U-joints, probably every other year, then the Jacobs is certainly worth the cheaper price. If you are not willing to do this work, stick with the Bergey. If you are not willing to climb the tower for annual inspections, nor willing to hire someone to do this work annually, than neither machine will work for you over time.

In many cases, people skip inspections. When tragedy strikes, which it will if the system is never looked at, they are often surprised, and blame the equipment. In fact, they were gleaning short-term savings at the expense of long-term reliability. By the way, either machine can last indefinitely with proper annual inspections and prompt maintenance when problems arise. Good luck with your decision. Mick Sagrillo, Sagrillo Power & Light • msagrillo@itol.com

Mounting Solar Thermal Panels
Dear *Home Power,* I'm finally starting to build my dream solar lifestyle! Right now I'm in the process of setting up a solar heated radiant floor for my barn workshop here in Maine. See my Web journal page for construction images of my solar shed and other projects: www.arttec.net/Maine/Moving.html

Ken Olson's recent article describes my setup almost exactly. I'm about to mount the panels to the roof, but I'm not sure if it's best to mount them high enough that they have an air gap beneath them, or let them rest directly on the asphalt shingles. I would appreciate any advice you can offer. Thanks much! Guy Marsden

Hi Guy, I would not recommend installing the collectors directly in full contact with the roof. I suggest you use an angle or other bracket that holds them at least 2 to 3 inches clear from the roof. This will permit water or snow melt to run off. That extra little distance will come in handy when you turn your plumbing in through the roof too, otherwise it is difficult to put a 90 degree elbow on without distorting the weatherproof roof flange that takes the pipe through the roof. It gives you a little more room for working with your pipe insulation as well. Best of luck with your project. Ken Olson

Solar Math in Ashland, Oregon
Hello Joe, We are debating adding solar power to our house in Ashland, Oregon, and are looking for guidance on the whats and hows. We are in an odd situation because the house is currently used as a bed and breakfast, which uses considerably more energy than it will with just us. To be

conservative, I would figure on somewhere between 700 and 1,000 KWH per month, but we don't have a good baseline on what the numbers will be yet as a regular residence. Thanks for your assistance. Sean

Hello Sean, A very rough rule of thumb for cost of a professionally installed PV system is US$10,000 per KW of installed capacity.

In Ashland, a KW of PV (batteryless system) will produce approximately 3 KWH per day on a yearly average (1,000 W x 0.7 system efficiency x 4.5 peak sun hours annual average). The system efficiency figure is based on a 15 percent derate, reflecting realistic module operating temperature/output and a 15 percent derate for inverter inefficiencies.

If your home's appliances consume 800 KWH per month, daily KWH use is about 27 KWH per day. Your 27 KWH ÷ 3 KWH = 9 KW of installed PV capacity x $10,000 = $90,000—a big price tag. Ashland rebates and rate-based incentives for RE generated electricity, and Oregon tax credits will lower this cost a bit.

So it's already obvious that PV generated electricity is expensive. The place to start is reducing the electrical load. This doesn't mean going without, just using efficient appliances. When you're making your electricity with PVs, every dollar spent on efficiency will save you 3 to 5 dollars in equipment and installation costs. Most homes' electrical loads can easily be reduced by 30 percent—or $30,000 in your case! Joe Schwartz

Wind & Batteries

Dear *Home Power*, I am hoping you can help me with two questions I have.

First, I have two Air 303 wind gennys that I'm wondering about where to set the voltage regulation. Since they are generating far less frequently than the solar panels, I don't want to waste *any* of the potential charging time I get from them. As a result, I have been setting them at a regulating voltage of about 14.2 volts, rather than the 13.9 volts float voltage that I use for the solar-electric panels. This way, even if my bank is fully charged and floating, I can get the additional energy storage from the gennys rather than wasting it. Do you think this is a viable method? Do you feel that there is a better way of running my system? Will that help my batteries, or will it still just be wasted if the batteries are at a point where they just need float charging?

Second, I have two different types of battery banks, and I am still unsure of how I am going to use them and split their use. I have a 1,760 amp-hour bank using telecom gel cells, and another bank of 660 amp-hours, using Exide flooded lead acids—6 VDC, wired series parallel for 12 volt use. I am trying to determine the best way to keep both banks charged, even if I don't use both of them, so that they can be kept up as well as possible (from self-discharge or whatever).

One thought was to use a marine battery switch on the charging side to simply switch between the two, based on which one I was going to charge at a given time. This would be while I have only one bank connected to the load (supply) side. However, this way I would not have all the pertinent battery info available, because I only have one meter (an E-meter). I think the Link 20 has the capability of working on two banks, but I wasn't planning to be in this situation when I purchased the E-meter.

