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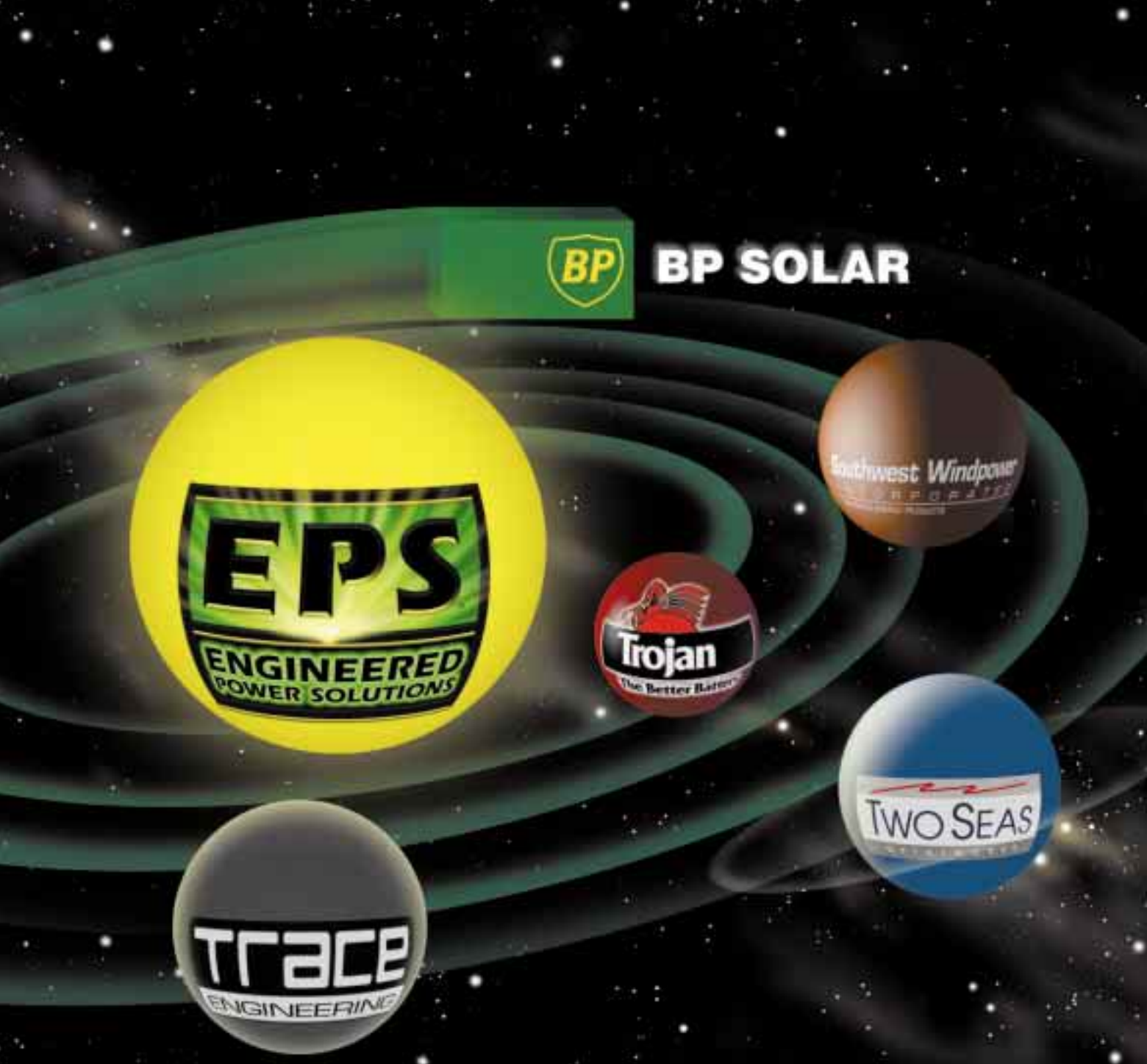

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THE HANDS-ON JOURNAL OF HOME-MADE POWER

Issue #69 February / March 1999

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Homebrew

Cover: Ed LaChapelle's little PV-powered EV in the USA's biggest state.

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Access Data

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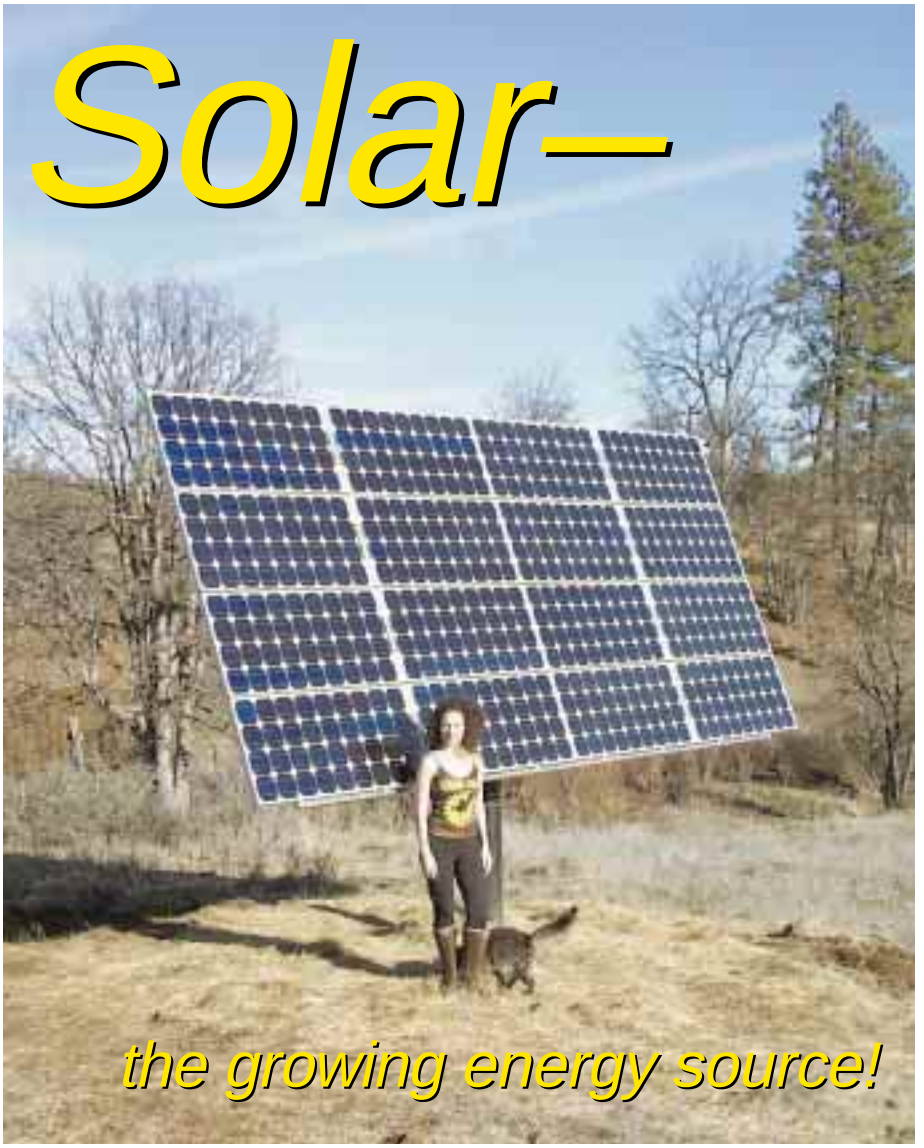

Above: Home Power's new PV array of sixteen BP Solar 90 watt modules on a Wattsun tracker, Joy Anderson, *Home Power's* new Associate Editor, and Elfie, solar-powered puddy.

We've been a little short on energy here at *Home Power* lately. Every new appliance and every new worker requires energy. Even though we already had over 1,800 watts of PV, we needed more. With our new tracker, we have over 3,000 watts of solar power!

Adding this tracker brought home one of PV's strong points—it can grow with our needs. We started out with a single module in 1983. Now we have over sixty modules in the sun. All day long, they make quiet and dependable power. Year after year, they just keep on pumping out the watts. Some folks might consider this boring—the PVs just smile at the sun and pump out the power. I find it exciting....

Richard Perez, for the Home Power crew.

People

Joy Anderson
Corey Babcock
Mike Brown
Sam Coleman
G. Forrest Cook
Windy Dankoff
David Domermuth
Anita Jarmann
Kathleen Jarschke-Schultze
Stan Krute
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Karen Perez
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Myna Wilson
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"Think about it..."

"The implication is that anyone choosing to pay for PV electricity is foolish, while anyone choosing to pay for a Lexus is discerning."

—Dave Lehmicke.
See *Letters* this issue.

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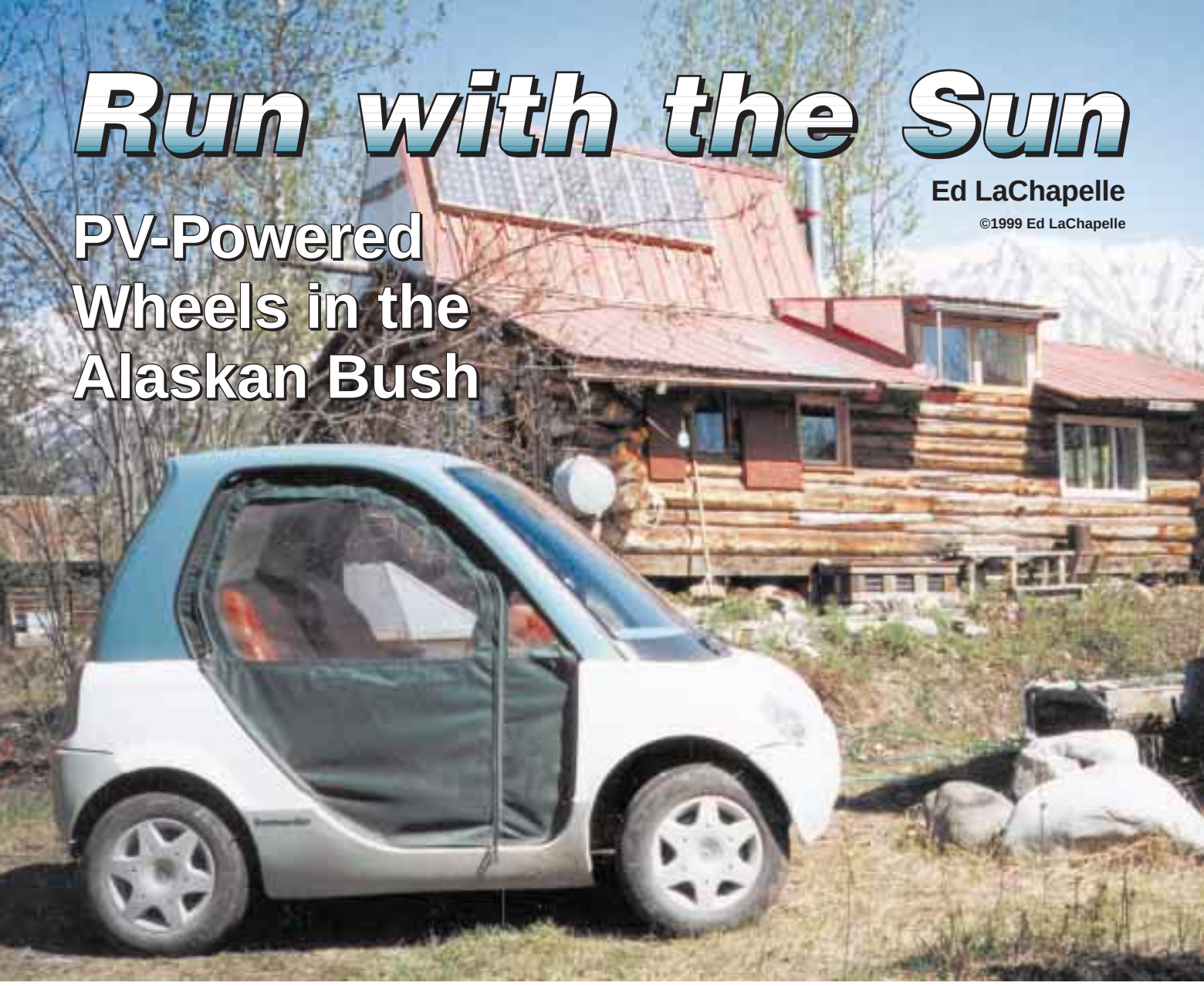
Run with the Sun

PV-Powered Wheels in the Alaskan Bush

Ed LaChapelle



Above: The little EV in Alaska. The PVs on the cabin roof provide the energy.

Yes, folks, it is possible to enjoy solar-powered transportation in an off-grid and off-road system. After several years of studying all the angles, we finally came up with a combination that has survived thorough testing during the summer of 1998.

Our site is in McCarthy, Alaska, a remote bush community where my partner, Meg Hunt, and I make our home. For eleven years we've enjoyed the full benefits of solar power (our system is described in *HP17)*.

We wanted to extend our solar usage to include transportation. None of the many vehicle conversions were exactly what we wanted. Then the Bombardier Neighborhood Electric Vehicle (NEV) came on the market. We liked what we saw. But could the NEV, designed for charging from 120 volts AC, be converted to work from solar panels? I am happy to report that the answer is yes.

Performance

This is a neat little car with plenty of power for real work. It is fun to drive—very quick to turn or accelerate. We have yet to try a hill it won't climb or a trailer it won't pull. Our community is separated from the road system by a river. The farthest we can drive is five miles (8 km), climbing about 800 feet (244 m) in the process. With driver and passenger, this takes less than half the NEV's battery charge. The downhill return is practically a free ride. We sized the PV array to allow this ten mile (16 km) round trip every other sunny day. In practice, one clear day gets the NEV back up to full charge.

The Numbers
The NEV is 100 inches long, 55 inches wide, and 61 inches high (254 by 140 by 155 cm). The curb weight is 1275 pounds (578 kg). The drive motor is a 72 volt, 4 KW, shunt-wound DC motor, geared directly to the rear differential. Power is stored in six GNB Type M83CHP12V27 Champion 12 volt batteries connected in series. These are sealed lead-acid batteries with absorbent glass mat separators between the plates. They are rated at 110 AH at a 20 hour rate and are designed for EV use.

The onboard charger draws 15 amps maximum at 110 volts. When the batteries are discharged to their design maximum, 80% depth of dicharge (DOD), it takes eight hours to recharge. A sophisticated sensor and display system reports state of charge (SOC) and status of the power system. A separate 12 volt, 24 AH battery supplies power for lights and accessories. The onboard charger recharges this auxiliary battery and the main battery. It uses a complex charge program for the propulsion batteries, finishing with a 2 amp equalizing charge, up to 110% of the previous discharge.

Maximum speed of the NEV is 25 mph (40 kph), limited by the motor controller for safety. The design range is 30 miles (48 km). This assumes level ground on a paved road, nonexistent here in McCarthy. The NEV is fully equipped with headlights, turn signals, and seat belts. It is street legal where allowed by state slow vehicle laws.

Solar Modifications
We wanted to be able to charge from both the PV array and an AC household outlet. Thanks to extensive and helpful discussions with the design engineers, we can do this. The onboard charger rectifies the AC power and uses a microprocessor-controlled DC to DC converter to recharge the battery. I replaced the AC cooling fan in the charger with a DC fan, powered through a full-wave bridge rectifier. So we can charge the Bombardier on either AC or DC.

The PV array design was based on a season of solar power data. We logged our data with a Fluke 87 meter from the output of a single 48 watt Kyocera PV panel. We designed an array of seven 75 watt BP panels connected in series for nominal 120 volts DC at about 4 amps in full sun. This was not enough power to run the charger for its full programmed charging regime, but enough to make it work. With our marginal PV charging capacity, it shuts down after two hours. I installed a fused panel on the NEV dash, with jacks giving direct access to the main and auxiliary battery terminals. Parallel pin jacks allowed easy monitoring of the battery voltages.

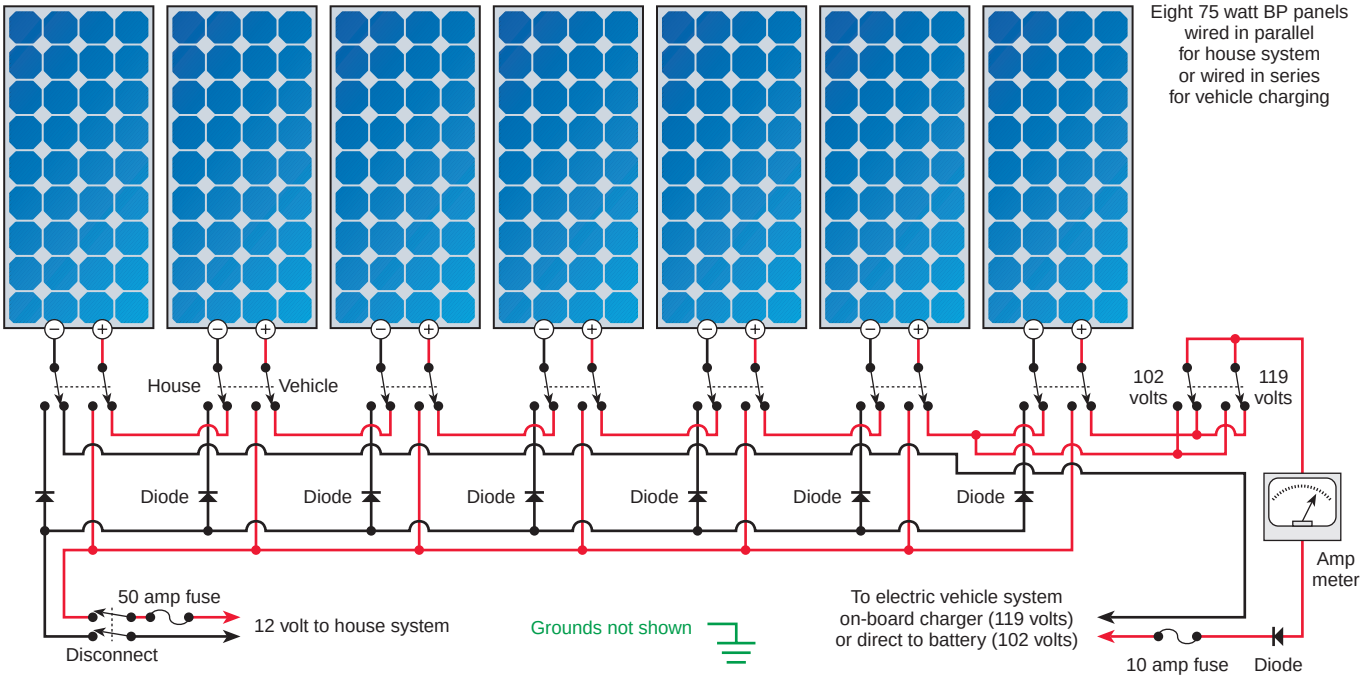
Above: Meg takes the Bombardier to town.

Switching
At Alaskan latitudes, this is obviously a summer vehicle. Very little sun is available in mid-winter, and sub-zero temperatures degrade battery performance. But no solar enthusiast is going to let all those PV panels sit idle for 6 months of the year, just when they could offer a big boost to our house system. So we've set up a system that allows us to switch from EV battery charging to charging our house battery bank.

The changeover requires switches—lots of them. Each panel connects to a double-pole, double-throw, center-off switch. In one position, all seven panels are connected in series. In the other position, the panels are connected in parallel to a 12 volt bus bar feeding our house system. This arrangement runs the panel outputs through a lot of wires. In order to minimize losses, the switch box is located within six feet (1.8 m) of the array.

A separate switch allows us to select the series output from either six or seven panels; six for direct EV battery charging and seven for the onboard charger. When we switch the array to six panels in series, we connect it directly to the main 72 volt battery. This works fine, but it does require manual monitoring and control. A 72 volt charge controller will be the next improvement. My present practice is to charge direct, close to the battery gassing point, then switch over to seven panels and the onboard charger to finish the charge.

Ed LaChapelle's Electric Vehicle Charging System



The big unknown here is how this modified charging method will affect battery longevity. Good management for a lead-acid battery means only withdrawing half of its capacity and then fully recharging it. By retaining the AC charging option, I do have the occasional chance to do a programmed recharge cycle by plugging into a diesel generator.

Below: The array of switches.

Downside

The designers of the electrical and propulsion systems of the NEV have done a first-rate job. But prospective buyers should be aware of some peculiar deficiencies.

When it comes to servicing, this vehicle is not just user-unfriendly—it is downright user-hostile. The main and auxiliary batteries and the onboard charger are mounted on a single tray weighing 480 pounds (218 kg). To access these components the NEV must be put up on a rack, and the tray lowered by a forklift using a special pallet. The main fuses for propulsion, auxiliary batteries, motor controller, and onboard charger can be reached only by removing the battery tray. If you need a forklift to change a fuse, someone was asleep at the design board.

The vehicle is furnished without a spare tire or jack, which is very optimistic for a street vehicle with a 30 mile (48 km) range. Fortunately, a standard four lug, twelve inch (30 cm) trailer wheel serves nicely as a spare and fits in the trunk.

On a dry gravel road, driver and passenger are enveloped in clouds of dust even with the canvas hatch and door covers completely closed. Liberal use of duct tape and silicon sealer helps, but dust still boils up through the battery compartment vents.

Success

We racked up an estimated 100 happy miles (161 km) on the NEV this past summer (there's no odometer). It has delivered just what we wanted at this remote site—

a way to get around, haul supplies, and have a little fun. Taking visitors for demonstration rides is part of the fun. Freedom from hauling gasoline or diesel oil over a long and inconvenient route was a big motive for exploring EV options in the first place. But the real reward was the satisfaction of designing the PV-powered system for pollution-free transportation. Compared with noisy, gas-powered ATVs common in this area, the silent running of the NEV continues to astonish onlookers. And if you want to use wheels to sneak up on a moose, go electric!

Above: Kids help spread the word.

Access

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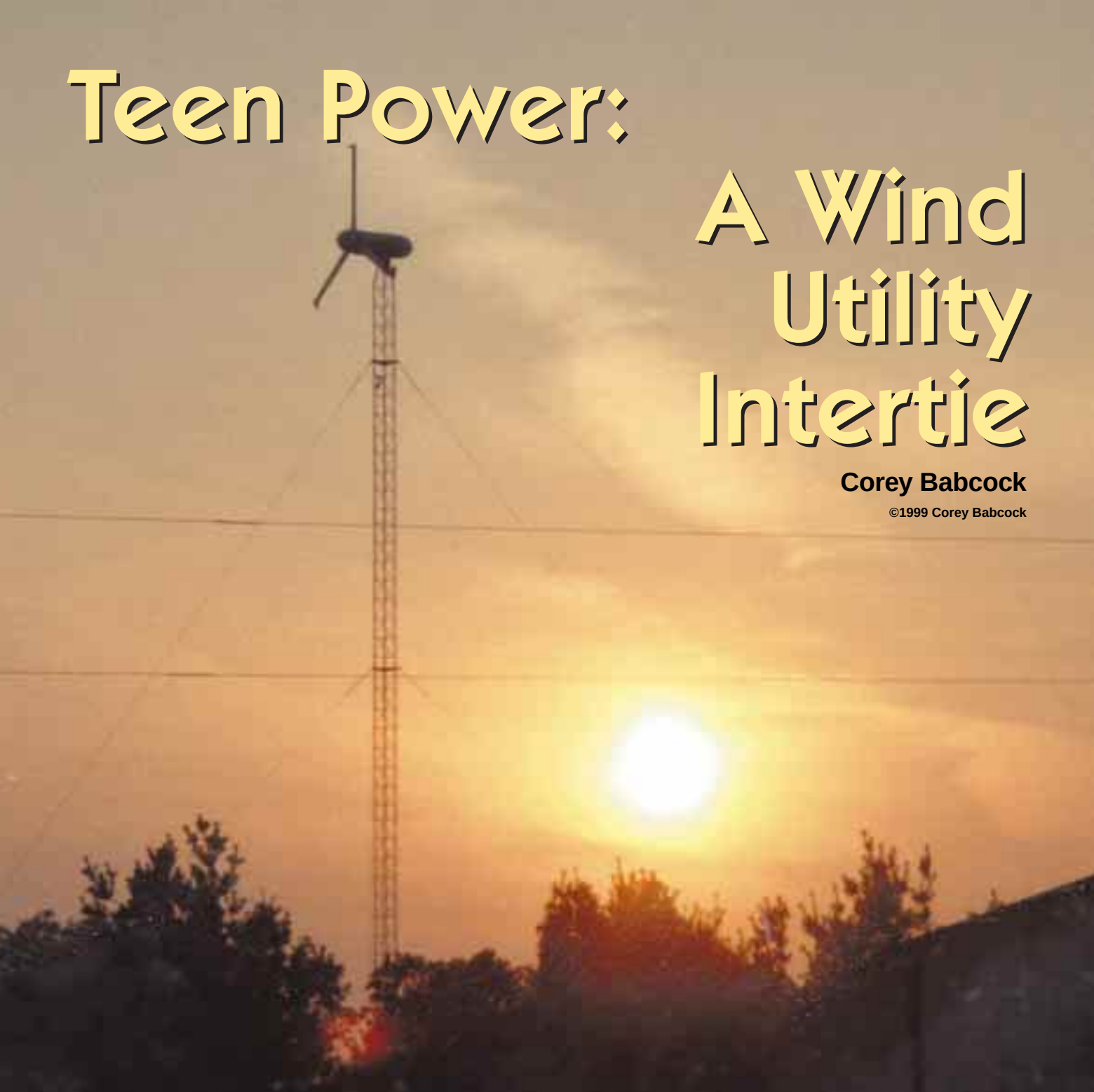
Teen Power:

A Wind Utility Intertie

Corey Babcock



Put another thumbtack on the wind power map—we're online! Our used wind generator started pumping electricity onto the grid on September 9, 1998. The hardest parts of this project were dealing with the local electric utility and educating our electrician. Once they understood all of the safety components built into our system, their fears dwindled.

Wind energy works. My family and I proved it by installing our own utility-intertied wind system. We had been using wind power to charge batteries for a few small loads for a couple of years. We figured that it was time to move up.

Free Wind Machine

The wind generator that we installed is an Enertech 1500. This machine was a generous gift from Don Marier. Many wind power fans know him from his book, *Windpower for the Homeowner.* Don was moving from his home in central Minnesota and offered me the wind generator. The people buying his house did not want anything to do with it, so he sold the entire rig to me for a dollar! I am very thankful. Not very often do you see someone giving away a wind generator. The catch was that the tower and turbine were still up and needed to be taken down.

Since Don's house was three hours away, we wanted to have the machine and tower entirely removed in a day. We could have used a tower-mounted gin pole to remove everything piece by piece. But that isn't a one day project, especially with a green crew. So we set up a day with the local crane. It should have only taken about a half-hour of crane time, but the tower was in trees where messing with guy lines isn't all that easy! We had the blades and nose cone removed, tower lowered, guy lines pulled out of the trees, and the tower disassembled in about five or six hours.

Installation

Safety was key when we reinstalled our wind turbine. All of the anchors for the guy lines are oversized and are set out at 80 percent of the tower height. The tower itself was installed section by section with a tower-mounted gin pole that I borrowed from Dean Antilla, a good friend.

Once the tower was standing and all the guy lines installed, the wind turbine was also hoisted to the top with the gin pole. We pulled the generator up without the blades or the nose cone so they wouldn't get in the way or be damaged. Once the turbine was bolted to the tower, the blades and nose cone were lifted and installed.

We installed the tower a safe distance from nearby buildings and property lines. Even though it is more likely that your roof will blow off or the trees in your yard will blow over, we were taking precautions, just in case. Last summer we had a very severe wind storm with winds of over 90 miles per hour (145 kph) lasting more than 45 minutes. There was damage all over the county. One of our smaller towers was blown up against our garage, pulling a large concrete footing out of the ground! One of my home-built wind generators didn't like that storm very much either. I found only two of its three blades. Its alternator fell through the roof of our garage. This shows that my two 30 foot (9 m) towers were too close to the building.

Above: The Enertech 1500, a downwind generator.

All of the wiring for the new wind machine was buried underground. This minimizes the possibility of wiring being damaged by wind storms. It also looks a lot neater. The tower was also grounded at each guy anchor and at the tower base. Playing with lightening is no fun. We have lots of troubles with lightning at our house. Our satellite dish has been struck by lightning more times than I can count on my fingers! Having a melted set of guy lines isn't the best thing during a wind storm.

The tower wouldn't have gone up as soon as it did without help. I would like to thank my parents Ron and Sue, and my friends for all their help and for putting up with my BS. Hunter Jonsgaard was part of the ground crew and Andy Mundt helped on the tower up to the sixth section, when his fear of heights started to kick in!

Above: Corey's utility required two KWH meters.

Enertech 1500

Most people who know wind machines can tell you that Enertech was one of the wind pioneers of the late 70s and early 80s. Our wind machine was manufactured in 1979. Enertech started out selling various brands of wind turbines, including Wincos and Dunlites. Later, they started producing their own line of wind generators. The Enertech 1500 was one of the first models built by the company. And ours is one of the early ones, with serial number 49!

The Enertech is rated at 1500 watts at 24 mph (39 kph). From watching the meters on the control box, I would say that this machine is capable of producing more than 1500 watts at 24 mph. I have seen the meter peg past 1750 watts in gusts of about 29 mph (47 kph). The machine has a 13 foot (4 m) rotor that is downwind of the tower. The blades have special tip brakes on them that are used in case of an emergency such as gearbox failure leading to the rotor overspeeding. The Enertech runs at a nice, slow 190 RPM, no matter what the wind speed, because of its induction generator. The slow speed means that it is much quieter than other machines.

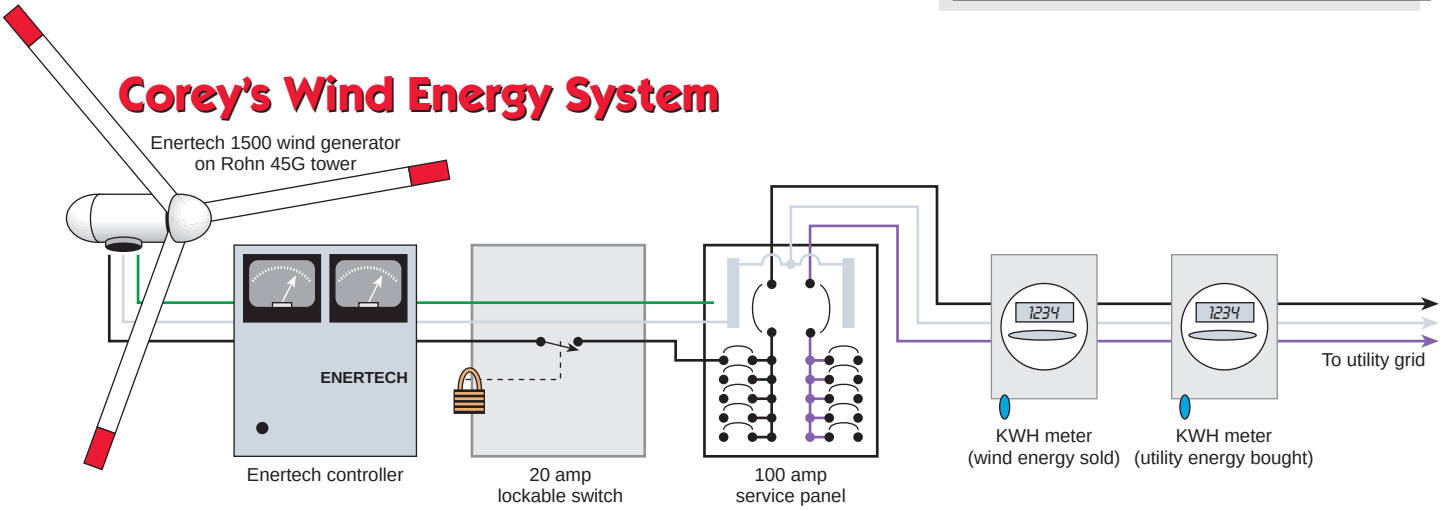
Induction Generator

All of the Enertech wind plants drive an induction generator. Induction generators are kind of hard to understand. We do know that they can operate either as a motor or as a generator. Another feature of induction generators is that they operate at a near constant speed, regardless of the load. They simply draw or generate more or less current depending on the conditions.

When the wind generator is running as a motor, it uses electricity to start the blades turning. When the wind dies down, the machine will continue to draw current to keep the rotor at the synchronous speed until the controller shuts it down. If there is a mild breeze, the wind on the blades will take over. Current will no longer flow to the generator; instead current begins to flow *from* the generator.

The key to the Enertech's control system is the anemometer on the tower. It tells the controller the current wind conditions. In the automatic mode, the electronic controls turn the machine on only when winds are strong enough to cause the induction generator to behave as a generator. The controls apply the electro-mechanical brake in lighter winds when the generator would act as a motor. The brake is also applied in high wind conditions to protect the machine. The control panel has a line-activated contactor in it that automatically disconnects the wind turbine when utility power is lost. Another feature of the control system is that it allows the user to run the machine as a motor for testing.

Below: The control box synchronizes with the grid.



Repairs

Our wind turbine needed a few minor repairs before it could be reinstalled. There is a centrifugal switch on the back of the generator that cuts power and engages the brake if the machine ever overspeeds. This switch is mechanically operated and is online whenever the machine is running. It was getting pretty worn and needed replacement. The blades also needed to be refinished after sitting in the elements for 20 years. Now this machine looks great! It doesn't show very much of its "guts" to the world. Everything is housed in a nice white nacelle.

Our machine is perched atop the 80 foot (24 m) Rohn 45G tower that Don had it on. If my family ever decides to install a larger wind generator, we can go up to a 4 KW machine using this tower.

Local Electric Un-Cooperative

Our local electric cooperative already had a couple of other wind generators on their lines before this one, but for some reason they were stumped about what they were supposed to do with ours. This is odd, since ours is one of the simplest types of wind machines to tie into the grid.

After about a month of explaining to the utility how our wind machine works, they finally got their act together. We sent them copies of the Enertech owner's manual, which explains in detail how the machine works. They didn't seem to understand that it needs electricity to release the brake and energize the generator. At first, they wanted us to install a transfer switch so we could switch off the utility and switch on the wind generator. This won't work because the machine needs electricity to operate.

They demanded that we install two kilowatt-hour meters. They charged us for the difference in cost for the ratcheted (only measures current in one direction) meters and their installation. I really feel that this is a major waste because one meter could easily be used, especially with our small 1.5 KW turbine. It would just run backwards when we are selling electricity.

The meter technician from the utility agreed that one meter would work, but the Minnesota Public Utilities Commission no longer allows co-generators to run meters backwards. We were kind of stuck on this one. The utility installed two electronic meters because they could be programmed to be detented (ratcheted) and they were cheaper than the mechanical ones. The electronic meters can also show more data than the mechanical ones.

Because our wind machine is so small, they tried to tell us that it wasn't going to be economical to tie it in with their lines. But, once we told them that renewable energy itself is not yet economical, they understood. We told them that if it were economical, everybody that thought it was a good idea would have an RE system. It's too bad that hasn't happened yet.

Safety Features

Even though the local utility has a few wind generators intertied with their lines already, one of which uses an induction generator, they were still confused about our machine. They were afraid that our puny 1500 watt wind machine might backfeed a dead line and electrocute one of their linemen. This is a huge myth. It's kind of like trying to use a 10 watt PV panel to recharge a totally dead 60,000 AH battery bank and give you a shock in the process. It just won't happen!

We told them about the numerous safety features built into our wind generator. These include a line-activated contactor that automatically disconnects the wind turbine from the utility when power is lost, and a brake that must have electricity in order to be released. Once power is lost, the brake is engaged automatically.

The generator itself is another safety feature. Let's say that for some reason our line activated contactor and our electric brake both malfunctioned in an outage. This

Above: Corey assembles the 80 foot tower.

would leave the rotor free to spin while connected to the utility. The generator would not produce any power in this case, even if the rotor were spinning, since it requires electricity to make electricity. This is where induction generators get very complicated.

Wiring Up The System

We could have saved ourselves a lot of money if we had purchased the electrical supplies ourselves. But before we had the chance, our electrician had all the materials and had started installing them. The electrician was the single most expensive part of the entire job. He was the one who really turned out to be the bad guy—he didn't have a very good attitude. He kept trying to tell us that wind power doesn't work, and that we wouldn't make anything. And his bill turned out to be over twice what he estimated. I don't think he'll be back around here for a while!

The whole reason that we had this electrician wire it up was because he is extremely fast and most of the time he knows what he is doing. We could have done most of the wiring ourselves, but nobody had very much time. I'm finishing up my last year of high school, and my parents both work all day. The turbine and tower were installed during summer vacation when I had plenty of time.

We have two separate sets of meters at our place—one for the house and the other for our shop and garage. (We have two meters because our house uses dual fuels for heating and cooling and is being monitored by the utility.) Since we only use 30 to 40 KWH a month in our shop, we wired the wind turbine there. It was also closer to our tower site and made trenching and wiring easier.

Problems

For being almost 20 years old, the Enertech has been doing very well. We sold back over 140 KWH to the utility in November, and our shop consumed 40 KWH. There have been a couple of problems though. The nice "marshmallow" nacelle got torn off in early November when we had a wind storm with steady 50 mph (80 kph) winds and gusts up to around 90 (145 kph). A little fiberglass resin, a little fiberglass mat, a little paint, and it was as good as new. It was a bit tricky to put the thing back on, but we did it.

Another problem we had was that the junction box at the bottom of the tower collected rainwater. We didn't

Corey's Wind System Costs

Component	*Cost*	*Percent*
Electrician	$2,056.72	56.3%
Crane Service	$465.00	12.7%
Utility Fee	$450.00	12.3%
Cement	$248.00	6.8%
Backhoe	$140.00	3.8%
Gas in Trucks	$65.00	1.8%
Rebar	$50.00	1.4%
Line Activated Contactor	$49.76	1.4%
Ground Rods	$42.95	1.2%
Paint	$32.00	0.9%
Iron	$30.00	0.8%
Misc. Electrical	$20.80	0.6%
Enertech, Tower, Control	$1.00	0.0%
Total	$3,651.23	

figure this out right away. I couldn't understand why every time it rained, the machine would repeatedly start up, and then stop after running for five to ten seconds. What it was doing was sending a small trickle of current into the anemometer wires through the water whenever the machine would start up. This increased the anemometer voltage and told the control box that there were high winds present, so it would shut down. After a little while, it would start back up again, and then the control box would again sense "high winds" and shut down.

But it would not go through this cycle in the controller's "test" mode. I started looking over the start-up/shut-down circuit board to try to find an error, but I couldn't. So I let the machine run in "test" and went to the base of the tower where I could hear a hissing and zapping coming from the junction box. As soon as I took a screw out of the box, water started spraying from it. I used silicone to seal the conduit connections and other openings in the junction box. Since we solved that problem, we haven't had any major trouble, except the occasional calm day!

