HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

ISSUE #68

December 1998 / January 1999

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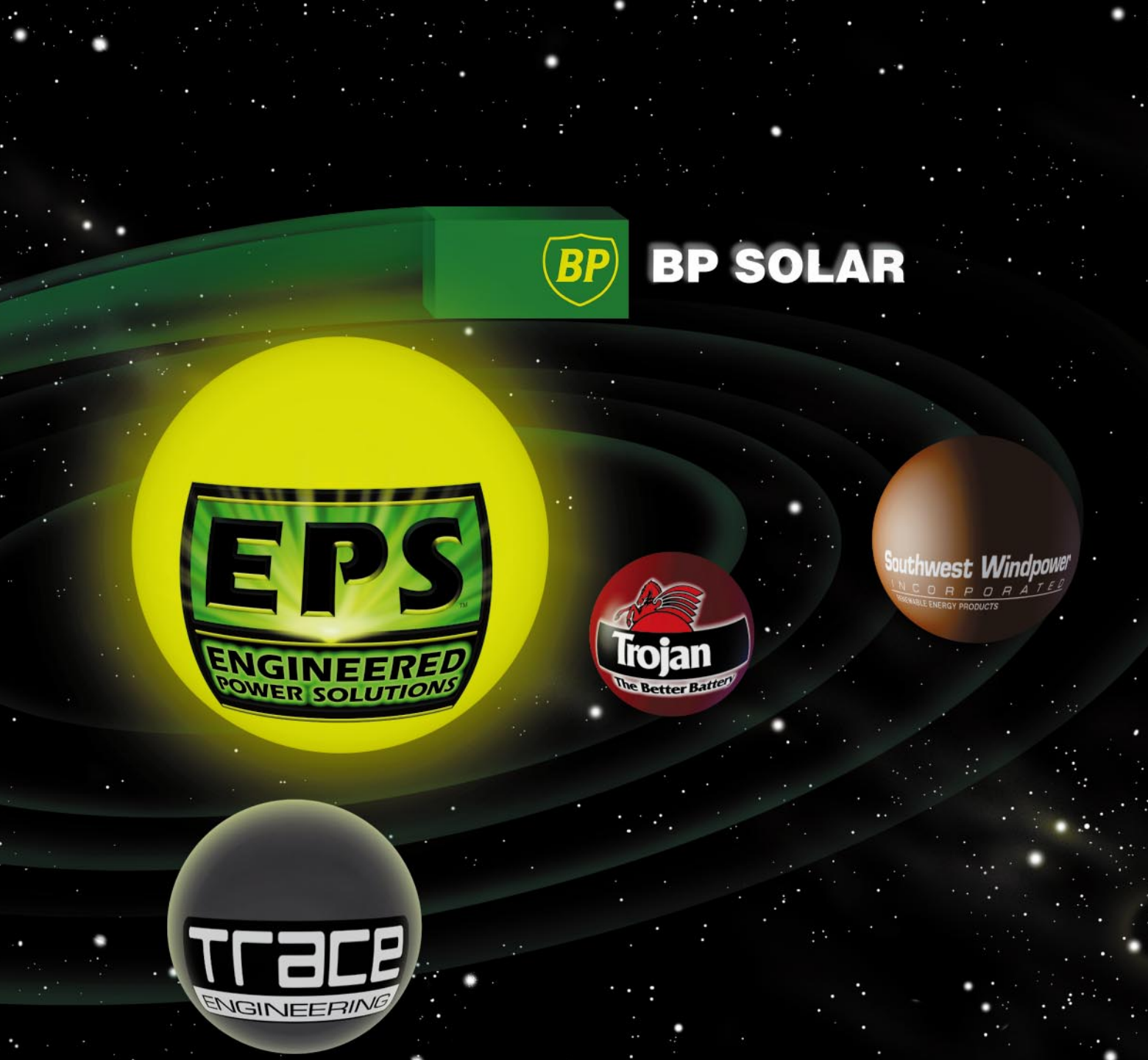

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HOME POWER

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Features

GoPower

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Cover: Paul Gipe's Bergey 850 on a 64 foot tower in the Tehachapi Mountains of California.

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Guerrilla Solar

Guerrilla solar is the unauthorized placement of solar electricity on the utility grid. We became solar guerrillas to make a positive change in our lives, our environment, and even in the grid.

Guerrilla solar is at once a dangerous and positive philosophy—personal and environmental freedom is not an excuse to harm others. There is no fine line between right and wrong here. Does an act make us free, or does it enslave us? Does an act help our planet, or not?

We must take control of our lives. When we relinquish our energies and responsibilities, we give away our freedoms and rights. Today, we have fewer freedoms and more environmental problems than ever before.

The utilities' oppressive denial of our solar energy is unacceptable. Pure spite might be enough reason to go guerrilla solar for some. Rubbing guerrila solar in the utilities' face is just the icing on the cake for us. We have other motives.