Another thought was to have a switch of some sort on both the charge side and load side (like a marine battery switch?), so that at any time I could choose which bank to charge and which bank to use as my supply to my home. But I think this would certainly make me need two separate E-meters to read both banks.

I just wanted to tap your experience in seeing so many different installations over the years, as to what different people have done, and what type of good working configurations you may have seen when people have had two battery banks. If you could just give me some thoughts on the subject, I'd really appreciate it; I want to make the most of the positive situation I find myself in, that is, having so many batteries! I'd love to know what options I have to make a great system for myself with these. Thanks, Victor

Hello Victor, The problem is that you have two different battery types that require different regulation set points. The gel cells should be bulk charged to 14.2 VDC and floated at 13.6 VDC. The flooded cells should be bulk charged to 14.8 VDC and floated at 13.6 VDC. Charging the sealed cells to 14.8 VDC will damage them. Charging the flooded cells to only 14.2 will leave them undercharged. So charging these two battery banks from the same source presents you with an immediate hurdle. If you do decide to switch the charging sources between battery banks, you'd need to be constantly readjusting the charge controller (if you have PV) and Air 303 regulation set points. And the latter is done at the wind turbine, not on the ground.

Without knowing the daily KWH load or condition and age of each battery bank, it's hard to make specific recommendations. Are the 1,760 and 660 AH figures both at 12 VDC? What's the daily KWH load? Are there additional charging sources besides the Air 303s?

If I were in your shoes, and assuming that the 1,760 AH pack is at 12 VDC and of sufficient size for your daily load, I'd consider selling the 660 AH pack and simplifying your system (and your life!).

You could also split the charge sources and loads between the two banks (we do this at HP*). But this gets complicated and expensive. You'll probably need two inverters, separate wiring, separate overcurrent protection, etc. And you'll always be trying to balance out charge vs. loads on each system.*

Regarding the Air 303s. I run a 12 VDC Air 403 here (moderate wind site, no trees, 29 foot tower) and have the voltage set up around 15 VDC. My Air 403 rarely raises the battery voltage up to regulation on a 440 AH, 12 VDC bank of flooded golf cart batteries.

If you live in a high wind location and are getting better output out of your Air turbines, try setting the regulation up to 14.2 VDC. For reference, the factory default regulation set point (14.1 VDC) is marked on the casing. Any higher than 14.2 VDC and you risk overcharging the sealed cells. Joe Schwartz

Writing for *Home Power* magazine

Home Power is a user's technical journal. We specialize in hands-on, practical information about small-scale renewable energy systems. We try to present technical material in an easy to understand and easy to use format. Here are some guidelines for getting your renewable energy (RE) experiences printed in *Home Power.*

Informational Content

Please include all the details! Be specific! We are more interested in specific information than in general information. Write from your direct experience—*Home Power* is hands-on! Articles must be detailed enough that our readers can actually use the information. Name names, and give us actual numbers, product names, and sources.

If you are writing about someone else's system or project, we require a written release from the owner or other principal before we can consider printing the article.

Article Style and Length

Home Power articles can be between 350 and 5,000 words. Length depends on what you have to say. Say it in as few words as possible.

We prefer simple declarative sentences that are short (fewer than twenty words) and to the point. We like the generous use of subheadings to organize the information. We highly recommend writing from within an outline. Check out articles printed in *Home Power.* After you've studied a few, you will get a feeling for our style.

We edit all articles for accuracy, length, content, organization, and basic English. You can help by keeping your sentences short, simple, and to the point. Our editing crew will make your text shine.

Photographs

We can work from any photographic print, slide, or negative. We prefer 4 by 6 inch color prints with no fingerprints or scratches. Do not write on the back of your photographs, since the ink can transfer to the front of the next photo. Please provide a caption and photo credit for each photo. Include some vertical format photos—you might even find your system on *HP's* cover. People are nice in photos; a fuse box is only so interesting, even to solar nerds.

Digital photos should be at least 280 pixels per inch (ppi) at the final printed size. This means that a column width photo should be 1,000 pixels wide or more. A full page width photo should be at least 2,300 pixels wide. Basically, set your digital camera at its highest resolution, and crop thoughtfully. We prefer Photoshop files, but we can handle the following formats in descending order of preference—EPS, TIFF, and JPEG.

Art, Schematics, & Tables

System articles must contain a schematic drawing showing all wiring. Our art department can make gorgeous diagrams, charts, and schematics from your rough sketches. If you want to submit a computer file of a schematic or other line art, please call or email us first.

For system articles, we require a load table listing all loads, with wattage and run time. We also require an itemized cost table listing each system component and its cost. We prefer to have the tables come to us in Excel format. But we can use them from any word processor or spreadsheet format if they are saved as "text only," with tabs as the delimiter between cells.