Dreams Come True

Not often do you get a call about a wind machine that is looking for a good home. I really appreciate Don's donation and all the help and support that everyone has given me on this project. Living with a machine tied into the grid has been a dream of mine for years now, and finally it has come true. It has been a real challenge to the brain of an 18 year old. But, it is all worth it to be able to go outside and hear the slight swoosh, swoosh, swoosh of the machine running on a breezy day.

So what does it all mean? Anybody can install and maintain a renewable energy system. All you need is a little knowledge of your equipment—how it works and what its limits are. I am only 18, and I installed a wind machine tied into the local electric power cooperative. What have you done?

Access

Author: Corey Babcock, Route 2, Box 8B, Lewiston, MN 55952 • 507-523-3266 • Windkid1@aol.com

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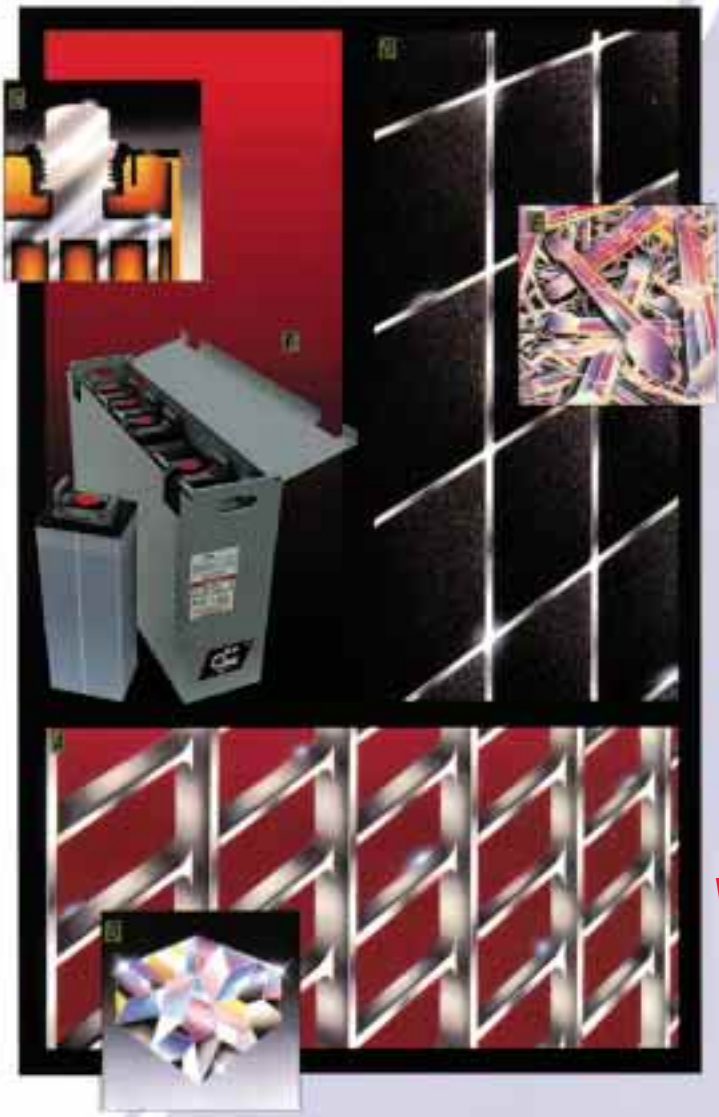

E *This process known as fibrillation, locks the active material into place and virtually eliminates flaking and shedding - the chief causes of battery failure.*

F *Tested at the National Battery Testing facility batteries with* **H.U.P.** *have been shown to increase working life by at least 20%, with absolutely no sacrifice of capacity! In fact,* **H.U.P.** *batteries deliver full capacity longer, have faster voltage recovery with lower internal resistance, and last longer than conventional batteries. For more power in your Renewable Energy System look for the* **H.U.P. Solar-One™** *label. High Utilization Positive plate technology only from:*

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IMPROVING SOLAR FOOD DRYERS

Dennis Scanlin,
Marcus Renner,
David Domermuth, &
Heath Moody

Above, Photo 1: Three identical solar food dryers for testing against a control.

This article describes a series of experiments conducted over the last year and a half with three solar food dryers. The food dryers were constructed at Appalachian State University (ASU) using plans published in *HP57*. The goal of this research program was to improve the design and to determine the most effective ways to use the dryer.

Figure 1: Cutaway View of the Appalachian Solar Food Dryer

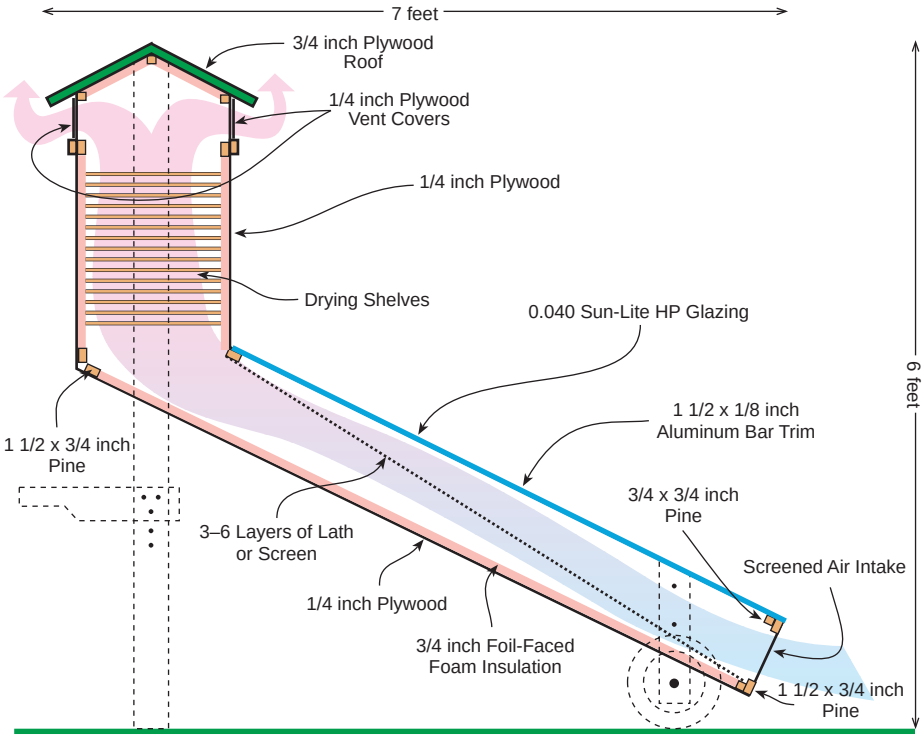
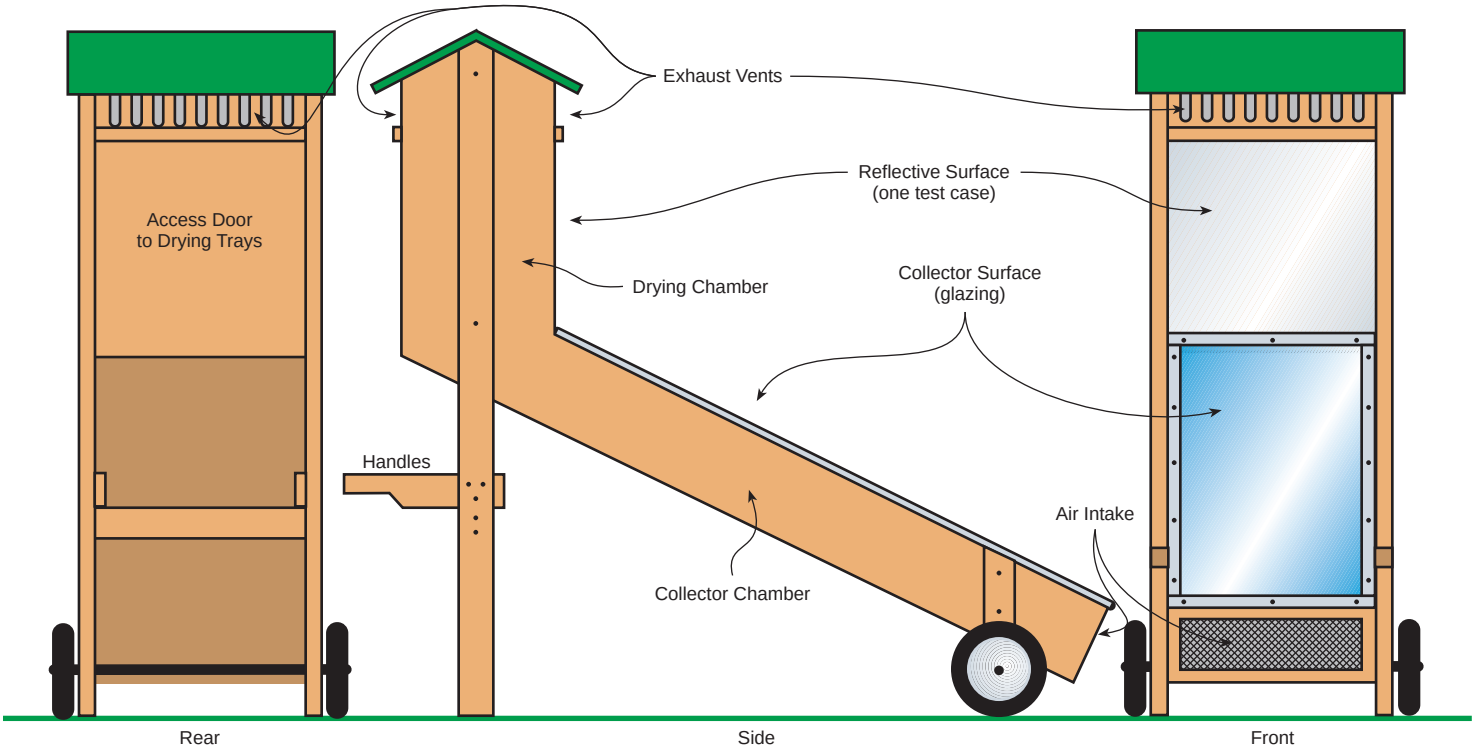


Figure 2: Multiple Views of the Appalachian Solar Food Dryer

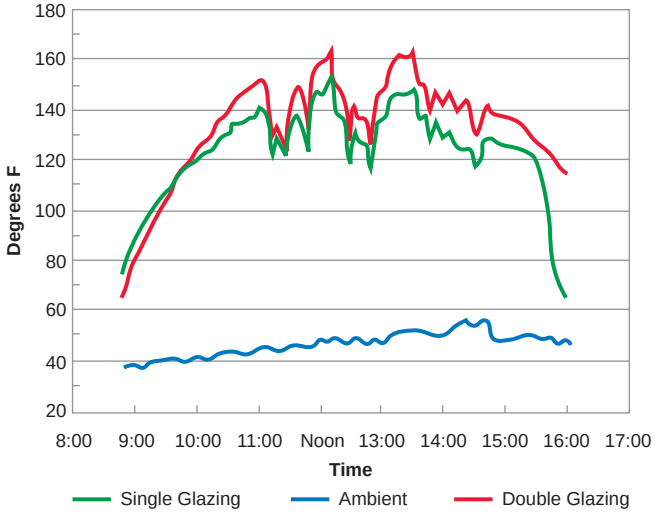


These solar food dryers are basically wooden boxes with vents at the top and bottom. Food is placed on screened frames which slide into the boxes. A properly sized solar air heater with south-facing plastic glazing and a black metal absorber is connected to the bottom of the boxes. Air enters the bottom of the solar air heater and is heated by the black metal absorber. The warm air rises up past the food and out through the vents at the top (see Figure 1). While operating, these dryers produce temperatures of 130–180° F (54–82° C), which is a desirable range for most food drying and for pasteurization. With these dryers, it's possible to dry food in one day, even when it is partly cloudy, hazy, and very humid. Inside, there are thirteen shelves that will hold 35 to 40 medium sized apples or peaches cut into thin slices.

The design changes we describe in this article have improved the performance, durability, and portability of the dryer, and reduced construction costs. This work could also help in designing and constructing solar air heaters used for other purposes, such as home heating or lumber drying. Most of our experiments were conducted with empty dryers using temperature as the measure of performance, though some of our experiments also involved the drying of peaches and apples. We have dried almost 100 pounds (45 kg) of fruit in these dryers during the past year. Graduate students in the ASU Technology Department constructed the dryers, and students taking a Solar

Above, Photo 2: Setting up the solar simulator.

Graph 1: Single vs. Double Glazing



Energy Technology course modified them for individual experiments.

Methodology

We began by constructing three identical food dryers. Having three dryers allowed us to test two hypotheses at one time. For example, to examine three versus six layers of absorber mesh and single versus double glazing, Dryer One might have three layers of black aluminum window screening as an absorber with single glazing; Dryer Two, six layers of the same absorber screen with single glazing; and Dryer Three, six layers of the same absorber screen with two layers of glazing. Once we set up an experiment, we collect data. This lasts from several days to a couple of weeks until we are confident that the data is reliable. Then we try something different.

Using three food dryers also allows us to offer more students hands-on experiences with solar air heaters. Each semester, students take apart the dryers' solar collectors and rebuild them using different materials or strategies. This classwork was supplemented with experiments set up and completed by several graduate students.

Equipment for Data Collection

We have two systems for measuring temperature. The first system uses inexpensive indoor/outdoor digital thermometers. One temperature sensor is placed inside the dryer and the other one outside. Different locations are used for the sensor inside the dryer. If food is being dried, we normally place it under the bottom tray of food and out of direct sunlight. This temperature data is recorded on a data collection form every half hour or whenever possible.

The other system uses a $600 data logger from Pace Scientific to record temperature data. It is capable of measuring temperature, relative humidity, AC current, voltage, light, and pressure. The logger does not have a display, but it's possible to download the data to a computer. The software that comes with the logger allows us to see and graph the data. The data can also be exported to a spreadsheet for statistical analysis.

We measure air flows with a Kurz 490 series mini-anemometer. We weigh the food before placing it in the dryer, sometimes during the test, and at the end of each day. We use an Ohaus portable electronic scale, purchased from Thomas Scientific for $111. We measure humidity with a Micronta hygrometer purchased from Radio Shack for about $20.

Solar Simulator

In addition to outdoor testing with the actual food dryers, we use a solar simulator (see Photo 2) built by David Domermuth, a faculty member in the Technology Department at ASU. With the simulator, we can do more rapid testing and replicate the tests performed on the dryers, even on cloudy days. The simulator also lets us control variables such as ambient temperature, humidity, and wind effects. The unit can be altered quickly because the glazing is not bolted on. The simulator was constructed for $108. It was built in the

Below, Photo 3: This dryer has both a vertical wall reflector and side reflectors.

same way as the food dryer, but without the food drying box at the top.

The simulator uses three 500 watt halogen work lights to simulate the sun. The inlet and outlet temperatures are measured with digital thermometers. The temperature probes are shaded to give a true reading of the air temperature. We conducted the simulator tests inside a university building with an indoor temperature of 62–64° F (17–18° C). As we changed variables, we noticed significant differences in outlet air temperatures. The simulator did produce temperatures comparable to those produced by the food dryers out in the sun. However, we did not always achieve positive correlations with our food dryers' outdoor performance. We may need to use different kinds of lights or alter our procedures somewhat.

Experiments

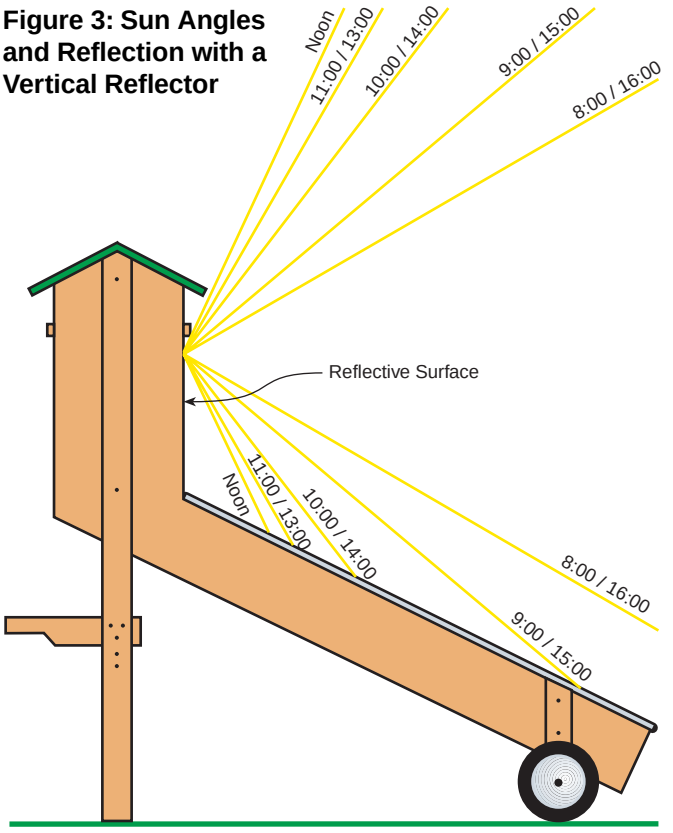
We have done at least twenty different tests over the last year and a half. All were done outside with the actual food dryers and some were also repeated with the solar simulator. The dryers were set up outside the Technology Department's building on the ASU campus in Boone, North Carolina. We collected some additional information at one of the authors' homes. Every test was repeated to make sure we were getting consistent performance. We tried to run the tests on sunny to mostly sunny days, but the weather did not always cooperate. The dips in many of the charts were caused by passing clouds.

Single vs. Double Glazing

The original design published in *HP57* used two layers of glazing separated by a 3/4 inch (19 mm) air gap. We used 24 inch (0.6 m) wide, 0.040 inch (1 mm) Sun-Lite HP fiberglass-reinforced polyester plastic for the outer layer. For the inner layer, we used either another piece of Sun-Lite, or Teflon glazing from Dupont. Sun-Lite glazing is available from the Solar Components Corporation for about $2.40 per square foot ($25.83 per m^2). These two layers cost over $50, or about one-third of the total dryer cost. We wanted to see if the second layer helped the performance significantly and justified the added expense.

We set up two dryers with six layers of steel lath painted flat black. One had single glazing and the other had two layers of glazing. The outer glazing was Sun-Lite HP on both dryers. The dryer with double glazing used Teflon as the inner glazing. The two dryers were identical except for the number of glazing layers. The tests were run on nine different days between February 17 and March 26, 1998. We opened the bottom vent covers completely and the top vent covers to two inches (51 mm). The ambient temperatures were cool and no food was being dried.

Figure 3: Sun Angles and Reflection with a Vertical Reflector



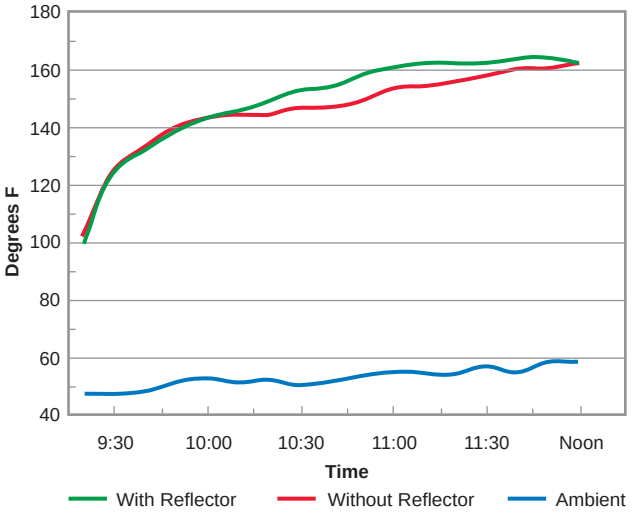
As Graph 1 shows, the double glazing did result in higher dryer temperatures. This was on a sunny day with clear blue skies and white puffy clouds, low humidity (30%), and light winds. The temperatures throughout most of the day were slightly higher with double glazing. However, the single glazed dryer works well and routinely reached temperatures of 130–180° F (54–82° C). When this test was replicated with the solar simulator, the double glazing also produced slightly higher temperatures.

Our conclusion is that double glazing is not necessary for effective drying. It does reduce some heat loss and increases the dryer's temperature slightly, but it increases the cost of the dryer significantly. Another problem is that some condensation forms between the two layers of glazing, despite attempts to reduce it by caulking the glazing in place. The condensation detracts from the dryer's appearance and may cause maintenance problems with the wood that separates the two layers of glazing.

Reflectors

One possible way to improve the performance of these dryers is to use reflectors. We tried several strategies: making the vertical south wall of the dryer box a reflective surface, hinging a single reflector at the bottom of the dryer, and adding reflectors on each side of the collector.

Graph 2: Vertical Wall Reflector vs. No Reflector



Look at the temperatures recorded on Graph 2. A slight increase in dryer temperature was recorded in the dryer having the south-facing reflective wall. The reflected light covers the collector most completely at mid-morning and afternoon. As the sun gets higher, the light is reflected onto a smaller area of the collector.

Single Reflector

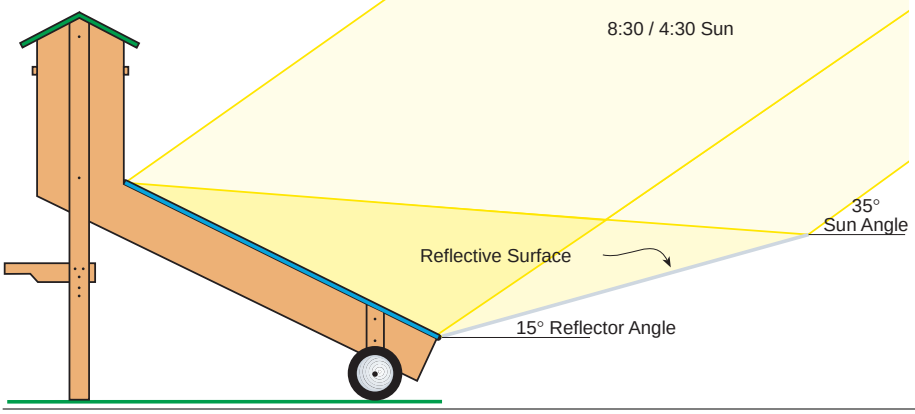
A single reflector was hinged to the bottom of the collector (see Photo 4). This reflector was supported with a string and stick arrangement, similar to one used by Solar Cookers International. With all reflector systems, the dryer has to be moved several times throughout the day if performance is to be maximized. This allows it to track the azimuth angle of the sun. The altitude angle of the reflector also needs to be adjusted during the day from about 15° above horizontal in the morning and evening to 45° above horizontal around noon (see Figures 4 and 5). The reflector added 10–20° F (2.4–4.8° C) to the temperature of the dryer and removed slightly more moisture from the food than a dryer without a reflector.

Vertical Wall Reflector

We realized that the vertical south wall of the dryer box could be painted a light color or coated with aluminum foil, a mirror, or reflective Mylar (see Photo 3). A vertical south-facing wall reflector would reflect some additional energy into the dryer's collector, protect the wood from cracking, and prevent deterioration from UV radiation. Considering the fact that the angle of reflection equals the angle of incidence, we were able to model the performance of this reflector, using a protractor and a chart of sun altitude angles (see Figure 3). If the dryer is moved several times throughout the day to track the sun's azimuth angle, then the reflector concentrates some additional solar energy onto the dryer's collector during most of the day.

Above, Photo 4: Setting the front reflector angle.

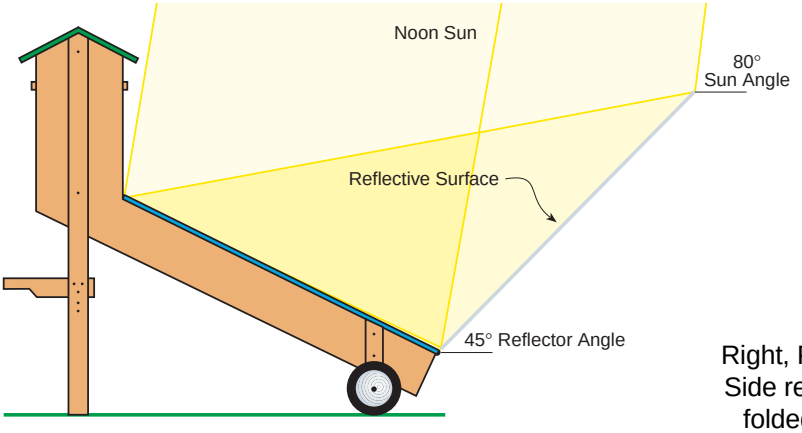
Figure 4: Single Reflector at Low Sun Angle



Side Mounted Reflectors

A third strategy was to add reflectors to both sides of the collector. This captures more solar energy than the

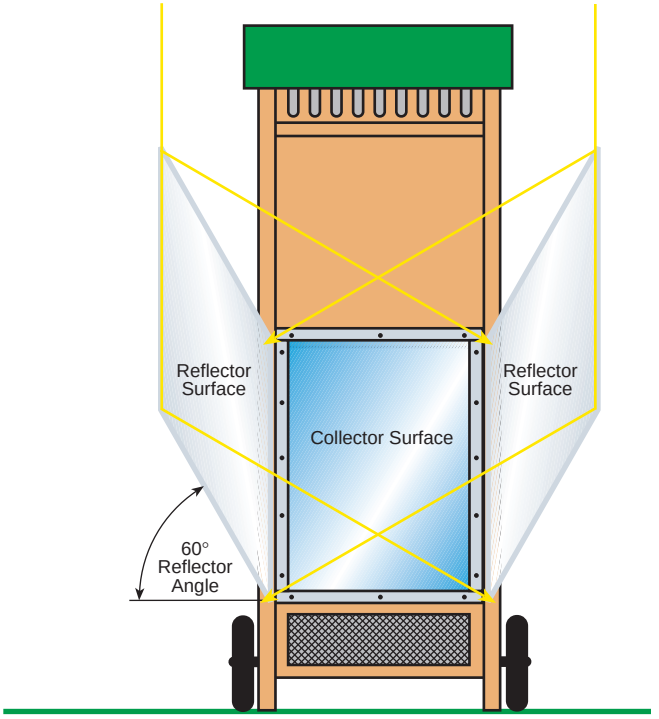
Figure 5: Single Reflector at High Sun Angle



other two strategies. We determined that the ideal reflector angle would be 120° from the collector surface (see Figure 6). This assumes that the dryer is pointing toward the sun's azimuth orientation.

We performed an experiment to compare a dryer with two side reflectors and a vertical wall reflective surface with a dryer having no reflectors (see Photo 3). Both dryers were moved throughout the test period to track the sun. The reflectors were mounted with hinges and could be closed or removed when transporting the dryer (see Photo 5). Graph 3 shows the significant increase in temperatures attained by using these reflectors. The problem with this design was that if the dryer could not track the sun for one reason or another, one of the

Figure 6: Ideal Angle for Side-Mounted Reflectors



Right, Photo 5: Side reflectors folded onto glazing for transportation.

reflectors would shade the collector in the morning and the other in the afternoon.

We concluded that the vertical wall reflector and the single reflector mounted to the bottom of the collector are the best ways to add reflectors, since tracking is not crucial in these applications. However, these dryers routinely attain temperatures of 130–180° F (54–82° C) without reflectors, which is hot enough for food drying and for pasteurization. Based on our work so far, reflectors just don't seem to be worth the trouble.

Absorbers

All low temperature solar thermal collectors need something to absorb solar radiation and convert it to heat. The ideal absorber is made of a conductive material, such as copper or aluminum. It is usually thin, without a lot of mass, and painted a dark color, usually black. The original dryer design called for five layers of

Graph 3: Vertical Wall & Side Reflectors vs. No Reflector

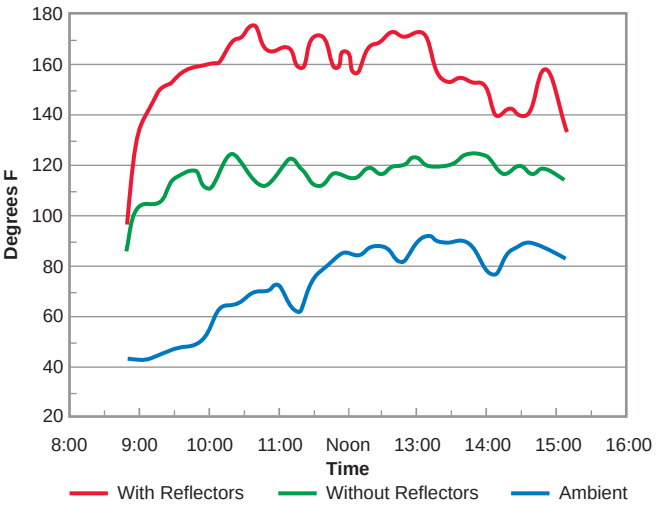
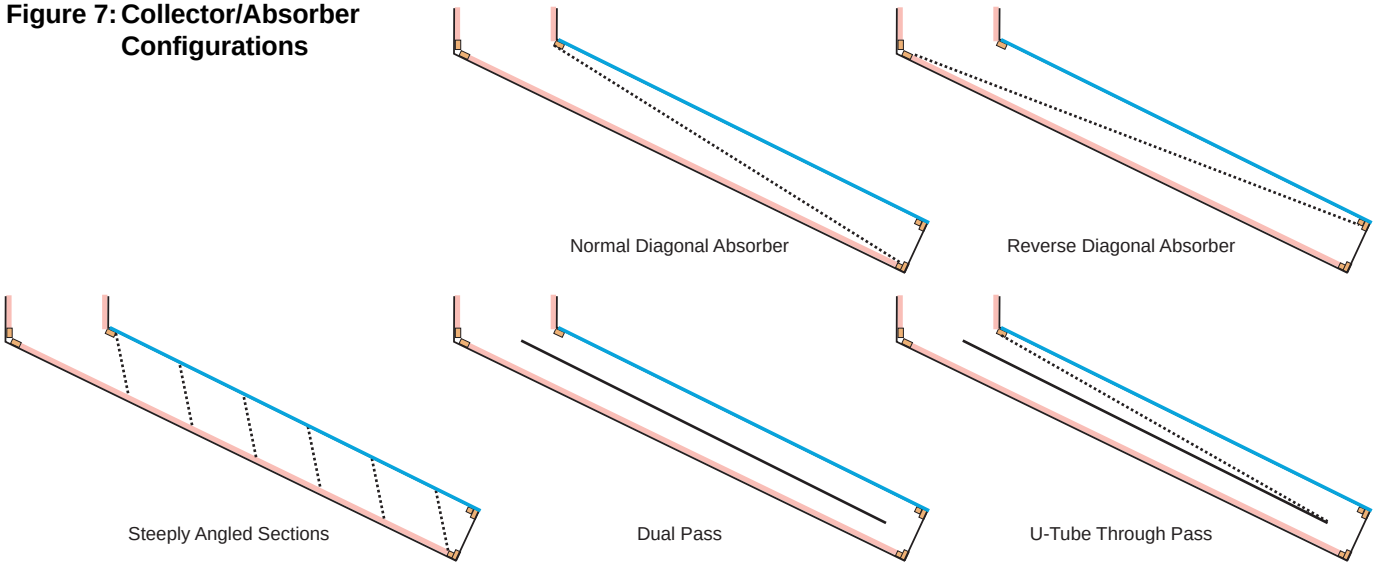


Figure 7: Collector/Absorber Configurations

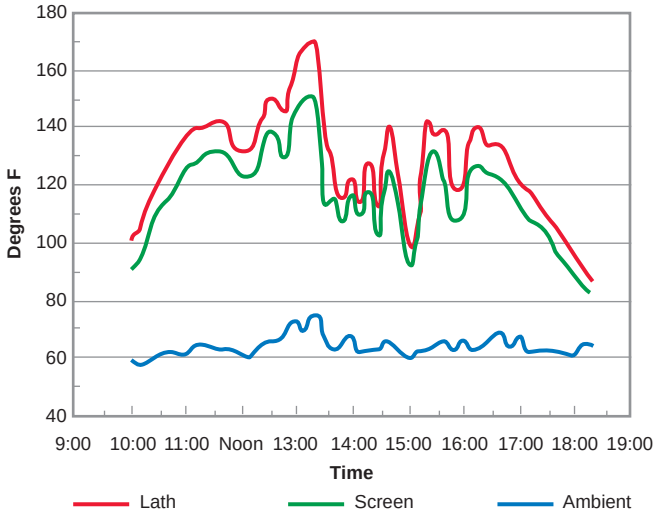


black aluminum window screening, which had proven to work well in other air heating collectors we had constructed. Other designs call for metal lath, metal plates such as black metal roofing, or aluminum or copper flashing. We decided to try some different materials and approaches to see if we could come up with a better absorber.

Plate vs. Screen

First, we compared five layers of black aluminum window screen placed diagonally in the air flow channel to one piece of black corrugated steel roofing placed in the middle of the channel (see Figure 7). We found that the mesh produced temperatures about 7° F (3.9° C) higher than the roofing in full sun. Other experiments have shown that mesh type absorbers are superior to plate type absorbers. These differences might be reduced if we used a copper or aluminum plate instead of the steel roofing.

Graph 4: Lath vs. Screen Absorber



Lath vs. Screen

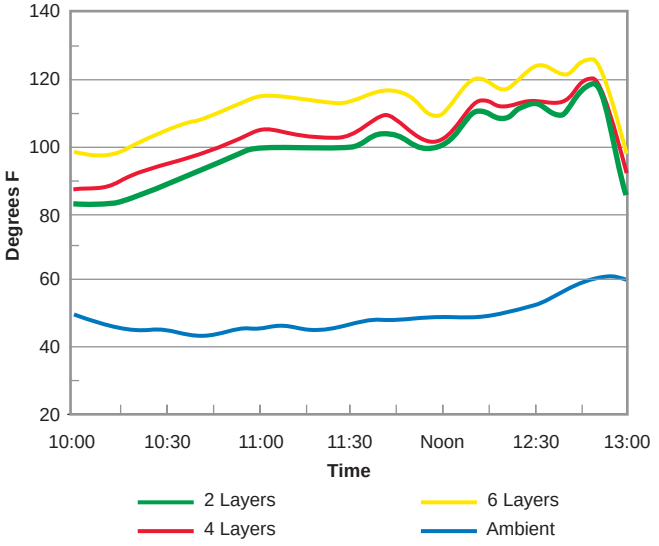
Next, we compared three layers of pre-painted black aluminum window screening to three layers of galvanized steel lath painted flat black. We found that the lath produced temperatures as much as 15° F (3.6° C) higher than the screen in our outdoor solar food dryer tests. We got the same results when we compared six layers of screen to six layers of lath (see Graph 4). While we found that the lath produced slightly higher temperatures, it was harder to work with, needed to be painted, and cost slightly more than the screen.

When these tests were replicated with the solar simulator, we had slightly better results with the screen than with the lath in both the three and six layer tests. We were disappointed by the lack of positive correlation between our outdoor tests with the actual food dryers and our indoor tests with the solar simulator. But there are many variables to control and quite a few people involved in setting things up and collecting data, so our control was not as tight as we would have liked. Despite these problems, we are confident in concluding that there is not a great deal of difference in performance between lath and screen—both work effectively.

Layers of Absorber Mesh

We then compared three layers of lath to six layers of lath, and three layers of screen to six layers of screen. Obviously the more screen used, the greater the expense. The literature on solar air heaters recommends between five and seven layers. We arbitrarily picked three and six layers. In our outdoor tests, we found that six layers of screen produced temperatures 5–10° F (1.2–2.4° C) higher than three layers. Likewise, when we repeated these experiments outdoors with lath, we found that six layers outperformed both two and four layers (see Graph 5).

Graph 5: Two vs. Four vs. Six Layers of Absorber

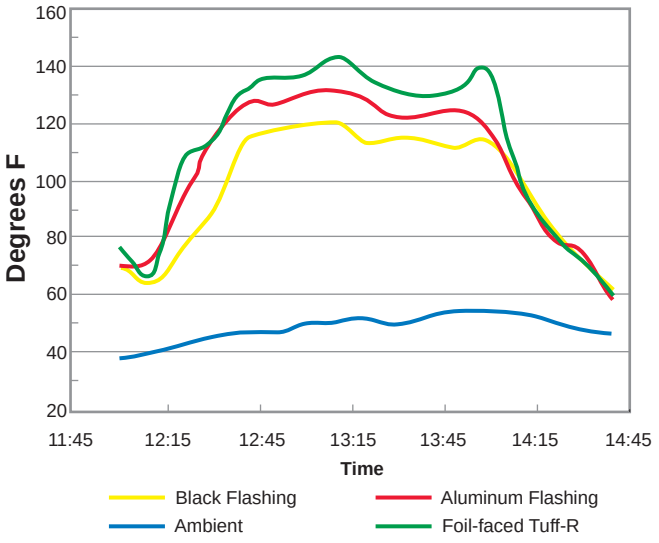


Tests performed in the solar simulator showed very little difference between three and six layers. We used the simulator to test one and two layers and no absorber. With no absorber, the temperature decline was over 60° F (33° C), dropping from 153 to 89° F (67 to 32° C) . The temperatures for one, two, three, and six layers of lath after one half-hour were 145, 155, 159, and 160° F (63, 68, 70, and 71° C). Based on our work, we feel that two or three layers of screen or lath are adequate for effective performance, but adding a few more layers will produce slightly higher temperatures.

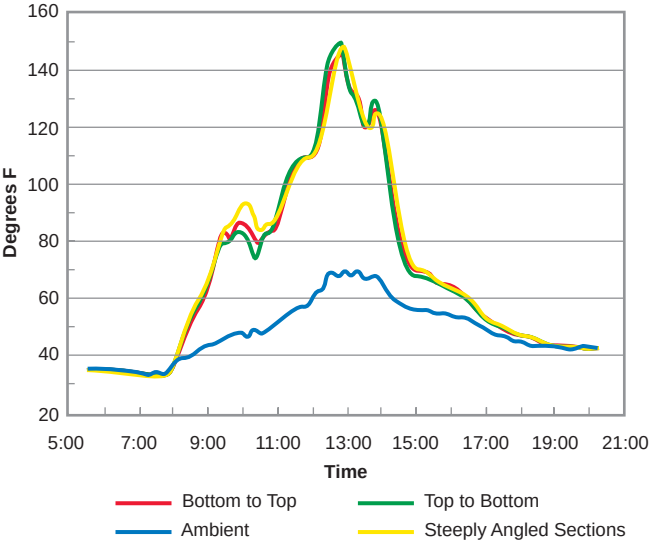
Reflective Is Effective

When constructing a solar air heater, you must decide what to do with the bottom of the air flow channel, below the absorbing material. In the next part of our research, we placed aluminum flashing in the bottom of the air flow channels of two of the three dryers, on top of the 3/4 inch (19 mm) foil-faced insulation (Celotex Tuff-R, polyisocyanurate). The flashing in one of the dryers was painted flat black. The third dryer was left with just the reflective insulation board on the bottom of the air flow channel. This test was done with both the actual dryers and the solar simulator. In both cases, the highest temperatures were attained with the reflective foil-faced insulation. The differences were substantial, with the reflective insulation showing readings as much as 25° F (14° C) higher than the dryer with the black aluminum flashing (see Graph 6).