We want more personal freedom, and a cleaner planet. That's why we are solar guerrillas.

—Maka Rukus and Jenny Freely

People

Joy Anderson
Mike Brown
Ellen Coleman
Mark Coleman
Sam Coleman
Joel Davidson
Bob Ellison
Paul Gipe
Anita Jarmann
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"Think about it..."

There are few things as fun as raising hell for the good of the people.

– Molly Ivins

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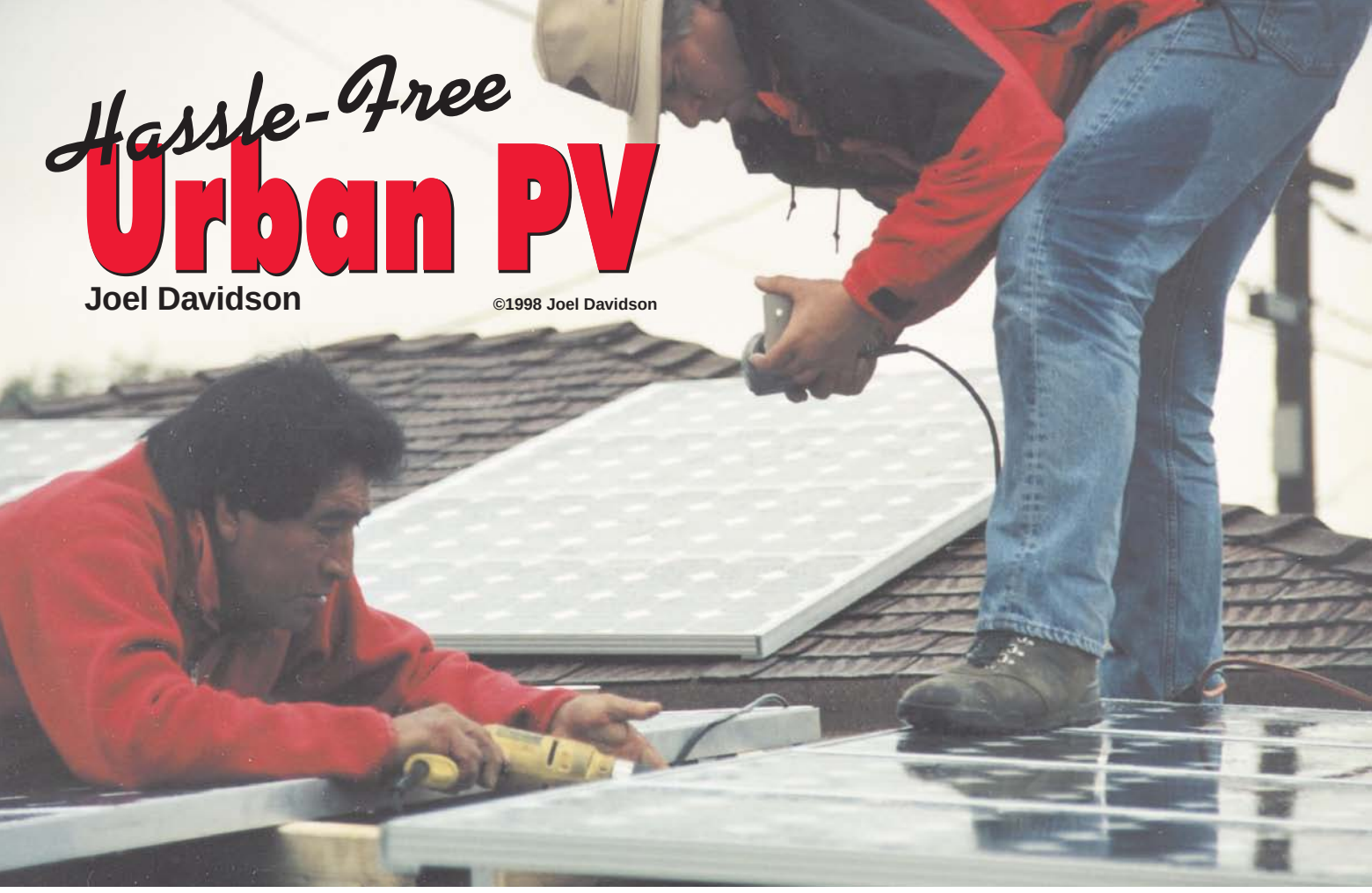
Hassle-Free Urban PV

Joel Davidson



Above: Fastening stand-offs to panels during installation of the 2 KW intertied PV array.

The United States is an urban society, with 72% of Americans living on less than 2% of the land. Photovoltaics (PV: solar-electric modules) can displace a significant percentage of polluting electric generators if it becomes an urban technology. With a little patience, planning, and help from an experienced contractor, city folks can install a PV system hassle-free.