Computer Talk

We can take text from most word processors. Save all word processor files in "TEXT" or "ASCII TEXT" format. This means removing all word processor formatting and graphics. Use the "Save As Text" option in your word processor.

If you want to send files larger than 5 MB (such as digital photos), use removable media and snail mail it to us. We can read ZIP disks (either Mac or IBM) and CD-ROMs. You can also FTP your large files to us at ftp.homepower.com, to the "incoming" folder. Please let ben.root@homepower.com know after you have sent us files via FTP.

Putting it All Together

We get many more articles submitted than we can print. The most useful, specific, organized, and complete get published first. Here are the basic components of a great *Home Power* article:

- Clearly written, well organized, and complete text, with a strong introductory paragraph, subheads for each major section, and a strong closing paragraph.
- Photos (plenty) with clear captions.
- Cost table.
- Load Table.
- Other tables, charts, and diagrams as appropriate.
- System schematic.
- Complete Access information for author, installers, consultants, suppliers, and manufacturers.

Have any questions? Give us a call Monday through Friday from 9 to 5 Pacific and ask. Or send e-mail. This saves everyone's time. We hope to see your RE project in *Home Power* soon!

Access

Home Power magazine, PO Box 520, Ashland, OR 97520 USA • 530-475-3179 • Fax: 530-475-0836
hp@homepower.com • www.homepower.com
For FedEx, UPS or other shipping only (no postal service): 312 N. Main St., Phoenix, OR 97535 • 541-512-0201

Amazon
Power Company

Photovoltaic Systems
for Home, Water pumping, & RVs

System Design, Sales,
& Installation

Donna Fischer
Amazon Power Company
RR 1, Box 1, Embudo, NM 87531
505-770-0498

Colorado Electrical Contractor Lic. # 025230
New Mexico Electrical Contractor Lic. # 80290

GREAT NORTHERN

**Waking Up
the Northland to
Renewable Energy &
Sustainable Living!**

Bringing the finest in technology, equipment, and knowledge to the northern midwest.

Solarex & Kyocera photovoltaic modules
Trace & Heart inverters
controllers, meters & more!

Great Northern Solar

SOLAR

IPP MEMBER

77450 Evergreen Road, Suite #1, Port Wing, WI 54865
(715) 774-3374 • gosolar@win.bright.net

Solar Hydrogen Chronicles

Edited by Walt Pyle • First Edition 1998

A collection of articles from *Home Power Magazine*
on Hydrogen Technology for small-scale systems

Hydrogen Production

Hydrogen Purification

Hydrogen Storage

Utilization for Cooking, Heating, & Electricity Generation

118 pages of useful information

Extensively Illustrated • $25 + $3 S/H = $28

H-Ion Solar Inc.
6095 Monterey Avenue
Richmond, CA 94805 USA
phone: 510-237-7877 • fax: 510-232-5251
email: hionsolar@aol.com
website: www.hionsolar.com

Pony Enterprises

Offering affordable custom services
to small businesses for single projects
or recurring needs.

Design & Production Services Include:
- Mechanical Design
- CAD Drafting
- Machining & Prototyping
- DC Wiring
- Short Run Assembly & Production

Documentation & Marketing Services Include:
- Technical Writing
- Article Writing
- Web Site Design & Maintenance

We provide "a little extra horsepower"
to take your project to completion.

Pony Enterprises
POB 1113, Felton, CA 95018
phone: 831-429-1994 • email: electro@cruzio.com
web site: www.cruzio.com/~ponyent/

Home Power MicroAds

Rates: 15¢ per CHARACTER, include spaces & punctuation. $20.00 minimum per insertion. All MicroAds are published in both the print and web versions. Please send check or Visa/MC data with ad. Please, no money orders. We do not bill MicroAds, they must be paid for in advance of publication. Your cancelled check or credit card bill is your receipt.

Help us prevent fraud! Home Power MicroAds from individuals must supply serial number(s) for equipment being sold. Businesses must supply published phone number(s) and physical address. While Home Power is doing everything we can to prevent fraud, we can assume no responsibility for items being sold.