Graph 6: Collector Bottom Material Comparison



Graph 7: Absorber Installation Comparison



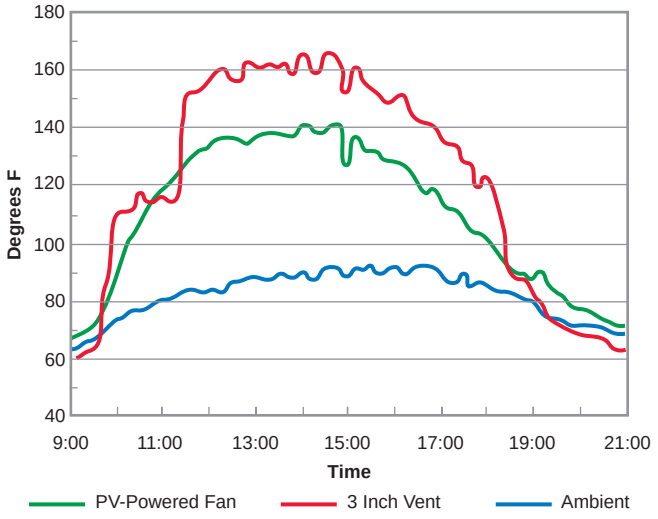
Mesh Installation

The original design called for the mesh to be inserted into the collector diagonally from the bottom of the air flow channel to the top (see Figure 7). This seemed the best from a construction point of view. In this test, three configurations were compared: from bottom to top as originally designed, from top to bottom, and a series of more steeply angled pieces of mesh stretching from the top to the bottom of the air flow channel. The differences in temperatures attained were very small (see Graph 7), and we concluded that there was not much difference in performance.

U-Tube vs. Single Pass

Another characteristic of the original design is the U-tube air flow channel. In addition to the air flow channel right below the glazing, there is a second air flow channel right below the first one, separated by a piece of insulation board (see Figure 7). We compared a dryer with this U-tube design to a dryer with just a straight shot single channel and found no significance difference in temperatures. We removed the insulation board from our dryers and have completed all the experiments detailed in this article without the U-tube setup.

Graph 8: PV Exhaust Fan vs. Vent

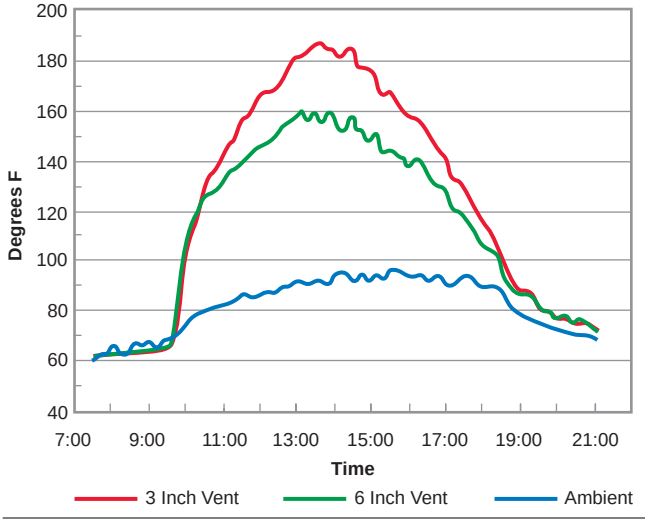


Active vs. Passive

We experimented with several small, PV-powered fans to see if they would generate higher air flows and possibly accelerate food dehydration. We tried three different sizes: 0.08, 0.15, and 0.46 amps. We placed the fans in the exhaust area of the dryer. Of the three, the 0.15 amp fan seemed to work the best. It increased the air flow from about 25 to 50 feet per minute (8 to 15 meters per minute), but decreased temperatures significantly (see Graph 8). The larger fan did not fit in the exhaust vent opening, and the smallest fan did not significantly increase the air flow.

Even with the fans in use, the drying performance did not improve. In every trial, the passive dryer either matched or outperformed the active dryer. Each morning during a five-day experiment, we placed exactly the same weight of fruit in each dryer. We used one to three pounds (0.4 to 1.4 kg) of apple or peach slices. Each afternoon between 2:30 and 5 PM, we removed and weighed the fruit. On all five days, the fruit dried in the passive dryer weighed either the same or less than the fruit dried in the active dryer.

Graph 9: Three Inch vs. Six Inch Exhaust Vent



Vent Opening

The dryers have vent covers at the top which can be adjusted to regulate the air flow and temperature. The smaller the opening, the higher the temperatures attained. We wanted to know how much the vents should be opened for maximum drying effectiveness. We tried a variety of venting combinations while drying fruit. For most of our experiments, we filled five to seven of the thirteen shelves with 1/8 inch (3 mm) fruit slices. We cut up, weighed, and placed an identical quantity and quality of fruit in each of two dryers in the morning. Sometime between 2 and 6 PM, we removed the fruit from the dryers and weighed it again. We compared openings of different measurements: a one inch (25 mm) to a seven inch (178 mm), a 3/4 inch (19 mm) to a five inch (127 mm), a three inch (76 mm) to a six inch (152 mm), a three inch (76 mm) to a nine inch (229 mm), and a three inch (76 mm) to a five inch (127 mm). During these experiments, the bottom vents were completely open.

We found that higher temperatures were attained with smaller vent openings, but that drying effectiveness was not always maximized. The best performance was observed when the vents were opened between three and six inches (76 and 152 mm), and temperatures peaked at 135–180 °F (54–82° C) (see Graph 9). With the one inch (25 mm) and smaller openings and the seven inch (178 mm) and larger openings, less water was removed from the fruit. There was no difference in the water removed when we compared three inches to five inches (76 mm to 127 mm) and three inches to six inches (76 mm to 152 mm).

Based on this work, we would recommend opening the leeward exhaust vent cover between three and six inches (76 and 152 mm), or between ten and twenty square inches (65 and 129 cm^2) of total exhaust area. The exact size of the opening depends on the weather conditions. With the vents opened between three and six inches (76 and 152 mm), we have been able to remove as much as sixty ounces (1.75 *l*) of water in a single day from a full load of fruit and completely dry about three and one-half pounds (1.5 kg) of apple slices to 12–15% of the fruit's wet weight.

Construction Improvements

As we experimented with the dryers, we came up with some design improvements to simplify the construction, reduce the cost, and increase the durability or portability of the unit. To simplify the construction and eliminate warping problems caused by wet weather, we decided to eliminate the intake vent covers during our

experiments. The vent covers at the top, if closed at night, would prevent or reduce reverse thermosiphoning and rehydration of food left in the dryer.

The redesigned air intake now has aluminum screen secured to the plywood side pieces with wooden trim. We also redesigned the top exhaust vent cover to eliminate the warping problem caused by leaving the vent covers opened during wet weather. The new exhaust vent cover works very well (see Photo 6). It spreads the exhaust air across the dryer's width rather than concentrating it in the center. This should improve convective flows and performance. However, the vent cover makes it more difficult to calculate the exhaust area, and as a result, we mainly used the old design for our research this past year.

We added wheels and handles to the unit, as it is heavy and difficult to move around. It's now easier to maneuver, although it is still difficult to transport in a small pickup truck. We purchased ten-inch (254 mm) lawnmower-style wheels for $6 each. The axle cost $2. With the wheels on the small legs at the bottom of the collector, one person can move the dryer.

The original design specified thin plywood for the roof of the dryer. We replaced that with 3/4 inch (19 mm) plywood and covered the peak of the roof with aluminum flashing. We also used 1/2 inch (38 mm) wide by 1/8 inch (3 mm) thick aluminum bar stock and stainless steel screws to attach the glazing to the dryer's collector. Each collector used fourteen feet, eight inches (4.5 m) of aluminum bar at a cost of $23. The 1/4 inch (6 mm) plywood strips used in the original design were adequate and less expensive, but would have required more maintenance.

Conclusions and Recommendations

The dryer described in *HP57* has worked well in our tests. It produces temperatures of 130–180° F (54–82° C), and can dry up to 15 apples or peaches—about 3 1/2 pounds (1.6 kg) of 1/8 inch (3 mm) thick slices—in one sunny to partly sunny day. The best performance in our outdoor tests was attained with six layers of expanded steel lath painted black, although aluminum screen works almost as well and is easier to work with. We also found that two or three layers of screen or lath would produce temperatures almost as high as six layers. The surface behind the absorber mesh should be reflective, and for best performance the exhaust vent covers should be opened three to six inches (76–152 mm). The cost of the dryer and the time to construct it can be reduced by eliminating the U-tube air flow channel divider, the second or inner layer of glazing, and the intake vent covers, and by reducing the number of layers of screen or lath to two or three.

Above, Photo 6: The new vent design.

We made the unit more portable by adding wheels and handles, and improved the durability by fastening the legs with nuts and bolts, using aluminum bar to hold the glazing in place, and using 3/4 inch (19 mm) plywood for the roof. We would also like to take the insulation board out of a dryer to see if it significantly impacts the performance. This would further decrease the cost of the dryer. Soon, we hope to compare this design to direct solar dryers, which a *Home Power* reader has recently suggested can outperform our design. Thus far, we have avoided direct dryers because of concerns about vitamin loss in foods exposed to direct solar radiation.

We have tried to carefully explore all of the significant variables affecting this dryer's performance. We have been able to increase drying effectiveness with higher temperatures of approximately 30° F (16.6° C), while decreasing the cost by about $30. We have demonstrated the best vent opening for drying effectiveness, and seen the impact that variables such as double glazing, fans, reflectors, and absorber type have on performance. We have also developed and demonstrated a low cost solar simulator that can be used to test solar thermal collectors indoors.

Access

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Solar Cookers International (SCI), 1919 21st Street, Sacramento, CA 95814 • 916-455-4499
Fax: 916-455-4498 • sci@igc.org

Sun-Lite HP glazing was purchased from Solar Components Corporation, 121 Valley Street, Manchester, NH 03103-6211 • 603-668-8186
Fax: 603-668-1783 • solar2@ix.netcom.com
www.solar-components.com

Scales, anemometers, and other data collection equipment were purchased from Thomas Scientific, PO Box 99, Swedesboro, NJ 08085 • 800-345-2100
609-467-2000 • Fax: 800-345-5232
value@thomassci.com • www.thomassci.com

Data logger was purchased from Pace Scientific, Inc., 6407 Idlewild Rd., Suite 2.214, Charlotte, NC 28212
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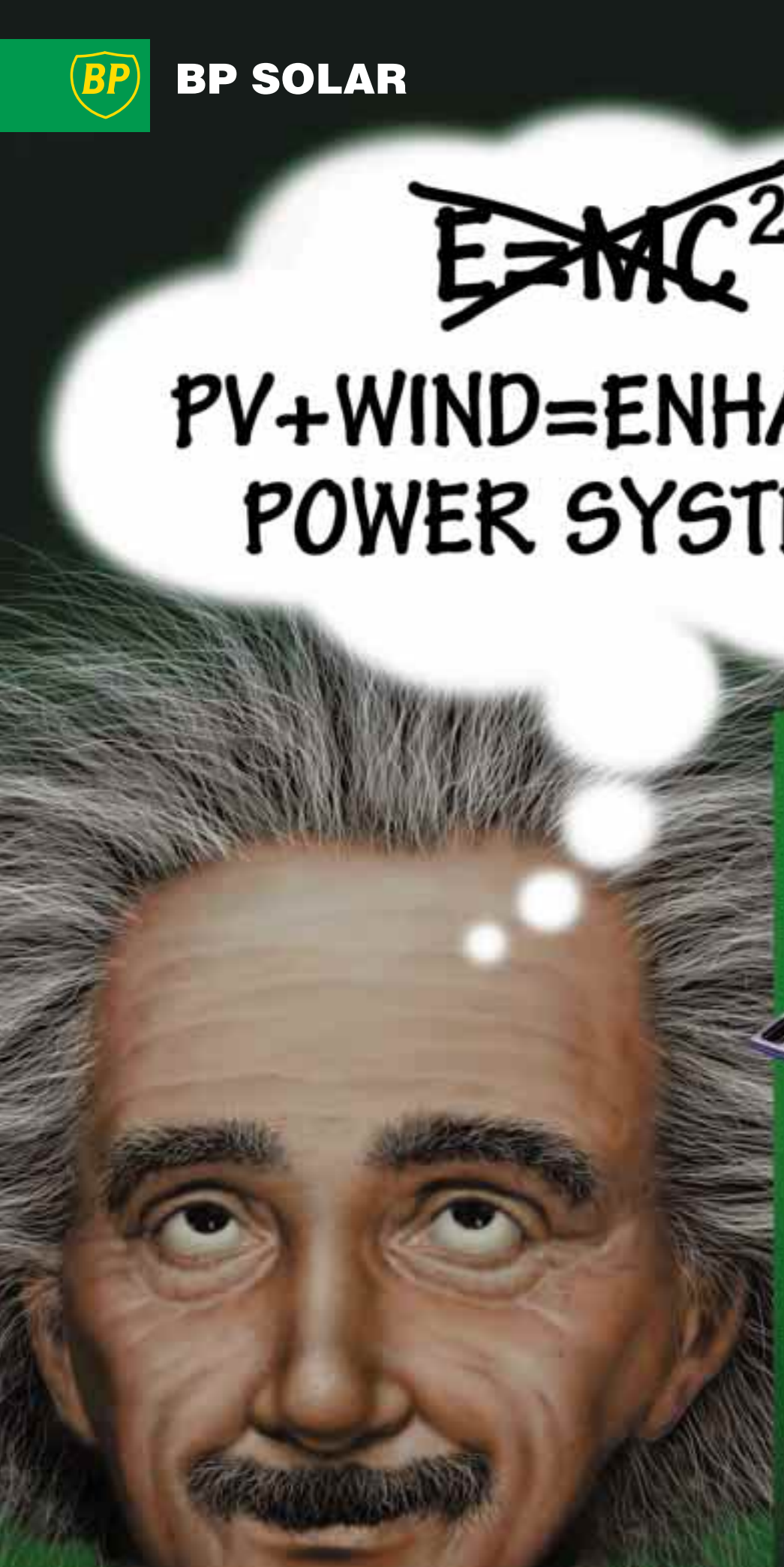

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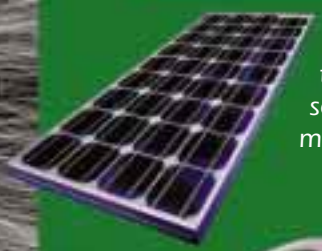

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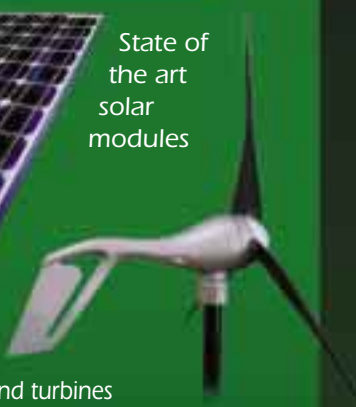

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SIEMENS Solar Industries
A Century of PV Experience

Richard Perez, Karen Perez, & Joe Schwartz

Above: Tina Nickerson, Dave Holt, Arthur Rudin, Raju Yenamandra, and Mark Mrohs of Siemens Solar.

On December 9th and 10th, Karen, Joe, and I had the opportunity to visit Siemens Solar Industries in Camarillo, California. Most home power folks tend to cast a suspicious eye toward large corporations, and rightfully so. Many of these corporate entities are responsible for fostering our fossil fueled economies, devouring finite resources, and indiscriminately polluting the land, air, and water. But after spending two days at Siemens Solar, we have a very different feeling towards this particular corporation and the people who work there.

When corporate resources are used for the public good as well as for corporate profits, good things happen. Siemens creates solar products of exceptional quality on a truly massive scale. Without this level of corporate involvement, we wouldn't have PVs on our roofs.

Siemens Solar Industries

Siemens Solar Industries is one of the few large manufacturers of photovoltaics without direct financial ties to oil interests. The parent company, Siemens AG, is a global electrical engineering and electronics company. They are active in many diverse business segments including power engineering, electric components, telecommunications, automation systems, transportation systems, and health care and diagnostic equipment. With 65 billion dollars in sales and over 373,000 employees worldwide, the sheer size of Siemens is striking.

Siemens Solar in Camarillo, California and Vancouver, Washington are registered ISO 9001 compliant sites. Siemens Solar maintains other manufacturing sites worldwide and requires them to have ISO compliant systems. First, silicon ingots are grown in Vancouver and then shipped to Camarillo for cell processing. Module assembly takes place in Camarillo, Munich, and Tokyo, with satellite assembly facilities in Brazil, Portugal, and India. Siemens boasts the largest installed product base of all PV manufacturers and produces 25 megawatts of PV annually. This capacity is projected to reach 30 megawatts by the end of 1998.

The five representatives we met at Siemens Solar Industries share over a century of collective PV manufacturing and marketing experience. Many

employees worked with ARCO Solar before it was purchased by Siemens in the early 90s. We could see the cohesiveness of the personnel at Siemens, and we believe that their products reflect this.

Chet Farris, Executive Vice President and Chief Operating Officer, answered all of our technical questions—and then some. Dave Holt, Manager of Distribution, briefed us on Siemens' distribution network and their rapidly expanding PV dealer network. Raju Yenamandra, Director of Sales, provided us with a corporate overview and addressed technical and distribution questions. Art Rudin, Marketing Manager, guided our tours of the single crystal and CIS manufacturing facilities and two Siemens PV installations. He also shared his extensive knowledge of PV manufacturing. Tina Nickerson, Marketing Specialist, coordinated our trip to the big city, which we survived without even a scratch. Special thanks, Tina!

Above: A silicon boule ready to be sliced into wafers.

Siemens Single Crystal PV Manufacturing

The silicon used to make PV cells is a highly engineered material. Siemens grows the single crystal silicon material in Washington state because of the easy access to inexpensive Northwest hydro power. Making raw silicon into the ingots (called boules) is very energy intensive. The silicon must be heated to a high temperature and held there as the crystals are slowly grown. In single crystal PVs, each silicon molecule is an exact clone of its neighbor.

Once made, the boules are shipped to Camarillo for manufacture into PV cells. The boules are sawn into wafers using multiple wire slurry saws. Imagine taking a brick of glass and sawing it into slices 300 microns thick, about as thick as a human hair. This is very hard to do without breaking the thin brittle wafers of single crystal silicon.

After the boules are sawn into wafers, they are cleaned and doped. Doping means adding small amounts of other elements to create a semiconductor junction. One layer of silicon is doped with phosphorous to create an excess of electrons. This is the negative layer (N), which faces the sun. The other layer is doped with boron to create a shortage of electrons. This is the positive layer (P). Once the P and N layers are established in the wafer, it becomes a PV cell. The boundary between the P and N sides of the cell forms a photodiode. When light hits the cell, electrons migrate to the N side because they've had their energy increased by photons.

In order to get the photoelectric current out of the cell, metal traces are photolithographed (printed) onto the N side of the cell. Once these traces are added, we have a working PV cell. In order to further improve the cell's performance, an anti-reflective coating is added to the N side. This coating reduces light reflection on the cell's surface and helps the PV cell absorb more sunlight. The process of making a PV cell is complete at this point. (For a more detailed description of PV cell design and operation, see Chris Greacen's article in *HP23*, page 37.)

Automated Assembly

Since a single PV cell only produces about 0.48 VDC, it is necessary to series connect many cells (usually 36) to make a standard PV module. At Siemens this process is highly automated. Strings of robot-soldered cells ride down conveyor belts on their way to encapsulation into modules. Once the cells are collected and interconnected, the back of the PV module is coated with a sheet of EVA pottant and baked in an oven. All that remains at this point is to add the junction box and aluminium frame to the module.

These few paragraphs leave out volumes of info. The manufacturing processes are carried out precisely in

Below: Hi-tech automation assures consistency.

Above: A safe environment for employees.

spotless “clean rooms.” Some of the operations, such as doping the cells, occur in vacuum chambers. Turning beach sand into PV modules is a triumph of technology—it’s not easy by any stretch of the imagination. It requires meticulous attention to every detail. From what we saw, Siemens is up to the job.

A Quality Work Environment

There are over 350 employees at Siemens Solar Industries in Camarillo, working three shifts, five days a week. We were very impressed by two aspects of the PV manufacturing process at Siemens—quality control and environmental/worker safety. Every step of the manufacturing process has quality control checks. Some of these are automatically logged into Siemens’ vast computer system. In other cases, the inspection is made by a human and logged into the computer. Siemens is dedicated to quality control—there are no out-of-spec modules being shipped.

The workers and our environment are not endangered by this hi-tech facility. All around us workers were warned of hazards and protected by safety gear. All the solvents and potentially nasty materials used in the PV making process are controlled, reused, and then recycled. The PV manufacturing process at Siemens creates minimal environmental damage. We respect Siemens for this. They could have moved their PV cell manufacturing facility to some third world country with no environmental protection laws. Instead, they put it in Camarillo, California, a Los Angeles suburb with extremely strict laws governing industrial processes and pollution. In our opinion, Siemens is part of the environmental solution, not part of the problem.

CIS PV Manufacturing

The folks at Siemens have their eyes on the future—a solar-powered future that includes us all. They are dedicated to research. They want to make PVs less expensive, better, and longer lasting, so they are researching a new thin film technology. This new kind of PV doesn’t use highly pure, energy intensive silicon, but instead uses materials with less embodied energy. These materials promise easier to make and less expensive PV modules.

Siemens uses the Copper Indium Diselenide (CIS) thin film technology. CIS uses far less material than single crystal technology does. While the single crystal cells are over 300 microns thick, the CIS thin film is only 2.0 microns thick. Less hi-tech engineered material means lower cost. CIS technology also lends itself to highly automated, faster manufacturing techniques, further reducing module cost.

The really big news about the Siemens CIS modules is their present efficiency of 11 percent. This means that 11 percent of the incident photons are converted to photoelectrons. This is the highest efficiency ever attained in a single-layer thin-film PV junction. Other single-layer thin film junctions have efficiencies of 4 to 8 percent. Modern single crystal PV cells have a conversion efficiency of 14 to 18 percent.

Siemens has been working on this CIS technology for over eight years. Many companies would have rushed this new product into the marketplace. Instead, Siemens is on its ninth year of testing. They want to be sure that their new CIS modules are up to at least a ten year lifetime out in the sun and weather. During 1999, Siemens CIS modules will be for sale to the public. The first versions will be 5 and 10 watt modules, to be followed by 20 and 40 watt modules. These CIS modules will initially carry a five year warranty and will be less expensive than conventional single crystal PVs.

Siemens Educational Programs

On Wednesday evening, Mark Mrohs gave us an overview of Siemens’ PV training program. He is responsible for both designing and implementing the course, which is specifically geared toward professionals who want to do PV system design. Mark has been offering the course since 1981, and has its content and presentation honed to near perfection. It consists of four to six weeks of home study, followed by a five day intensive study program in Camarillo. The home study portion of the course is available on VHS video cassette with the written documentation on CD-ROM or on paper. Mark’s enthusiasm is as infectious as his teaching style. We highly recommend this training course to those who are serious about getting involved in the PV industry.

Mark is also responsible for developing the current version of Siemens' PV design software. Joe, Karen, and I had a personal tour of this new program, PVDesigner 2.0. I could write a complete series of articles on this software alone. It's the bee's knees! It has a complete suite of software tools for designing PV systems for use anywhere in the world. This software is currently available to Siemens Solar dealers and will soon be sold to the general public. It's the reason that we are inviting our first IBM type computer into this previously all Macintosh office. If that doesn't tell you how much we like this PVDesigner 2.0 program, then nothing will.

Siemens Solar Answers *HP* Readers' Questions
Thursday morning there were 50 mph (80 kph) Santa Ana winds which toppled utility poles and left 20,000 households in the LA basin without power. We made our way back to Siemens through the wind and whipping vegetation. Our first order of business was to get some answers to common PV questions asked by *Home Power* readers.

Broken Module Glass
My daughter and her baseball, or my horse and its hoof, just shattered the glass on one of my PVs. What should I do? After checking the damaged panel with a multi-meter, you're amazed to find that the PV's power output still meets spec. What to do with that broken module? Treating the panel with silicone sealer will seal the glass for the time being. However, be aware that once a module's encapsulation is damaged, it's usually only a matter of time before the elements take their toll and corrode the connections between the individual cells, eventually destroying the module.

Embodied Energy
How long does it take a PV module to make back the energy it took to manufacture it? The amount of energy that goes into the manufacture of a given product is often referred to as its embodied energy. In a high insolation region like Southern California, a Siemens PV module will produce enough electricity to offset its embodied energy in approximately 18 months. That means a given module will produce free electricity, in terms of embodied energy, for 23.5 years before it's even out of warranty!

Environmental Cost
What are the environmental consequences of manufacturing PV? Photovoltaic production is essentially semiconductor manufacturing. While a large amount of energy goes into the manufacturing process, the materials and solvents used are typically not extremely toxic. With proper recycling and disposal of waste materials, the manufacture of photovoltaics can be labeled tolerable. Since PV modules produce clean solar electricity, the manufacture of photovoltaics can be labeled highly desirable.

PV Warranty
What's included in a PV warranty? With warranties varying from 10 to 25 years, PVs are perhaps the longest warranted products you can purchase. However, before you purchase a given module, inquire about the warranty specifics. PV warranties typically allow for a certain percentage of decreased output over the duration of the warranty.

If your Siemens PV module loses more than 20 percent of its rated power in 25 years, then Siemens will replace it. Not included in this warranty are the daughter with a baseball, the kicking horse mentioned above, and using the PV module with solar concentrators.

Bootstrap PV Production
Can I go into PV production myself? Expect to invest at least $100,000 in equipment if you plan to assemble another manufacturer's cells into your own module on a production basis. Want to produce the actual PV cells yourself? Expect to spend at least $10,000,000 on equipment before your first cells roll off the assembly line.

Siemens Solar in Action
After our question and answer session, Art Rudin was kind enough to guide us on a tour of two unique Siemens PV installations. We thoroughly enjoyed the chance to stretch our legs and treat ourselves to some blissfully warm Southern California sunshine. First we visited the residence of Greg Johanson, an authorized Siemens dealer and owner of the Thousand Oaks, California based Solar Electrical Systems Company.

Below: Installing junction boxes by hand.

Above: Greg Johanson's 3,100 watt grid-intertied PV array.

Above: Greg's meter runs either way.

Greg's utility-intertied PV system was perhaps the first to go online after the establishment of California's RE buy-down program. The system shows just how easy it is to put clean, renewable energy back on your local power grid. Greg's roof is graced with a 3.1 KW array of 48 Siemens SP75, 75 watt PV modules. The PVs were installed using mounts which Greg designed and manufactured specifically to interface with his home's tile roof.

The array is configured with sets of three modules in series to feed a Trace SW4048UPV batteryless inverter. Array voltage ranges from 34 to 75 VDC. The inverter is housed in Trace's weatherproof SWODE enclosure and mounted on the exterior of the house. The inverter utilizes maximum power point tracking software to optimize the array's output before inverting and synchronizing it with the utility grid. As we heard the hot tub circulation pump kick on, our attention was drawn to the utility meter. It was spinning steadily backward, still pumping solar electricity into Southern California Edison's utility grid.

The second installation was situated smack dab in the middle of the Santa Monica pier. As we approached the pier, we saw the three massive PV arrays that comprise Siemens' 50 megawatt grid-intertied installation.

Below: The world's only solar-powered ferris wheel at the Santa Monica Pier sports a new 50 kilowatt grid-intertied PV array.

The pier, with its carnival rides and throngs of tourists and locals, is the perfect site for a high profile demonstration of photovoltaics. The project, completed in the summer of 1998, was funded by Southern California Edison and the California Energy Commission. Even the utilities are beginning to come around and acknowledge the benefits of PV. Southern California Edison's involvement in the Santa Monica pier project illustrates growing support for renewable energy. Every step taken in the right direction is a good step taken.

Siemens in the Next Millennium

Siemens is a very large company

dedicated to a sustainable energy future that we can all share. These folks may look corporate, but in their minds and hearts we discovered true solar fanatics—just like us. It's really easy to recognize solar fanatics, regardless of appearance. Start talking solar energy, and watch their eyes light up so brightly that you want to put modules in front of their faces to capture the energy!

To say we had great fun on our visit to Siemens would be an understatement. Actually seeing the PV manufacturing process was a real treat. Meeting these wonderful people, who are doing so much for our energy future, was an honor. If we weren't so happily employed here at *Home Power*, we'd be sending Siemens our resumes and trying to join in their wonderful work.

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SOUTHWEST WINDPOWER

full page
four color
on negatives

this is page 45

Batteries:
How to Keep Them Alive for Years & Years...

Windy Dankoff

Lead-acid batteries are often considered to be the "weak link" in renewable energy systems. However, today's renewable energy batteries are better than ever, and so are the devices that regulate and protect them. Battery failures are rarely the fault of the batteries themselves! Follow these guidelines to avoid most battery problems.

Size a Battery Bank Generously

The battery bank is the foundation of the power system. Don't skimp here! A good working minimum size can be based on your estimate of seven days of energy storage. Keep in mind that after one year of service, it is *not* advisable to enlarge a battery bank by adding new batteries to it. Doing this will cause mismatch problems and stray currents between the newer and the older sets. Instead, anticipate your growing energy needs by sizing the set properly from the start, perhaps to twice the minimum (seven day) size.

Avoid Multiple Strings

The ideal battery bank is the simplest, consisting of a single series of cells that are sized for the job. Higher capacity batteries tend to have thicker plates, and therefore greater longevity. Having fewer cells will reduce both maintenance and the chance of randomly occurring defects. For example, suppose you require a 700 amp-hour battery bank. You can approximate that by using three parallel strings of golf cart batteries (220 AH), or two strings of the larger L-16 style batteries (350 AH), or a single string of larger industrial batteries.

It is advisable to have fewer than three parallel battery strings if possible. Battery banks with multiple strings are more likely to develop cells with unequal states of charge. Weak cells will be difficult to detect because they will "steal" from the surrounding cells. The system will suffer as a whole and will cost you more in the long run.

Prevent Corrosion

With flooded batteries, corrosion of terminals and cables is an ugly nuisance that causes resistance and potential hazards. Once corrosion takes hold, it is hard to stop. The good news is that it's easy to prevent! Apply a non-hardening sealant to all of the metal parts of the terminals *before assembly.* Completely coat the battery terminals, wire lugs, nuts, and bolts individually. A sealant applied after assembly will not reach all around every junction. Voids will remain, acid spatter will enter, and corrosion will begin.

Special compounds are sold to protect terminals, but you can get perfectly good results using common petroleum jelly (Vaseline). It will not inhibit electrical contact. Apply a thin coating with your fingers, and it won't look sloppy. If wire is exposed at a terminal lug, it should be sealed airtight, using either adhesive-lined heat-shrink tubing or submersible rubber splice tape. You can seal an end of stranded wire by warming it gently and dipping it in the petroleum jelly, which will liquify and wick into the wire.

It also helps to put the batteries over a floor drain, or in a space without a floor, so that they can be rinsed with water easily. Washing the battery tops about twice a year will remove accumulated moisture (acid spatter) and dust. This will further reduce corrosion, and will prevent stray currents from stealing energy. Batteries that we have protected by these measures show very little corrosion, even after ten years without terminal cleaning.

Moderate the Temperature

Batteries lose approximately 25 percent of their capacity at a temperature of 30° F (-1° C), compared to a baseline of 77° F (25° C). At higher temperatures they deteriorate faster. So it's good to protect them from temperature extremes. If no thermally stable structure is available, consider an earth sheltered enclosure. Where low temperatures cannot be avoided, get a larger battery bank to make up for the loss of capacity in the winter. Avoid direct radiant heat sources that will cause some batteries to get warmer than others.

Use Temperature Compensation

When batteries are cold, they require an increase in the charge voltage limit in order to reach full charge. When they are warm, they require a reduction in the voltage limit in order to prevent overcharge. Temperature compensation is a feature in many charge controllers and in the chargers of some inverters. To use this feature, order the accessory temperature probe for each charging device, and attach it to any one of the batteries.

Use Low-Voltage Disconnects
Discharging a battery to exhaustion will cause irreversible loss of capacity and reduced life expectancy. Your system should employ low voltage disconnect (LVD) in the load circuits. Most inverters have this feature, and so do many charge controllers and power centers.

Buy High-Quality Batteries
You get what you pay for! Good deep-cycle batteries can be expected to last for five to fifteen years, and sometimes more. Cheap batteries can give you trouble in half that time. Buy industrial quality deep cycle batteries from a reputable renewable energy supplier.

Charge Completely
Bring batteries to a full state of charge (SOC) at least every three weeks. This reduces internal corrosion and degradation, and helps to insure equalization, so that any weaker cells do not fall continually farther behind. A full SOC may occur naturally during most of the year, but don't hesitate to run a generator when necessary, to bring the batteries up. For more details, refer to the instructions for your inverter/charger and batteries. You may wish to post clear instructions about charging requirements and methods at your power center.

When Is a Battery Full?
The "charged" indicator on most PV charge controllers means only that battery voltage is relatively high. The SOC may be approaching full, but is not necessarily near 100 percent. A voltmeter reading gets you closer, but it is not a foolproof indicator. Voltage varies too much with current flow, temperature, and time to give a clear indication.

For flooded batteries, a hydrometer is the definitive indicating device, although not a convenient one. You can measure every cell individually with this tool. Get a good hydrometer from a battery or automotive supplier. Rinse it after use, and keep it clean. An amp-hour meter is the most informative and user-friendly way to monitor SOC. For sealed batteries, it is the *only* definitive method.

Install a System Monitor
Would you drive a car with no instrument panel? Metering is not just "bells and whistles"—it is necessary to help you keep tabs on the system. Many charge controllers have indicator lights and readouts built in. For a full-scale remote home, consider the addition of a digital monitor, like the Trace TM-500, Tri-Metric, E-Meter, or Omni-Meter. These devices monitor voltage and current, record amp-hours, and accurately display the SOC of the battery bank. They also record more detailed information that can be useful for troubleshooting. The monitor may be mounted in another room or building, for handy viewing.

Just Add Water
Note: This applies only to "flooded batteries," not to "sealed batteries." The plates of every cell in your battery bank must be submerged at all times. Never add any fluid to a battery except distilled water, deionized water, or very clean rainwater collected in plastic containers. Most batteries need water every six to twelve months. Don't fill them more frequently than needed to submerge the plates. Fill them only to the level recommended by the manufacturer, generally about an inch (25 mm) below the top; otherwise they may overflow during finish-charging.

Not a Struggle
Batteries are the heart of your power system. They may demand your attention occasionally, but your relationship with them need not be a struggle. With a proper installation, a little understanding, and some simple maintenance, your batteries will live a long and healthy life.

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Continuing the tradition of fine professional communications receivers designed and built by Rockwell-Collins Canada. The HF 2050 covers 14kHz-30MHz and features a built-in speaker, DSP, noise blanker, squelch, up to 30 memories, 3 speed 10Hz tuning resolution, keypad for data entry, scan, variable AGC, extensive built-in self test, and a large liquid crystal alpha-numeric display. Very Collectable!!

Price: $3000.00 Including operation/service manual. These are fully tested and burned-in.

LOW VOLTAGE EXTENSION LIGHT

This handy little extension light is designed for the military to help with equipment repairs. It plugs into any automotive bayonet socket and will operate on 12 or 24vdc/ac. It has hooks at both ends of the handle and is supplied with 24ft of cable.

Price:unused in original box $19.00ea

MODIFICATION KIT
Goodie box

This kit was originally designed for military vehicles. It provides capability for backup battery use in emergencies where the primary battery is drained. It contains a motorola rectifier MR1265FL rated at 300V @ 700 Amp capacity, plus it contains a 24v contactor, phenolic insulator and pre-terminated hookup wires.

New, unused in original carton.....$75.00ea

LINEAR 1 CHANNEL
CHART RECORDER

This is a handy compact general purpose chart recorder with all kinds of applications. Its input range is 1mv-10V/division. Two chart speed ranges from 0.5-10cm/min and 0.5-10cm/Hr are selectable on the front panel and it comes with 3 rolls of paper. **Price: $75.00ea Good Condition.**

TEKTRONIX 465B
OSCILLOSCOPE

Superior Quality, only found in Tek products, is built-in to this 100 MHz dual trace scope. It features delayed timebase, Ch1/Ch2 sum or difference. Vertical deflection range 5mv-5V/div. This is an excellent general purpose oscilloscope

Very good condition.....$750.00
Tek 465 good conditon.....$650.00
Tek 465M ruggedized military ver $495.00
New "Avex" 100MHz scope probes .$24.00
465(?) Manual $45.00

TENTECH SP-325
RECEIVER

This dual conversion synthesized radio covers 300 kHz-30MHz. 25 different channels can be programmed into memory. Modes are AM, USB/LSB, CW. Bundwidths are .5/ 2.8/ 6.0 kHz. This is a decent radio for a **low price $350.00**

NOVA ELECTRIC CORP
GALAXY 2KW INVERTER

These inverters are brand new, unused in the original carton. Input voltage is 22-34Vdc 140A max, output voltage is 120Vac @ 20.8A 60 Hz. These are high efficiency, stepped wave inverters with logic interface.

Price: new unused.....$925.00ea

MILITARY STANDARD
24V DC GENERATOR

Superior QUALITY plus rugged design are features of this deluxe 2 cylinder 4 stroke gasoline generator. The control panel contains meters for voltage & current indication, main circuit breaker and voltage adjustment. Shielded wires and plugs comprise the RFI suppressed ignition system eliminating all radio noise. These units are "new" in the original carton complete with operators manual and pull-start cord. Output voltage is adjustable approx 18-32vdc (24,28v) nominal @53.3A (1,5Kw) continuous duty 100% load.