Hire a PV Contractor

Experienced do-it-yourselfers can install grid connected PV systems. They need the same skills and knowledge required to install a service panel and re-wire a home. However, dealing with inspectors and your local utility requires special skills.

I've built a lot of homes and have even trained building inspectors. My wife Fran and I have 35 years of PV experience between us. We've learned that most inspectors prefer not to discuss codes and rules with owner-builders. That's why we hired Greg Johanson, owner of Solar Electrical Systems, when we were ready to do our own PV system. Greg is a general and electrical contractor who has installed a megawatt of PV and has a 3 KW PV system on his own home.

Designing the System

We wanted as much PV as we could afford, that would fit on our home's 1400 square foot low-pitched roof, so we chose a 2 KW system. Tilted optimally at 35°, the 225 square foot single crystal array would have looked like a billboard on our home. Behind the house, our office and garage have 10° and 15° south-facing roofs. A tilt-up array would look bad there too, and would be costly to protect from high winds.

We decided to use the low-profile, structurally engineered mounting system that Greg and I designed for PV Pioneer (a utility program) homes and churches in Sacramento. Here in Los Angeles, annual PV production is only 5% less at 10° tilt than at 35°. We also didn't want to spend more for the extra structural engineering and hardware for the high-tilt mount. The low-profile array also put us in compliance with local building codes that prohibit unsightly roof panels and antennas. Our neighbors like the low-profile panels and are thinking about going solar, so we know we made the right decision.

Above: The garage roof just begs for PV.

The System

Our PV array has thirty-two Siemens 70 watt modules wired in sets of four in series. Eight groups of four modules are fastened to the roof with wood screws. The mount meets local wind and seismic requirements. All wiring is in flexible or rigid conduit approved by the inspector.

We have a battery bank to protect our computers and for emergency power. Our office, garage, kitchen and home lighting are on dedicated circuits. If the grid is disconnected, the Trace inverter switches these circuits to the batteries. Some people call this configuration a PV UPS (Uninterruptible Power Supply). Despite news reports to the contrary, Los Angeles has had relatively few power outages in the past 30 years. Most blackouts were only a few minutes long. Our grid power was off for twenty minutes during the 1994 earthquake. Four Johnson Controls 12 volt, 86 amp-hour, sealed gel-cell batteries provide 3.4 KWH energy storage (at 80% depth of discharge). If we need more autonomy, we can get locally manufactured industrial flooded batteries.

So many good things have been said about Trace Inverters that more would be redundant. We thank the folks at Trace for helping make urban PV a reality. We installed a Trace Modular System and SW4048 sine wave inverter that can handle our largest combined loads. The modular cabinet looks good, is easy to install, and impresses inspectors.

Our system cost was $19,742 and qualified for a $5,835 California Energy Commission buy-down rebate. So the net price was $13,907 or $7.15 per watt AC. The battery storage package cost another $2,709 but was not eligible for the grid-tie buy-down.

So Where's the Hassle?

If you want hassle-free PV, you have to understand inspectors. When we upgraded our service panel a year earlier, Fran told the inspector we planned to install PV. He was really interested and wanted to learn more. Our PV system would be the first in Culver City, so teaching was the key to opening inspectors' minds.

I put together a permit package that would educate inspectors. It included a general outline of the work to be done, system description, design calculations, equipment specifications, parts list, wiring diagrams, drawings, plans, and elevations. Of course, we added the impressive California Buy-down Confirmation application as well as attractive product literature.

I began the inspection process by applying for a homeowner's permit listing Solar Electrical Systems as our licensed electrical sub-contractor. First, I met with the electrical inspector and gave him a copy of the permit package, some photos, and additional information. Next, I met with the engineer responsible for inspecting signs, poles, towers and other things stuck on roofs. He liked the low-profile design.

Next, I met with the construction permit engineer and hit a snag. He couldn't care less about PV. All he wanted were site specific structural calculations. I told him that our generic calculations included my roof type, but he refused to look at them. So I politely asked to see his boss.

The building department director is a professional engineer (PE). I told him about the PV work we did for

Below: The low profile array installed.

Above: Running the wires in rigid and flexible conduit.

utilities, showed him lots of photos and explained our structural calculations. He confirmed the calculations and even waived the construction permit because our design was under three pounds per square foot dead load. The three meetings took two well-spent hours. We ended up paying only $31.50 for an electrical subpanel permit.

Our equipment arrived on schedule. We installed the array on a Saturday during a light rain. Working in the rain is not recommended, but it was our only free day and the roof is nearly flat. Four guys worked for three damp hours to get the array in place. We installed the wiring on the next available clear day. The inspector passed the job without a hitch. We mailed the final papers to the California Energy Commission and received our rebate check within a month.