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 36 HP, Deming, WA 98244, 360-592-5552. e-mail: citurbine@aol.com web page: canyonindustriesinc.com

XXXXXXXXX USED SOLAR MODULES XXXXXXXXX XXXXXXXXXXXXX 64 Watts $319 XXXXXXXXXXXXX Used MSX60s $295, BZ 8 amp pwm controller $49, Ex 2KW inverter SB, 110 amp charger New $850, 3000+ watt resistors $35, new 75 Watt modules $375. Buy, sell New/Used, Trace, NiCds. refrigerator. Try to match anyone's prices. Call or send S.A.S.E. to Craig Eversole, 10192 Choiceana, Hesperia CA 92345 for free flyer. M/C VISA Discover 760-949-0505

The big-box Solar Mart may talk a good game from behind the order desk, but are they actually out there doin' it? VERMONT SOLAR ENGINEERING takes pride in being a reality-based dealer/designer/installer. We know the products because we work with them every day—PV, hydro, wind & domestic hot water, from components to complete systems. So reject the romantic salesspeak offered by the volume dealers and give us a call. Thanks! 800-286-1252, 802-863-1202, 863-7908(fax). PO Box 697, Burlington, VT 05402. Our Website contains our installation portfolio and attractive sale pricing—www.vtsolar.com-Visa/MC

RADIO/TELEPHONES for Remote Homes: Internet access, Voice/Fax up to 20+ mi, U-own 1-8 line system. Also 2-way radios. (208-263-9755 PST) Send $2 cash: KRES, Box 215-HP, Kootenai ID 83840

VERY LOW PRICES Solar Electric & Thermal Equip. Panels-Inverters, Charge regulators, wind generators-pumps-controls Please Call (888) 817-1737 or write to 6 Cresta Cir. #8, San Rafael, CA 94903 www.afterhourssolar.com

INTERESTED IN INTENTIONAL COMMUNITY? Communities magazine offers complete, updated listings of intentional communities not found in the Communities Directory. Practical information about forming/joining community—alternative buildings & structures; getting off the grid, legal, financial, & land options. Plus Eco-villages, Cohousing, decision-making, conflict resolution, successful communities, children in community, research findings on community living. Quarterly. $20/yr, $5/sample. 138-HP Twin Oaks Rd., Louisa, VA 23093 (540) 894-5798

EARTH SHELTERED HOMES This definitive manual by noted authority Loren Impson features detailed building instructions for the amazingly affordable and practical Ferro Cement Domes. Only $15 from Sun Life, 71 Holistic Mount Ida AR 71957 www.2BbyD.com

FOR SALE: Photocopied reprints of Home Power issues 1–10 available. All proceeds will be donated to IRENEW. Call 815-469-5334 or email Jeff_Green@msn.com. Sold only in sets of 1 thru 10 for US$30 which includes shipping in most cases.

EDTA RESTORES SULFATED BATTERIES. EDTA tetra sodium salt, $12/lb. plus $5 S&H for 1st lb. plus $1 S&H for each additional lb. Trailhead Supply, 325 E. 1165 N., Orem, UT 84057, (801) 225 3931, email: trailheadsupply@webtv.net, info. at: www.webspawner.com/users/edta.

WANTED: The Midwest Renewable Energy Association is in need of two wind generator towers. We'd like Rohn SSV towers, one at 90' to 100', and the other at 110' to 120'. Donations always accepted. Please call Mick at 920-837-7523 or Katy at 715-592-6595.

The Solar Cell Co. We carry solar cells for building your own panels at a much lower price than from a manufacturer.We carry satellite cells which are 23% efficient Vs 13% with standard cells. We custom build L.E.D. light strips (white or yellow).We carry 2 catalogs, 1 is a copy of our website ($1.00) the other is a larger, more complete catalog with every solar product needed for complete off-grid living, as we have for 5 years ($6.50). For both catalogs,$7.00. Check out our very Low prices on our website @ www.solarcell.net or e-mail us @ highgfm@solarcell.net The solar cell co. P.O.Box 275,Lincoln,Me. 04457

VERMONT PV DEALER. David Palumbo/Independent Power & Light has been designing and installing PV systems for more than 12 years. Trace and Exceltech inverters. Siemens, BP, Kyocera and Solarex PV's. Harris Hydro. Surrette, Rolls, and Dyno batteries. Honest dealer who offers personal support and service. "David is one of the original RE pioneers... he knows how to really squeeze all the energy out of a KWH!" Richard Perez (HP60). I P & L, 462 Solar Way Drive, Hyde Park, VT 05655. Phone 802-888-7194. Email: ipl@sover.net. Web site: www.independent-power.com. No catalog requests please. Please call for appointment before visiting.