Price: $579.00 ea. or 2 units for $1000.00

Dranetz 8000 energy analyzer

Price: $1200.00 *demo unit* (includes unused clip on voltage probes but no current xfmrs)

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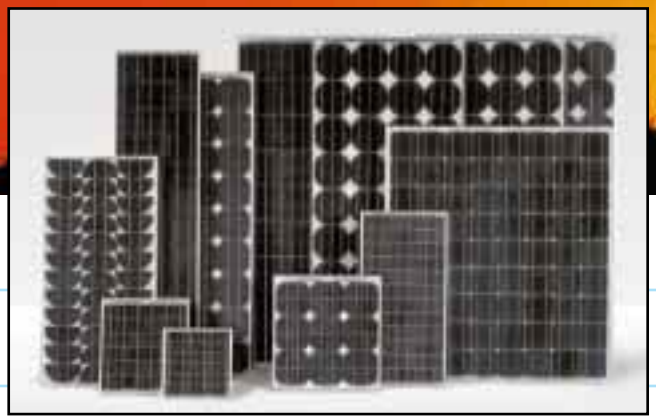

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Thinking Green & Saving Money ...with OIL

Harry O. Rakfeldt

There is no denying that we are a mechanized society that cannot function without lubricants. Our dilemma is that oil is both necessary for our way of life and potentially destructive to nature. Quite simply, we must select innovative, efficient products that help solve our pollution problems.

As oil consumers, we can reduce our oil consumption and dependence on foreign oil. We can make a choice that results in improved performance and longer-lasting equipment. This choice will reduce pollution, emissions, waste, handling, and disposal—in quantity and cost. This choice will improve our lifestyle, benefit the environment, and save money. Choose the alternative to "regular" oil—clearly superior, synthetic lubricants.

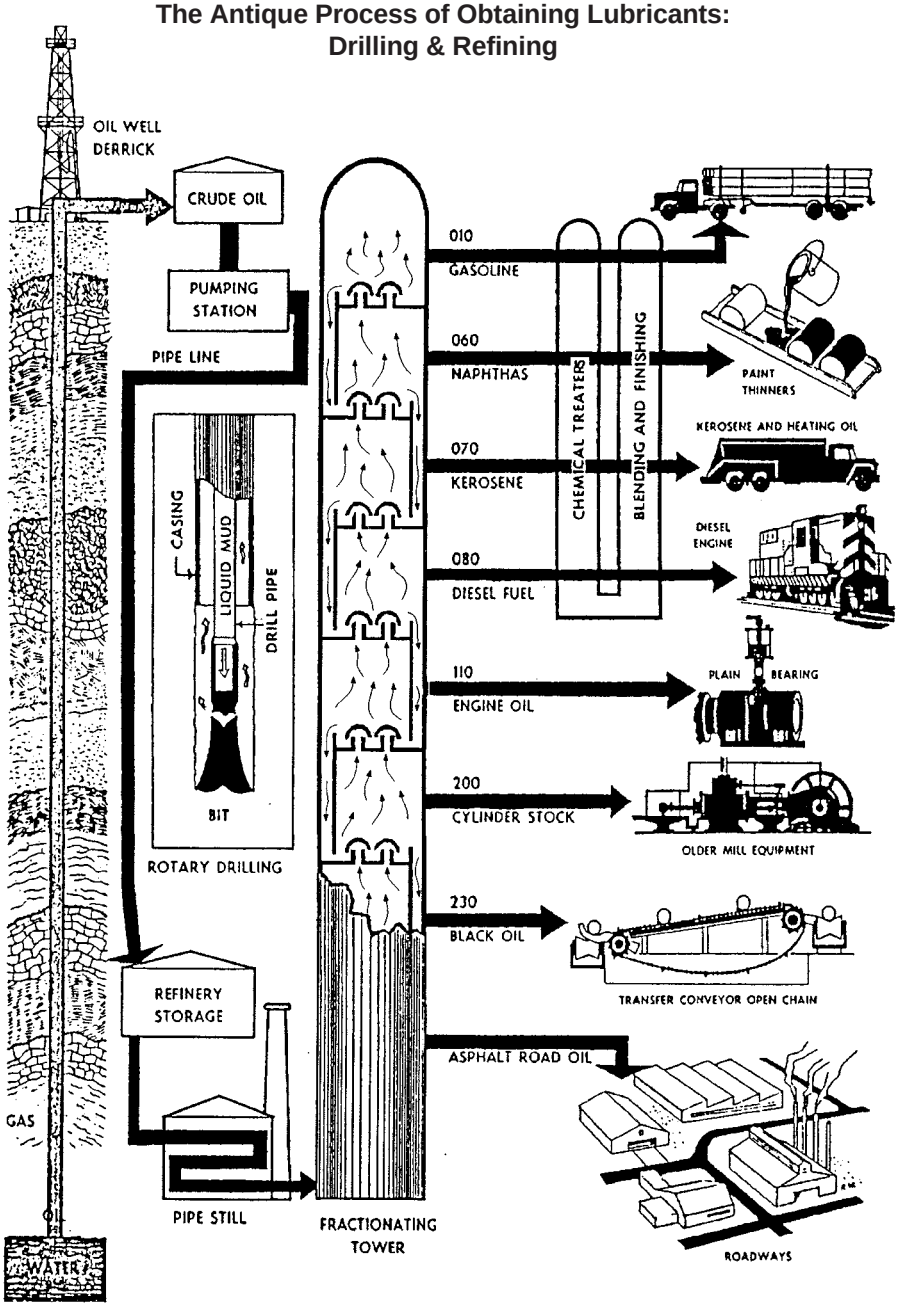
Oil History 101

"Fixed" oils, made from tallow, sperm whale, cod liver, and vegetable oils, were the lubricants of the day when Charles and Frank Duryea introduced the auto wagon. These lubricants were called "fixed" because they frequently decomposed at certain fixed temperatures.

Motorcar engines often overheated with fixed oils. By comparison, mineral oils were clearly the superior lubricant for the automotive engine. But refining was expensive, and production of an oil just for cars seemed economically unjustifiable.

When Henry Ford's production line swung into gear, the fixed oil of the day was sperm oil. Mineral oils did not become the most used lubricants until many years, and countless repairs and replacements, later. Today, mineral oils are everywhere and make up about 95% of all available lubricants.

The Antique Process of Obtaining Lubricants: Drilling & Refining



Performance Characteristics of Mineral Oil Compared to Various Synthetic Oils
(Data courtesy of *Plant Engineering Magazine*, Cahners Publishing Co.)

Properties	Mineral Oil (Paraffinic)	Synthetics: Polyalphaolefin*	Dialkylated Benzene	Dibasic Acid Ester	Polyol Ester	Polyglycol	Phosphate Ester	Silicone Fluid
Viscosity-temperature	F	G	F	G	G	VG	P	E
Low temperature	P	G	G	G	G	G	F	G
High temperature oxidation stability with inhibitor	F	VG	G	G	E	G	F	G
Compatability with mineral oil	E	E	E	G	F	P	P	P
Low volatility	F	E	G	E	E	G	G	G
Compatability with paints & finishes	E	E	E	P	P	G	P	VG
Hydrolytic stability	E	E	E	F	F	VG	F	G
Antirust with inhibitor	E	E	E	F	F	G	F	G
Additive solubility	E	G	E	VG	VG	F	G	P
Seal swell performance	E	E	F	F	F	G	F	E

E=Excellent; VG=Very Good; G=Good; F=Fair; P=Poor

* Polyalphaolefin (PAO) is a widely-used, popular synthetic base-stock. Its solution of identical molecules are completely saturated and non-polar, making it very stable.

Conventional Oil Basics
Crude oil contains millions of different types of molecules. Refining separates molecules according to physical characteristics and separates unwanted materials from desirable materials. Crude oil is refined into conventional basestocks, which always contain a variety of molecules and some residual contaminants.

Mineral oil has a complex molecular makeup with different sizes, shapes, and weights of molecules. Some molecules are not completely saturated. Others contain sulfur or nitrogen atoms. Incomplete saturation and the admixture of molecules contribute to thermal and oxidative instability. Sulfur and nitrogen atoms contribute to oil contamination and breakdown.

"Over one third of the energy produced in the world is consumed in overcoming friction."
—Kenneth E. Bannister,
Lubrication for Industry

Today's small engines run hot. Heat is not good for conventional motor oil. When hot, oil becomes volatile and loses some of its light hydrocarbon components to "boil off." Volatility leads to increased hydrocarbon emissions and reduced oil volume. When hot oil breaks down and oxidizes, heavier components become sludge and hard deposits.

Quantity, Not Quality
You and I are strongly influenced in our motor oil thinking by the corporate giants. There is intense competition among them. As one oil company vice president put it, the motor oil market is moving from "extremely competitive to even more extremely competitive."

Most motor oils are price-formulated and are not sold on a performance basis. Group I oils make up seventy-five percent of all conventional oil basestocks. These are the least expensive to produce and define the bottom tier of lubricant performance. We are conditioned to "buy cheap and change often."

Oil Quality and the Automakers
But the unifying cry of the automakers regarding motor oil quality is "We want more!" The primary issue is extended drains—longer intervals between oil changes.

Dr. Mike McMillian of General Motors states, "Oil performance standards are minimum standards. Certainly there is technology available to raise the standard and extend the drain interval without compromising engine durability. Europe is already at a 9,000 mile (14,000 km) drain interval and is seriously considering twice that."

GM's focus groups and consumer research studies call for longer oil drain intervals for customer convenience. Extended oil drain intervals would also benefit the vehicle lease programs. Lease customers have little or no incentive to perform routine maintenance such as oil changes. GM is also interested for environmental reasons. The government has tried twice to declare used oil a hazardous waste, and disposal is an issue.

Quick Lubes and Oil Companies
According to *National Oil & Lube News (NOLN),* May 1998, "the topic of oil change intervals has grabbed the

fast lube industry's undivided attention…more than any other issue." Oil and related industries are very reluctant to accept extended drains. A 3,000 mile (4,800 km), three month service recommendation has been the industry standard since 1980. It's a pocketbook issue—they are fighting to retain this standard because they sell more oil that way. "My hat is off to Jiffy Lube," said Jim Sapp (Nov. 1996), President of the Convenient Automotive Services Institute (CASI). "For years Jiffy has preached the 3,000 mile or three month oil change interval. And fortunately for us, many motorists take it as gospel. But we need to do more as an industry..."

The top five motor oil suppliers, Quaker State, Pennzoil, Texaco/Equilon, Valvoline, and Castrol, support this campaign against extended oil drain intervals. As CASI president John Bochnowski said, "...[it] will run into the millions. However, the cost of doing nothing is far higher. Each percentage point decline in oil change volume would hit our industry and all others in the oil change business like a ton of bricks." (NOLN, Sept. 1998)

Big Oil makes big money on low quality motor oils and short drain intervals. Big Oil fiercely resists anything that affects or might affect its market.

Synthetic Lubricants

By definition, a synthetic basestock is manufactured by organic synthesis. This allows manufacturers to determine specifications in advance. Synthetic lubricants (synlubes) are pure, uniform, and designable. They have the ideal physical geometry—in molecular size, shape, and weight. Many synthetic basestocks are blended to create finished lubricants with characteristics superior to the individual basestocks. Creating synthetics and blending them allows synthetics to be "tailor made" for various lubricating applications.

Synthetics excel because of three predominant characteristics:

- **Significant reduction in friction and wear**
- **Optimum performance at temperature extremes, high and low**
- **Rigorous and lengthy operation without chemical breakdown.**

In contrast to mineral oils, synthetic hydrocarbon fluids are built up from specific starting materials such as ethylene. These fluids form well-defined products which are comprised of molecules that contain only carbon and hydrogen atoms. Synthetics can be made from vegetable oils, for example. Crude oil can also be chemically manipulated to produce synthetic hydrocarbon basestocks. Because synthetics last much longer, far less crude oil is used to do the same job. Some synthetic basestocks that are suitable for use as lubricants include polyalphaolefins (PAOs), polyinternalolefins (PIOs), alkylated aromatics, polyisobutenes (PIBs), and polyol esters.

Synthetic lubricants outperform conventional lubricants in *all* criteria and applications. The superior performance characteristics of synthetic lubricants are derived from the physical and chemical properties of the base fluids and the effects of additives introduced into the final product.

Myths & Tales

"Using synthetics will void my warranty." Some car owners have been misled. They believe using synthetics and/or extended drain intervals will void the vehicle warranty. OEM's specify API ratings and SAE viscosities. Any oil meeting these requirements—including synthetics—may be used. Since 1992, the Corvette has been factory-filled with synthetic engine oil. Only synthetic oil (5W-30 preferred) is specified for service fills.

"Synthetics will leak even more." No, a properly formulated synthetic has appropriate seal swell characteristics to keep leaks from forming.

"But you can't mix regular oil and synthetics." Yes you can. Virtually all automotive synthetics are fully compatible with conventional lubes, but read the label.

"I have to use conventional oil to break in my new engine." Quality synthetics may be used from day one in your new engine. However, perform your first oil drain per manufacturer's recommendation. Then, your drain can be extended to the synlube producer's recommendation.

"Synthetics will miraculously cure my ailing car!" Synlubes can markedly improve performance, but they can not repair a problem. Use synthetics only in mechanically sound equipment to achieve the best results.

Advantages

Cars have become more fuel efficient and less polluting due to EPA mandates. Today's engines have small components with tight clearances. Temperatures under the hood are close to 250° F (121 ° C), and climbing. This is very near the limit of continuous service for conventional oil.

Modern engines require low viscosity oils, but conventional low viscosity oils fall down on the job. To provide high temperature wear protection, conventional oils require a lot of special additives to raise their Viscosity Index (VI) rating. A higher VI indicates a better relationship of fluid viscosity to fluid temperature. High

VI fluids display less change in viscosity with temperature than low VI fluids. When VI additive polymers rupture under stress, the oil becomes too thin to protect engines adequately, and engine wear increases dramatically.

Synthetics protect well, regardless of comparable viscosity. They naturally have very high viscosity indices. Synthetics maintain their viscosity and are shear stable even after exposure to highly stressful engine conditions.

To produce high horsepower, today's small engines crank out very high RPMs. Each revolution generates friction, which makes heat. Synthetics operate at very high temperatures because they are chemically stable. They are minimally volatile and are very resistant to sludge and hard deposit formation. With synthetic oil, engines stay remarkably clean.

Synthetics have a very low pour point and flow easily in cold temperatures. This results in excellent wear protection and quicker startups with less drain on the starter and battery.

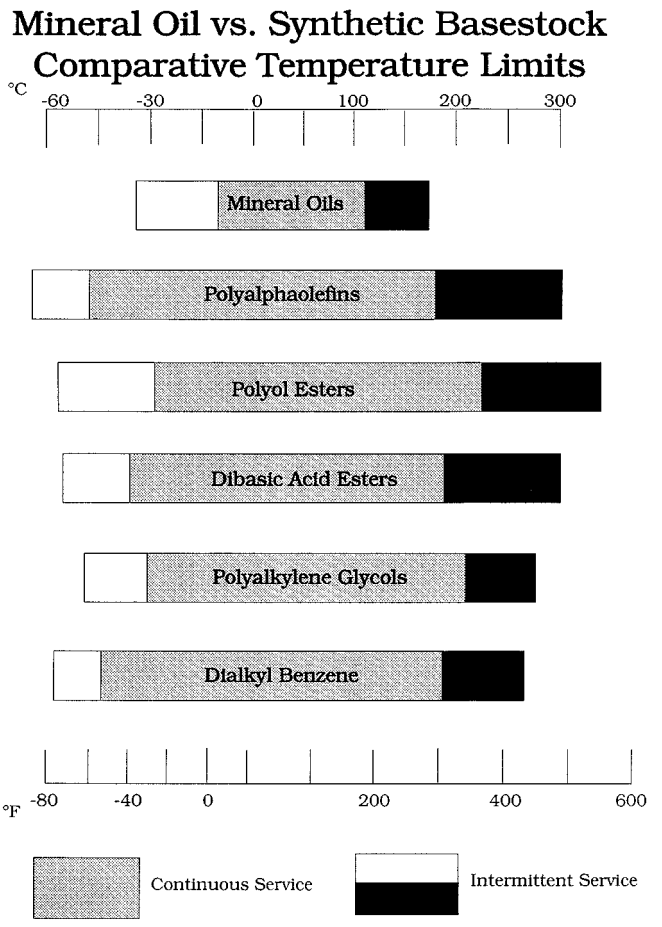
Synthetic lubricants do not contain contaminants. Their stable chemistry is very resistant to thermal and oxidative breakdown. This allows synthetics to be safely used for much longer drain intervals than conventional lubricants.

Some 60 firms make industrial grade lubricants. Engineers look for improved performance, increased benefits, and cost effectiveness—synthetics deliver. Of all the lubricants available in the United States, only about three percent are synthetics. In Europe, where they always seem to be ahead, six percent of the lubes are synthetics.

Energy Efficiency

"Energy efficiency is the single most cost-effective step to reduce pollution that leads to global warming," said David Nemtzow, president of the Alliance to Save Energy. Even in production, synthetics tread lightly on the environment. First, because quality synthetics last much longer, less needs to be produced for a given customer. There's less packaging, less resultant waste disposal, and less energy used in production. Synlubes are recyclable, and even slightly more biodegradable than conventional lubes.

Synthetics are inherently very slippery. Much less energy is needed to overcome internal fluid friction. Equipment performance and fuel efficiency are improved with synthetics. With friction reduced, engines run cooler than with conventional oils. Synthetic oils have much higher film strength than conventional oils. Metal-to-metal breakthrough is significantly reduced.



Synthetics control friction and heat very effectively. This significantly reduces component failure and the rate of component wear.

Applications

We look for conservation and efficiency in many areas, but not in our lubricants. The common refrigerator has become much more efficient. But would electric motor bearings sealed in a high quality synthetic grease help? What about the same for other appliances? Bearings, gear boxes, pumps, transmissions, compressors, electric motors—anything that transmits power is a prime candidate for efficient synthetics.

Lets look at some synthetic applications for *Home Power* readers. I'll use myself as a general example. All of our vehicles, including the diesel pickup, use synthetic engine oils. The transmissions (manual and automatic) and differentials have been changed over to the appropriate synlubes. If you do any towing of boats or trailers, seriously consider synthetic drive train fluids. My two cycle applications include an 8 hp Evinrude, a large chainsaw, and a weedeater. These are fed a single two cycle synthetic premix. The low viscosity hydraulic fluid in our wood splitter is synthetic ATF.

Show Me the Proof

In 1972, the first API-approved, fully synthetic engine oil was introduced, with an extended drain interval of 25,000 miles (40,000 km). Since then, it's been story after story:

- **In 1994, the Illinois State Police began using synthetic engine oil in all of their patrol cars. Their oil drain interval had been 3,000 miles (4,800 km). With the synthetic oil, it's 15,000 miles (24,000 km). In the first year they reported about $27,000 in savings, downtime reduced by 80 percent, and almost 4,000 patrol hours gained.**
- **TAXI 9000 of Bismarck, ND, has been using synthetic engine oil, ATF, and grease for over eleven years. They operate a fleet of over 100 cabs and have achieved a life cycle of 250,000 to 300,000 miles (400,000 to 480,000 km). Although operating under extremely severe conditions, the vehicles are on a 24,000 mile (39,000 km) oil drain interval.**
- **Fuel mileage was tracked on a salesman's car using premium 0W-30 synthetic. Mileage on the Ford Taurus before the change averaged 24.2 mpg. Mileage increases with the synthetic have measured 3.8 to 5.2 mpg.**
- **A flatbed trucking company used a quality 15W-40 synthetic in a continuous use test in their diesel trucks. The trucks with synthetics went an average of 79,000 miles (127,000 km) without changing oil while the conventional oil had to be changed every 20,000 miles (32,000 km) in the control vehicles.**
- **Dale Wagner is Chief Mechanic at the Central Yavapai Fire District and for the City of Prescott Fire Department in Arizona. He is responsible for 58 fire apparatus vehicles. In 1993, pressed for manpower and time, the decision was made to use synthetics. Service intervals increased 100 percent. Oil drain intervals were performed based on oil analysis. Savings in engine oil alone were about $2,000. Labor costs dropped $9,600, and reduced waste disposal saved $1,400.**
- **Synthetic oil is used exclusively in every commercial and military jet engine and in all spacecraft.**

I have used two synthetic greases: heavy duty in some parts of my backhoe, and a general purpose synthetic for virtually everything else—lawn mower, wheel bearings, U-joints, wood splitter, etc. All of my utility engines with low horsepower have used synthetic engine oil with extended drain intervals. These include an 8 hp Tecumseh on a wood splitter, an 8 hp B&S on a 4 KW genset, a 3 hp B&S on a small air compressor, a 3.5 hp lawn mower, and a 24 hp Wisconsin on a 15 KW genset.

Motor oils for vehicles and utility engines, drive train fluids, and grease will cover the bulk of your needs. Add two cycle equipment premix or injector and you have made a serious and significant change in your lube usage.

Finding Synthetics

Representing only three percent of available lubricants, synthetics are overshadowed by Big Oil's conventional lubes. Because synlubes are not on every shelf, finding them requires some effort. Look for brand selection in better auto supply outlets. Discount stores carry synthetic engine oil and transmission fluid. Specialty stores such as race shops and suppliers of ATVs, snowmobiles, and motorcycles carry or have access to synlubes. These are often good sources of technical information from people who use the products.

In 1972, Amsoil Inc. of Superior, Wisconsin, brought out the first approved synthetic engine oil with a recommended 25,000 mile (40,000 km), one year drain interval. Amsoil specializes in synthetics and produces the largest selection in the world, including industrial items. Anyone can order their premium synthetics factory-direct from a catalog. Amsoil has a strong distributor network and a Web site, listing an extensive selection of lubricants.

Red Line Synthetic Oil and Royal Purple are two other companies that specialize in automotive, general use, and racing synthetics. Shaeffer Oil, the oldest producer of lubricants, carries some synthetics. All of these companies have Web sites with links to distributors.

About four years after Amsoil's introduction, Mobil brought out its synthetic engine oil, Mobil 1. Mobil, often seen in racing circles, produces a selection leaning towards industrial applications. In the early '90s, a number of major oil producers brought out synthetics for general public use. However, synlubes represent a token appearance only. Generally, variety is relatively

small, with various grades of engine oil, ATF, and some greases available. But this limited selection which covers general needs is widely available.

Selection Guidance

The latitude in formulating and blending finished synthetics can result in a wide range of performance. Do not rely on pricing alone as a comparative selection criterion. Some synthetics in specialty stores may be highly priced. Although the product may carry a brand name, the synlube often has been made by someone other than the listed brand. Higher price doesn't always mean that the product is better, but a low price can be suspect when it comes to long-term performance. Quality products are priced higher. They have to be—you can't pay a little and get a lot.

Review company credentials and look at published technical data to arrive at a true basis for synthetic selection. For example, Corvette comes from the factory with Mobil 1. Service fills call for "Mobil 1 or equivalent." An equivalent oil *must* meet GM specification "4718M," which should be on the label. Look for valid comparative data and written use recommendations. Ask about guarantees, and evaluate the quality of the technical support.

Companies marketing synthetics stay in business because of commitment to quality, customer satisfaction, and an ethic to always improve. That's the only way they can compete with the Big Oil Boys and their cheap oil.

It's Personal

Between 1985 and 1992, my wife and I lived off-grid in a lovely passive solar home (see *HP6,* page 5). The memories are many and warm from this special experience. Synthetics have been part of my life for 19 years. All my equipment has been nourished on synthetics, including vehicles, small engines, chainsaws, and a backhoe. Our 1992 Subaru Legacy has traveled over 133,000 miles (214,000 km) on only eight oil changes. I've helped reduce crude oil depletion and our impact on the environment. I can live with that.

Every *Home Power* reader has a choice. You can continue to use products with *initial low price* or change to products with *long term value.* Use both where appropriate. With the intelligent choice of synthetic oil, you can think green, save money, and help our planet.

Access

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hrakfeldt@mcsi.net

The New Energy Manifesto, by Skip Goebel: www.calstart.org/news/columns

Synthetic Oil Companies: www.amsoil.com, www.redlineoil.com, www.royalpurple.com, www.schaefferoil.com, www.northland-racing.com

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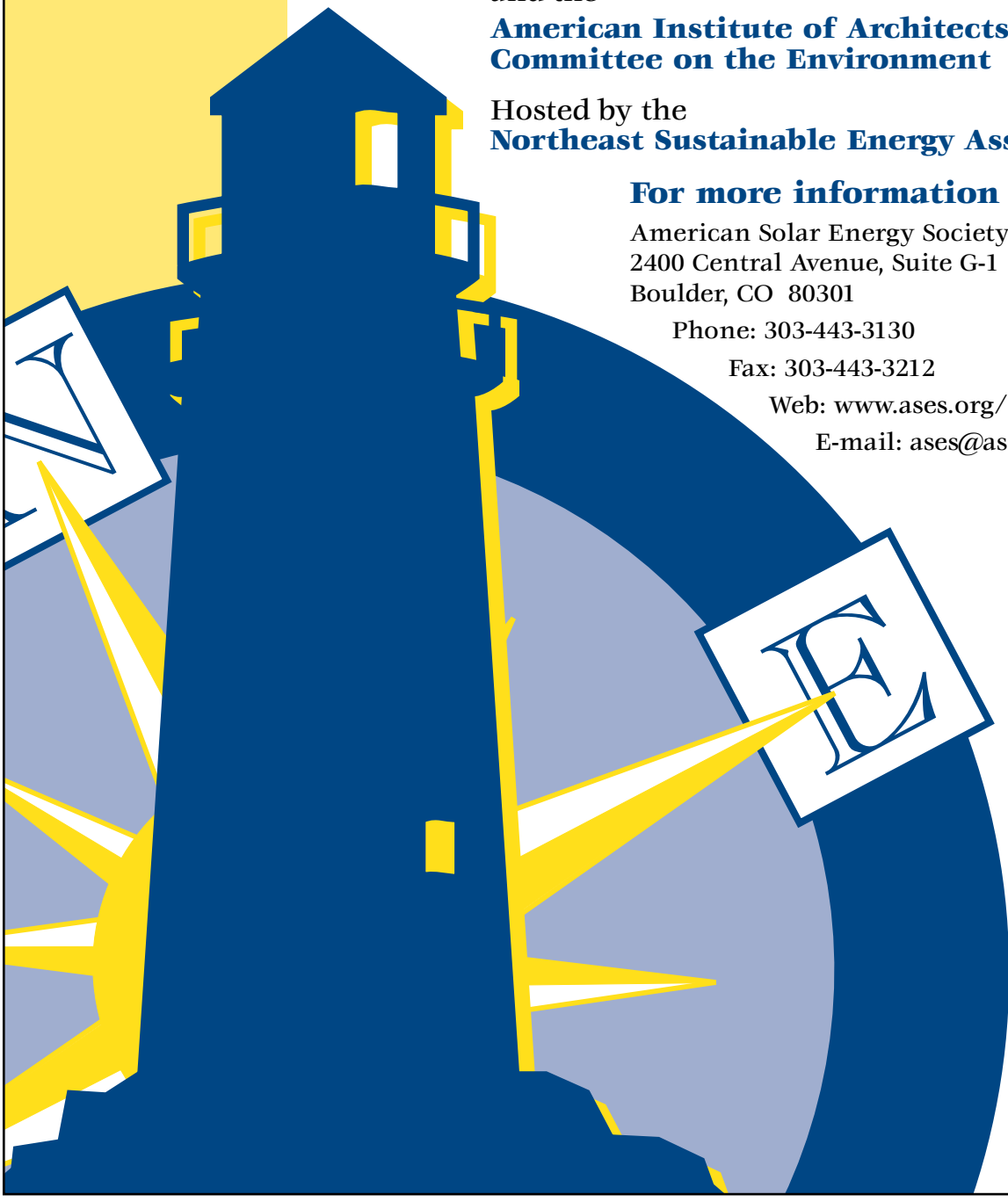

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Things That Work

Tested by Home Power

Statpower's PROsine™ 2.5 KW Inverter/Charger

Tested by Richard Perez, Joe Schwartz, and Sam Coleman

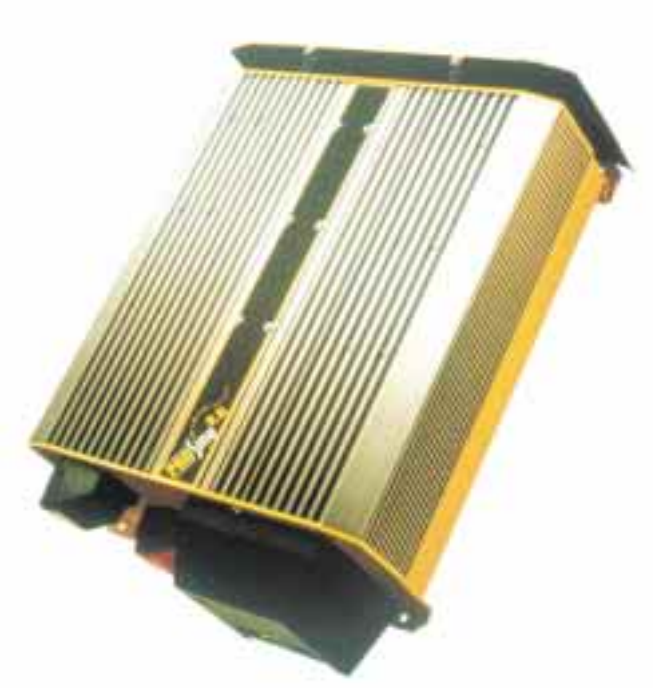
This small inverter/charger beats the pants off other sine wave inverters that cost hundreds of dollars more and weigh three times as much. The Statpower PROsine™ 2.5 KW Inverter/Charger makes cleaner and more reliable power than any utility or generator.

Shipping Container and Documentation

The PROsine 2.5 arrived at *Home Power* intact via UPS, in a rugged shipping carton. The documentation provided with this inverter/charger is outstanding. The docs came in three parts—a *Quick Installation Guide* for impatient installers, an *Installation Manual*, and an *Owner's Manual.*

The *Quick Installation Guide* is profusely illustrated with photos. It was all we needed to get the inverter installed and working. The 22 page *Installation Guide* covers all the material in the *Quick Installation Guide.* It's more thorough and contains many bits of line art to help the novice installer get everything properly and safely wired up. The *Owner's Manual* is 27 pages long and covers the actual operation of the inverter and charger.

We had no problems understanding the installation and operation instructions. Too much information, poorly presented, can be worse than not enough information. Statpower has done a great job with their documentation—the information supplied was complete, well organized, and easy to understand.



Above: The Statpower PROsine 2.5 inverter.

PROsine 2.5 Inverter/Charger Data

This is a pure sine wave inverter. Its single sine wave cycle has 667 steps—far more steps than other "sine" wave inverters employ. Many steps in the sine wave synthesis coupled with analog filtration yields power of higher purity.

The PROsine 2.5 is physically small for a high performance inverter. The unit measures 20 inches high by 15 inches wide by 5.5 inches deep (51 by 38 by 14 cm) and weighs 32 pounds (14.5 kg). This inverter/charger is far smaller and lighter than 2.5 KW sine wave models made by other manufacturers. Inverter weight and size is largely a function of transformer size. Statpower's high frequency switching power supply design requires a much smaller transformer than traditional 60 Hz inverters. (See *HP36,* page 36 for a detailed explanation and comparison of inverter designs.)

The PROsine 2.5 comes with a remote control and instrumentation panel and enough wire to mount it 50 feet (15.2 m) from the inverter. This distance can easily be increased to 100 feet with a standard four-wire telephone extension cord.

The PROsine 2.5 is rated at 2,500 watts output with a surge rating of 4,000 watts. Input voltage range is 10–16 VDC. Statpower also makes 24 VDC models of this inverter. The battery charger has a maximum rated output current of 100 amps. This inverter consumes less than 3 watts in search mode. Transfer time from AC source to inverter operation is 20 milliseconds. The

unit has automatic overload protection, short circuit protection, and reverse polarity protection via an internal fuse. This inverter is not designed for synchronous operation, selling power to an electric utility. It is designed as a stand-alone unit in both on-grid or off-grid applications.

Installation and Test System

Joe Schwartz did the actual installation late in September of 1998. He attached the inverter to the wall of our battery room and connected it to DC power at the main bus of our Ananda Power Center with two 4/0 (107 mm^2) copper cables. The inverter is protected on its DC input with an Ananda 400 ampere Big Switch and a 400 ampere Class-T fuse. The entire installation took less than two hours.

Statpower PROsine 2.5 KW

Input Data on the 12 VDC side			*Output Data on the 120 VAC side*				
Battery Volts	*Amps In*	*Watts In*	*Vp Out*	*V RMS Out*	*A RMS Out*	*Watts Out*	*EFF %*
14.20	6.0	85	173.6	122.8	0.31	38	45%
13.93	11.0	153	172.8	122.8	0.77	95	62%
14.10	16.0	226	173.2	122.7	1.31	161	71%
13.80	36.0	497	172.4	122.3	3.35	410	82%
13.40	51.0	683	172.8	122.0	4.66	569	83%
13.21	60.0	793	172.8	121.8	5.62	685	86%
13.23	88.0	1164	171.6	121.1	8.22	995	86%
12.93	110.0	1422	171.6	120.7	10.32	1246	88%
12.64	133.0	1681	170.4	120.3	12.30	1480	88%
12.38	167.0	2067	170.4	120.0	14.94	1793	87%
12.14	222.0	2695	168.0	118.7	18.70	2220	82%
11.91	276.0	3287	166.0	117.8	22.30	2627	80%

The PROsine 2.5 is fed by a 1,640 ampere-hour, 12 VDC Surrette lead-acid battery. This battery is charged by about 1.8 KW of PVs and a 1 KW wind generator. We also have two backup generators in the system—a Honda ES6500 120/240 VAC generator and a 100 ampere, 12 VDC Genny DeeCee.

Joe found the installation easy and straightforward. He commented that the unit's light weight made it much easier to install than some other sine wave inverters. The light weight and compact size of this inverter make it a natural choice for RVs and boats, or anywhere where space is tight.

Joe wired the 117 VAC input to the inverter using 8 gauge (8.4 mm^2) SO cord and a heavy duty three-wire plug. He connected the inverter output to a distribution panel with 8 gauge wire. The control and instrument panel simply plugged in with its RJ-11 phone jack.

Left: The Statpower's remote metering and controls.

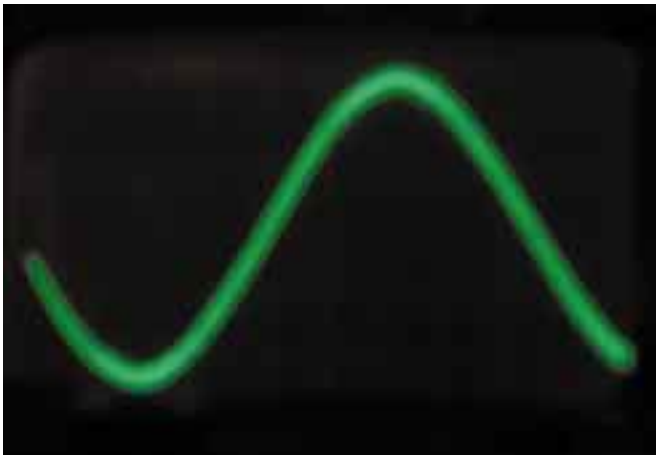
We program the inverter by DIP switches on the inverter's left side. It has settings for battery type, battery capacity, battery temperature (with an optional temperature probe), 117 VAC service rating, and load sensing. We had no problems programming the PROsine 2.5 to match our particular system.

Smooth Operation

Once the PROsine was properly installed, we put it into our normal operating regime. We used the inverter to power a variety of 117 VAC loads including computers, a laser printer, various construction tools, deep well pump, microwave oven, toaster, food processor, and other common household appliances.

We noticed immediate performance increases in the well pump and microwave oven. These inductive loads operated better on the PROsine 2.5 than on the previous sine wave inverter. The well pump delivered more water using less power. The microwave oven took less time to heat food. I attribute this to the PROsine's high power quality and ability to maintain output voltage. When powering inductive loads, a pure sine wave means better performance and lower energy consumption.

We found the control and instrumentation panel a joy to deal with. It's simple and clear. This panel has two bar graph LED meters. One is for battery voltage and the other is for both output current (when inverting) and input current (when battery charging). We can control the inverter/charger easily with a push of a button, and the LEDs tell us just what the inverter/charger is doing. The PROsine 2.5 has the most user friendly interface I've ever seen on an inverter.



Above: A photo from our oscilloscope shows the PROsine 2.5's waveform, loaded to 1470 watts output. Note the smoothness and lack of switching glitches.

The only operational wart we've encountered is the inverter's response time coming out of sleep mode. We'd like to see this three-second response time reduced to one second. This really only bothered us while operating power tools. We did not test the optional Advanced Control System (ACS) panel, listed at US$249. With this option, you can reduce the time delay to two seconds and fine-tune other variables.

Test Data

After about three months of day-to-day operation, we decided that it was time to test the PROsine 2.5 and see if it met Statpower's published specifications. The table shows the data we took from the PROsine inverter under actual operation. It met all of Statpower's specifications. The PROsine held its voltage well while under load—it never dropped below 117 VAC even when we overloaded the unit at 2627 watts. Peak voltage of the AC output also remained high—166 Vp at 2627 watts output. This outstanding performance insures that all loads run on this inverter will function well.

During the entire time we were testing this inverter, we kept its waveform up on the oscilloscope. It constantly remained a pure, smooth sine wave, even when we plugged in nasty inductive loads such as the well pump and microwave oven. The Statpower PROsine 2.5 KW Inverter/Charger makes cleaner and more reliable power than any utility or generator. While Statpower rates this inverter at less than 5 percent Total Harmonic Distortion (THD), we never saw anything on our oscilloscope to indicate that it went above 2 percent THD. The scope picture was always smooth and clear—no switching transients or dancing glitches.

Testing the PROsine 2.5 Battery Charger

When powered by our Honda ES6500 generator (120.3 VAC RMS at 16.2 amps RMS input), the charger delivered 117 amperes DC into our battery at 13.5 VDC. This is better than Statpower's specs. We also measured the power factor (PF) of the battery charger using a Brand 20-1850 digital power meter. The meter showed a 1.00 PF, confirming Statpower's claim of near unity power factor. This explains why we had been noticing that the charger seemed to load our generator less. A favorable power factor is another benefit of the high frequency switching design of this inverter.

We also recorded more ampere-hours going into the battery, with less fuel used in the big 6500 watt Honda generator. The battery chargers on most inverters have power factors of less than 0.75. This gives them reduced battery charging output and higher generator fuel consumption. The battery charger on the PROsine 2.5 is compatible with both sealed and vented lead-acid cells. It contains an equalization mode which allows equalization of cells up to voltages as high as 17.0 VDC.

Conclusions

The Statpower PROsine 2.5 Inverter/Charger is an excellent choice for both on-grid and off-grid use. It makes highly stable, pure sine wave power. It's easy to install and use. It makes no audio noise except for the fan which only operates when the inverter is heavily loaded. The battery charger in the unit is very compatible with engine/generators. With a retail price of US$2599.95, it's considerably less expensive than other sine wave inverter/chargers with similar capabilities. The PROsine 2.5 has earned itself a permanent home in our power room.