Net Metering

The next step was getting our net metering agreement. It is important for folks with PV to spin their utility meters backwards. They get full value for their home-grown energy, while displacing polluting electricity. All utilities in the USA are required to allow qualified generating facilities to connect to the grid. California utilities are required to net meter qualified residential and commercial PV systems under 10 KW.

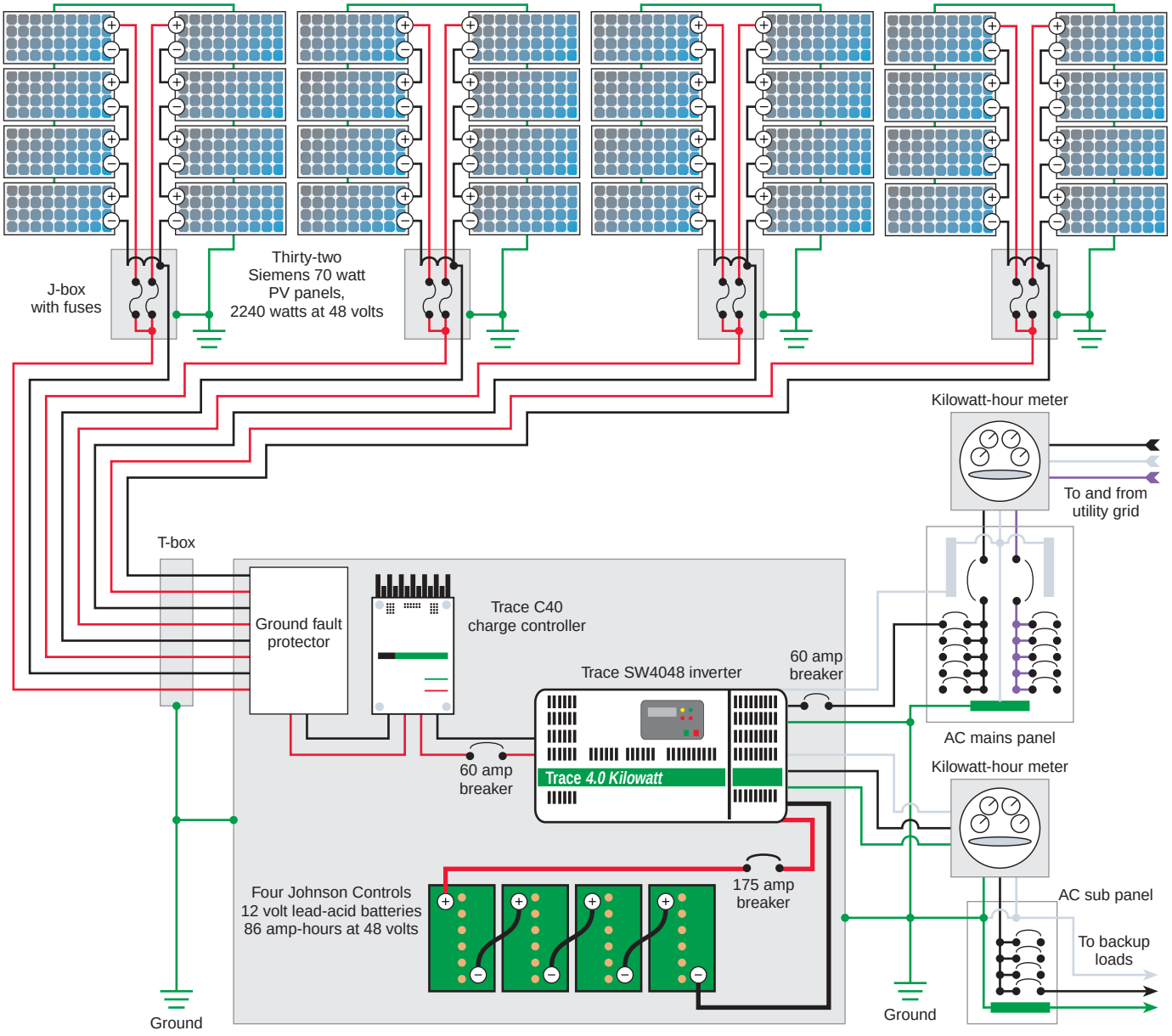
The California Energy Commission's *Consumer's Guide to Buying a Solar Electric System* listed the Southern California Edison (SCE) net metering contact person. We called SCE and promptly received an application by fax.

SCE recommends, but does not require, a lockable AC disconnect between the PV system and the grid. SCE says that their kilowatt-hour meter in the customer's service panel is their disconnect. Pacific Gas & Electric and most other utilities require lockable disconnects. It will be years before utilities and the PV industry agree on national interconnect standards, so consult with your local contractor.

Below: The exposed Trace Power Module with SW4048 inverter, C40 charge controller, and batteries.