INTERNS WANTED at SOLAR ENERGY INTERNATIONAL! Work/study trade opportunities, 6–12 months "Hands-On" workshop attendance in exchange for multi-faceted office work, beginning ASAP. SEI, Carbondale, CO. sei@solarenergy.org • (970) 963-8855 (For SEI info see HP ad)

TELLURIDE COLORADO: Off the Grid Properties! Hot Springs, Riverside, solar powered homes, large and small ranches. Find your own place in the sun with the only solar powered real estate office in Colorado. T.R.I. (970) 728-3205 1-800-571-6518

PROPERTY CARETAKERS/Housesitters enjoy rentfree living, worldwide 700+ opportunities available! The Caretakers Gazette (715) 426-5500. www.caretaker.org

POND AERATION WINDMILL: Koenders Air Compressor, 12 ft. Tower, 100 ft. Air Line, Aeration Stone: $585. Electric Air Pump: $375. Electric Aerator System $465. Air Powered Water Pump $180. Green Windmill info. Solar & Wind Powered Electric Products. We can ship worldwide. Malibu Water Resources — 800 470-4602 — www.MalibuWater.com

NEW MILLENNIUM Specials: Now offering you more!! Save 5%–50% off marked down prices on all solar products. Register to win Free Gifts at our website: http://www.solartech3000.com Call Toll Free 1-877-246-8217

BACKUP PROPANE SPACE HEATER, no electric required, flameless catalytic—warms like the sun, 10,000 btu, wall mount, vent free, thermostat control, piezo ingiter, ODS and thermocouple safety controls. $199 including domestic shipping (compare to others at $495 plus shipping) www.solar1online.com, 314 631 1094 Solar 1

WANTED: RURAL OFF-GRID HOME/PROPERTY TO RENT OR BUY. Must have excellent fresh water source, very clean air, any combination of wind/solar/hydro OK, prefer 40+ acres, will consider less. neelon@deeppool.com or 410 752 7156

SATELLITE TV - Large selection of items at reasonable prices. We specialize in Big Dish TVRO C & Ku Band equipment. Check us out at www.daveswebshop.com

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX XXXXXXXXXXX WWW.NEMOPUMPS.COM XXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

BUDGET SOLAR, your first choice for solar electric products. Quality solar products, from educational kits, gadgets, and books to PV modules, inverters, and batteries, priced to fit every budget. Shop today at www.budgetsolar.co

WINTER SUN in New Mexico! New 2 bedroom, all-solar adobe style home on 40 acres. Excellent well, storage shed, easy access, views of two mountain ranges 4,200' elevation. $46,500! Write Orin, Box 224, Rodeo NM 88056. phone 505-557-2244 email:quietland@vtc.net

HOW TO BUILD A SOLAR HOT WATER SYSTEM, Build your own collector, Book and Kit available at www.JC-SolarHomes.com

AUTO STANDBY Generators Propane or Natural gas 6 KW – 40 KW Xfer switch incl. Tel: 732.271.7704 Fax: 732.271.9990 www.focallighting.com 1830 Washington Valley Rd. Martinsville, NJ 08836

IF YOU'RE INTERESTED in discussing building a city without internal combustion transportation please visit biketopiaproject.com

SURPLUS INDUSTRIAL BATTERIES: If ever batteries could be called beautiful, these are they. Powder coated steel cases, clear Lexan covers, stainless steel interconnect hardware, sealed V.R.L.A. technology, 20 year float rating. Super heavy duty. Unused, factory boxed, fully charged. Save 75%. 12-24 and 48 V sets. Up to 150 cells available in two sizes, 1200 amp hour or 1400 amp hour at 8 hour rate. Non-spillable, can be shipped by truck or picked up FOB Palmdale CA. Call or fax for complete specifications, prices, and availability. D.P.S.D. Inc. (661) 269-5410, fax (661) 269-1303.

TRACE DR3624 inverter w/standby charger. Works perfectly, used for 1.5 years. Dealer changeout. $950.00, you pay shipping (I have orig packaging). frenergy@psln.com

FREE ENERGY Build a simple self contained—recycle water turbine, Info.-catalog $3.00 Ganther Technologies N5408 Romadka Ave HP Granton, WI 54436-9010

Batteries & Panels- (6) C & D, LT–840, 12 volt system $750. (3) Solec panels # S–4611HE, 5 volts & 56 watts per panel, $600 O.B.O. 760-868-8830

A BREAKTHRU in windturbine technology.Penturbine available in kit form.modular, expandable and self limiting. send $3 for wind siting data and details to: f.m.hall, pobox 95, chimacum, WA. 98325

NO. CALIF–Solar powered home for sale 1000+SQ FT, on 40 acres, adjacent to nat'l forest. Basement/garage. Good well. Quiet. Beautiful views, Trees. $105,000 PH 530-459 1110 MSG. or sneeties8@aol.com

Long range installed type 12 VDC cell phone. Includes interface for fax, extension phones, modem, etc and 9 db marine antenna. Bandership@aol.com