Access

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An EV Of Your Very Own

Shari Prange

Above: The Honda EV Plus is a very popular EV available for lease in many cities.

You're past the initial stage of curiosity. You've read about electric vehicles, maybe even driven one. Now it gets personal. How can you put an EV into your garage?

Define Your Goals

Before you start shopping, take a minute to examine your needs. This involves asking yourself a lot of questions. It's a good idea to write down your answers, to clarify the picture.

Will this be your only car, or one of two or more vehicles? Will you need a back seat for the kids? Do you need trunk space for groceries or golf clubs? Do you crave a sports car or convertible? How far do you need to drive in a typical day? What's the longest drive that must be done by this car? Is it possible to charge during the day at work? What top speed do you need? Will you be driving at night, in wet or cold weather? Is air conditioning essential to survival where you live? Are your roads hilly, bumpy, unpaved? And, last but not least, what's your budget for acquiring the car?

That's a lot of questions. But if you take the time to answer them all, and add anything that's important to you but not on that list, you'll have a pretty good profile of the car you want and need. Be sure you do a little research on any tax breaks or other incentives available in your area (see *HP68*). Then adjust your vehicle budget accordingly.

Now you're ready to start sorting through options. We'll start with the "easiest" options, the ones where you just put down your money and drive away. We'll work our way down to the ones that include skinned knuckles and jack stands. You will notice that there is generally an inverse relationship between the amount of money you spend getting the car, and the amount of time you spend.

Step Right Up!

Yes, you can get a ready-to-drive electric car with full factory support. Every major manufacturer has at least one electric vehicle in the lineup. There are, however, a few restrictions which may put some of these cars out of the running for you.

Below: Many of the new EVs from the major manufacturers are only available as fleet vehicles at this time.

For a start, some of them may not be available in your area. The Toyota Prius is not yet available anywhere in the United States, but will be in a year or two. The GM EV-1 is a very nice car, but may not be offered in your city. Or you may not meet GM's strict criteria, which include living within a specified radius of a dealership. Honda is also offering the EV Plus, another fine car with similar limitations on availability.

Other vehicles, like the Ford Ranger or GM S10 pickup, are only available to fleets. And most of the electric vehicles offered are not available for sale, but only for lease. The lease payments can be several hundred dollars a month. On the other hand, this does include a full warranty (even the battery pack) and may also include insurance.

Then there are the minor manufacturers. Solectria, in Massachusetts, has been selling the Force for several years. This is a professionally done standardized conversion of a brand new Geo Metro. These cars have found their way into numerous fleets and have served successfully there, and have also made many private owners happy.

Corbin, located in California, has just launched the Sparrow. This is a fresh design from the ground up. The Sparrow is a unique, fully enclosed, single-seat, three-wheeled vehicle for the commute driver (see *HP67*).

The advantages of buying from a manufacturer are many, including factory warranty and support, full amenities, and professional "fit and finish." You don't have to pick up a wrench, or know anything about building a car. The disadvantages are high price, limited selection, and limited availability. If you can find a car that meets your needs, desires, and budget, and it's available in your area, go for it.

Clean Cream Puff

The next easiest option is buying a used electric car. Fleets "turn over" their rolling stock every few years, and these vehicles are available at auction to any buyer. Also, private EVs get sold for the same reasons used gas cars get sold: the owner had a baby and needed a back seat, got issued a company car, wanted to get something newer, etc. These cars may be commercially built or hobbyist conversions.

The best way to tap into the used EV market is through electric car clubs and the internet. EV club newsletters usually have classified ads, and may have notices of fleet auctions. Searching on the internet will turn up sites offering used EVs for sale.

Above: You can get a very nice electric conversion by having a mechanic build it for you.

The advantage to buying a used car is, of course, lower price. It might also be the only kind of EV that is available in your area. Frequently, these cars have a dead battery pack, so you need to factor a replacement into the deal. Maybe you can negotiate the seller into installing it for you.

One of the nice things about EVs is that they don't start to fall apart the way gas cars often do. Sure, the battery pack wears out, and so will the brakes and wheel bearings. But most of the normal wear items in a gas car have been removed. The electric drive train has one moving part—the motor—and with a change of brushes every 80,000 miles (130,000 km) or so it just keeps on going. So a used EV, if the chassis is well cared for, retains much of its value.

On the downside, it may take you longer to find the car of your dreams as a used car. And if it isn't in your town,

Below: Sometimes an older, "entry-level" EV can be found on the internet, and can be a good deal.

it might cost you a significant amount to ship it home. As with any used car, you need to exercise caution. It helps to have done your homework, so you know a little bit about various motors, controllers, batteries, chargers, and so forth. This is especially true if the batteries are dead and you can't test drive the car. If you are unsure of your knowledge, find an experienced EV person in your area to look at the car with you.

If the car is in another town, see if you can find a knowledgeable local there to check it out for you. You can also get some free advice from EV parts companies. We're generally small businesses, and happy to spend a few moments answering questions for the good of the cause, even if you're not buying anything from us.

Will Build To Suit

The next choice is to have a car converted for you. An advantage to this is that you get to choose the chassis you want, and what you want in it. If you've just got to have a convertible, then by all means, get one. You want the car optimized for tire-burning acceleration? Can do. You don't really care about speed, but want every possible mile of range? No problem.

All of this is limited by your budget and by the constraints of the technology, of course, but you do have more flexibility in many ways with a custom conversion.

The disadvantages include the cost and time for the custom work. Your mechanic will have between fifty and a few hundred hours in the project, which will be spread over several weeks.

Help Wanted

First, of course, you need to find a mechanic to do the job. Employing a hobbyist to build your EV is a lot like employing an amateur mechanic to work on your gas car. Some of them are bargain geniuses, but some of them will assemble a contraption that never quite works right, that no one else can even begin to understand. Proceed with caution. If you don't feel qualified to judge the mechanic's skills, then get an independent opinion on his previous work from someone who is qualified. Or buy a little peace of mind and go to a professional shop. You can get a lemon there too, but your odds are better.

If you're lucky, there's an EV conversion business in your area. More likely, there is not. Your next best bet is to approach an independent garage that specializes in your model of car. You will need to find a mechanic who's a little adventurous and up for an interesting project. It may help if you can show him the installation instructions for the kit you intend to buy, or put him in touch with your kit supplier in advance. This will give the mechanic some idea of just what he's getting into.

There's Kits And There's Kits

You should be aware that there are different levels of conversion kits available. In very general terms, there are complete bolt-in kits that are custom designed and pre-fabricated for a specific car model, and there are more basic, generic kits. The bolt-in kits will cost more, but will save money on labor, since the mechanic doesn't have to design or fabricate any parts. Your mechanic may be more inclined to take on the job if he has the security of a "paint-by-numbers" kit to work with. On the downside, these kits are only available to fit a few models of cars.

The other type of kit is universal. It contains all the essential electric drive system components, but none of the custom pieces, such as battery boxes, suspension modifications, component mounts, or wiring looms. (The one exception is the adaptor. Any good kit should include the appropriate motor/transmission adaptor for your model of car.) This type of kit costs less, and is very adaptable to different chassis. However, it requires a more confident and dedicated installer, and will cost more in labor.

A Learning Experience

Another option, particularly if your budget is limited, is the auto shop at your local high school or community college. Many of these places would jump at the chance to do a conversion as a class project, but they are short of funds. If you supply the donor car and the parts, and they supply the labor, both sides win. The disadvantage to this option is the time involved. It may take an entire semester (or even school year) for the class to finish the job.

Goodbye, Gasoline

These are some of the ways you can own an electric vehicle without becoming an engineer or mechanic yourself. Next time we'll talk about finding a suitable donor chassis and rolling up your sleeves.

Access

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this is page 71

Building an Inexpensive Time-In-Use Meter

Homebrew

Bob “Mac” McIlvaine

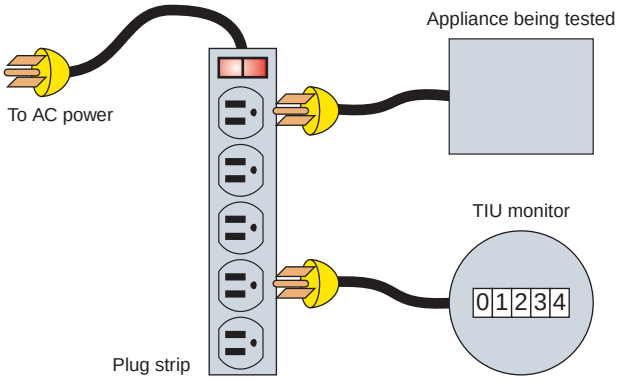
I’ve been an advocate of alternative energy systems since the 1970s, but have only recently begun my personal journey to power independence. When I began to look at power usage around my house, I realized that I didn’t have a good handle on how often and how long appliances were actually being used. Yes, my wife and I could do the guessing game—“Well, I think we use that about an hour, two or three times a week. What do you think?” This didn’t seem to provide the accuracy that would allow me to develop reliable estimates.

Mac’s R & D Lab

I decided that I needed a device to monitor the length of time an appliance or other load was actually in use over a period of time. I looked around for a while and didn’t come up with anything, so I decided that it was time to get Mac’s Research and Development Laboratory—actually, it’s just my basement shop—to work building the required unit.

I wanted to be able to monitor the Time In Use (TIU) on several different items around the house. The well pump, furnace, TV, stereo, and a variety of lights were all candidates. Devices that plugged in were easy. I had already set up most of them with power strips to put an end to any phantom loads they presented. This meant that I could use a simple elapsed time indicator.

Figure 1: The Five Dollar Version



The Five Dollar Version

Elapsed time counters are used in many industrial applications to keep tabs on when machines need maintenance. These units are usually available at used equipment dealers. They typically have a face that is about three inches (76 mm) in diameter with a counter that resembles an automobile odometer, with several wheels numbering 0 through 9. Each number on the far right wheel represents a tenth of an hour, or six minutes. I found a bin of them at my local surplus electronics dealer for about $2 each.

I connect these units across the leads of the load on the device side of its on-off switch. They simply run when the machine is on and count the time in tenths of an hour. Add a power cord and plug, and it can be plugged into the power strip of the device in question. This means that it will monitor the TIU whenever the power strip is turned on. See Figure 1 for details.

The Ten Dollar Version

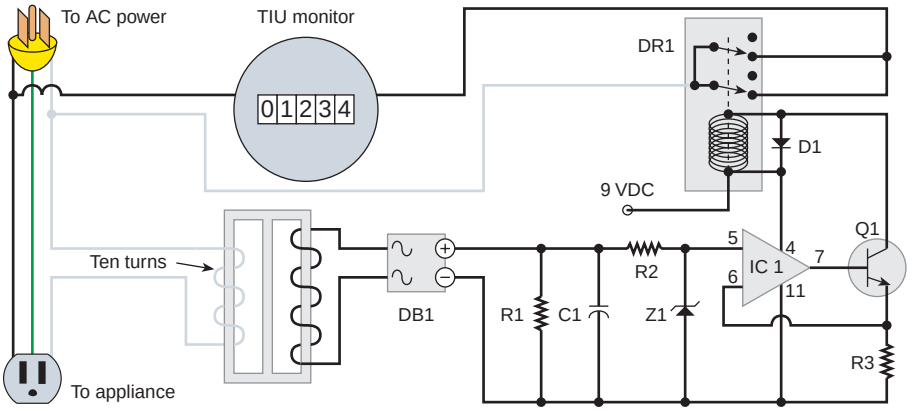
For devices such as the well pump, which are permanently wired, another method is required. I decided to monitor the TIU only when current was present. This required some electronics wizardry.

Note: The next sections describe circuits and techniques that can potentially expose the experimenter to lethal voltages. If you don’t feel comfortable in these areas, get someone who is experienced to help you.

Figure 2 shows the circuit I devised. The key to the circuit is the magnetic pickup. You can either find these at surplus houses or salvage a clamp-on current meter. I scavenged a used signal transformer instead. I carefully removed the primary winding, leaving the secondary intact. Then I found a length of wire that would handle the expected maximum current and threaded it around the empty side of the transformer core ten times. This new winding was then put in series with one lead of the device under test.

The sensitivity of this circuit is determined by the number of turns on the modified transformer. The more turns on both the primary (our ten-turn winding) and the secondary (the remaining original winding), the smaller the current required in the primary to activate the TIU unit. The primary winding should use the largest wire practical to minimize the resistance in series with the device being tested. The transformer I scavenged was about 2 inches (51 mm) square and I was able to use 14 gauge (2 mm^2) stranded wire. The prototype was able to activate with as little as 0.01 amps flowing in the primary. I could probably have used 12 gauge (3.3 mm^2) wire and fewer turns. This would have allowed me to monitor larger loads, while sacrificing the low current sensitivity.

Figure 2: The Ten Dollar Version



The secondary is connected to a diode bridge that rectifies its output. The rectified output is then fed to a capacitor/resistor network to produce a DC voltage. This DC voltage then turns on the opamp (operational amplifier) and provides base current to the transistor. This activates the relay and the TIU monitor. The 5.6 volt zener diode limits the voltage seen at the input of the opamp. In the prototype, the opamp and relay coil are powered by a 9 volt battery, but you can use any convenient 6 to 15 VDC source.

To test a device, plug it into the socket shown on the lower left in Figure 2. Insert the plug into an AC outlet. When the device is switched on, the circuitry activates the TIU unit. When the device is switched off, the TIU unit is deactivated. The display will accumulate the time in use.

In some situations, this type of connection may not be practical. If this is the case, use this trick: With some work, the E-shaped laminations of the transformer can be made to slide open and closed. This usually requires loosening the lacquer that binds the laminations. Slide the laminations open, then carefully clamp them over one conductor of the device in question. You have now created a non-invasive homemade clamp-on current monitor. Be careful not to damage the insulation of the wire you are clamping around. Note that this method decreases the sensitivity of the circuit, since the single wire passing through the transformer core is, in effect, a one-winding coil. This means that it won't work on low-power devices.

Application and Results

To determine the length of time on a load, connect the TIU unit to the device in question and zero it. Note the time of connection. The test is now underway. After an appropriate amount of time, the time displayed on the monitor is divided by length of time the unit was connected. This gives the amount of time the device was used during the test period. For example, if the TIU unit shows twelve hours and the device was connected for three days, this would be an average of four hours of use per day.

I'm currently using the $5 version in a long-term test on my well pump. The test has been underway for about 98 days and has shown that the pump runs an average of twenty minutes per day. The $10 version is monitoring our TV, and has shown that it gets used about thirty minutes per day. This figure will probably increase when my wife starts watching the football and basketball games. This data will be very valuable when I sit down to calculate the number of solar panels and batteries I'll need to be able to take our house off the grid.

Parts List

D1	Diode, 1N1004
DB1	Dip package diode bridge
DR1	Dip package DPDT relay
C1	Electrolytic capacitor, 50 µF, 50 VDC
R1, R2	Resistor, 4.7 KΩ, 1/4 watt
R3	Resistor, 10 Ω, 1/4 watt
IC1	Integrated circuit, LM34
Q1	Transistor, 2n2222
Z1	Zener diode, 5.6 V, 1/2 watt

Access

Author: Bob McIlvaine, 36 Parker Rd. Brookline, NH 03033 • mac@mv.mv.com

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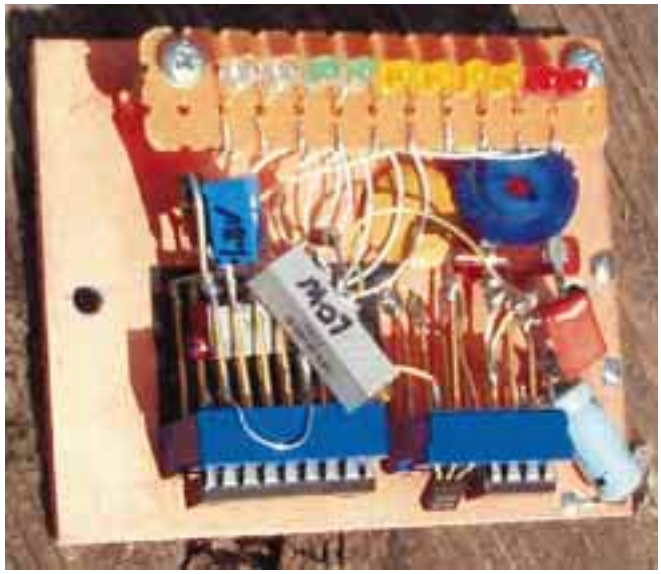


This article describes a low power voltmeter circuit that can be used with alternative energy systems that run on 12 or 24 volt battery banks. The voltmeter is an expanded scale type that indicates small voltage steps over a 10 to 16 volt range for 12 V batteries and over a 22 to 32 volt range for 24 volt batteries. It is possible to set the meter to read equal steps across a variety of upper and lower voltages.

Power consumption can be as low as 14 mW when operated at 12 V, or 160 mW when operated at 24 V. The meter saves power by operating in a low duty cycle blinking mode where the LED indicators are only on and consuming power briefly during a repeating 2 second cycle. The circuit may be switched to a high power mode so the active LED stays on at all times.

Light Emitting Diodes

Different colored LEDs may be used for the voltage level indicators to allow users to read the meter in the dark. With the new blue LEDs, it is possible to have a nice looking rainbow of colors using two LEDs each of red, amber, yellow, green, and blue. The circuit will also work with inexpensive and common red LEDs. If the circuit is to be used in sunlight, ultrabright LEDs should be used, and even those may be hard to read without some kind of sun shield.

The meters can be used to monitor portable battery operated systems or can be mounted in a home or shop to monitor a power system battery. The cost of the parts for the circuit is around US$25. These parts are commonly available, except for the optional blue LEDs. If blue LEDs are used, expect to pay a premium for them. They cost several dollars each, compared to around 15 cents each for the other colors. But the blue LEDs do look nice.

The circuit may be built with either the CMOS ICM7555 timer or the more common bipolar 555 timer. The 7555 timer will provide much more efficient operation and should be used for systems with small batteries. The voltmeter works nicely with the solar charge controller and low voltage disconnect circuits described in the homebrew sections of *HP60* and *HP63*.

Theory for 12 Volt Operation

The heart of the circuit is the LM3914N dot-bar voltmeter IC, U2. This chip is operated in the expanded-scale mode so that the circuit responds in the 10 to 16 volt range. U2 outputs a steady voltage on pin 7 from the internal voltage reference. This is fed via voltage dividers VR2 and R5 to the internal reference input pins to set the range that the meter is sensitive to. The measured voltage is fed in on pin 5 via the voltage divider consisting of R4 and VR1.

This divider scales the input voltage down to a range that is useful to the IC. The basic expanded 12 V scale LM3914 voltmeter circuit was published in *Nuts & Volts* magazine (*Electronic Q&A* column, July 1997). A similar circuit was shown in *HP10*, on page 27. The U2 positive supply is connected to pin 3, which is nominally 12 V. The U2 negative supply is switched on momentarily via transistor Q1. This switching action is what makes the circuit efficient since U1 (ICM7555) consumes a mere 0.34 mA while U2 consumes around 18 mA with one LED on.

Specifications

	7555 timer	*555 timer*	*7555 timer*	*555 timer*
Operating Voltage	10–20 V (12 V)		20–35 V (24 V)	
Nominal Scale	10.5–15 V in 0.5 V steps		22–31 V in 1 V steps	
Idle Current	0.34 mA	6.1 mA	6.3 mA	24 mA
LED ON Current	18 mA	22 mA	12 mA	28 mA
Average Current	1.2 mA	6.9 mA	6.6 mA	24 mA
Average Power	14 mW	83 mW	160 mW	580 mW
Duty Cycle	Approximately 5%			
Blink Frequency	Approximately 0.5 Hz			

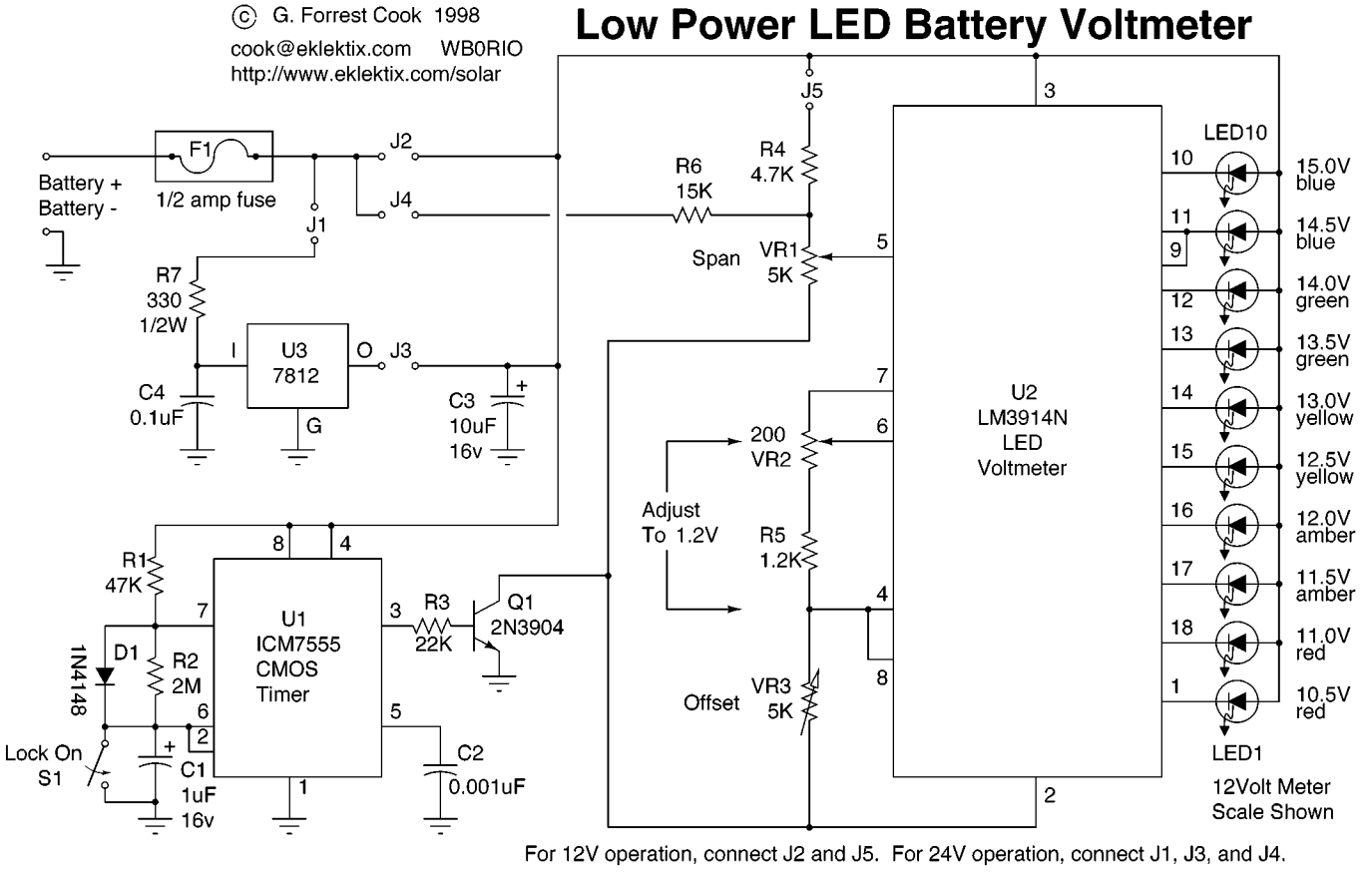
Timer

The ICM7555 timer, U1, is wired to run in an astable (free-running) mode with a narrow pulse width square-wave output. The duty cycle of U1 is controlled by the ratio of R1 and R2. R2 may be adjusted to a smaller value if faster blinking is desired, and a potentiometer may be substituted for R2 if a rate adjustment is desired. R1 may be increased if a longer on-time is desired. Changes in R1 and R2 will affect the average current that the circuit consumes. The frequency of oscillation is determined by C1, R1, and R2. C1 may be either an electrolytic or poly capacitor. If an electrolytic part is used, be sure to connect the positive terminal to U1 pins 6 and 2, and the negative terminal to ground.

The output of the timer IC is fed through current limiting resistor R3 to transistor Q1, which controls power to U2. Capacitor C2 filters the control voltage input to U1, and capacitor C3 provides DC filtering for the whole circuit. When the lock-on switch across capacitor C1 is closed, the output of the timer remains on. This enables the U2 circuitry and increases the current drain to 18 mA.

The reason the switch is not simply wired across the transistor is to keep the negative supply to U2 the same as when the circuit is pulsed on. This maintains the same calibration on the LEDs in both modes because the transistor's voltage drop is always part of the circuit. Last but not least, fuse F1 protects against a fire hazard should the circuit become shorted out.

The average current is calculated by adding the constant current required by U1 to the product of the current from U2 times the duty cycle (see the specifications for details). To operate the circuit in the 12 V mode, wire the circuit so that jumpers J2 and J5 are shorted. Parts U3, C4, R6, and R7 may be left out in 12 V mode.



Theory for 24 Volt Operation
When wired for 24 volt operation, the meter responds in the 20 to 32 V range. R6 is connected to the 24 V supply instead of R4. The greater value of R6 scales the higher input voltage to a range that is useful for U2. Voltage regulator U3 with series resistor R7 scales the 24 V down to a regulated 12 V to provide the proper operating voltage for the ICs. Resistor R7 assures that the input voltage to the regulator stays well below the 35 V absolute maximum specification of the IC.

Operation in 24 V mode is less efficient than in 12 V mode because of the extra power dissipated by the voltage regulator and R7. For efficiency, only the 7555 timer should be used in the 24 V version of the circuit. To operate the circuit in the 24 V mode, wire the circuit so that jumpers J1, J3, and J4 are shorted. R4 may be left out in the 24 V mode.

Construction
I built the prototype of the circuit on a two by three inch (51 by 76 mm) copper plated PC board. I installed the chips in wire-wrap sockets, glued to one side of the circuit board. I soldered the parts to the back of the wire-wrap socket pins. I used the copper as the ground plane, and soldered all ground connections directly to the board. I arranged the LEDs in an array on a separate piece of perforated circuit board, and wired them back to U2 using wire-wrap wire. I mounted the perforated LED board to the main circuit board using spacers and machine screws.

If you solder to the LEDs, be sure to connect a heat sink clip to the LED pins before soldering, since LEDs are easily destroyed by excess heat. The 7555 timer and the blue LEDs are static sensitive. Avoid zapping these or any of the other semiconductor parts with static electricity. Beginners should probably use a larger piece of circuit board to start with—wiring mine was very tight. Drill any mounting holes in the circuit boards before connecting the parts. Use a thin gauge electronics solder and a 30 watt electronics soldering iron. Voltage readings may be printed or drawn on a piece of paper and placed next to the LEDs.

Alignment
It will be necessary to have an adjustable regulated DC power supply and an accurate voltmeter to perform the alignment. Follow these instructions for the 12 V version of the circuit. Close switch S1 so that the LEDs stay on. The first step of alignment involves setting the reference voltage for U2. Connect the external voltmeter across U2 pins 6 and 4 and adjust VR2 for a reading of 1.2 volts. Center the settings of VR1 and VR3.

At this stage, you should decide what scale you want the meter to read. I was able to adjust the circuit to read 0.5 V steps between 10.5 and 15 V, or 0.3 V steps between 10.5 and 13.2 V. For this example, I will use the 10.5 to 15 V scale. The span between the end points is 4.5 V. Adjust the power supply from 9 V to 15 V and see what the meter reads. It may not read at all until the potentiometers are near the right range. If this is the case, set the power supply to 12 V and adjust VR3 until one of the center LEDs light.

Adjust the power supply until the first LED just comes on, and measure that voltage. Then adjust the supply up until the last LED just comes on. Measure that voltage and subtract the first voltage from it—this is the span. Adjust VR1 and repeat the previous adjustment until the span is 4.5 V. Now set the voltage to 10.5 V and adjust VR3 until the lowest LED just turns on. VR1 and VR3 interact so it may be necessary to perform the adjustments a few times to get it right.

To align the 24 volt version of the circuit, it will be necessary to have a variable power supply that can be adjusted up to around 30 V. A good method for achieving a higher voltage adjustable supply is to put a charged 12 V battery in series with a lower voltage variable supply. As always, when dealing with high current sources such as batteries, use fuses in the wiring and insulate exposed connections.

Using the Meter
Connect the appropriate voltmeter circuit across a 12 or 24 volt battery and observe the blinking LED for a battery voltage indication. Activate switch S1 for a display that will remain on. If the voltage is higher than the top step, the highest LED will remain on. If the voltage is lower than the bottom step, all of the LEDs will stay off.

Parts

U1	ICM7555 CMOS timer IC (Harris/Intersil)
U2	LM3914N LED voltmeter (National Semiconductor)
U3	7812 12 V regulator (National Semiconductor)
Q1	2N3904 NPN silicon transistor
D1	1N4148 silicon switching diode
LEDs	Red, yellow, amber, green, and blue LEDs in any arrangement, see text.
C1	1.0 µF capacitor, electrolytic may be used.
C2	0.00 1µF ceramic disk capacitor
C3	10 µF electrolytic capacitor
C4	0.1 µF ceramic disk capacitor
R1	47 KΩ 1/4 W resistor

R2	2 MΩ 1/4 W resistor
R3	22 KΩ 1/4 W resistor
R4	4.7 KΩ 1/4 W resistor
R5	1.2 KΩ 1/4 W resistor
R6	15 KΩ 1/4 W resistor
R7	330 Ω 1/2 W resistor
VR1 & 3	5 KΩ trimmer potentiometer, 10 turn style
VR2	200 Ω trimmer potentiometer, 10 turn style
F1	1/2 A DC fast blow fuse
S1	miniature toggle or pushbutton switch

Access

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www.eklektix.com/solar

Parts: Circuit boards may be made available for this project. Check the author's Web site, or write or email for details.

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Renewable Energy Terms

Ian Woofenden

Ampere, or Amp for short—rate of electrical current flow

Derivation: Named after Andre Marie Ampere (1775–1836), the French physicist who developed the first electromagnet and first used the word "current."

What's an amp? We talk about them all the time in renewable energy circles, but there is still plenty of confusion about just what the term means. An amp is a measure of current flow. But is it a quantity, a certain amount of electricity? No, an amp is a quantity flowing over a specific time—a *rate* of current flow.

I think it's unfortunate that the term doesn't *sound* like it's a rate. When we say "miles per hour," we know we are talking about a rate of speed. But "30 amps" doesn't sound like a rate of current flow. So we need to remind ourselves that an amp is in fact a coulomb per second—6.28 billion billion (6.28×10^{18}) electrons passing a point in one second. We can compare 15 amps and 50 amps when talking about electrical energy to 15 miles per hour and 50 miles per hour when talking about travel.

When we say a light "draws 2 amps," we mean electrons flow through it at a certain rate. A motor that draws 16 amps has current that is flowing eight times faster. If both the motor and the light are left on for an hour, eight times fewer electrons will pass through the light than through the motor. The amp rating of each load tells us the rate at which electrons will flow through it when it is on.

And it doesn't matter *how* they are flowing. In direct current (DC) circuits, the flow is all in one direction. In alternating current (AC) circuits, the direction of flow is constantly changing. An ammeter (a meter that measures amperes) measures the current in a circuit. DC ammeters measure current in one direction, while AC ammeters measure alternating current, ignoring the direction of flow.

Remembering that an amp is in fact a rate of current flow makes electrical talk a lot easier to understand. Perhaps you can see why we shouldn't say, "amps per hour." Next column I'll talk about that, and how to get from amps to *amp-hours*.

Access

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Mike Brown

"I just acquired a surplus aircraft generator and I'm planning to build an EV with it. What can you tell me about it? Is this a good place to start?"

As soon as I read the question, I knew what I had to do. In preparation, I read some Bram Stoker, rented "Buffy The Vampire Slayer" from the video store, and put garlic pasta on the menu for dinner. Reinforced by these actions, I am now going to attempt to put an end to one of the undying myths of the EV world: *Aircraft Generators Make Great EV Motors.*

First, let me say a few words in their defense. Aircraft generators are fine, precision-made machines. They do their very important job extremely well. They are carefully engineered and built to aircraft or mil-spec standards. They are great generators, but they are bad EV motors. Let's see why.

Mechanical Problems

In an airplane, the generator is mounted on an engine and driven by an accessory drive. Because the accessory drive is supported by its own bearings, the bearing on the drive end of the generator is lightweight. It is only expected to partially support that end of the armature.

This becomes a problem when the generator is used as an EV motor. This lightweight drive end bearing will fail quickly from the radial loads imposed by the weight of a flywheel and clutch assembly, in addition to the axial loads imposed when the clutch is disengaged. This problem can be overcome by designing and building an adaptor with a pair of heavy duty ball bearings to handle the loads. But this solution brings with it penalties of increased weight, cost, complexity, and a physically longer motor/adaptor package.

Another mechanical problem is the drive end of the armature itself. Because of the aircraft's demand for reliability, the drive end of the shaft is a 7/8" (22 mm) diameter 16 tooth male spline that fits into a matching female socket on the accessory drive. The equivalent female socket suitable for an adaptor hub is in very short supply, and having one made in a machine shop is an expensive proposition. These mechanical problems alone should be enough to keep aircraft generators out of EVs.

Electrical Problems

The second problem area is electrical. The majority of the aircraft generators out there are shunt field or separately excited field machines. Since their rated output is 30 volts, the maximum field voltage should not exceed 30 volts at 16 amps. This brings us to the heart of the electrical problem: how do we control the voltage to the motor, which controls the speed of the EV?

In the early days, the parallel/series control system was the most widely used. This system had the battery pack split into two separate packs of equal voltage. The parallel mode provided a voltage output equal to the voltage of each individual pack, with twice the amperage capacity—good for take-off. The series mode provided the sum of the voltages of the individual packs, with the amperage capacity of a single string of batteries.

This system gave two voltages to the armature, and thus two motor speeds. The field volts and amps were usually supplied by a 24 volt tap off one of the individual battery packs. This led to an uneven discharge of those batteries and a shorter life.

The Willey models 7, 8, and 9 transistorized speed controllers were one of the first steps toward the controllers we use today. They had a separate field control option that eliminated taps, and a completely variable voltage to the motor, but not without a price. The armature windings of the generator do not provide enough inductance for the controller to work, so a heavy, expensive, and now practically non-existent inductor had to be added in series between the controller and the generator/motor.

This was also true of the PMC 21 and 25 controllers, which did not have the field control option. The PMC 1209 and 1221 also require an inductor, which still leaves the field control problem. Their incompatibility with modern control systems is another reason aircraft generators do not belong in EVs.

Poor Performance

The third problem area is performance. How well does the EV drive and how reliable is it? The first EV I built was a Fiberfab Aztec kit car body on a VW Bug chassis—a very light car. It was powered by an aircraft generator from a 48 volt battery pack connected in two 24 volt packs for a parallel/series control system. The best range under controlled conditions at an EV rally was 42 miles (68 km). Range is a function of battery capacity versus amp draw. With the ampsucking motor drawing 800+ amps for normal acceleration and 250 amps for cruising, this range was the best that could be expected.

The top speed was 60 mph (97 kmh). Because it only weighed 2100 pounds (953 kg), the Aztec was able to keep up with traffic fairly well and climb moderate hills. However, this wouldn't be true for all cars. I recently received a call from a person who had converted a VW Bug with an aircraft generator. He wanted to know why he couldn't climb a hill that was on his way home. The answer was the generator/motor.

The Aztec, as it was originally built, was a marginal, low voltage car when compared with its modern configuration of 96 volts and a suitable series motor and solid state controller. Even at a paltry 48 volts, the generator was operating at twice its rated voltage and half its rated speed. Under these conditions, it required forced air ventilation by a fan producing a minimum of 100 cubic feet per minute to survive at all. As it was, I still burned up a field winding and two armatures. Some of the damage could have been from inexperience on my part, but most of it is consistent with other peoples' experiences.

Suit Yourself

The list of horrors given above could be expanded upon, but I don't think it should be necessary. If you want to build a slightly cheaper but poor performing, unreliable EV with an aircraft generator for a motor, go ahead. But be prepared to redo it at some point with a real motor to get a useful, reliable EV. And by the way, everything I said about aircraft generators would also apply to the less common aircraft starters.

I hope by hammering on these three stakes—er, I mean problem areas, and exposing the monster to a little daylight, I have finally laid to rest the *Aircraft Generators Make Great EV Motors* myth.

Send me your questions, comments, or gremlins for exorcism.

Access

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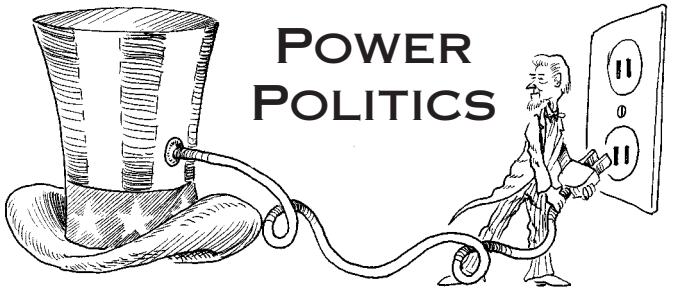

Down in Flames, An Autopsy of Prop 9

Michael Welch

It's a sad day for US energy policy and for participatory democracy. Utilities broke out the big guns to soundly defeat California's Proposition 9 in the November election.

Prop 9 was a grassroots effort to fix what was wrong with the utility deregulation law in California. It would have saved ratepayers about 20 percent on their electric bills by making utility owners cover their own overly expensive investment in nuclear energy. Prop 9 would have resulted in two nuke plants shutting down because they can't compete economically with other power sources. For more information on Prop 9, see pages 88 and 94 in *HP67.*

California's legislature had included a multi-billion dollar bailout for nuclear utilities in the original deregulation law. It was a sweetheart deal made behind the backs of the citizens and propagated by the massive influence of California's nuclear utilities. The utilities are very wealthy. They own the Public Utilities Commission, many legislators, and both the incoming and outgoing governors. They consider this influence an investment in their future, and it seems to have paid off.

Massive economic influence was brought to bear against the voters in the weeks leading up to the election. Utility "front groups" spent over $40 million dollars on the anti-Prop 9 campaign, outspending consumer advocates by about 20 to 1.

The Initiative Process

California has been fortunate to have a state constitution guaranteeing the right to an initiative process. The people who set up the process knew there could be times that our legislature and governor might not act in the best interest of the citizens. They realized that our representatives might instead yield to the influence of the wealthy and powerful. The initiative process allows voters to participate directly in decisions that are too important to leave to the legislators or that were improperly enacted by them. Such was Prop 9.