Below: The Power Module closed up tight. Note the earthquake-proof mounting.

Joel & Fran's Grid Intertied PV System



Utilities require homeowners to insure their grid connected systems. We told our insurance agent that our PV system was an electrical improvement approved by the building inspector, the utility, and the California Energy Commission. Our insurance rate remained unchanged.

Finally, we signed the net metering application, attached a one-line electrical drawing, and mailed them to SCE. Three weeks later, we received permission to connect to the grid by mail. SCE did not visit our installation but reserved the right to inspect it later.

You Can Do It Too

Our PV system performs flawlessly. In the first full month, it produced 292 KWH and our electric bill dropped from $60 to $24. Yearly production is 3,400 KWH or about 60% of our home and office load.

The savings are great. Inflation free electricity for the rest of our lives is nice. What is most important is that everyone involved in this installation thinks positively about PV. The next PV installation in Culver City will go in even more smoothly.

If you live in the city or suburbs and want to go solar, prepare to do some trail blazing. You are going to be a PV pioneer. An experienced contractor can be your guide. Have complete plans before you meet your building inspector and your utility. Follow the rules—

Above: Tidy installs keep the neighbors happy and help to promote renewables in a professional and trustworthy light.

don't fight them. If you run into a problem, calmly find the work-around. If you have any questions or need help, give us a call. We installed a hassle-free PV system in the city and so can you.

Access

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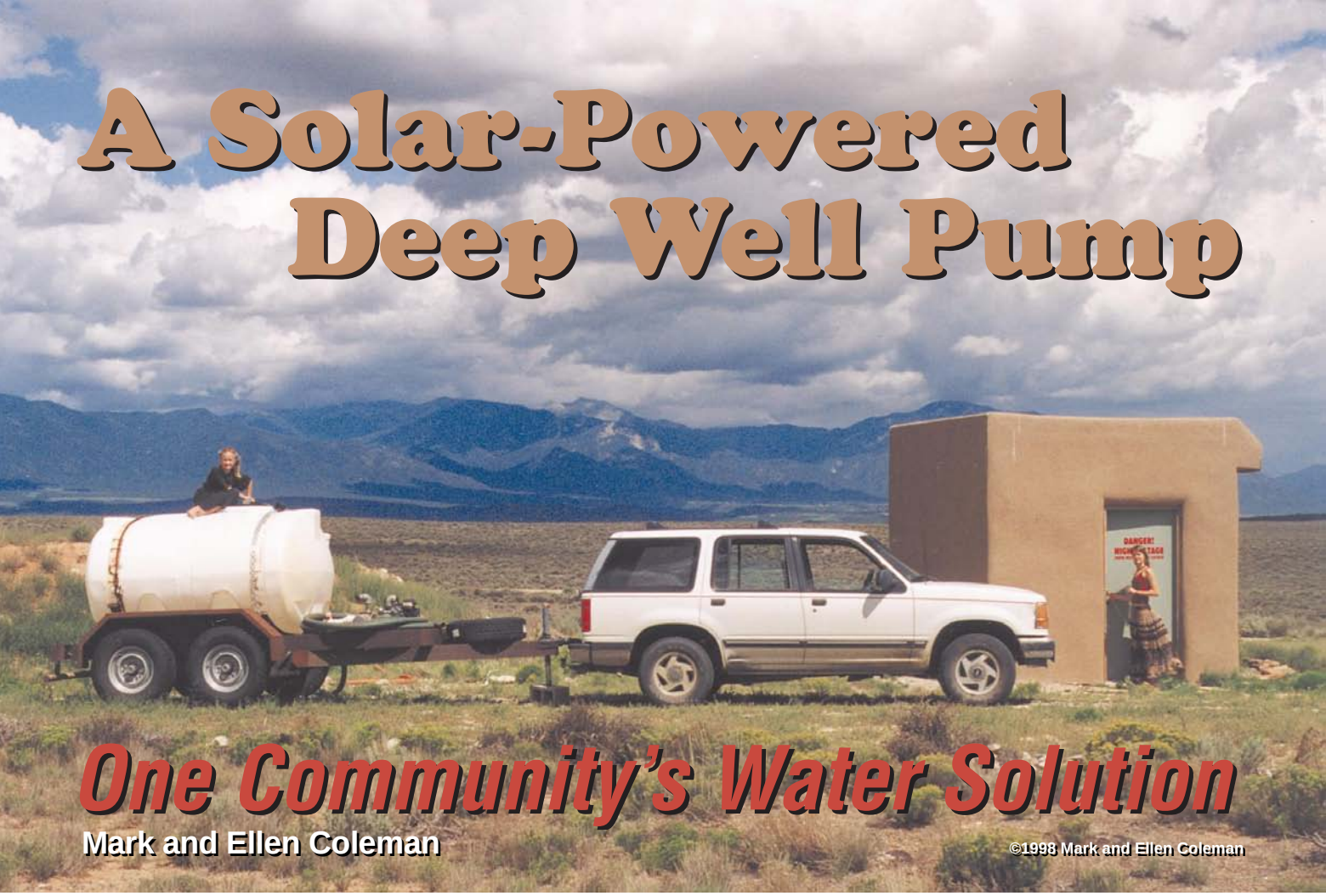
A Solar-Powered Deep Well Pump



One Community's Water Solution

Mark and Ellen Coleman

Above: Allie and Jessica Coleman pump water from underground tanks into the mobile tank.