COMPLETE OFF GRID SOLAR/WIND POWER SYSTEM Brand New Whisper 3000HVLV high voltage wind turbine with Easywire monitoring center 3kw wind turbine heavy duty blade option with 84' tower and guide line kit, 8 Siemens SR100 photovoltaic panels with a 12 panel Wattsun dual axis tracker, Trace SW4024 inverter with generator auto start , transformer, Diversion load heater, 12 T105 trojan batteries, to store energy for days with no wind and sun light, 1000 ft UF-B 14-2+G, 250FT UF-B 8-2+G wire still on spools and all connecting wires Wind turbine and solar panels are still in crate. Purchased December 1999 (y2k) The rest of the system is currently powering a 3000 SQ FT home for power outage backup It is a complete system from Windstream Power System Inc. Vermont Tel - 802-658-0075 Paid 27,000 + new, will sacrifice for 15,000. Beats the cost of bringing electric to the remote locations. EMAIL Macgyverman@netzero.net or call Mark @ 603-837-2195

WIND GENERATOR TOWER for sale. Rohn SSV 90' with concrete anchors in excellent condition. Can ship. $3500.00 616-676-0002

FOR SALE STABER WASHER model #D 9600 1152. Purchased 6/25/98, will sell for $200.00+ cost of this ad. To anyone coming to Winchester VA area to pickup. Please call 540-667-1766

TWO 17.5KWH JACOBS wind turbines on 120' self standing galvanized towers with grid intertie Mastermind Inverters. $12,000.00 each or both for $20,000.00 call 715-682-9240

NEW SOLAR SYSTEMS 44, 150–watt modules, 96 cell Siemens single crystal, glass and EVA, 35.25" X 52"X 2" panelized and wired in series in sets of two. Each module 57 Voc, 46 Vpk 3.5 Isc, 3.2 Ipk great for Sunny Boy, ST or 24 volt systems. $450 ea. Min 8 modules. To big to UPS Sol Cal P/U preferred. Siemens Solar 48,Sp 70 watt modules four years old 20 year warranty, $215 each min order sets of twelve. Trace 2524,$500 Trace 4048 PV in SWODE cabinet with GFI board four years old $1,800. Ominion 6kW inverter UL listed 6 years old. (805) 497-9808, 8–5PST or gj@solarelectricalsystems.com

CBS071 GENUINE LOG HOMES Energy efficient. Superior quality. 8–10' logs. Custom kits. Also, send for catalog of beautiful log furniture made from dead–standing timber. 1740 H Dell Range Blvd #328 Cheyenne, WY 82009 307 634-8729, www.genuineloghome.com

Sun Frost RF16 12V refrigerator $1,900. (can convert to 24V), Solarjack 4gpm 1/2 hp 24V well pump $500., Dankoff Flowlight Booster pump 4.1–4.5gpm 12V $350. Serious buyers only in AZ Call 928-339-4623.

EXPLORER GRQ–15 (14.4 Cu Ft) Propane refrigerator. Works well. Less than 2 years old $900 Buyer makes shipping arrangements and pays freight. wout@airmail.net 903-695-2864

I AM A SOLAR WHOLESALER looking for retailers to carry my solar electronic and hobby goods. Phone # (916) 486-4373. Please leave message.

WIND TUBINES! Best prices nationwide. Bergey- Aeromax- Turbex. www.pineridgeproducts.com 406-738-4284

Honda Generators - 1000 to 10,500 watts. Fast shipping and great prices! www.hayesequipment.com 1-800-375-7767