Initiatives can get on the California ballot in two ways. Either the legislature can include an item on the ballot or the citizens can petition the government to place it on the ballot. Proposition 9 was petition-based. Several non-profit consumer groups put together an initiative that they hoped would do the job without being overturned by a court challenge. Then legions of citizens circulated the petitions, and gathered enough signatures to get Prop 9 on the ballot.

But most voters were unable to ferret out the facts among the lies and fear-mongering. The well-designed smear campaign run by California's nuclear utilities was to blame. This tactic has been commonplace in US politics for a long time, but it has only recently become common in initiative campaigns. Here's how it worked.

Utility Strategies

1. Torpedo the Initiative Process

Many of us mistakenly felt the initiative would easily turn into a success, empowering the citizenry to correct an obvious and horrible wrong. But it quickly became evident how hard the utilities would fight Prop 9. They did everything they could to stop the petition via the court system, but the courts agreed with the petitioners that the proposition should not be excluded from the ballot.

2. Exert Political Power

The utilities exerted their vast influence on the Attorney General's office. He succumbed, and the legal description that appeared with the petitions and on the ballot was misleading enough to help confuse the issue.

3. Make Up an Organization

The utilities set up a couple of pseudo-organizations with names that sounded a lot like they were on the side of consumers and ratepayers. If you are trying to fake out the electorate, name your group "Californians Against Higher Taxes and Higher Electric Rates" even though your purpose is nearly the opposite.

4. Manipulate Influential Citizen Groups

The utilities called in their favors among the larger environmental groups that have access to utility

executives. Many grassroots activists are concerned that some of our colleagues have been influenced by the utilities. We have been nervously watching professional groups like Natural Resources Defense Council (NADC) negotiate "on our behalf" with California utilities.

When you get something out of the utilities, there is often a stiff price tag for that access, and it looks like PG&E and Edison exacted their payment. It was quite a feather in the utility cap to have NRDC, the Environmental Defense Fund, the Planning and Conservation League, and others all actively fighting Prop 9.

5. Bury the Truth

The next step in the utilities' assault on Prop 9 was to bury an analysis from the California Energy Commission verifying that the law would save California ratepayers a lot of money. First, the utilities' influence got the CEC to censor the original report as being an early draft, premature and incomplete. Then, even though the study was finalized more than two weeks before the election, the utilities succeeded in delaying its release until well after the election. As expected, the report showed that there would be dramatic decreases in customers' bills if the proposition passed.

6. $40,000,000 Media Blitz

Finally, came the three-pronged media attack which left Californians dazed and confused. More than $40 million dollars was spent on the attack. The first ad showed images of trains, planes, and animals all running backwards, with a narrator telling us how Prop 9 would undo all the effort put into California's deregulation. Next, commercials and mailers claimed that Prop 9 would not help competition, but would actually end it. Finally, utility supported weasels spent much of their ad money telling the public that Prop 9 would result in higher, not lower, electricity costs.

Results

Less than 27 percent of California voters voted yes on Prop 9. You can imagine how disappointing this was to folks actively fighting for the law. A huge battle was lost, but there is an even bigger picture. As an informal election observer, I think the conclusion is clear. The corporate world owns the initiative process just as they own many of our elected officials. California can expect to see big business weigh in every time there is an environmental or consumer-oriented ballot initiative that could affect the corporate bottom line.

It is incredible to realize how much attention people pay to a media blitz—even slick television ads with suspicious origins. My kinder side thinks that the success of media campaigns is due to a human need to believe other people. We have an inherent belief that most people are basically honest. Viewers are pre-disposed to trust what the TV tells them, and the corporations and politicians know it. Trust is a good thing—except when it is twisted and manipulated.

Resurfacing Mantra

What do we do about this problem? I suggest we just get more alienated, try to ignore politics even more, and put our trust in the corporations and media... That was just to see if you were reading carefully or if yet another media piece had zoned you out.

The mantra: *Institute Real Campaign Reforms*. Say it again, and repeat it as often as possible to every level of elected government. California's one-sided deregulation wouldn't have happened in the first place if politicians had been listening to the public. Instead, the politicians listened first and most often to those paying the campaign bills—the corporations.

None of our country's more serious ills will be fixed until the corporations are effectively taken out of the election process. Nor will they be fixed until we effectively limit the access of corporate lobbyists to our government. Repeat the mantra again, on the phone to your local officials.

Not All Bad

Can we find some good that came out of the Prop 9 debacle? You bet! In spite of the utilities' huge campaign, over two million California voters took enough time to get the facts on Prop 9. The initiative's backers were confident that as long as folks got the facts, they would vote for the proposition. As a result, there are a couple million people who understand how important energy-related consumer issues are. Now, if we can just get those folks mobilized to help the national effort to make utility deregulation work for the consumer.

RAGE is a national campaign to make renewable energy and consumer protection a more prominent factor in the utility deregulation debate. For more information and to find out how you can help, contact Public Citizen and see my column in *HP67* on page 88.

Access

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The Value of Grid-Connected Solar

Don Loweburg

In the letters section of *Home Power,* people have questioned efforts to extend PV to grid-connected locations. Readers expressed resentment that public money in the form of rebates would be made available to affluent grid-connected homeowners but not to modest offgrid installations.

It was pointed out that grid-connected, rebate-funded, PV homeowners might feel ennobled because they are "green," but they might actually increase their total energy consumption. On the other hand, off-grid users would pay full price for their PV and necessarily implement "heroic" energy conservation to achieve a high level of comfort with limited energy.

Which pattern of use better serves the planet? Shouldn't rebates encourage what's best for the planet? The rationale given by the state is that off-grid PV is already cost effective while grid-connected PV is not. Hence, grid-connected PV gets the assist.

Others have asserted that whatever method gets the most PVs in use is a good thing. Every watt generated from the sun and other renewable sources represents carbon atoms not introduced into the atmosphere. Since far more households are grid-connected than not, the most effective program would be to target these energy users.

The Big Picture

In *IPP 65, Beyond Net Metering*, a synergistic relationship was envisioned between centralized renewable energy providers and distributed PV generation. Households or businesses could be both users and producers of energy at different times. The term "Beyond Net Metering" was used because at times of high demand, distributed producers would be paid a premium well beyond the average or commodity price of "system" power. The market price would dictate when a user chose to "dispatch" or sell power into the system.

This model, to be fully realized, would require distributed storage, ideally fuel cell or flywheel. Many times during this past summer's heat waves, peak demand drove the price for supplementary spot power well over $1 per KWH. You could pay for a PV system at that price!

But it isn't simply a question of either on-grid or off-grid. For example, though "wireless" has revolutionized the communications industry, we don't see any wires being taken down. In fact, the explosion in wireless is matched by a corresponding explosion in "connected" technology—wire, cable, and fiber optics.

Transformation

A similar transformation can be anticipated for the electric energy network. Renewable generation could become cost effective. Remember when cellular phone service was $1 per minute? Now wired phone service is scrambling to keep up with the wireless market.

Another system-wide change will be in reliability. The present system is very unreliable. For example, on December 9, 1998, much of the San Francisco area (about a million people) suffered an outage of over four hours induced by a single event at a utility substation. This kind of "migrating" outage was not supposed to be possible. Some have pointed to this event as a Y2K wake-up call.

An entire industry, the computer backup-UPS business, is itself testimony to utility power's lack of reliability. How many gigawatt hours of distributed storage exist right now in the network as computer backup? Yet this is just a tiny fraction of what will eventually exist.

Distributed generation will mean other shifts. Now utility engineers are driving inverter manufacturers nuts with picayune anti-islanding requirements. Yet in the near future it will be understood that maintaining a powered

island within a collapsed network is desirable. Islanding will be good!

Battle for Funding

Does rooftop PV compete with centrally generated renewable energy in the marketplace? This question surfaced during IPP's recent work with the California PV Alliance to secure educational funding for Emerging Renewables (PV and Small Wind). In *HP68* I reported that the Alliance had formed it's own marketing board for the purpose of countering a major funding grab by the Renewables Energy Marketing Board (REMB). REMB represents centralized renewable generators willing to pay $10,000 per membership. They had proposed a marketing program that completely excluded distributed generation. The PV Alliance, including Small Wind, has countered by developing its own program to market distributed renewables.

Cynthia, my partner and an active IPP participant, offered this analysis: "It's a paradigm clash. Every watt generated locally is a watt not purchased from a central generator." Until centralized renewable generators and their marketers understand the larger synergistic possibilities of distributed generation, the PV Alliance, Small Wind, and the PV industry will promote the unique benefits of distributed generation.

A Plan in the Works

Our first efforts at promoting PV will be to better understand the characteristics of PV purchasers. Renewable marketing is now focused on the "green" customer. This customer is usually profiled as affluent, college educated, an early adopter, a building professional (architects and designers), an environmentalist, and so forth. Judging by the lack of performance of the "green" market in California, this model is flawed.

The Alliance will adopt the position that we don't know who the customer is. My personal experience is that there is no single profile. Everyday people from all walks of life purchase PV. Also, the Alliance's marketing efforts will focus on the values of PV. We expect grid-connected customers to be seeking independence and reliability, which PV and distributed generation bring, regardless of whether these homes are grid-connected or not.

Earth's 911

PV Alliance will use the World Wide Web as part of a grassroots approach to spread PV information. To do this, we are forming a partnership with an educational non-profit, Earth's 911.

Earth's 911 (known locally as the California Environmental Hotline) wants to help citizens protect the environment in their own backyard. The Renewable Energy and Energy Conservation section of Earth's 911 is a natural and important extension of their mission statement. Director of Research Kathryn Merrill explains their objective. They plan to "use this project as a pilot for nationwide expansion, so that all communities...incorporate alternative energy sources into their daily lives." They have a commitment from Time Warner/Turner Broadcasting to promote public service announcements nationwide.

Y2K Out of the Closet

I guess I shouldn't have been surprised when several Y2K customers commented favorably on last issue's column. In fact, I know that the readership of *Home Power* is growing due to Y2K awareness. As I mentioned in the last issue, this is driving a huge upswing in the renewable energy business.

My comments here are not meant to be insensitive to anyone's misfortune, but I see a great deal of good coming out of Y2K. Huge numbers of people are re-examining our modern infrastructure. Major systems are being examined—everything from food production and delivery to fuel, electricity, and communications. People are beginning to think in terms of independence, energy conservation, and self sufficiency.

So, if Y2K is as bad as some predict, many people will be prepared. If Y2K fails to materialize as a significant problem, many people will be prepared. No harm done. As a societal growth exercise, I see positive value. Instead of the survivalist-loner mentality prevailing, I have witnessed a general expression of community by most Y2Kers. And if it isn't Y2K, we still have ice storms, hurricanes, drought, weather change, economic system collapse, and war to worry about! Being prepared doesn't hurt.

The Problem with Carbon

It's too cheap. Rather than running out, vast new oil reserves exceeding those in the Persian Gulf are being developed in and around the Caspian Sea. These reserves are described as being capable of fueling the next 100 years of industrialization in China and India. This is frightening! The need for capital to finance the costly pipelines necessary to move this oil to the Mediterranean, coupled with the falling price of oil, is in large part driving the latest wave of mergers in the petroleum industry. There seems to be a disconnect between the global surplus of petroleum and the fact that renewables must compete in the marketplace. From this perspective, the deck is stacked against renewables.

Can it Last?

From a geologic perspective, global carbon reserves date from the Carboniferous Age. At that time, the

global temperature was significantly greater than it is today. Atmospheric CO_2 levels were much higher and there was much more free carbon in the environment. The storage of free carbon in geologic reserves resulted in bio-geologic change. This process provided the conditions for mammalian evolution. The reintroduction of these carbon reserves back into the environment on a global scale must result in global warming. From this perspective, renewables are the only answer.

Bottom Trolling

I coined this somewhat unkind term after interacting with a phone customer some time ago. I was dealing with someone who had definitely done his shopping. He had found the lowest price on every component in the system. As we went down his list of items and prices, I realized I was not feeling good about the process. I was withholding information from the customer! I knew that from a systems level the overall design was terrible. But rather than volunteer information, I was just matching prices, knowing that I could turn a quick 10 percent on a drop-shipped, credit card transaction and be done with it.

I couldn't do it. I couldn't ship a SW4024, inline fuse, no disconnect, 1/0 battery cables, golf cart battery system. That guy got less than what he paid for, but not from me.

I am bringing this up for the benefit of the customer. Don't cut your own throat. Respect the expertise of a qualified designer-dealer and be willing to pay for the service. I feel good when customers get more than what they pay for. And yes, this is a blatant plug for IPP member/dealers.

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PV and the 1999 National Electrical Code

John Wiles

Sponsored by The Photovoltaic Systems Assistance Center, Sandia National Laboratories

The 1999 NEC has been published. It is available in large bookstores, local electrical supply houses, and directly from NFPA and other organizations. It will be automatically adopted by many states on January 1, 1999, but other jurisdictions may require legislative actions for adoption. The following information summarizes the most significant changes that were made in this code cycle.

Figure 690-1, long a source of confusion to many who thought it was a design diagram for a PV system, has been completely revised to show most of the components in different types of PV systems and how they typically interrelate.

In Section 690-2, many definitions were updated and five new ones were added to clarify the terms used in Article 690. For example, the term “Power Conditioner” was replaced with the more commonly used term “Inverter” and confusing references to solar hot water control systems were removed. The new AC PV module was defined (by the NFPA editors) as an Alternating Current Module, and definitions relating to stand-alone, hybrid, and utility-interactive systems were revised.

Section 690-4 was revised to clarify the interconnections of modules. Except for the Underwriters Laboratory (UL) label requirement for module-protection fuses, “daisy chaining” modules from junction box to junction box should not cause any problems.

Section 690-5, requiring ground-fault protection for the PV array on dwellings, was extensively revised for clarity and to simplify the requirement, while still maintaining system safety. Listed equipment (in utility-interactive inverters, power centers, and as separate components) is now available to meet this requirement. The hard-to-define term “disable” was removed from this section and from Section 690-18.

Section 690-6 is new, and was added to fully define the uses and connection requirements of the AC PV module. Among other things, a ground-fault protection device is required on the dedicated circuit connecting the AC PV module or modules to the load center. Since a receptacle outlet GFCI violates the dedicated circuit requirement, a panel device must be used. Some of the equipment protection ground-fault circuit breakers are not suitable for back feeding.

The UL requirements (found in the instruction manual of listed modules) for multiplying module open-circuit voltage and short-circuit current by 125% before using the NEC have now been included in the NEC. Section 690-7 includes new Table 690-7 that assigns the voltage multiplier as a function of the lowest expected ambient temperature. The factor will increase to 1.25 only when the expected temperature reaches -21° C (-5° F). The correction factor on open-circuit voltage will only be 1.06 if the modules are to be installed where the coldest expected temperature is a balmy 10-25° C (50-77° F). UL Standard 1703 will be modified to remove the requirement from the module instruction manuals. While that is being done, there may be modules in the pipeline that still have this requirement in the instruction manual. Those using the 1999 NEC are cautioned not to duplicate the requirement.

In a similar manner, Section 690-8 was revised to include the 125% multiplier on PV source circuit and PV output circuit currents, previously required in the PV module instruction manual. This section now includes both the 125% multiplying factor required to deal with daily variations in PV module output and the same 125% multiplier required to derate all conductors and overcurrent devices throughout the code. The combined factor of both 125% multipliers for PV source and output circuits is 156%. All other circuits are subject to only a single 125% multiplier (or the 80% derating factor found throughout the NEC).

Section 690-9 has exceptions that do not require overcurrent devices on limited types of circuits. These exceptions generally apply to small, single-module, direct-connected water pumping systems.

Section 690-10 is a new section that should benefit the installer and owner of stand-alone PV systems when

the overly cautious inspector has questions. The code now allows the PV system inverter AC current output to be less than the rating of the building load center or service entrance equipment. A 500 watt inverter may now be legally connected to a 120/240 volt, 200 amp load center. The conductor that is used for this connection only has to be rated to carry the 500 watt output of the inverter, not the 48,000 watts that the service entrance can carry. Also, it is now legal to connect a 120 volt inverter to a 120/240 volt load center when certain conditions are met. There must be no 240 volt circuits and no multi-wire branch circuits in the building.

Section 690-13 was revised to clearly state (at least as clearly as is possible in a code) that a switch or circuit breaker should not be placed in a grounded conductor.

AC PV modules may be grouped together on a single circuit with a single disconnect for all modules according to additions in Section 690-15.

Section 690-17 allows the use of a connector for a disconnect device as long as it is listed for the use and meets certain other code requirements. This applies primarily to AC PV modules.

The new Section 690-52 lists the markings required on AC PV modules.

Utility-interactive systems (including AC PV modules) received considerable attention in the 1999 NEC because of the expected proliferation of these systems. Marking the points of connection of these systems is required by Section 690-54. Most of Part G (Connection to Other Sources) was revised to allow easier connection of utility-interactive systems while still maintaining high levels of safety.

Section 690-72 was revised to require no charge controls for batteries on systems where the maximum charging currents are very low (less than 3% of battery capacity).

A new Part I was added to Article 690 to specifically address systems operating over 600 volts. Some of the larger utility-interactive systems may operate above 600 volts.

1999 NEC Handbook

The 1999 NEC Handbook (available from NFPA) includes significantly more detail, substantiation, and explanation of Article 690 and the changes that were made for 1999. It is also an excellent reference to have for other articles of the NEC, many of which apply to PV systems. It is now in an 8 1/2 by 11 inch format which makes for easier reading, but harder handling.

Changes to the NEC

The 1999 National Electrical Code® (NEC®) has just hit the streets, but complete and well-substantiated proposals for changes to the 2002 NEC are due to the National Fire Protection Association (NFPA) no later than 5 PM EST on Friday, November 5, 1999.

This gives those individuals wishing to change the new 1999 Code less than a year to write and submit the proposed changes and required substantiations. The correct form for submittal to the NFPA can be found in the back of the 1999 NEC. Electronic submissions may also be made. Contact NFPA for details. I can also forward substantiated proposals to the established PV Working Group regarding Article 690 for review.

Questions or Comments?

If you have questions about the NEC or the implementation of PV systems following the requirements of the NEC, feel free to call, fax, email, or write me. Sandia National Laboratories sponsors my activities in this area as a support function to the PV Industry. This work is supported by the United States Department of Energy under Contract DE-AC04-94AL8500. Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy.

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Home & Heart

Kathleen Jarschke-Schultze

Kathleen Jarschke-Schultze

The Y2K phenomenon is being thrust at us from everywhere. Our Post Office in Ashland, Oregon has a big millennial countdown clock on the wall. It ticks off the remaining time to the hundredth of a second.

Blind Dates

It turns out that January 1, 2000 isn't the only date coming up soon that might cause problems with computers or computer chips. On the Julian calendar April 9, 1999 is "9999," which means "end of input" or "discard" in computer programming language. September 9, 1999 is the same as April 9, containing "9999." January 3, 2000 will be the first business day of Y2K. January 10, 2000 is the first date with seven digits. February 29, 2000 is the first Leap Year day. October 10, 2000 is the first date with eight digits. Everyone will have to wait it out to see if these dates will cause system crashes or equipment failures.

August 22, 1999 is the rollover date for the Global Positioning Satellites. Even though this date isn't associated with the millennium, the GPS satellites are programmed to work a week at a time and designed to run 1,024 weeks and then roll over.

Yankee Ingenuity

In terms of getting by when faced with shortages and stoppages, I would like to think most of us will be okay. Eighty percent of pre-World War II Americans lived and worked on farms. Most farms could produce what they needed and could repair what they could not. Folks got by using Yankee ingenuity (that's Southern ingenuity for y'all down that way) or what I think of as Physical Ad-Libbing. This is something my Dad taught me. If you need a "do-hickey" and you don't have one, then what do you have that is similar? What will it take to modify it? How can you make it either as efficient or more efficient?

We have to remember that when Daniel Defoe wrote 'Robinson Crusoe' in the early 1700s, people were amazed that a man could survive on a lush, tropical island—and with only one servant at that! I think that because of the books we have read and the movies we have seen, we could survive on that island, without servants. But even with preparation, emergencies will arise. Don't lose your head, use your head.

The Five Stages of Y2K

1. Denial and Isolation

Some problems are going to occur with the coming of the millennium. I don't think society is going to crumble, but there will most likely be shortages and stoppages to varying degrees.

Ignoring the information coming in about Y2K is not the answer. However, we need to filter the hype and use the core of knowledge to prepare for our needs. And if we don't need our preparations, we are still ahead.

2. Anger

It is easy to be angry about the whole situation. After all, didn't the programmers expect to live to see the year 2000? Wasn't it like *really* obvious that this particular date would approach at a steady determined rate? I can't figure out why it took so long for the dated chips to be changed to include the needed four digits. Back in the early 80s, a few programmers brought the Millennium Bug to the attention of the computer world. They were totally ignored. Since there is documentation of the warnings, the lawyers are going to have a field day with the post-Y2K lawsuits.

3. Bargaining

Well, if I knew what was going to happen I could be more prepared. If I am informed better I can avoid any problems.

4. Depression

Oh, no! The whole system is going to go kaput, and society will be crippled for years to come. I will have to give up the entertainments and luxuries I enjoy. No matter what I do, things will go wrong.

5. Acceptance

Oh, well. Something is going to happen. I will prepare for this event as best I can. It won't be any worse than the time the pipes froze for two months and it got down to -17° F. We kept a hole broken through the ice in the creek and hauled water. Bob-O said we had running water—we ran to the creek and ran back with the bucket of water. I found then that we could always get by.

More Preparations

Our county's Y2K task force says to be prepared for two months of dicey services. After reading Bob Ellison's

account of the ice storm in New York last year (*HP68,* page 42), I realized that some of my advice in the last column wouldn't have helped. The solar shower would have frozen solid.

Here are a few more things to consider tucking away. A small wood stove with pipe. A stash of wood to burn. If you keep it dry it will last a very long time. I have seen a gizmo that rolls newspapers so tightly that they can be burned as fuel. Household bleach to purify water. A good water filter. An extra pair of glasses. You should already have fire extinguishers by every door in your house. Plastic garbage bags, tarps, and rope—for those of us living rurally these are a necessity of our lifestyle. Assorted soaps and detergents. Last but not least, duct tape, or as we call it "hippie chrome."

Here's a good idea I read about: Have a working bicycle handy. Ride it once in a while now and you'll do yourself a favor in any case. Extra tubes and a patch kit would be smart too. Make sure you have a non-electric can opener. Spring is coming—get those open pollinated seeds now.

Enjoy the Trip

I saw a clock for sale—its only function was to count down to the millennium. I figure they used the old chips in these because, hey, they don't have to work past New Year's Day 2000 anyway.

I still don't think this bug will be devastating. I like to plan and pack though. Whenever we go on a trip of any kind, long or short, I am the one to pack and plan. I find the preparation as fun as the trip. I have found though, that as careful and thorough as I try to be, I always forget something. You know what? The trip always turns out okay anyway. Don't stress. Enjoy the trip.

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Kathleen Jarschke-Schultze and her Airedale, Emma Rushingheart, are taking puppy socialization classes at her home in Northernmost California, c/o Home Power Magazine, POB 520, Ashland, OR 97520
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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 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 so that our readers can actually use the information.

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 which are short (less than fifteen 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 the feeling of our style. System articles must contain a schematic drawing showing all wiring, a load table, and a cost table. Please send a double spaced, typewritten, or printed copy if possible. If not, please print.

Written Release
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. This will help us respect the privacy rights of individuals.

Editing
We reserve the right to edit all articles for accuracy, length, content, and basic English. We will try to do the minimum editing possible. You can help by keeping your sentences short and simple. We get over three times more articles submitted than we can print. The most useful, specific, and organized get published first.

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. Please provide a caption and photo credit for each photo.

Line Art
We can work from your camera-ready art, scan your art into our computers, or redraw your art in our computer. We often redraw art from the author's rough sketches. If you wish to submit a computer file of a schematic or other line art, please call or email us first.

Got a Computer?
Send us the text for your article on 3.5 inch computer floppy diskette, either Mac or IBM format. We can also read ZIP disks (either Mac or IBM), and Magneto-Optical disks (128 MB, 230 MB, 1.2 GB and 1.3 GB all Mac only). This saves time and reduces typos. Please also send a hard copy printout of your article. Save all word processor files in "TEXT" or "ASCII TEXT" format. This means removing all word processor formatting and graphics. Use your "Save As Text" option from within your word processor. Please don't just rename the file as "text" because it will still include unreadable (at least to us) word processor formatting.

You can send your article via Internet to richard.perez@homepower.com as an enclosed ASCII TEXT file. If you are sending graphics, or articles with embedded graphics, then use this special email address: rap@snowcrest.net

It is wise to telephone or email ahead of electronic file submission. This is particularly true concerning graphics files. There are many, many, many ducks and they all need to be in a row....

Got any questions? Give us a call Monday through Friday from 9–5 Pacific Time and ask. This saves everyone's time.

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HAPPENINGS

AUSTRIA
March 4-5, '99: World Sustainable Energy Day. Wels, Austria. Call for papers. Follows 1998 World Energy Efficiency Day. Showcase successful projects from round the world. Will launch new initiatives to promote market penetration on energy efficiency and RE. • esv1@esv.or.at www.esv.or.at/esv/

CANADA
Aug. 11-14, '99: North Sun '99. Biennial Conference on Solar Energy in High Latitudes. Edmonton, Alberta. Call for papers. Info: Solar Energy Society of Canada, 116 Lesgar St. #702, Ottawa, Ontario, K2P 0C2, Canada +1-613-234-4151 • Fax: +1-613-234-2988 northsun.99@cyberus.ca www.solarenergysociety.ca

Alberta Sustainable House: Open on 3rd & 4th Saturdays (except holiday weekends), 1-4 PM free of charge. Cold-climate features/products based on principles of occupant health, environmental foresight, conservation, AE, recycling, low embodied energy, self-sufficiency, & appropriate technology. Contact: Jorg Ostrowski, Autonomous & Sustainable Housing, 9211 Scurfield Dr NW, Calgary, Alberta T3L 1V9, Canada • 403-239-1882 • Fax: 403-547-2671 jdo@acs.ucalgary.ca www.ucalgary.ca/~jdo/ecotecture.htm

Electric Vehicle Society of Canada, Toronto Chapter promotes EVs to reduce the impact of conventional autos (and has fun!). We are enthusiasts, inventors, Sunday mechanics & environmentalists sharing the belief that EVs are a viable alternative. Meetings: 3rd Thursday each month, Sept-June. New members welcome! Info: Howard Hutt, 21 Barritt Rd, Scarborough, Ontario, M1R 3S5, Canada • 416-755-4324

The Institute for Bioregional Studies demonstrates & teaches ecologically-oriented, scientific, social & technological achievements for ecological, healthy, interdependent & self-reliant communities. Info: IBS, 449 University Ave, Charlottetown, Prince Edward Island C1A 8K3, Canada 902-892-9578

Vancouver Electric Vehicle Association, Call for meetings. Info: 1402 Charlotte Rd., North Vancouver, BC V7J 1H2, Canada 604-987-6188 • Fax: 604-253-0644 rcameron@statpower.com

FRANCE
March 1-5: European Wind Energy Conference and Expo. Nice, France. Info: WIP +49-89-720-1235 Fax: +49-89-720-1291 • www.wip.tnet.de

NEPAL
March 1-9 & April 1-9, '99: Participate in "Solar Sisters"—Install solar in Himalayan communities, giving women the opportunity to provide hands-on solutions to energy problems faced by Nepalese communities. Volunteers come to Nepal for intensive installation training course, contribute to the cost of a solar home system, & install the systems for the benefit of the local community. Info: Stephanie Davis, Himalayan Light Foundation, PO Box 9219, Kathmandu, Nepal 977 • 1 418 203 • Fax: 977 1 412 924 hlf@mos.com.np

NETHERLANDS
May 25-27: World Sustainable Energy Fair, Amsterdam. The premier meeting point for the sustainable energy industry. Info: PO Box 259 Bromley, U.K. BR1 1Zr +44-181-289-8989 • sustain@emml.co.uk www.emml.com

NICARAGUA
March 16–27, 1999: A special short course on Solar Energy in Nicaragua will be an opportunity to offer your hands, heart, and a unique gift: Electricity! A great introduction to PV for developing countries, the course offers a combination of lectures, field experience, and tourism. Taught by Dr. Richard Komp of Sunwatt & Maine Solar Energy Society and Professor Susan Kinne of FENIX & the Nicaraguan Engineering University (see *Photovoltaics in Nicaragua, HP61*). Together with Nicaraguan colleagues, get your hands into PV panel assembly and installation of lighting systems in a rural village. Come participate in Fenix's unique efforts to produce and install solar equipment in the third world. Cost is $650 (all expenses) plus airfare. Contact Barbara Atkinson, lightstream@igc.org • 215-942-0184

RUSSIA
May 25-28: ICEF '99, The Ecological Revitalization of Great River Basins: Experience and Problems. Nizhny Novgorod, Russia. An international congress and exhibition, including some RE and other energy technologies. Info: ICEF, 13 Sovnarkomovskaya st., Nizhny Novgorod, 603086, Russia • +007 (8312) 34-55-95 Fax: +007 (8312) 34-55-68 tatiana@yarmarka.ru • www.yarmarka.ru

NATIONAL US
May 22-29, '99: 11th Annual American Tour de Sol, US EV Championship. 50 EVs traveling from Waterbury, CT to Albany, NY and beyond. Info: NESEA, 50 Miles St., Greenfield, MA 01301 • 413-774-6051 Fax: 413-774-6053 • www.nsea.org

American Hydrogen Association nat'l headquarters: 1739 W. 7th Ave, Mesa, AZ 85202-1906 • 602-827-7915 Fax: 602-967-6601 • aha@getnet.com www.clean-air.org

American Wind Energy Association. Info about US wind energy industry, AWEA membership, small turbine use, & more. www.igc.org/awea

National Summary Reports on State Financial and Regulatory Incentives for RE. Current info on state and federal tax, grant & loan programs. To order, contact: 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 and Renewable Energy Clearinghouse (EREC) offers free info: 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). Info: EREC, PO Box 3048, Merrifield, VA 22116 • 800-363-3732 TTY: 800-273-2957 • energyinfo@delphi.com www.eren.doe.gov

Energy Efficiency and Renewable Energy Network (EREN) provides links to hundreds of gov't and private internet sites & offers an "Ask an Energy Expert" online form to email questions to specialists. • www.eren.doe.gov 800-363-3732

Green Power web site: Forum for consumers, policy makers & green providers to discuss green power including deregulation, "green" electricity choices, technology, marketing, standards, environmental claims, & varying national & state policies. Links, articles & news. Global Environmental Options (GEO), & the Center for Renewable Energy & Sustainable Technology (CREST). www.green-power.com • other web sites: www.greendesign.net • www.greening.org Sustainable energy info: www.crest.org

Kids to the Country is an ongoing program to show at-risk urban children a country alternative. Info: PLENTY, 51 The Farm, Summertown, TN 38483 • 615-964-4391 ktc@thefarm.org

Non-profit Tesla Engine Builders Association (TEBA): info & networking for building Tesla disk turbines. The 18" diameter, single stage steam version, operating at 9,000 rpm, has been documented to consume 38 lbs of saturated steam per hp/hr @ 125 lbs inlet pressure & free exhaust. Send a SASE to TEBA, 5464 N Port Washington Rd Suite 293, Milwaukee, WI 53217 teba@execpc.com • www.execpc.com/~teba

Sandia's web site includes "Stand-Alone Photovoltaic Systems: A Handbook of Recommended Design Practices," "Working Safely with PV," & balance-of-system technical briefs, providing information on battery & inverter testing. www.sandia.gov/pv

Solar Energy & Systems, an Internet college credit course. Fundamentals of RE for the homeowner or small village. Weekly assignments reviewing various texts, videos, WWW pages, weekly chat room, & email questions and answers. Mojave Community

College. Tuition $100 plus $10 registration. 800-678-3992 • lizcaw@et.mohave.cc.az.us Or: chacol@hal.mccnic.mohave.az.us

The Federal Trade Commission offers free pamphlets: Buying An Energy-Smart Appliance, the EnergyGuide to Major Home Appliances, & the EnergyGuide to Home Heating and Cooling. Contact: EnergyGuide, Federal Trade Commission, Room 130, 6th St & Pennsylvania Ave NW, Washington, DC 20580 • 202-326-2222 • TTY: 202-9326-2502 www.ftc.gov

The Interstate Renewable Energy Council (IREC), SEIA, & Sandia National Labs: Handbook to guide state and local government procurement officials and other users in the specs and purchase of RE technologies. Biomass, PVs, solar domestic water & pool heating, small wind systems, technology specs, RE equipment, photographs, vendor contact info, & simple methods for estimating the pollution benefits of RE systems. Send US$15 ppd (make checks to ASES) to Interstate RE Council Distribution Center, c/o ASES, 2400 Central Ave Ste G-1, Boulder, CO 80301

ALABAMA

The Self-Reliance Institute of Northeast Alabama seeks others in the southeast interested in RE, earth sheltered construction, & other self-reliant topics. Info: SINA, Route 2 Box 185A1, Centre, AL 35960 cevans@peop.tdsnet.com

ARIZONA

PV Design Workshops, Tucson. Feb. 22-27 (geared towards women) & March 1-6 (bi-gender). Hands-on basics of electricity, site analysis, system components, wiring, & safety. SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 • Fax: 970-963-8866 sei@solarenergy.org • www.solarenergy.org

Tax credits for solar energy systems in Arizona. A technician certified by the AZ Department of Commerce must be on the job site. Info: ARI SEIA • 602-258-3422

CALIFORNIA

Campus Center for Appropriate Technology, Humboldt State University, Arcata, CA. Ongoing workshops and presentations on a variety of alternative, renewable, and sustainable living subjects. Contact: CCAT, HSU, Arcata, CA 95521 • 707-826-3551 ccat@axe.humboldt.edu www.humboldt.edu/~ccat

Rising Sun Energy Center. Ongoing Solar Energy Classes incl. electricity, water heating, cooking, & kids day. Schedule and info: PO Box 2874, Santa Cruz, CA 95063 408-423-8749 • sunrise@cruzio.com www.cruzio.com/~solar

Siemens Solar Industries offers two levels of PV training: Basic PV Technology Self-Study Course, & Comprehensive Photovoltaic System Design Seminar (call for dates). Self Study program includes: 500 pg training manual, video lessons, applications, w/exercises & examples. ($500). System Design Seminar: 5 day intensive lecture, hands-on assembly, labs, & team system design problem solving. ($1000). Contact: Siemens Solar Training Dept, 805-388-6568 Fax: 805-388-6395 • cvernon@solarpv.com www.solarpv.com

COLORADO

Solar Energy International (SEI), a non-profit dedicated to the practical use of RE. Hands-on workshops: solar, wind, & water power. One & two week sessions: PV Design & Installation, Advanced PV, Wind Power, Micro-hydro, Solar Cooking, Environmental Building Technologies, Solar Home Design, & Straw Bale Construction. Experienced instructors & industry reps. For owner-builders, industry technicians, business owners, career seekers, & international development workers. Workshops may be taken individually or as a comprehensive program. $500/week. SEI, PO Box 715, Carbondale, CO 81623 • 970-963-8855 Fax: 970-963-8866 • sei@solarenergy.org www.solarenergy.org

National Wind Technology Center, operated by the NREL, near Golden, CO. Assisting wind turbine designers & manufacturers with development & fine tuning. Computer modeling & test pads. Call in advance: 303-384-6900 • Fax: 303-384-6901

IOWA

May 15: Iowa Electrathon, sponsored by IRENEW and the Center for Energy and Environmental Education (CEEE) at the University of Northern Iowa, Hawkeye Downs racetrack; Cedar Rapids, Iowa. Contact Iowa Electrathon Hotline at 319-273-6912 or Tom Deves at 319-556-4765

Iowa Renewable Energy Association (IREA) board meetings: 2nd Sat every month at 9 AM, Cooper's Mill Restaurant (Village Inn Motel), Cedar Rapids. Everyone welcome. Call for schedule change. I-Renew, PO Box 2132, Iowa City, IA 52244 • 319-338-3200 Fax: 319-351-2338 • irenew@igc.org

Iowa Renewable Energy Association (IREA) to sponsor workshops this spring. Two on straw bale houses (April 16-21 or 23-28), domestic hot water installations, & DC PV systems at Prairiewoods Nature Center near Cedar Rapids, Iowa. Contact IRENEW or Tom Snyder, 611 Second St. SE, Dyersville, IA, 52040 • tsnyder@mwci.net Or: Prairiewoods, 120 E Boyson Road, Hiawatha, IA 52233 • 319-395-6700

Sept 23–26, 1999: IRENEW Energy Expo/Convention. A four-day energy expo/conference. Sheraton Four Points Hotel and Convention Center, Cedar Rapids, Iowa. Many events: Solar cars, electric cars, Cedar Rapids Electric bus, Electrathon cars and races, demos. Many workshops—PV, wind, active vs passive, political issues. A second Iowa Electrathon Race will be held—following the first race in May—close to Hawkeye Downs. Info: I-Renew, PO Box 2132, Iowa City, IA 52244 • 319-338-3200 Fax: 319-351-2338 • irenew@igc.org

KENTUCKY

Appalachia-Science in the Public Interest. Ongoing projects & demos in gardening, solar, sustainable forestry, & more. Info: ASPI, 50 Lair St., Mt. Vernon, KY 40456 606-256-0077 • aspi@kih.net www.kih.net/aspi

MAINE

June 12-17, Solar 1999: Growing the Market, American Solar Energy Society's Annual Conference. Devoted to taking solar energy into the 21st Century. Growing strong and sustainable markets is our compass. Portland, ME. Info: NESEA • 413-774-6051 Or: American Solar Energy Society 303-443-3130 • ases@ases.org www.ases.org/solar

MASSACHUSETTS

Greenfield Energy Park needs help preserving Greenfield's historic past, using today's energy & ideas, creating a sustainable future. Info: Greenfield Energy Park, NESEA, 50 Miles St, Greenfield, MA 01301 • 413-774-6051 • Fax: 413-774-6053

MICHIGAN

Tillers International lists classes in draft animal power, small scale farming, blacksmithing & woodworking. Class catalog info: Tillers Int'l, 5239 S. 24th St., Kalamazoo, MI 49002 • 616-344-3233 Fax: 616-344-3238 • TillersInt@aol.com www.wmich.edu/tillers

MONTANA

Sage Mountain Center: Life Skills Workshops. One day, comprehensive classes: Inexpensive earth-friendly home building, straw bale construction, making log furniture, cordwood construction, natural & non-toxic interiors, & more. $45 incl lunch & literature. Info: SMC, 79 Sage Mountain Trail, Whitehall, MT • 406-494-9875

NEW YORK

May 26-27 Hybrid-Electric Vehicle Symposium, Society of Engineers and NESEA, presents the latest technology and research on these vehicles. Info: NESEA, 50 Miles St., Greenfield, MA 01301 413-774-6051 • Fax: 413-774-6053 www.nsea.org

NEW MEXICO

"Profit from the Sun" offers holistic seminars in Albuquerque. Sustainable Living, Feb. 20-21 and Energy Independence, Feb. 27-28. Let them help you create an earth-friendly lifestyle for $180. Info: PO Box 1962, Moriarty, NM 87035 • 505-832-1556

OHIO

Solar/Wind classes taught at rural solar and wind powered home with utility backup. Maximum of 10 students. Must advance register. $65 per person $85 per couple

(spouse only for couple rate), lunch provided, please advise of dietary restrictions. Class will be full of technical info, how it works, system design, NEC compliance and efficient appliances. Students will see equipment in use. Every second Saturday of each month. all classes 10AM to 2PM. Available in spring a hands on project in straw bale post & beam building. Call 419-368-4252, or write Solar Creations, 2189 S.R. 511 S., Perrysville, OH 44864 www.bright.net/~solarcre

OREGON

Aprovecho Research Center is a non-profit educational institute on forty acres nestled in the forest of Oregon. Internship programs March 1, June 1, and Sept 1. Six week winter internship in Baja, Mexico: Studying and researching appropriate technology applications, learning Spanish, teaching in a grade school, & working in fruit orchards & gardens. Info: Internship Coordinator, Aprovecho Research Center, 80574 Hazelton Rd., Cottage Grove, OR 97424 541-942-8198

April 15–18:1999 Eco Design Arts Conference, Equity and Ecology. Call for papers deadline—March 26, 1999. Submissions can range from a design of urban gardens in the inner city to a poem honoring a local community effort. From a sculpture protesting the destruction of the ecosystem to a high density co-housing project. Entries should clearly convey design concepts through visual and written material. Students, professionals, and community members—participate and/or collaborate on entries. Three entries will receive an Outstanding Merit award and equal portions of a $1,000 cash prize. Info: University of Oregon, School of Architecture and Allied Arts, H.O.P.E.S., Lawrence Hall, 5249 University of Oregon, Eugene, OR 97403-5249 • 541-346-0719 http://gladstone.uoregon.edu/~hopes hopes@laz.uoregon.edu

TEXAS

April 12-17, PV Design Workshops, Austin. Hands-on basics of electricity, site analysis, system components, wiring, & safety. SEI, PO Box 715, Carbondale, CO 81623 970-963-8855 • Fax: 970-963-8866 sei@solarenergy.org • www.solarenergy.org

SEASUN, El Paso Solar Energy Association www.epsea.org

VERMONT

Free PV Workshops for beginners & experienced off-gridders. 9-3 PM, 1st Sat, most months. Topics determined by interest: site selection, system monitoring & maintenance, PV modules, batteries, charge controllers, inverters, lighting (AC & DC), water, snow, ponds, living in cold climates, living with our woods, wood heat, & root cellars. Meet people living with RE or considering it. Free! Bring your lunch & coffee. Info: David Palumbo, Independent Power and Light, RR1 Box 3054, Hyde Park, VT 05655 • 802-888-7194 indeppower@aol.com

WASHINGTON

GreenFire Institute: Workshops and Info on straw bale construction. Info: GreenFire, 1509 Queen Anne Ave #606, Seattle, WA 98109 • 206-284-7470 • Fax: 206-284-2816 wilbur@balewolf.com • www.balewolf.com

WISCONSIN

June 18-20, 1999: 10th Annual Midwest Renewable Energy Fair, Amherst, Wisconsin. Hundreds of workshops, speakers, exhibits, and demonstrations. Events for children, educators, and the public. Bus and bike tours of RE homes, on-site model home, and entertainment. Info: MREA, PO Box 249, Amherst, WI 54406 • 715-824-5166 Fax: 715-824-5399 • mreainfo@wi-net.com

Midwest Renewable Energy Association (MREA) Workshops. See ad in this issue. Call for cost, locations, instructors & further workshop descriptions. MREA Membership & participation: all are welcome. Significant others 1/2 price. Info: MREA, PO Box 249, Amherst, WI 54406 • 715-824-5166 Fax: 715-824-5399 • mreainfo@wi-net.com

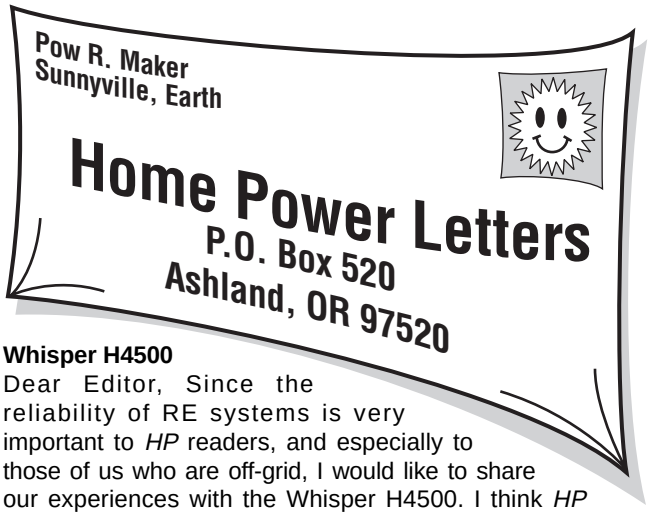
the Wizard speaks...