Hitting water at 900 feet (274 m) was great, but how could we get it out of the ground without grid energy? Most folks we talked with said it couldn't be done, but it just took a little figuring. Our off-grid community in northern New Mexico now enjoys all the water we need without resorting to power lines or gas generators.

Buying Land in the Boonies

Six years ago, our family moved onto 20 acres of semi-arid, undeveloped land. We built an off-grid, environmentally conservative "Earthship". This is a thermal mass building that self-heats and cools, collects water, generates electricity, grows food, and provides shelter. Since we moved here, thirty more 20 acre lots have been bought around us, and five other homes have been built—two other Earthships and three straw bale houses. All are solar-powered and make use of water catchment systems.

Wow, It Doesn't Rain Much Here

We soon realized that despite our conservative use of water, we would need another source besides rainwater. The real estate broker had anticipated that the community would need to be off-grid, but he didn't give us accurate information about the rainfall and depth of underground water. Actually, we're in an interesting spot geographically. We're on the high semi-arid mesa 30 miles from the verdant New Mexican village of Taos, which is fed by mountain streams and acequias (irrigation ditches). But the rain clouds often just put on lightning shows for us, and then rain on the mountains twenty miles east of us.

The groundwater at our property is 900 feet (274 m) below the surface. People who live in Taos, with groundwater only twenty feet (6 m) down, viewed our land as good for nothing more than grazing sheep and cattle. But the price was right ($19,000 for 20 acres), the views spectacular, and we were able to build what we wanted without a mortgage. To take a walk here under the big sky is like meditating without having to sit still. We buy a little propane for cooking, but other than that, there are no utility bills. We took a risk buying undeveloped land, but solar technology provides for our electrical needs *and* solved our water problems.

Above: The thirty Carrizo SG 105 PV panels.

Solar Turned High Risk Into Homestead Equity

Three years ago, our community of landowners voted to change our "electrical escrow account" into a water drilling account. We decided to drill a community well so that we can haul water when our individual catchment systems are inadequate. With our solar-powered homes working just fine, we had no need to bring in electricity from the highway three and a half miles (5.6 km) away.

It may sound odd, but none of us were interested in piping the water from the well into our houses. We prefer to use the well as a backup to our catchment systems and to limit water use by the slight inconvenience of hauling it in a 1,000 gallon (3,785 liter) tank. We also made a group decision to power the well with photovoltaics if at all possible. Nobody wanted to deal with maintenance of a gas generator, much less the noise and having to haul gasoline. As a dealer of solar electric equipment, I was elected to design and troubleshoot the system that we would need. We wanted a relatively maintenance-free, safe, and easy system, with equipment that old or young people could handle.

While the well was being drilled, I began searching for the equipment to get the water out of the ground. There was a lot of hoopla the day the well driller hit water at 900 feet (274 m). He put down a temporary pump and powered it with a gas generator to bring up the first sample of our water. But the day I celebrated—all alone—was the day that I hooked up our solar equipment to the pump and saw the cool wet stuff come pouring out of the pipe.

Pumping and Hauling

Finding the right equipment to get water up from 900 feet (274 m) was a bit challenging, not to mention that I had to design the system for the future when usage would grow. DC pump systems couldn't deliver the necessary projected flow rate from that depth. The well suppliers I contacted were familiar only with grid and gas generator power systems. It seems that powering a deep well with PV with the flow rate that we needed had never been done before. Working with Steve Secrest of Golden Genesis, Inc., I designed a system (see schematic) that the spec sheets said would work. Now that it's up and running, we've seen that our system works very well indeed.

A Gould two HP 220 VAC pump gives us seven gallons (26 liters) per minute. We have 150 feet (46 m) of artesia which means that although we didn't hit water until 900 feet (624 m), the natural pressure is enough to fill the line up 150 feet (46 m) from there. Our pump is at 850 feet (259 m), which gives us 100 feet (30 m) of buffer in case the level ever falls. We have one-way check valves on the top of the pump and at 200 foot (61 m) intervals up the line. This is to avoid having the water fall all the way back to 750 feet (229 m) when the pump turns off. So there is a standing column of water ready to move into the storage tanks as soon as the pump is turned on. This also saves wear and tear on the pump and the inverter because the surge is lessened.