Index to Advertisers

HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

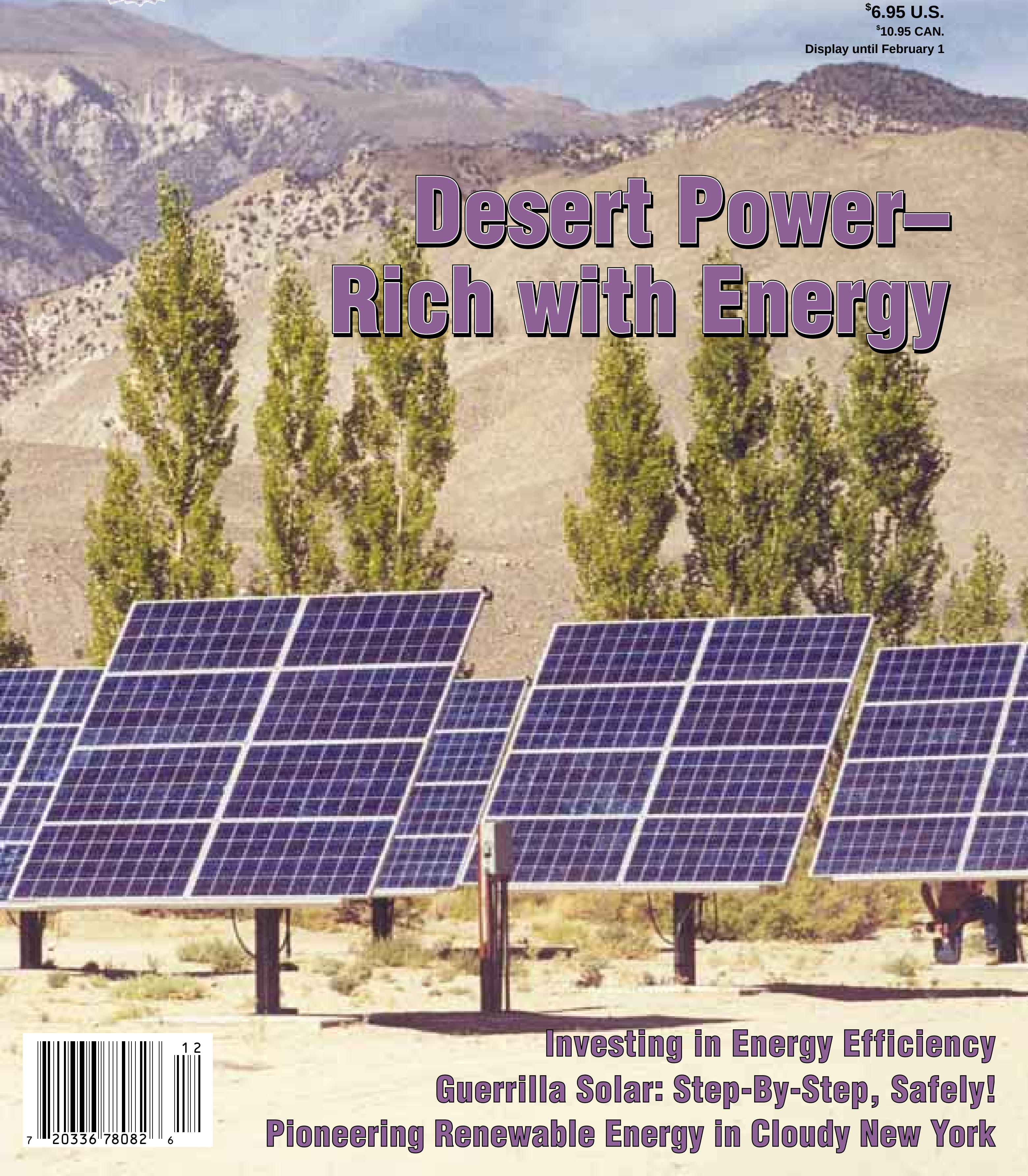
ISSUE #86

December 2001 / January 2002

$6.95 U.S.

$10.95 CAN.

Display until February 1



Desert Power– Rich with Energy

Investing in Energy Efficiency

Guerrilla Solar: Step-By-Step, Safely!

Pioneering Renewable Energy in Cloudy New York

7 20336 78082 6 12

SOLAR ELECTRIC GENERATORS
WIND POWERED GENERATORS
SOLAR WATER HEATERS
SOLAR POOL HEATERS

ENTERING THE 21ST CENTURY
SOLAR DEPOT
WITH 21 YEARS OF EXERIENCE

SOLECTROGEN
SOLAR ELECTRIC GENERATORS

Quality Products
Technical Support
Huge Inventory
On-Line Catalog
On-Line Ordering
Staff Engineers
System Design

Trace Engineering
Authorized Distributor

SMA

bp solar
Distributor

SOLAR DEPOT

UTILITY INTER-TIE EXPERTS RESIDENTIAL & COMMERCIAL

Our packaged systems are well thought out and time-tested

Easy to set-up, code compliant & complete with everything you need for a functional system.
All system components have UL listing and all required approvals to qualify for California Cash Rebates.

We Offer Owner-Builder Discounts
Performance and Reliability at Great Prices
Referral to the Solectrogen Dealer-Installer in your area (call us)
Dealer Inquiries Welcome. Free Catalogs to Dealers

WWW.SOLARDEPOT.COM

SOLAR DEPOT - SAN RAFAEL
61 PAUL DRIVE
SAN RAFAEL, CA 94903
415.499.1333
FAX 415.499.0316
ORDER LINE 800.822.4041

SOLAR DEPOT - SACRAMENTO
8605 FOLSOM BLVD.
SACRAMENTO, CA 95826
916.381.0235
FAX 916.381.2603
ORDER LINE 800.321.0101

SOLAR DEPOT - SoCAL
1520-H COMMERCE STREET
CORONA, CA 92880
909.737.SOLAR (7652)
FAX 909.737.7630
ORDER LINE (800) 680-7922