The Quantum Field

We can consider the space-time continuum to be a quantum energy field with density variations. Perturbations arise in this field due to internal self-organization. These perturbations produce very short-lived density bubbles in the field itself. As these bubbles arise and collapse, they produce longitudinal waves within the quantum field. These waves may be called quantum phase waves.

The quantum phase waves interfere with each other forming structured interaction patterns in the field. The most stable of these interaction patterns are what we perceive as matter. The phase waves must be mathematically modeled so that their interaction patterns manifest all the properties of matter. Material forces can then be seen as fluctuations in the quantum phase waves due to the formation of such patterns.

One conclusion that can be drawn from the foregoing discussion is that there are no pre-existent material entities. What we perceive as matter are just patterns in the quantum field. This leads inevitably to the idea that matter and its associated forces are just information, which is presented to us by the quantum field. The universe can then be seen as a large information processing entity, whose neuronal nodes are what we call material particles.



Whisper H4500

Dear Editor, Since the reliability of RE systems is very important to *HP* readers, and especially to those of us who are off-grid, I would like to share our experiences with the Whisper H4500. I think *HP* readers both need and want to know this field-service record.

My brother and sister each have one of these machines. I will refer to my brother's machine as Machine 1, and my sister's as Machine 2. They are both installed in North Dakota (several hours apart), and have *not* experienced any winds that come close to the manufacturer's stated survival wind speed of 120 mph. They are the tenth and eleventh units off of the production line.

Since we've owned the two machines, we have, under warranty service, received (or will receive) two new rectifiers, two new transformers, five new or rebuilt machines (I don't know which the factory did), and five new sets of blades.

"Regular" down-time is based on the time the machines or parts were absent from our site, making operation impossible, starting from when we first put the machines in service. "Voluntary" down-time is when we had the machine off, or parts were on site, but not yet put together. "Total Days" is the number of days since we turned the machines on the very first time. "Days On" is the actual service we have received from the machines. We purchased them at the 1996 Midwest Renewable Energy Fair. Machine 1 was first turned on in mid-November, 1996, and Machine 2 was turned on March 1, 1997.

I have been very conservative in estimating my direct involvement with these failures which include direct costs of $295, 69.5 hours labor time, and 186 hours driving 10,235 miles. The hours I have spent because of these machines is probably easily double what is listed here, but these are the hours my hands were "touching the machine," so to speak.

H4500 Down-time

	Machine 1	*Machine 2*
Regular Down-time	234 days	138+ days
Voluntary Down-time	195 days	205 days
Days On	321+ days	302 days
Total Days in Service	745 days	640 days
Longest Time On	97 days	117 days
Longest Down-time	142 days	58 days
Average Down-time	78 days	34+ days
# of Service Outages	3	4

The complete service record is available from me directly (SASE appreciated) or online (at http://csf.colorado.edu /perma/energy/jan98/msg02354.html) in the American Wind Energy Association's archive. Sincerely, Michael Klemen, PO Box 86, Tuttle, ND 58488 • makbek@daktel.com

World Power Technologies Responds

Dear Richard, Thank you and your wonderful magazine for the opportunity to comment on our wind generator model Whisper H4500.

Since introduction in 1996, over 100 units of this model have been shipped, and we have had consistent reports of power output well in excess of the published power curve coupled with higher than expected electrical and mechanical problems. During the past summer we engineered and retrofitted all machines with a second "de-tuning" or governor adjustment to have the machine furl out of the wind sooner and more completely. Initial reports were favorable but during a November windstorm, at least four Whisper H4500 machines were damaged. We were alarmed and very disappointed, and World Power has stopped production and is no longer taking orders for the Whisper H4500.

Existing owners have been ordered to shut their machines down in advance of expecting winds over 50 mph until we can engineer a solution. Any owner of a Whisper H4500 who has not received Service Bulletin SB98-4 should contact World Power immediately. Those with a Whisper H4500 on order are being offered the opportunity to cancel, switch to the Whisper 3000, a two bladed machine using the same propeller blade, or wait until we have a solution to the governing problem. Anyone with a Whisper H4500 on order who hasn't received a notice from the factory should contact World Power immediately.

Our primary concern is to engineer and test those modifications which will provide current owners with the performance, safety, and longevity of service customers have come to expect from our products. To this end we have set up three new test sites in challenging wind conditions in eastern Oregon, the Colorado Rockies, and Southwestern Minnesota. This is in addition to our test site in Duluth, Minnesota where we must admit the winds are not as challenging as we would wish. An additional test site at the National Renewable Energy Labs in Boulder, Colorado is pending. All three new sites will be on line by Christmas [of '98]. For those with an interest in this testing and development program, send your e-mail address to elliott@worldpowertech.com and we will send summary reports as they are available from the field. We'll also welcome your feedback and ideas.

The World Power Technologies wind generator model Whisper H4500, along with other members of our product family sharing the same design philosophy, has attracted world attention. It has consistently demonstrated one of the highest efficiencies (power output per square foot of swept area at any windspeed) of any small wind generator made in the world. Our unique, patented "Angle Governor" has set a

new standard in its ability to provide both passive protection and maintained power output in high winds. A complete electronics package which integrates PV arrays with no additional components is included with all our wind generators at the lowest cost per wind capture (propeller) area in the industry. We pride ourselves on being dedicated to developing the most advanced technology available in a small wind generator.

It should be clear therefore, that World Power has been greatly humiliated by the failure of its flagship machine, the Whisper H4500, to meet the goals we have set for all our machines: 20 plus years service, 120 mph survival wind, whisper quiet in all winds, best output per swept area and no scheduled maintenance. We apologize from the depth of our corporate soul to our customers whom we have inconvenienced, disappointed and impacted financially. We acknowledge and gratefully thank virtually all our customers of this model who have expressed understanding, patience, graciousness and the confidence in us that we will solve these problems and ultimately provide them with the value and performance they expected. It brings tears to my eyes to especially acknowledge those three wonderful customers who have volunteered, at no cost to World Power, their sites and their labor to help us develop and test solutions to our misbehaving governor.

We are confident that with this kind of loyal support we will not only very quickly be implementing the required design changes, but that World Power will equally soon recover from the financial setback we have deservedly caused ourselves. We have been in business since 1974, longer than any company in the world manufacturing wind generators large or small. I assure you, and our current and future customers, that we plan to be around for many more generations to maintain the value of our current products in the field. We want to continue to offer the readers of *Home Power* the quality hardware they seek to make electricity from the wind and the sun a living reality.

Again, Richard, thank you from all of us for your kindness to World Power. Please accept our wishes that the countdown to Y2K be your best year yet. Sincerely, Elliott Bayly, President, World Power Technologies, Inc., Duluth, MN, USA elliott@worldpowertech.com

***Home Power* Responds to the H4500 Problems**

Hello Michael and Elliott. We at Home Power *are indeed sad to hear that the Whisper H4500 is having problems. Hey—World Power Technologies (WPT) is currently holding over $7,500 of our money for the Whisper 4500 we had on order. I discussed this with Elliott Bayly on the phone and we've decided to let our money ride with WPT until they either get the bugs out of the 4500, or redesign this genny into a more robust model.*

Building wind generators is a tough job, but we have faith in WPT. We know that they will fix the problems with their largest generator and support their customers. WPT has delivered good customer service while producing affordable wind generators. We look forward to having one of WPT's large models up on a tower here soon. Richard Perez

Cadmium Toxicity

Dear Michael, On page 116 in *HP68,* you make a note that "NiCd batteries also have a toxic and hard to reclaim component—Cadmium."

This, I have to confess, reflects modern thinking, but it is not necessarily fact. As product manager of BP Solar's new cadmium telluride based Apollo® modules, I have done a considerable amount of additional reading on the subject, supplementing previous work our company has done. I am enclosing some documents which I hope will add to your knowledge and make you consider whether your statement remains valid.

First, toxicity. Everything is toxic, it is a question of how much of it makes it toxic. There are indeed instances of people dying from drinking too much Coca-Cola, which contains caffeine, though few would expect it to be labelled a toxic product.

Second, cadmium is well researched and as nickel is valuable, many nickel cadmium batteries, particularly industrial size, are recycled. They present no different problem than lead acid when it comes to this. Recovery is simply more economically valuable.

Third, nickel and iron both can be considered as toxic. Dying from excess iron in the body even has its own name: Hemochromatosis.

While I understand and agree that most readers will not choose nickel cadmium batteries, the issue is cost, not toxicity. Yours sincerely, Mark Hammonds, BP Solar, Inc., 2300 N. Watney Way, Fairfield, California 94533

Hi, Mark. I appreciate the letter and materials you sent. You are right about cost being the issue rather than toxicity. But, if NiCd batteries did cost as little as lead-acid, then they might be the battery of choice for nearly all applications including starting cars. Think of the massive problem there once was with the disposal of lead and electrolyte (and even cases) from lead-acid batteries. This problem existed for years and caused environmental and health problems that are still being dealt with. The problem is pretty much fixed in the major industrialized nations, but still exists in many others. Now imagine wet-cell NiCd batteries being out there in the same ratio, which would likely happen if they were as cheap.

As your literature stated, the technology is out there to reclaim cadmium for reuse. But I failed to find a legitimate recycler for reuse of large nickel cadmium battery components. Small batteries for electronics and flashlights are being recycled, but boy, is it hard to find places that will take them. I buy my rechargable flashlight batteries from Solutions in Arcata, California. As of last summer they could not tell me exactly what happens to the batteries that they collect for recycling. Although I can't say so with full certainty, I'd bet a dime against a dollar that the cadmium in those cells is not being collected for reuse. Of course, the more NiCd batteries of all types that are sold, the more likely a legitimate reclaim and reuse program will become available.

How about it readers, what have your experiences been with recycling used alkaline batteries of all types? Michael Welch

"No" to Restructuring
Restructuring the electric utility industry is supposed to allow consumers of electricity to enjoy the benefits of free market forces. I believe that restructuring is instead an effort by utilities to maintain control of a rapidly changing industry—an industry they cannot effectively control in the presently regulated environment. Consider the following:

The utilities have us busy restructuring our electric generation business while new distributed generation technologies are rapidly making existing generation obsolete. (Pay no attention to the man behind the curtain!) Distributed generation (including renewables, fuel cells, and micro-turbines) is so superior in cost, efficiency, and reliability that the value of existing central generation coal and nuclear facilities has already been greatly reduced. What to do in the face of declining asset values? Simple: ask for your money back. On the brink of the distributed generation revolution, utilities are being reimbursed for investments-gone-bad in a scheme called "stranded costs."

What will they do with the trillion or so dollars they'll get back? Well, they've already purchased the rights to nearly all of the most threatening technology: the gas micro-turbine. Now they're lobbying to overturn net metering interconnection laws in an all out effort to suppress the self-generation revolution made possible by new technologies. The key is in preventing access to "their" grid—an asset that we, the ratepayers, have purchased in full.

The powerful monster we call the electric utility was created under an umbrella of regulation, and now deregulation will set this monster free. The utilities desperately want restructuring in order to recover their investments and finance their efforts to control distributed generation. But until our rights to interconnect, self-generate, and net meter are secure, let's just say "no" to utility restructuring. Mark Sardella, Southwest Energy Institute, Santa Fe, NM • msardel@trail.com

Hi Mark. Boy, doesn't restructuring just tick you off? I agree with a lot of what you say. I would like to clarify a couple of misconceptions that I see regularly. First, "dereg" is not something that was instigated by the utilities. Rather, it was begun by the manufacturing industries and other large users that got tired of high rates foisted upon them. Mostly, these high rates resulted from utilities' decisions to build the expensive power plants which are now becoming the stranded assets. Utilities used to be paid based on their investments: the more costly the power plant, the more money they made. PUCs should be faulted for allowing this to happen.

Utilities were against deregulation initially because they thought they might lose their cash cows. It was only after they found out they could find an even faster return on their investments by getting paid up front for their stranded assets that they have embraced what was renamed "restructuring."

The question brought to mind by your letter is, "Should we outright oppose electric utility restructuring?" I've been thinking about that. I would like to say yes, but I think that outright opposition is an exercise in futility. It would be like trying to stop a speeding train at this point.

The best we can do is to shape restructuring in those states that are working on it. Restructuring is also being debated on the national level. Federal laws may eventually supersede some state regulations. The time is now to put the public weight behind campaigns to protect ratepayers and the environment. One such effort is called RAGE (see HP67*, page 88). For more info: Public Citizen Critical Mass Energy Project, 215 Pennsylvania Ave. SE, Washington, DC 20003 202-546-4996 • vallette@citizen.org • www.citizen.org/cmep /rage/ Michael Welch*

Steam Power
Dear *Home Power,* This whole subject may be a bit off the wall, but it has long intrigued me: Do any readers have experience with the use of steam power for off-grid power supply? I have given the subject quite a bit of (casual) analysis, and it seems to me that, at least in certain situations, steam could provide an effective alternative to solar, wind, or hydro.

Before 1900, the use of small, portable steam plants was standard for the uses which we now routinely use internal combustion engine sets. While heavy and cumbersome, they did effectively meet the needs of the time, in several different configurations of horizontal and/or vertical engines and boilers. Even though the fuel to output efficiency of a simple steam power setup is only about 2 percent, I can still see applications where fuel is abundant, in the form of byproducts or waste.

I can visualize a steam powered unit of 2 to 10 hp, say, connected to a suitable DC generator to charge the system batteries for an hour or so a day, removing the onerous task of continual boiler firing. The fire could be either banked, with steam maintained for the rest of the time, or the cold boiler brought up once a day or so (perhaps shared with heating plant duties?).

Certainly equipment sources in this day and age are very scarce. What steam power equipment that is manufactured is either of the light hobby variety, or of the big industrial type. I occasionally see this type of thing show up at industrial auctions, but the equipment is a long way from being operational and probably very unsafe. It seems likely that there are manufacturers with files of old prints and shops that are somewhat obsolete that could fabricate the necessary units. An outstanding example of this is the steam-powered railroad subculture—all the working museums have developed infrastructure and sources of supply to keep their old steam engines functional and safe!

Just some casual thoughts to see if there are any others out there with similar inclination. W. Van Aller, Westminster, MD w.vanaller@co.mo.md.us

Hello W., Steam power is not an unfamiliar subject in the pages of Home Power. *A quick search of our back issues turned up quite a few mentions of the word "steam." Check out Skip Goebel's article in* HP62 *for a recent treatment of the subject. Ian Woofenden*

Unbiased Information
Dear Richard and the *HP* crew, I've been with you folks since I found the first issue of *HP* at the Yreka public library. After

reading some of the criticisms in *HP68,* please allow me to say that nobody puts out a magazine better than you.

Journalism used to be one of the last bastions of unbiased information, an attempt to keep the readership fully informed, so informed choices could be made. Who does this anymore besides you folks? You allow Mr. Wiles the opportunity to present his side of the equation, then Mr. Schultze and the other Wrenches get to state how they perceive the situation. When did open debate become unfair? When did expressing discomfort or disagreement with the decisions made by bureaucrats become improper?

Again, you incredible people do it all: the Wizard exists for those non-linear thinkers who like to push the envelope of conventional thought. Who can say whether there is any "real world" validity or not? We just recently discovered that the world may be round, and that Earth is *not* the center of the universe.

Kathleen ties it all into "Home and Heart," Ms. Prange, Paul Gipe, and others talk about vehicles, wind, heat, ad infinitum. Please, please, do not be the least deterred by those small souls who must carp about the things that don't appeal to them, hence should not exist. There are always articles in *HP* that I have little interest in for my own personal needs, but they frequently teach me something nonetheless. Your vision, your willingness to share, and your courage to fight the good fight, place you all head and shoulders above a (it sometimes seems to me) disappointing mass of humanity concerned with only our own desires.

Ian Woofenden and I have talked (on the AWEA list) about using TVs for planters or target practice (although I do watch the odd video from time to time), and the time I would have wasted watching TV is spent reading voraciously. That being said, *HP* is the only magazine I subscribe to. All the best, and Happy Holidays, Reg Thibodeau, somewhere near Roseburg, OR • regt@rosenet.net

Hello Reg, thanks for the praise. We try hard and letters such as yours keep us doing it! Richard Perez

Returned Peace Corps Volunteers

I just bought an inverter and some batteries to connect to some PVs. Yes, this is a backup system, I'm one of those still connected to the grid. But I am very interested in renewable energy and I am a Returned Peace Corps Volunteer (RPCV).

Are any of you *Home Power* people RPCVs, or do you know any RPCVs who are interested in energy? The Energy Committee of the RPCVs for Environment and Development subgroup is interested in contact with you. What are your energy experiences? Can you connect your Peace Corps experience to energy issues?

Interested people can contact David Borton at: 7 Hilltop Road, Troy, NY 12180 • bortond@rpi.edu

Solar2 Lover

I just got my copy of *Solar2.* Oh wow! This is the greatest! I have long been a follower of RE and had heard about your magazine in a book called *Solo.* But through procrastination and everything else…then one day I was surfing the Web for who knows what and I found your site, and you were giving away an E-copy of your magazine. I thought this was too good to be true! but after reading it, I thought, I need to get more of these.

I live in Canada which has a lot of good things going for it but the exchange rate to US$ is not one of them. I'm not sure if you've heard but Canada has a $2 coin but many people joke that we still have a $2 bill and it's called $1US (the exchange rate today was 64.77 cents). Because of this, I chose to spend the money on the CD-ROM instead of a subscription and I have not been sorry.

I hope to build a straw bale house this summer and I will be putting some of the good ideas that I have read to use. Thank you, thank you, thank you! This is the best thing that has happened to my computer! John A. Funk

John, thanks for the compliment and you are most welcome!

We worked hard on Solar2*. We issued* Solar1 *but it was just straight text and gif files—no photos and no working electronic index. When Adobe Acrobat came around, we redid the whole CD from the original page layouts. Be sure to check out the working electronic index, it's the way to find specific info.*

I hear you on the Can/US exchange rate—we just had to raise the Canadian price on our cover for HP69; *otherwise Canadian newsstands would stop carrying us.*

Keep me advised on the straw bale building. We just finished a 28 by 20 foot straw bale building and it's performing well (See HP63 *and* HP64*). During a recent cold snap, we had outside temperatures of -4° F at night, and 14° F during the day. The straw bale bathhouse had no freeze-ups, and we still had running water. Richard Perez*

Solar Partners for Pakistan

Dear Mr.Perez! I read *HP* mag and was quite impressed with the service this mag is providing to mankind. It is extremely awesome. I am sure this great service of providing solutions to energy related problems will save this planet from the disasters of pollution. We living in Pakistan are suffering terribly with the pollution problems as there is no awareness and lack of modern solar technology.

We are the main solar organization here to help promote the power of sun. We would welcome anyone who would help us in solarizing our water pumping system for irrigation, providing some basic lighting system as there is load shedding every day and medical clinic students are suffering badly. We could be able to consider some kind of joint ventures if some entrepreneurs are willing to participate in this help. Sincerely, M Siddiqi, #489- St 2-G11/1, Islamabad, Pakistan muneeb@solarpak.sdnpk.undp.org

Out of the Closet and Onto the Roof

Tell the *HP* gang that it's been a kick watching the "suits" look at the magazine. Their eyes light up like kids looking into a toy store window. Like kids, some just fantasize, some are saving their allowance, some are waiting for their parents to get it for them, some are waiting until they grow up, etc. There are a lot of armchair and closet PVers out there. Joel Davidson, Culver City, CA • joeldavidson@earthlink.net

Nevada Solar Bozo
I live near Reno, Nevada in the hill country to the north at about 6,000 feet, on 40 acres. A school teacher, I have built a 1000 square foot cabin and use twelve 45 watt ARCOs, twenty-four 2 volt, 8 amp-hour batteries, and a Trace 2024 inverter. I have a home-built wind genny of about 300 watts full tilt, and have built a 24 volt direct charge alternator using a 5 hp Honda. My water comes from a spring in the canyon below using four 45 watt ARCOs and a 12 volt Solar Star pump. It pushes up 400 feet to a storage tank of 3,500 gallons at about 1 gpm.

The cabin has the usual south facing glass, all fluorescent lighting, gravity water pressure, and uses a propane refrigerator, furnace, and water heater. The systems work very well. I use the Honda alternator when using the washer to avoid needless discharge.

By using two Trojan T105s and a C30 Trace controller at the spring with the four ARCOs, I am able to overcome the startup momentum associated with 400 feet of pipe height. When the batteries get low, they are disconnected until the sun recharges them, making water flow again.

I have determined that there is an inverse relationship between the voltage input and the AC voltage output with the Trace inverter. Thinking of the PV panels as current devices steered me to lower my storage voltage to 22 volts. This increased my array efficiency as my current increased. So, I have a perfect marriage of this stuff, so far.

I am using a permanent magnet motor on my wind machine, which is designed to be built easily using hardware store parts. The blade is two pieces of poplar, resin-glued together. I am using a belt drive system with an overdrive ratio of 3:1. One machine has a 6 foot diameter rotor, the other is eight, and both are mounted on 30 foot poles.

I could go on. I really loved the wind machine article in the last issue and also the “do it regardless of who says no” attitude you have. Will Peterson, Sparks, NV • wpeter9126@aol.com

Needs a Load to Start a Load
Dear Editor, We had an interesting few months after our purchase of an Asko washer. We are off-grid and couldn’t figure out why this $1,000 machine would not perform consistently. It took months of repairs, phone calls, and replacements before Trace technicians finally admitted that perhaps the solid state electronics in the Asko required a “load equalizer” (like a hair dryer or toaster) to get the washer going.

It’s a simple fix, but we’d already rid ourselves of things that draw heavy loads in preparation for our solar home and simple living scheme.

I thought I’d pass along this tip in case other Trace users were thinking of buying an Asko. That washer is, by far, the best an independent home can ask for. It uses less water, power, and detergent than any other washer on the market. Thanks, Susan Carlyle, Barnardsville, North Carolina

Hello, Susan. I suspect that your Trace was going to sleep during low power consumption periods in the Asko’s cycle. You have the solution—turn on a small load of at least 16 watts (the lowest wake-up setting available on the Trace) and it will keep the inverter awake while the washer runs. A 25 watt incandescent light bulb, or some similar resistive load should do the trick. You can also program the Trace to stay on with a just couple of button pushes in the “start” menu. Richard Perez

Good Tech Support
Howdy, Great mag! Gotta’ deal for ya’—you keep pounding out a great information source, and I’ll keep buying it. The ad to article ratio is perfect. Ads are required since they: 1) enable you to keep publishing (this is a good thing), 2) let me make informed decisions on where to buy the really cool products you review, and 3) inform me of products that youse guys haven’t got to fondle yet.

Now to the point, I am designing an RE electrical system for my new home. Our current grid usage is about 65 to 75 kWh per day (gas heat, hot water, and stove so this is nearly a pure electrical loading). So, I’m designing to that standard. I’ve pretty much decided on two Trace 4024s linked together.

After hitting all the information sources I could think of I still had some fairly important unanswered questions. Like, if I link two of these units together, do I get 120 or 240 amps of charging current? Are the outputs of the two inverters in phase or out of phase, and by how much? Will my APC computer UPSs like modified sine waves? Do I need a backup generator that puts out 220 VAC or 120 VAC? Do I split the lines to each unit, or run the same 120 into each? Is there IBM PC (Windows NT preferably) based monitoring and control software? What kind of data link is needed between

the PC and the inverter(s)—this tells me how close the PC has to be to the inverter(s), etc.

After reading the latest issue I noticed some less than complimentary comments on Trace's technical support. Bad tech support is *not* what I want to have to live with for the rest of my time on the planet. So with some (unfounded I might add) trepidation I hit Trace's Web site and got the tech support phone number and dialed it. Within 30 seconds I was connected to a technically competent individual who answered all of my questions and offered some rather innovative alternative solutions to some of my dilemmas. I'm incorporating these solutions into the design. I offered to buy a manual (Trace is currently refurbishing it and as such is not available as an Acrobat file on their Web site) and pay for shipping so I wouldn't keep bugging them on the phone. The tech's comment was, "I'll just drop ya' one in the mail, it'll go out today and it will probably answer most of your questions."

The whole encounter might have lasted 7 to 8 minutes. The tech was polite, competent, unhurried, and expressed a genuine desire to help and educate. All tech support should be this bad (said with all due sarcasm). Now maybe I hit the right guy on the right day but I doubt it—I'm not that lucky. I wish I'd written down the tech's name as he deserves kudos and I would certainly ask for him by name. Suffice to say Trace will at least supply the inverters and control units in my design. Jeff Schlenker, Dover, DE • jeffreyl@snip.net

Hello, Jeff. If you stack two Trace SW series inverters, then you get charging current from both of their battery chargers. In the case of the SW4024 (24 VDC), you get 120 amperes of charging current per inverter, or 240 amperes for two stacked inverters. The output of stacked Trace SW Series inverters will be 180° out of phase, producing 240 VAC across the two inverters. This yields 4 KW per 120 VAC phase, or 8 KW across the 240 VAC output of both inverters. These Trace inverters produce a reasonable facsimile of a sine wave (about 5% THD) and your UPS will easily digest their power. The battery chargers in the Trace SW series will only consume 120 VAC, so get a generator with two big 120 VAC legs (such as our Honda ES6500 with 28 amps per 120 VAC leg). Trace has IBM software for, and a serial port built into, the SW series inverter. Ask for it when you order your inverters. Consult Trace for the details—we are a Mac office and can't use this software. Richard Perez

Trace Tech Support

Dear *Home Power* staff, I am writing in response to a letter from Tom Elliot in *HP68* that was bashing the technical support at Trace Engineering. If your car is not running correctly, you contact the Chevrolet dealer, not General Motors. Trace Engineering is the manufacturer. If a customer has questions on Trace equipment, then the dealers should handle most of the questions and contact Trace on the tough questions. This will force the seller of the equipment (even the mail order houses) to be more knowledgeable on the parts that they sell, and leave Trace to continue to develop new products for us to use. If your dealer is unable or unwilling to give you technical help, find another solar dealer. Trace should not be expected to answer thousands of phone calls from the general public. David Love, Lacey, WA DLove@appliedpower.com

Hi David. I agree and disagree. Folks should be able to rely on their dealers for information, but most of the best installing dealers are small and cannot afford to manage tech support departments, specially for those customers that just bought the equipment, and not the installation/setup. Trace probably agrees with you that, ideally, users should go back to the dealer. But that is not the reality of the situation. Users need to get support from Trace when dealers can't or won't help them. And in this case, even dealers were having troubles getting support from Trace. Happily, Trace has stated they are revamping their tech support. This gives me a good opportunity to correct a spelling error that appeared in the last issue. If folks have troubles getting support from Trace, contact the person in charge of that revamping, Ray Barbee. Michael Welch

Cooling with Soil

I have heard of a method of cooling a home in the summer with large tubes buried in the ground and am seeking information on this alternative. I have had little success. Do you have any suggestions on where to look for information? Thanks, Chris Snyder • csnyder@trib.com

Hi Chris. We are primarily electrical geeks, so your question is a little out of our field. Here is what I do know.

Large diameter (six inches or more) aluminum or steel tubes are buried at least six feet deep on the north (or shaded) side of a building. Between three and a dozen tubes are used depending on building size and local climate. Tubes are a minimum of 25 feet long, but much longer is much better. Air is very slowly drawn through these tubes by natural convection. Hot air rises and is exhausted from the building's attic vents (which must be oversized for common roof construction). Ambient air enters the pipes and is slowly cooled by the cool earth (about 55° F). The air is filtered and allowed to rise into the building as the hot air flows out of the attic vents. It is a simple setup and uses no electricity, although you could slap a blower on it for faster results.

I know of systems that are using this sort of system in the Southwest USA, and even the folks at Gaviotas in Colombia have one.

Now, you'll need someone with hands-on experience to say exactly how many, how deep, and how long the tubes would need to be for your site and home. Sorry, but I don't have a specific person or organization to send you to for more info. How about it, readers, can you help Chris further? Richard Perez

Guerrilla Solar Concerns

Home Power has always promoted safe and legal alternative power systems. So when I saw the articles of Guerrilla Solar I was very concerned.

1. these systems are illegal. 2. These illegal systems are going to *kill* someone because the power companies are unaware of these systems and cannot take the proper precautions. 3. Equipment fails! All it is going to take is one incident of this stupidity to do *major damage* to the cause of independent power. Just because progress (for a cause) is slow, does not give any one the right to endanger others.

We have been on solar ten years and have been with *HP* from the beginning. Why this change away from safety? Claude Morris, McArthur, California

More Guerrilla Solar Concerns
I am really surprised you would promote such an article. I work for a utility but do share many of your beliefs. I don't work on the line equipment but work with the people who do. I have learned enough to know that your 100 watts at 120 volts can easily become 12,000 volts once it is passed through the transformer at your house. That is exactly how your power can be used by others when you have a surplus.

Since I do work on solid state equipment like the AC converter on this module, I do know that they can and will fail. Since this device is connected to the utility, it has a good chance of someday indirectly getting a lightning hit or AC surge that will partially disable it. When an unsuspecting lineman thinks the line is dead and goes to work on it, they will most likely be killed.

For a magazine of your kind that is fighting utilities to get easier access to the grid, this story gives them exactly what they need as an excuse to deny connections to their system. J Stobaugh • jstobaugh@inficad.com

Hello Claude and J., If the utility power gets even slightly out of spec, then the grid-intertied inverter jumps off-grid. PG&E was doubtful about "islanding," but after eight months of testing, the Trace inverters were approved for utility intertie. A guerrilla solar system has all the necessary safety gear that is also present in a non-guerrilla system. The only thing missing is utility approval, which hardly affects safety. You are mistaken on the subject of safety here—guerrilla solar systems are *safe.*

Utilities are already denying small-scale solar producers access to the grid. The whole idea behind guerrilla solar is that if these systems are denied access, then they can go ahead and intertie anyway. Richard Perez

Genny DeeCee
How appropriate that you should run this article just as we are on the verge of purchasing a new motor generator. My idea was a Honda 5,000 watt, electric start, propane fueled generator to interface with our Trace SW2512 to charge our 1800 amp hour NiFe at 12 volts.

I have seen the Genny DeeCee in *HP,* but knew nothing else about its performance and track record. A few questions if you would be so kind to respond:

1. How will the Genny DeeCee do on the NiFe batteries as compared to using the Trace? My Edison manual asks for up to 18.5 VDC, though I've never seen them that high in the 5 years we've had them.

2. Could the Genny DeeCee, with the electric start option, be auto started by the Trace?

3. Could the Trace shut the Genny DeeCee off?

4. Which motor generator system will you continue to use?

We've got snow and six weeks of cloudy weather. I'm running the Genny DeeCee right now! Julie and Mickey Wurl-Koth • wurlkoth@mail.bfm.org

Hello Mickey and Julie. The Genny DeeCee (GDC) will go to well over 18.5 VDC with no problem. The GDC is also far better suited to recharging alkaline cells than the Honda/SW2512 combo. I advise against auto starting/stopping any generator, but I imagine that the Trace could do this. The GDC has a timer that will shut the unit off. I continue to use both the GDC and our big Honda ES6500 through the inverter/charger. I use GDC for equalization and when I need less than 100 amps at 12 VDC. When the batteries are way down and I have big loads on, then I move to the larger 120 VAC Honda/charger routine. Richard Perez

Guilt-Free Electronic Edition
Hello Richard, One of the problems we have is that magazines are very expensive to subscribe to here in New Zealand. Although I did subscribe to *HP,* I have let it lapse because of my current financial position. Downloading each issue is now my *HP* 'fix.' I must admit to feeling quite guilty though, and have wondered how *HP* could charge for this service. Please have a look at how other online magazines have done it.

I think this is very fair given the size of the files to download and the ease of use, though there still is nothing quite like picking up some paper. For your information, I can subscribe to another E-zine for US$23.95 and to subscribe to the parent English magazine is US$82 for one year! I do feel you should be charging for the privilege of downloading. Guy Robinson • roblid@wave.co.nz

Hello Guy. I'm glad to hear that our electronic edition is working for you. We are going to keep this download free. Don't feel guilty—our mission is to spread the word about RE, not to make money. Richard Perez

Safety Equipment Placement
Dear *Home Power* staff, I have so enjoyed the *Home Power* articles which have helped many to benefit from renewable energy.

My *Solar2* and *3* just came and I am catching up on issues I had not been able to read. In looking at *HP58,* page 7, I could not help but notice a serious and potentially dangerous problem. The reference to the photo at the bottom of the page says, "…Note the 'safety equipment' on the floor." To the quick observer, this is laudable and a great example to others who wish to protect themselves, their homes and their equipment. On the other hand, when one reads and thinks carefully, this is a very dangerous situation.

In my youth, I thought myself wise for storing a coat hanger in the trunk of my car "in case I lock myself out and need a tool to get in!" I think proper advice to your readers on the choice and location of "safety equipment" would be in order. I just do not see that this would be easy to get at a) because one has to stoop to reach it, and b) because no one should have to run through a fire or hazard to reach the "safety equipment!" Keep up the good work. Doug Warkentin doug.warkentin@worldteam.org

Hello Doug. The safety gear was temporarily placed where it was so that it could appear in the photo. Actually, all that stuff is located many feet away, at the entrance to the room. Richard Perez

Trace C40 Charge Controllers & SW Inverters
Now out of the PV business after twelve years in it, I depend on *HP* for the latest info on products, players, and trends. Part of that information comes in the form of ads, which present a picture of the growth, change, and "standards" in the various parts of the PV universe.