When the water reaches the surface, it is stored in six interconnected 3,000 gallon (11,356 liter) galvanized steel tanks. For

Below: Jessica outside the straw bale power shed/wellhouse. A Trombe wall keeps the batteries at good operating temperature.

Above: The Colemans' garden benefits from the backup water supply.

insulation, the tanks are buried and bermed with earth. The 18,000 gallons (68,137 liters) of storage and our pumping capacity will provide 2,000 gallons (7,571 liters) a month for 30 landowners if necessary, though our usage is well below that at present.

When a landowner needs to haul water, the water from the storage tanks is pumped into a 1,000 gallon (3,785 liter) mobile tank (permanently set on a trailer). We use a 65 gallon per minute (gpm) sump pump set down in one of the steel storage tanks. The landowners drive the trailer to their own homes and pump the water into their own cisterns, using a 120 VAC, 60 gpm jet pump, or a gas driven irrigation pump (for folks who don't have their PV systems up and running). Both of these pumps are mounted on the tank-trailer.

Below: The earth-bermed north side of the Colemans' Earthship shows the rain water catchment system that is the primary water supply.

Our "Solar Farm"

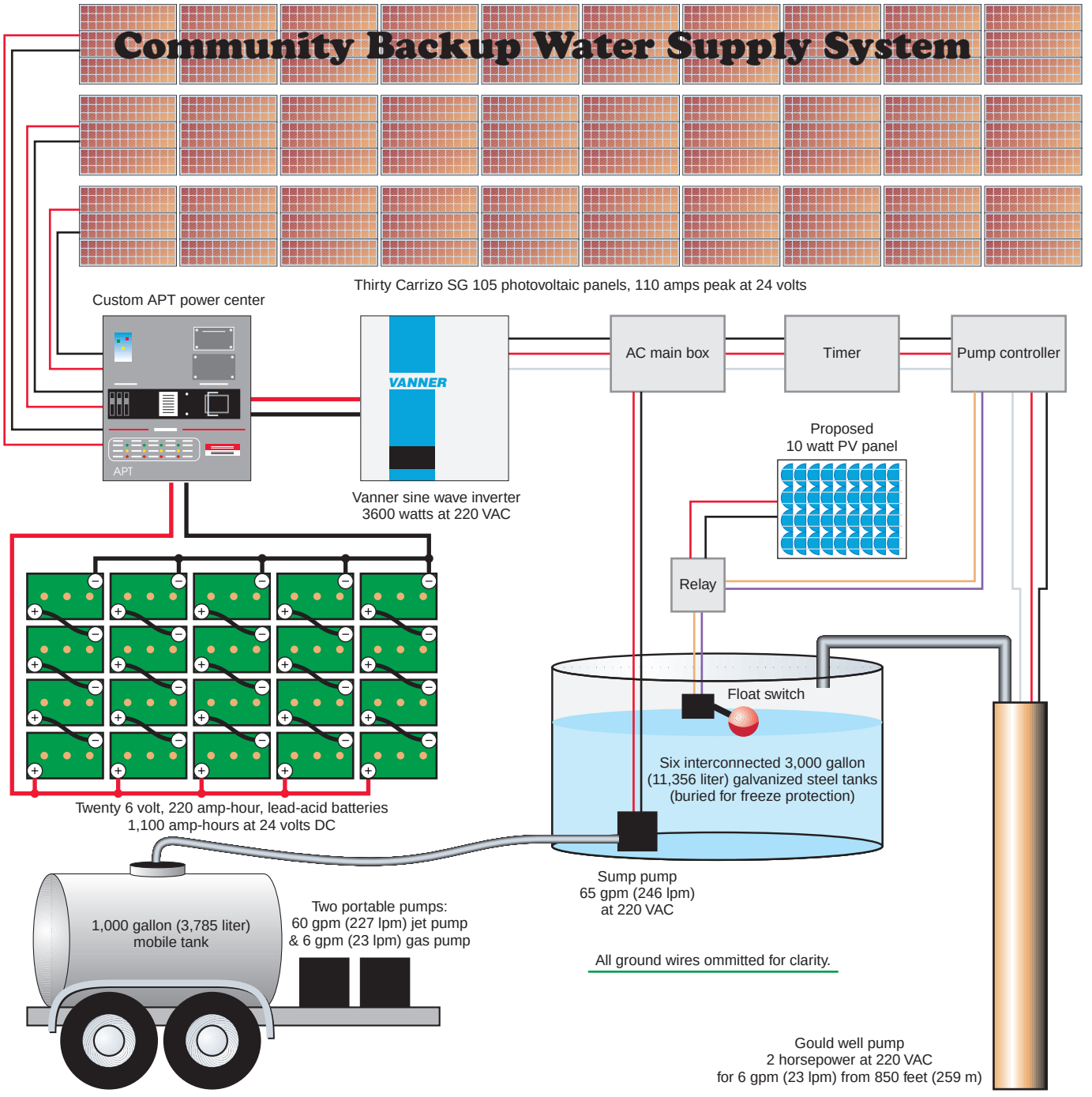
Both the deep well pump and the tank-trailer pump are powered by what we call our "solar farm". Thirty Carrizo SG 105 solar panels are mounted in three 24 VDC arrays. They sit three feet (1 m) off the ground, above our maximum snow depth. The Carrizos are used panels, originally unmirrored Arco ML 52s which Carrizo Solar resold as Super Gold 105s.