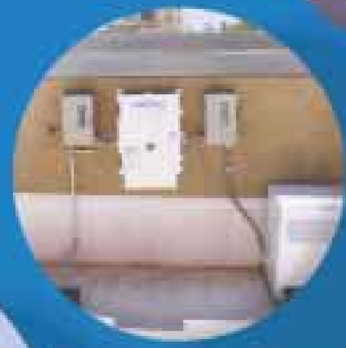
Schott Applied Power Corporation

Schott Applied Power Corporation is pleased to announce the grand opening of our headquarters near Sacramento, California. Our new 26,000-sq.ft warehouse and office facility will allow us to better serve our customers. Thank you for your business and support.

Call 800 777-6609
or 800 344-2003
4051 Alvis Court
Rockline, CA 95677






We would also like to thank our suppliers for their continued cooperation:

Advanced Energy Systems
BP Solar
Direct Power
Evergreen Solar
Exeltech
Matrix Solar
Morningstar
Outback Power
Siemens Solar
S.M.A.
Southwest Wind Power
Studer
UniRac
Unisolar
Vanner
Xantrex Trace
And many others

SCHOTT
glass made of ideas

KYOCERA
PRODUCT SHOWCASE

STANDARD PACKAGING DETAILS

Module Quantity per Carton	2
Carton Size in Inches (LxWxD)	60.0 x 28.0 x 3.5
Carton Size in Centimeters (LxWxD)	153.0 x 71.0 x 9.0
Carton Gross Weight	63.0 lbs. (28.6 kg)
Number of Cartons per Pallet	10
Number of Modules per Pallet	20
Max. Pallet Dimensions (LxWxD)	60.0 x 28.0 x 39.0
Max. Pallet Dimensions	38.0 cu.ft. (1.1 cu.m)
Gross Weight of Max. Pallets	685.0 lbs. (311.0 kg)
No. of Modules per 20' Container	440
No. of Modules per 40' Container	960

KC120-1

MOUNTING HOLE LOCATIONS

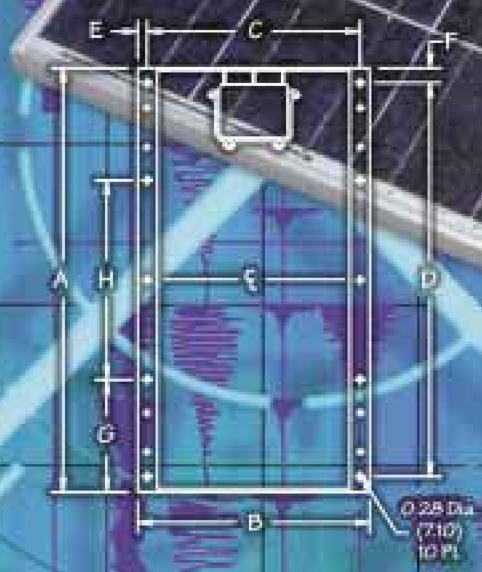
Dimension A	56.1 in. (1424.0 mm)
Dimension B	25.67 in. (651.0 mm)
Dimension C	23.94 in. (608.0 mm)
Dimension D	53.82 in. (1366.0 mm)
Dimension E	0.87 in. (22.1 mm)
Dimension F	1.14 in. (28.9 mm)
Dimension G	9.48 in. (240.0 mm)
Dimension H	37.12 in. (942.0 mm)

Kyocera's advanced cell processing technology and automated production facilities have produced a highly efficient multicrystal photovoltaic module.

The conversion efficiency of the Kyocera Model KC120-1 solar cell is 14%.

These cells are encapsulated between a tempered glass cover and an EVA pottant with PVF back sheet to provide maximum protection from the severest environmental conditions.

The entire laminate is installed in an anodized aluminum frame to provide structural strength and ease of installation.



ELECTRICAL SPECIFICATIONS

Maximum Power	120 Watts
Maximum Power Voltage	16.9 Volts
Maximum Power Current	7.10 Amps
Open Circuit Voltage	21.5 Volts
Short-Circuit Current	7.45 Amps
Length	56.1 in. (1425.0 mm)
Width	25.7 in. (652.0 mm)
Depth	1.4 in. (360.0 mm)
Weight	26.3 lbs. (11.9 kg)

KYOCERA SOLAR, INC.
7812 East Acoma Drive
Scottsdale, Arizona 85260 USA
T: 480.951.6330 • 800.544.6466
F: 480.951.6329 • 800.523.2329
www.kyocerasolar.com
info@kyocerasolar.com

KYOCERA

KYOCERA SOLAR, INC.