Your attention to utility-intertied PV is both responsible and shrewd. Not only are you not shunning the philosophically unclean, you realize there are one thousand potential intertied PV users for each potential off-grid user.

Regarding questions about PV's chemical evils and true energy balance, I think 1% of the questioners are concerned and 99% are looking for a reason not to be supportive. Another popular refrain compares the high price of PV electricity to the "low" price of grid electricity. The implication is that anyone choosing to pay for PV electricity is foolish, while anyone choosing to pay for a Lexus is discerning.

My question concerns the use of Trace C40 charge controllers with SW series inverters. Doesn't the SW series include a built-in charger? If so, is the C40 necessary? At least three systems in recent issues have incorporated both a C40 and and a Trace SW series inverter. Got time for a quick explanation? Still subscribed and satisfied after ten years, Dave Lehmicke, Hermosa Beach, California

Hello Dave. I love your comment on PVs and the Lexus! It's all a matter of perspective. To answer your question, the C40 regulates PV modules while the charger in the Trace inverter regulates the 117 VAC output of either your generator or the grid. They are different regulators for different power sources. Richard Perez

CoSEIA Responds
Home Power, Tom Elliot's letter in *HP68* severely criticizes the Colorado Solar Energy Industries Association (CoSEIA) for its solar rebate program for solar domestic hot water systems and grid-intertied PV systems. I feel I must reply to clear up his numerous misleading statements. Rebates of up to $1,000 for the solar domestic hot water systems and up to $2,500 for the grid-intertied systems are available for newly installed systems in Colorado until June of 1999. This rebate isn't available for stand-alone systems, because although still expensive, the stand-alone systems are considered to be cost effective when compared to extending utility power lines. Even with the rebate, the grid-tied systems are still not economical to install. Some people like the technology and want to use it to help clean up the environment. They are willing to pay the price of a grid-intertied system and the CoSEIA rebate helps them a little. This and helping to spur the industry along a bit are the prime purposes of the rebate program.

Tom states "The only thing CoSEIA has to gain is the potential for more work for its members." He also expresses concern about CoSEIA promoting its "narrow self interest" and "narrow self-serving attitude." Sure, CoSEIA is promoting its members and solar energy. After all, isn't that one of the objectives of a trade association? Tom, although not a CoSEIA member, was sent information about the rebate program from the CoSEIA office and invited to participate in the rebate program. CoSEIA has sent out rebate information to all Colorado people known to them who are involved in the renewable industry. A person need not be a CoSEIA member to participate in the program.

The money for the program became available in mid June, 1998, although the program was not widely advertised until late August. This advertising was in conjunction and cooperation with the annual Parade of Homes where several solar systems had been installed. That's why Tom's comments concerning only $6,000 in rebates being applied for by the end of September are misleading. As of early December, the CoSEIA office has received hundreds of inquiries and has sent out over 500 rebate information packets as a result of those inquires. The grid-intertied systems are still very expensive and the people who buy them are not doing so for economic reasons. But people are buying them.

As to Tom's leading question: "I wonder what they plan to do with all the money they will have left over?" All rebate funds are supplied from the Colorado Office of Energy Conservation and are totally flow-through funds. CoSEIA doesn't get one red cent of these funds. Monetary support for administrating the rebate program has come from Heliotrope General, Heliodyne Inc., Altair, and Trace Engineering. As President of CoSEIA, I thank them very much.

P.S. I'm glad to see you will be considering a different direction for the "Wrench Realities" column. Like it or not, John Wiles brings up good points that need to be addressed. The bottom line, as I see it, is that an installer needs to talk with the electrical inspectors *before* installing a PV system. Find out what the inspectors are looking for and ask about their interpretation of an NEC article or about a potential problem before it occurs. The criticism aimed at John in the past is of little value. Jon Klima, Rick and Karen Hubbart, Kerry Kalarney, Jeff Brady, Colorado Solar Energy Industries Association, 2170 South Parker Road, Suite 263, Denver, CO 80231 • 800-633-9764 • 303-750-9764 • Fax: 303-750-0085 seiacolo@aol.com • www.coseia.org

Ozonal Notes

Richard and Karen Perez

New Paper for Home Power's Printed Edition

For the last couple of years, some of you may have noticed that the paper we have been using has only ten percent postconsumer waste. For some strange reason, the paper mills here in the US are not making a high postconsumer coated paper. The mills say there's no demand. Well, I've been demanding, but to no avail.

I've found a 50% postconsumer, elemental chlorine free/totally chlorine free (ECF/TCF) paper, made by Stora, a German paper company. We have not tried paper from overseas before because of the high embodied energy involved in bringing it from Europe. Stora is committed to minimizing the effects of transporting raw materials and finished products. They are developing ways to use residues from their mills to fuel the boilers of steamships. "The ideal situation would be to use waste paper that is not suitable for recycling," says Olle Widigsson, Technical Director of Purchasing and Transport at Stora. "That way we would do away with the energy demanding and round-about method of making ethanol from biopulp, for instance." Also, Stora's Transport Environmental Programme (STEP) goal is to cut present consumption of electricity and fuel by more than half. The same applies to nitrogen oxide and sulphur emissions.

Appearance Sells

Here in the USA, appearance is very important. We're still amazed at the increase in newsstand sales after we switched to a glossy paper. The content is the same, but because the appearance is professional, folks are more inclined to give us a look.

HP69 is the test run issue for the new paper from Stora. This paper has a matte or calendered finish—favored in the European community. This finish is easier on the eyes but we are concerned that the dot gain (ink spreading in the paper fibers) will be increased. In other words, the photos and color ads may look a little different. Remember—I'm writing this before we've seen an issue printed on this paper. So far, we've just seen printed samples from the mill.

Enough of the unknown—here are some impressive facts. Stora manufactures this paper in Odense, Denmark. This coated two sided matte paper is called RePrint Web, and comes in a sixty pound base weight. It's made with 50% postconsumer recycled de-inked fibers and 50% TCF pulp. The mill tries to purchase chlorine-free postconsumer waste, but it's not always possible.

We purchased this stock through Andrew McLaughlin at Woodland Paper. Andrew has been very helpful and responsive. These folks sell a wide variety of paper, from office paper to the really big rolls for web press use. This paper is slightly cheaper than the type we've been using. If all goes well, this is the paper for us.

Stora's Certifications and Awards

BGA Standard: German Federal Board of Health certification for food contact and the European Standard for Safety of Toys. BGA is the German equivalent to the United States Food and Drug Administration.

EMAS: The Eco Management and Audit Scheme is a European program which sets guidelines for manufacturing companies. These guidelines introduce environmental management as well as systematic control and reduction of the company's overall environmental impact.

Nordic Swan: To be awarded the Nordic Swan Environmental Label, a company must undertake to keep emissions to air and water below strict levels. The chemicals and the production processes are also closely monitored as part of the Nordic Swan standard.

EUGROPA: The European paper wholesalers symbol for recycled paper containing at least 50% genuine recycled paper.

Aging Resistance: According to DIN 6378-LDK12-80, RePrint will retain its strength properties for at least 100 years. The Deutsche Industry Norm registration is a very specific standard for European business operations and details exact properties and testing outcomes.

Oregon Net Metering

On 17 December 1998, Oregon renewable energy activists journeyed to Portland to meet with some of Oregon's biggest utilities. The topic of discussion was our proposed Oregon Net Metering Bill for grid-connected RE systems. The purpose of this preliminary round of meetings was to introduce our net metering bill to the utilities and to answer any questions they might have had about this bill. Peter G. West, Senior Policy Analyst for the Renewable Northwest Project, and Tom Starrs, lawyer for the group and author of most of this nation's net metering bills, attended the meetings. David Parker, Joe Schwartz, and Richard Perez represented the Oregon Solar Energy Industries Association (OSEIA).

Our first meeting was with PacifiCorp, known in the energy biz as Pacific Power. We met with Terry Flores, Senior Government Affairs Representative; Bill Edmonds, Environmental Policy Manager of Government Affairs; and Corey Cook, Contract Administrator of Retail Sales and Distribution. Our second meeting was with Portland General Electric (PGE). There we met with John McLain; Wayne Lei, Director of Environmental Affairs; Sara J. Cardwell, Manager of Tarrif Administration; and Cindy Finlayson, Legislative Relations. For our third meeting, we drove to Salem and met with both Salem Electric and the Eugene Water and Electric Board (EWEB). Attending for Salem Electric was Robert J. Speckman, General Manager; and Roger Kuhlman, Engineering and Operations Manager. Mathew W. Northway, Manager of Energy Management Services, represented EWEB.

At all these meetings we discussed the energy, safety, economic, and environmental aspects of our proposed bill and how it might affect utilities in Oregon. Utility response varied from "Don't try to legislate our rates," to "Wow, if there were enough folks doing small-scale RE on-grid it could improve our power quality." We left PacifiCorp with a positive feeling that this utility might support the bill. I left PGE with the feeling that they would rather not see Oregonians making their own solar, wind, or microhydro power. The most favorable meeting was with Salem Electric and EWEB. These smaller utilities immediately grasped what we were trying to do, and wanted to help.

Every utility was concerned about the effects of this bill on the safety of their line repair people. We did our best to explain to them that these systems are safe and reliable—magnitudes safer than having homeowners trying to connect engine/generators to their homes. We explained how RE systems comply with IEEE, UL, and NEC equipment and installation standards. What amazed me most was that all of the utilities realized that this bill would place green power on their grid. They liked this idea and wondered if there was enough of this green power for them to actually market it to their other customers....

Were these meetings fruitful? Only time will tell. In today's environment of utility deregulation, I found these mega-companies strangely uncertain about their futures. After a century of publicly granted monopoly, they are being forced to compete. Their customers can now choose where their power comes from. Our renewable energy bill further complicates the confusing array of choices. Their customers can now turn the tables on them and put RE onto their grid—a customer tonight can be a supplier tomorrow when the sun shines. Stay tuned to find out if Oregon's utilities are up to the challenges they will face in the next century.

Meanwhile, the Proposed Oregon Net Metering Bill trucks on. We are now finding legislative sponsors for this bill. We will introduce it into this year's session of the Oregon Legislature. We are preparing for a public discussion of this bill and its benefits for Oregon and Oregonians. We've just begun!

Guerrilla Solar

I've been amazed by the number of guerrilla solar systems out there. I'm also amazed at utility response to the solar guerrilla—to say that utilities don't like them would be a huge understatement. I'm interested in this energy/social phenomenon.

Here's a deal for you solar guerrillas out there. Send us a description of your system, a short statement about why you are a solar guerrilla, and a photo of you and your PVs (be sure to wear a mask or put a bag over your head...)—we'll send you an ultracool Solar Guerrilla T-shirt for free! This T-shirt is a special run for solar guerrillas. You can't buy it—you have to earn it. Be sure to include a T-shirt size and shipping address with your message. All this correspondence will be held absolutely confidential. We want to profile Solar Guerrillas in each issue, so plan on being in print and in the utility's face. What fun!

Access

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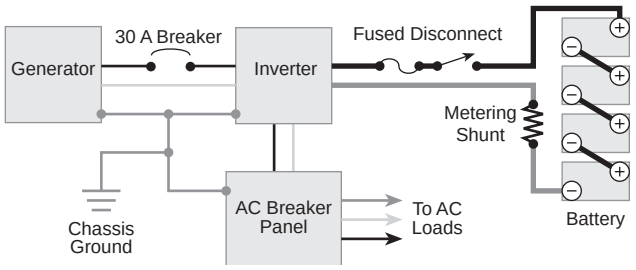
Q&A

Adding Safety Components

Dear *Home Power*, I'm new to the renewable energy force. Please find the enclosed drawing of what I'm trying to put together for occasional backup lighting. Please add to my drawing where and what else I need to complete it (fuses, shunts, etc.). I will appreciate any help you can be to me and I want to try to use what I have until I hear from you. Roger Shingleton, Wilson, NC



Hello Roger. Here is the drawing with the safety equipment to be inserted. Every hot or positive conductor should have overcurrent protection. For the low amperage conductors (under 100 amps), use circuit breakers, but for the positive battery cable use a 400 amp Class-T fuse. Also be sure to put a high-amperage DC-rated disconnect between that fuse and the battery. The AC breaker panel should be grounded, with the generator and inverter boxes bonded to that ground as well.

The shunt for the system metering goes on the negative battery lead. Connect all inputs and loads on the inverter/load/source side of the shunt so that it will monitor all current going into and out of the battery.

You should add some PV modules to your system. You will need to add a charge controller, with DC breakers on each side of it on the positive leg. Also, if you install the PVs on your roof, the NEC requires that the module frames be grounded and that you use a Ground Fault Protector (GFP) on the array. Good luck, and welcome to the world of RE! Richard Perez

Homemade Wind Gennies

I can't give up on the idea of building my own small wind generators. I would like to create my own small wind farm made up of the smallest micro-size wind generators available. The Thermax Corp. makes very small wind generators that are low rpm which, in my opinion, would be much better to use than trying to use small high rpm DC motors as generators.

Is it possible to connect several small wind gennies together and run them to the batteries? If so, how would I do it? Do I need to put a diode in each genny's wiring to prevent back-feeding from other wind generators and the battery? Where would I place the diodes?

Also, I am having trouble understanding how slip rings work to prevent the genny wires from being twisted. I would like to use pipes for the support structures. How do you connect wires to slip rings? How do you make the copper slip rings? Sincerely, David Hodgson, Indianapolis, IN

David, the Thermax generators from Windstream Power Systems are a good place to start building your own micro wind farm. Check out their ad in this issue. They're pretty much the only game in town for small do-it-yourself wind genny kits. You may want to start with one of their kits, then expand from there. After you've seen their blades, take a shot at carving your own. The same goes for the tail and mainframe assemblies. After buying your first complete wind generator kit from Thermax, you may end up making all of your own parts, except the generators. Shop skills come in handy, as does a well-tooled shop to work in.

Yes, it's possible to hook several wind turbines to the same battery bank. The usual approach is to put the diodes in the positive wires going from the generators to the battery. The negative wires from the gennys are just connected to the negative battery terminal. A voltmeter across the generator wires will tell you if a particular unit is charging. An ammeter on the wind genny side of each diode will tell you how much current each genny is contributing to the battery bank. Check out the Alternative Energy Engineering ad in this issue, they sell some inexpensive volt and amp meters.

Slip rings transfer current down the tower through a set of brushes that ride against them. Let's say the slip rings are attached to the wind genny mainframe. In this case, wires from the generator itself are connected to the slip rings. The tower wires would be attached to the brushes that ride on the slip rings. The electrical connection from generator to tower wiring is made through the slip ring brushes. Seeing the Thermax kit will go a long way to understanding how they work.

A great reference for building your own small wind genny is Hugh Piggott's book Windpower Workshop. *While not a step-by-step cookbook, Hugh takes you through the steps required to brew your own, including carving your own blades. A more advanced project involves building your own generator out of an automobile brake drum. Check out* HP65 *for the book review and access information. The easiest way to contact Hugh is via e-mail (hugh.piggott@enterprise.net).*

Good luck with your project. Please share your success story with us when you've got a few machines up and running. Mick Sagrillo

Care and Feeding of NiCd Batteries

I need information on the care, feeding, and reconditioning of industrial size NiCd batteries which have been donated to a local nature center. Can I break up "dendrites" in such large batteries as I do with the small sinter-type batteries using a quick "shock therapy" by creating a short duration overvoltage? If the cell is low on liquid without any signs of case damage, should fluid be added? Gail Burrington • BUR_SOLAR@commnet.edu

Vented pocket plate NiCds don't get dendrites such as those found in sintered plate (flashlight sized) NiCds. No zapping is necessary on the big pocket plate cells. When any NiCd gets low on fluid, refill the cell to the full line with distilled water before the plates are exposed. Extensive info on reconditioning alkaline cells is on our Solar2 *CD-ROM. Richard Perez*

24 vs. 12 Volt Systems

Hi Richard, I have been a great fan of *Home Power* for years and have all the back issues.

Any thoughts on 24 vs. 12 volt systems? I want to design an off-grid PV and wind system for a small home in Wisconsin. I am ordering a Sun Frost RF12. The folks at Sun Frost want to know if we need a 12 or 24 volt model. I always thought that 12 volt was the standard; now I'm intrigued with 24. Any advantages?

Thanks for being a great inspiration over the years. We are ready to take the off-grid plunge! Alan and Nancy • Wildlfsanc@aol.com

Hello Alan and Nancy, Go 24 VDC as a base system voltage for your battery. The loss in conductors (wiring) is inversely proportional to the square of the current flowing through the conductor. Remember, power in watts is equal to volts times amps. Doubling the voltage from 12 to 24 halves the current (amps), reducing the wiring loss by four times. With 24 VDC and higher voltages, PVs and wind gennies can be located further from the battery without buying large, expensive conductors. The same is true of conductors supplying appliances, such as the 24 VDC Sun Frost fridge/freezers.

The weak point of all low voltage systems is in their mechanical/electrical connections. Going to 24 VDC means that you only have to move half the current for a given wattage, compared to a 12 VDC system. 24 VDC systems have fewer problems over time in their mechanical low voltage connections—on the battery, inverter, PVs, wind genny, charge controllers, and DC appliances.

Since modern sine wave inverters are available in both 12 and 24 VDC models, you still have a wide choice of inverters. Just make sure that you buy a sine wave inverter—mod sine inverters are passé. A sine wave inverter allows the house to be wired using conventional 120 VAC techniques with very low power loss. It also allows access to common, full featured, and relatively inexpensive appliances. The only low voltage appliances we use here anymore are our venerable Sun Frost and a couple of ham radios. Richard Perez

DC Generating
Dear Mr Perez, I inquired previously about a source for the electronic controller which you have as part of your Honda-powered 12 V car generator. I learned about it from your *Solar2* CD-ROM. I still haven't found someone here who has the talent and believes from the schematic that it will work! Oh well, I have gathered up most of the parts for the generator and will be using a rheostat system by spring.

In the meantime, I am thinking about replacing my batteries and wondered if you have any preference for battery type (lead-acid, NiCd, gel-cell) or capacity based on my setup. Lead-acid seemed to be the compromise selection based on the articles I have read from *Solar2,* but a few years have passed since they were written. I have probably not provided all the information, but based on the following, would you have the time to suggest a battery type and total amp hour storage for my system?

My setup has been a 440 amp-hour, deep cycle battery bank (four 6 volt lead-acid golf-cart batteries) with a 75 amp battery charger. I just added the 75 amp charger, though I did have a 40 amp car battery charger. We probably draw a maximum of 40 amp-hours per day from it, most of the time at a 6 to 10 amp rate. I have a 1000 watt inverter which, after seven years, is still not hooked up although as I grow older it likely will be for TV, microwave, etc.

The system is at my cabin, which sits under 60 to 80 foot tall maple and beech trees. The trees do just what we ask, cool us off during the summer. But at the same time they are not conducive to solar or wind power (as I understand it, even in winter, solar panels that have tree branch shadows on them do not work effectively).

As I see it, my problems are two-fold. Since the cabin is in the Upper Peninsula of Michigan, below zero temperatures are not uncommon. Because it is a cabin, I can't be there all the time (sometimes two weekends in a row and sometimes it is four to six weeks between visits). So temperature and idle time are against me.

In my generator room I have an insulated (R-20, sides and top) battery box which I have set in the ground at or below frost line, but it is not totally sealed from air since these are lead-acid batteries and I have read about the need for venting. I believe I have been successful at keeping the batteries from freezing most of the time. But lead-acid batteries do not consider 40 to 60° F ground temperatures to be optimum.

Maybe there is not a better, reasonably priced battery solution to long periods of non-use and cold temperatures. In some ways I can't complain, my first set of batteries were seven years old when I replaced them and would have lasted longer since I usually run my generator an hour a day anyway. Would you or your staff have any suggestions and the time to make them? Thank you, Danny Gallagher, St. Helen, MI dgal1947@voyager.net

Hello Danny, I'd suggest sticking with deep cycle, lead-acid batteries. There are no longer sources for affordable alkaline cells. I'd suggest at least four Trojan L-16s (700 AH at 12 VDC). A larger battery capacity would be better for your system with your cold climate.

Even a couple of PV modules would make a big difference in your system because it's only used intermittently. Even if these PVs only got a few hours of sun, they would keep the battery fully charged and prevent it from freezing up in the winter. Be sure to use a regulator so that the PVs don't grossly overcharge the battery if you don't use the system for a month or two. Richard Perez

More DC Generating
Richard, I am a new subscriber to *HP* and I also purchased the *Solar2* and *Solar3* CD-ROMs. I have found lots of good information in them. I am trying to build the engine/generator from *HP42* and have it almost completed. But there isn't any info on how to adjust the potentiometers and I don't want to goof it up now.

If I missed an article that explains the operation of the charge controller, please let me know where to find it. If not, could you write me a short explanation on the necessary adjustments. Thank you in advance. Rudy Haak, Mesick, MI • rhaak@netonecom.net

Hello Rudy. Adjustment is easy. Turn the voltage pot all the way up (it's the one connected to the LM723). Adjust the amp pot (connected to the NE555) to the amperage you want. When the battery voltage reaches the limit you desire, adjust the voltage pot down until the system regulates at that voltage.

The amperage pot predominates until the system voltage reaches the one that is set on the voltage pot, then the voltage pot dominates. Richard Perez

Still More DC Generating
Dear Richard, In *HP68* you discuss the merits of a DC alternator as a battery charging device. Years ago I put together the various components for an almost identical machine, except that I used the Electron Connection power control for the alternator field. This machine has worked perfectly for me.

It seems to me that at that time you recommended charging lead-acid batteries at the C-20 rate. However, I don't remember noting the need for reducing that charge as the batteries approach full charge, although I realize that 117 VAC chargers perform this function automatically.

At what battery voltage during charging should the the charge rate be reduced, and by how much? What are the specifications for charge rate during cell equalization? You probably have issued all this data previously, but some days the Old Timer's Disease reigns and makes its inroads. Thank you, Bob Weaver, Waldron Island, WA

Hello, Bob. If you have one of the old Mark VI field controllers that I made when I owned Electron Connection, then keep on using it. Unfortunately, neither the Mark VI or the later Mark 8.3 are commercial products anymore—they're just homebrew. If you set the appropriate voltage limit on the Mark series controllers, then you don't have to worry about the current, as this system is voltage limited.

For normal use, charge your batteries to 14.8 volts, plus or minus 0.2 volts. An equalization charge is a controlled overcharge of a completely charged battery. The equalization charge is carried out at the C/20 rate for five to seven hours. The charge current can be less than C/20, but the equalization charge will take longer. During cell equalization, it doesn't matter how high the voltage gets—you can expect it to reach 16.5 volts for a 12 volt system. Equalization charges should be performed every two months or every five to seven deep cycles (cycles below 60% DOD). Richard Perez

Hydrocaps and Battery Pulsers
To the *Home Power* crew, Perhaps you or some of your readers would give me advice in the areas of Hydrocaps, a Power Pulse battery maintenance system, and propellers.

1. I have used around 500 Hydrocaps and kept track of them individually by numbering them. Nearly all 146 Hydrocaps on my first large battery seemed to fail in the first six months. This was during winter, and before I installed a Whisper 600 on the system. As a result, I could not put an equalizing charge into the battery until spring. The battery building is not heated and temperatures got down to -10° F at times.

I tried heating some of the Hydrocaps in the oven to dry them out as per instructions. I discovered that if I reinstalled the caps while they were still hot they seemed to stay warm with a 2 amp per cell charge on a full battery. But the next day after the battery was again full, a 2 amp per cell charge would not cause the caps to warm. I installed twelve new ones and they warmed quite a bit within 30 minutes. After several calls to the manufacturer, it was decided I should send some of the caps back for testing. The manufacturer returned them and said they all worked. They still did not warm under a 2 amp per cell charge on a full battery. I watched and recorded info for over a year and found the cells with caps that did not warm used more water than those that did warm. In all cases I can replace the cap that does not warm with a new one, and with a 2 amp per cell charge within 30 minutes the new cap is warm.

It seems to me that I have a large percentage of caps that do not warm and do not make water, so I feel they do not work. Can you suggest anything that might help?

2. My Power Pulse is the 48 volt model. I had two weak 6 volt batteries in with six good ones. I let the pulse operate six months. In the two weak batteries, there were three cells that would not go above 1.220 to 1.230 specific gravity. I could not see any improvement in the group. I wasn't

sure if the problem was sulfation so I put in a half ounce of EDTA solution in the three cells. Within a few days hydrometer readings increased about 5 points. I added an additional ounce for another 5 to 10 points. Another ounce yielded a modest increase in two of the three cells. One ounce more did not change the hydrometer readings.

I have no questions about what I did, just reporting what I found. One thing that did bother me is when I called Abraham Solar Equipment about the Power Pulse, I received a different story than when I called to ask about ordering a unit. I wasn't offered anything I might try differently and also was told that sometimes it doesn't work. I installed the Power Pulse on a brand new set of 48 volt golf cart batteries and we will see what happens in a few years.

3. Now, on to a different subject—propellers. I have had experience with one old 12 volt 200 watt Wincharger, two Whisper 600s, and one Whisper 3000. My biggest problems are with propellers. It is my opinion that we are so demanding that manufacturers have become too concerned with getting every watt of power they can out of a unit by over-sizing propellers. And that, I feel, leads to problems during high wind (40 to 70 mph) conditions. You notice that most of my experience has been with Whispers by WPT. I can't say enough good about World Power Technologies. They are helpful and their warranty service is well above average. The two 600s operate well and with the new injection molded plastic props, maintenance and replacement should be greatly reduced.

Most of my problems have been with the older model 3000, mounted on a 90 foot tower. It has self-destructed twice in high winds (60 to 70+ mph) while the unit was turned off. I expressed my feeling to World Power about too much prop. Although they did not agree with the shortening of the prop, they told me how to balance it if I did cut it off. I finally cut the props, but only 3 to 6 inches at a time. I wound up (no pun intended) cutting off a total of 19 inches for a diameter of about 11.5 feet. If my figures are correct, I have reduced the swept area from 163 to 95 square feet, as I figured that the center 1 2/3 feet had no effect. I do not have a wind speed indicator, but there is an automated weather station at a nearby airport that I listen to with my scanner.

During light winds there is less output, but during 25+ mph winds I feel I have actually gained usable power because the governing system does not have to click in so soon. And the best thing is that during recent winds of 60 mph with much higher gusts, there were no problems. Any further advice would be appreciated. Thanks for all the good basic info in your magazine. Michael Steil, N0QQS, West Bend, IA

Hello, Michael. It sounds like you have toasted some of the Hydrocaps. They are catalytic converters and can be overdosed by more hydrogen and oxygen than they can recombine. Most Hydrocaps can only metabolize about two amps of overcharge current. Perhaps yours have had too much?

I find it beneficial to remove the Hydrocaps during periods of battery overcharging, intended or otherwise, such as equalization. The electronic desulfators work best in lower voltage battery packs because there are fewer series connected cells. Electronic battery desulfators are primarily prophylactic and may or may not work on already heavily sulfated batteries. As you discovered, EDTA treatment is the last resort and often works where other methods of restoring lead-acid battery capacity have failed.

On the subject of Whispers and WPT, we are happy with their warranty service and machines. We've flown a Whisper here for over four years now. While it had problems and had to be repaired, we're still getting electricity from it. If you want simple no maintenance power, then go with PV. In places where the sun disappears for weeks, wind is an option. We have wind power here, and have learned to deal with the maintenance and failures. Richard Perez

Used Batteries

I have recently acquired thirty used 12 volt batteries (about two years old). They were used in a UPS system and are Johnson Controls Dynasty UPS12-270 270 WPC (not sure what WPC means) batteries. They are sealed lead acid batteries and do not need venting. On the battery case, it states the float charge is 13.5–13.8 VDC at 77° F and 14.4–14.8 VDC at 77° F for an equalization charge.

They are currently at full charge. I do not have any solar panels at this time, but I plan on a few in the next year.

I want to keep these batteries charged. I was thinking of buying a charge controller for a solar array and somehow hooking it up to my grid power (with an AC to DC converter) to keep the batteries charged. I want to be able to reuse the charge controller with solar panels at a later time.

Is this a good idea or is there a better way? Are these batteries any good for solar power? How do I determine the proper charge voltage for these batteries at different temperatures? How can I convert 270 WPC at 15 minutes to 1.67 VPC to amp-hours? Travis L. F. Bailey • tbailey@amaonline.com

Hello, Travis. Your idea will work. Just make sure that the AC to DC power supply (battery charger) is within the specs of the PV charge controller you use.

You should contact Johnson Controls and get their spec sheet for these batteries. It will give you float voltage and cycle voltage for various temperatures. I don't have this information for sealed cells, which we rarely use in home power systems because they are so expensive. Sealed cells are far more delicate than vented cells. Be sure to stick within Johnson Control's specs. Overcharging can easily ruin sealed cells if the voltage or charge rates are too high. Richard Perez

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CLOSE OUT PRICES to make space for new inventory. After awhile things just pile up on you. It's not that the products aren't quality, it's just that they didn't get promoted enough, I guess. Anyway it's time to head'em up and move'em out! Here we go: Exceltech Sinewave Inverters 1100 Watts, 24 VDC, $580. Exceltech Sinewave Inverter 125 Watt. 12VDC $140.00. Exeltech Sinewave Inverter, 125 Watt, 24 VDC, $170.00. Dimensions 1800 Watt Inverter/Charger. 12 VDC, $590. Statpower Prowatt Inverter 150 Watt, 12VDC, $43.00 (These are not the rebuilt ones you hear about, these are Brand New.) Trace TS512SB Inverter/Charger, $350.00. Solarex PV Module VLX 53 Watt, $228.00. Solarex 8 Watt Lite $60.00 (This module has a stainless steel back plate and 10 ft. of wire.) Finally, I have 140, 600 Watt Heart Inverters that are 12 VDC but have an output of 230 VAC/60 HZ (According to Heart they can be adjusted to 50 HZ if necessary), $45. All the items above come with factory warranty and Sun Electronics complete refund if you have any problem. As far as photovoltaic modules go Sun Electronics is the Master Distributor for the Caribbean for Solarex Inc. and as you may know Solarex prices are by far the most competitive in the industry at the present moment. I know, I've been tracking prices for 15 years. Call me, I'll prove it. Sun Electronics, John Kimball, working on solar power for 25 years. And if it's seconds or cosmetic blemed panels you want our VLX 48's are a super deal. As far as New Trace Inverters or Heart Interface Inverters, you may see a lot of low pricing on the pages of this magazine. I think we can be a little more than competitive and this is why. 10 years ago we discovered that the Dominican Republic and Haiti had regular power failures of several to 24 hours per day. Through our distributor network and sales force Trace and Heart have seen their sales peak at over 60,000 systems sold into this market. You might say we've got buying power. The same goes for Trojan Batteries, over 100,000 sold, good old T-105's. You can't beat'em. Our distributors and sales people made this happen. Let us help you get started in the Alternative Energy and Battery Backup Business. Call or Fax us for a complete price list at Tel. 305-536-9917 or 305-381-6166. Fax 305-371-2353. E-Mail SUNELECTRONICS@BELLSOUTH.NET.

IF YOU KNOW ANYTHING about Hemispherical dish concentrators as roofs, let me know too, Michael Meredith, 5521 Southampton Dr, Springfield, VA 22151

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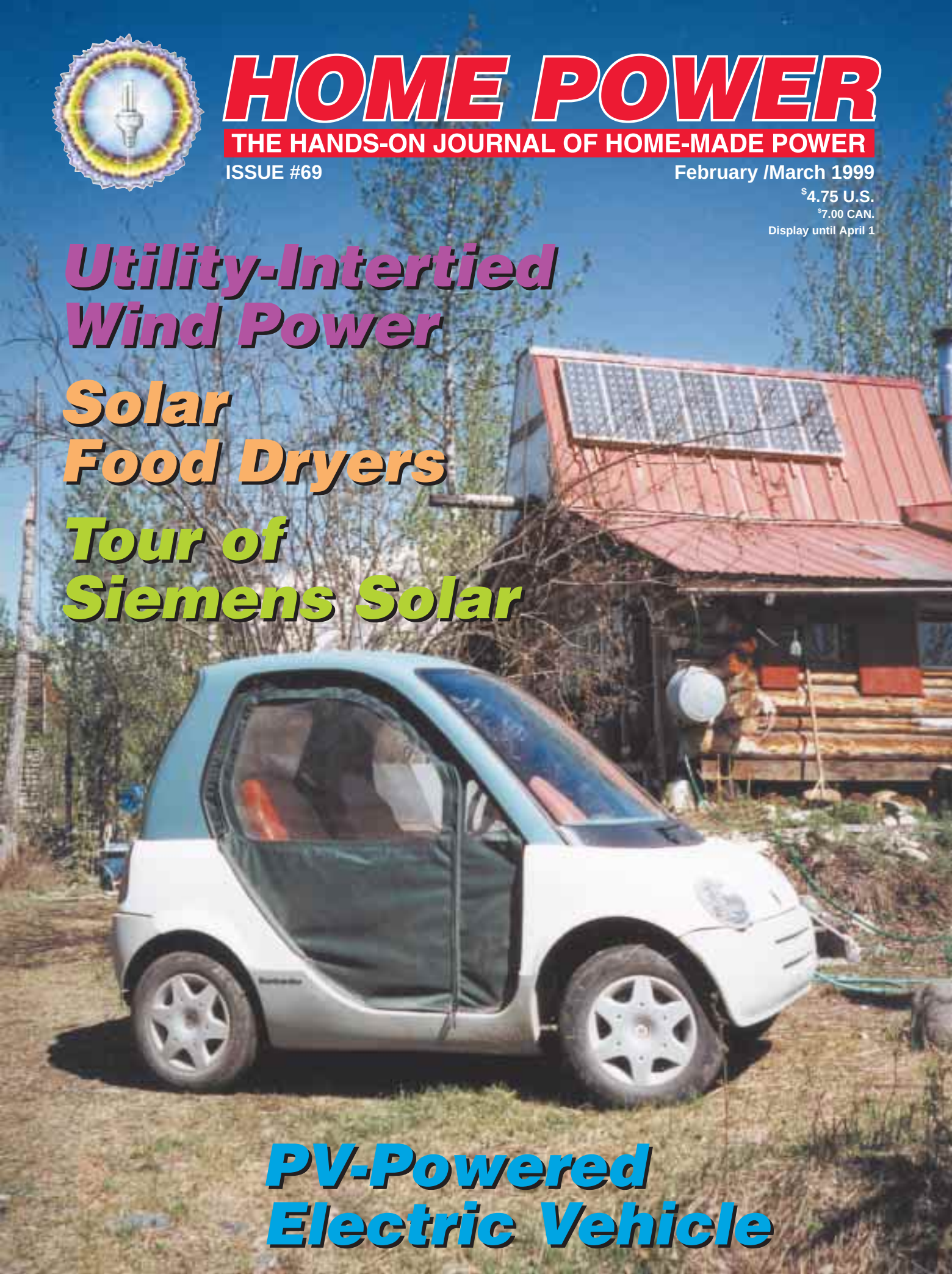

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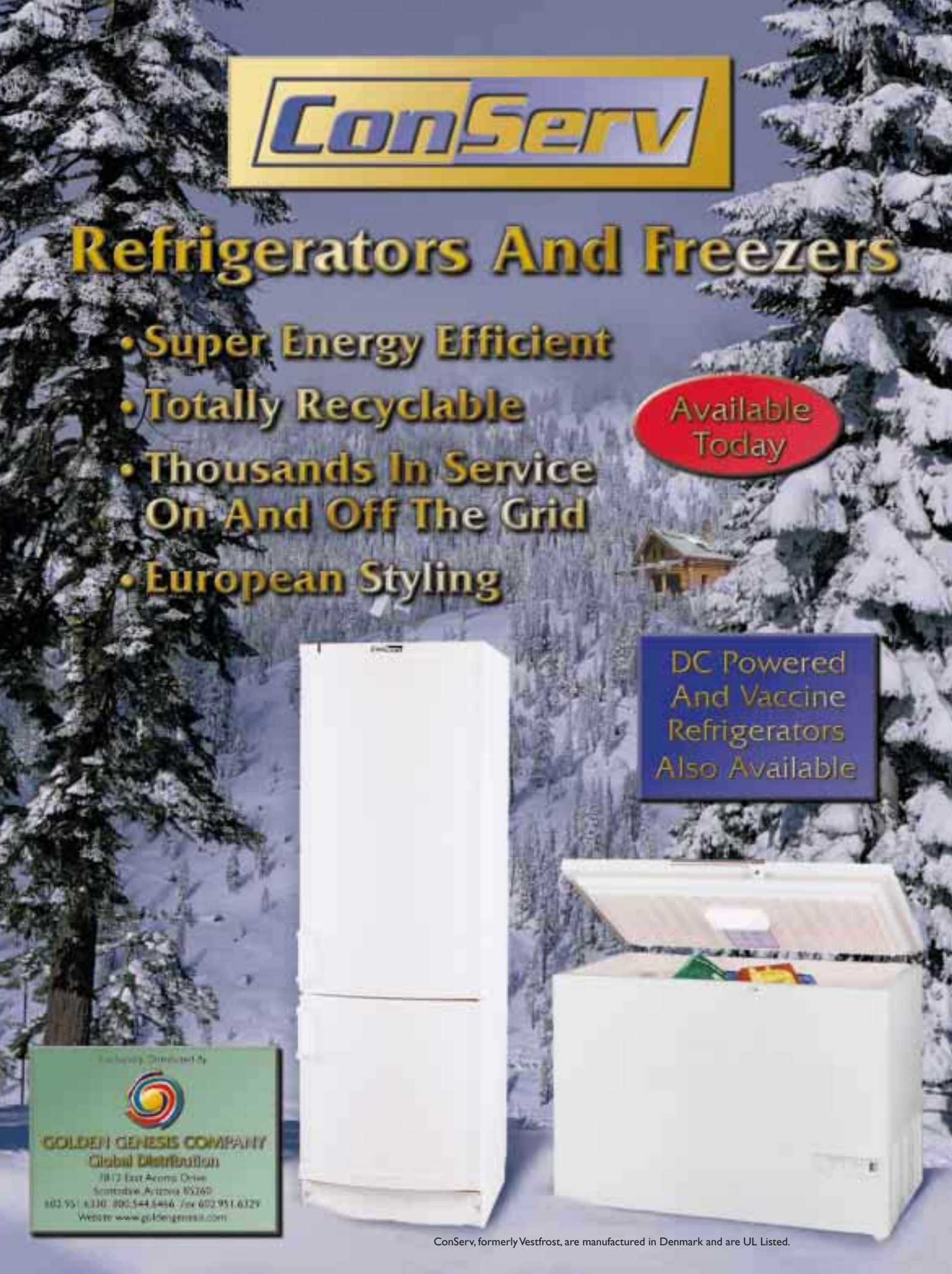

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