Energy is stored in twenty 6 volt golf cart batteries wired in series/parallel (five groups of four). APT Technologies (now Pulse Energy Systems) put together a power center with three array disconnects, lightning arrestors, and metering for the system. A Vanner 3600 watt, 220 VAC sine wave inverter provides the power needed to run the pumps.

The batteries, inverter, metering, and safety equipment are stored in a ten foot by twelve foot (3 by 4 m) stuccoed straw bale building. A Trombe wall—a passive solar-thermal storage wall—on the south facing wall provides extra heat for those below-zero nights. During our cold winters, temperatures can drop to minus 25° F (-32° C), and we really notice the decrease in capacity of batteries kept in uninsulated areas. Battery maintenance is shared by landowners. We plan to add Hydrocaps in the future to ease this burden.

When the deep well pump is running, it draws 145 amps at 24 volts. Our panels put out 110 amps at 24 volts at their peak. The panels don't put out as much as the pump uses, and they don't have to. The battery bank provides 1100 amp-hours at 24 volts, which buffers and supplements the panel output. A timer cycles the pump on and off so that the battery bank can recharge periodically when the deep well pump is being used.

With our current setup, someone has to monitor sunlight conditions when the deep well pump is needed because the system does not recognize when there is not enough sunlight to recharge the batteries. The system shuts down when the batteries are at low voltage and has to be started back up when the sun has provided sufficient charge in the

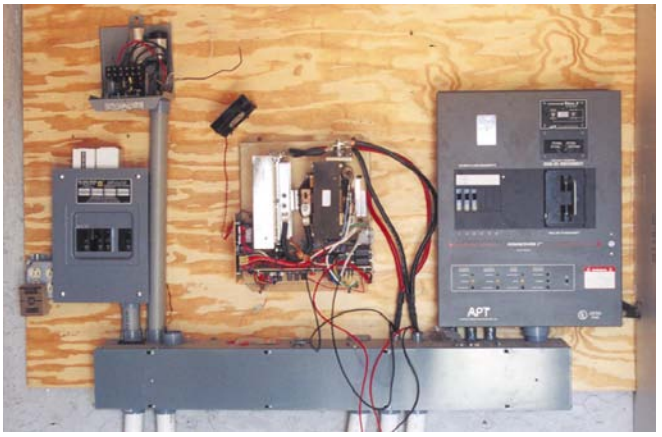


batteries. We do plan to add a relay, powered by its own solar panel, which will open a float switch loop if we're having a cloudy day. Fortunately, cloudy days are few and far between here in New Mexico.

Don't Try This At Home, Folks

The only snag I ran into was with the first inverter system I had set up. Originally, I had two Trace DR2424 inverters running out of phase to create the 220 VAC. The system would work some times and not others, which made me suspect the pump controller instead of the inverter setup. One of the inverters burned up—it literally smoked—three times before I figured out what was wrong. I then replaced it with a 3600 watt Vanner 220 VAC sine wave inverter. Until we were ready to make the larger investment for the bigger inverter, I tried to "make do" with what we had. At one point, I was running a hair dryer to bleed off some of the extra juice while the system was running the deep well pump!

For some reason, when the inverters were powering an additional load (the hair dryer), the pump controller would not shut down. I suspected that the output wave form of the inverters changed when it was operating at



Above: Components inside the power shed. The Vanner inverter is in the center with its cover off.

its peak output. We finally had the well driller come out again with his generator to power the well pump and confirm that the problem was not the pump controller. It turns out that the well pump controller could not handle the modified sine wave output of the Trace DR2424 inverters. We have had no problems with the replacement sine wave inverter.

Well System Capacity

Our community well system is designed to handle the supplementary water needs of thirty landowners who live in water-efficient homes with little or no blackwater (water from flush toilets). Our houses have 1,400 to 3,500 square feet (130 to 325 m^2) of roof and 3,000 or 6,000 gallons (11,356 or 22,712 liters) of water storage capacity. A one inch (25 mm) rain on 1,000 square feet (93 m^2) of roof can catch 600 gallons (2,271 liters) of water. In our system, rainwater is routed from our Propanel roof into 3,000 gallon (11,356 liter) cisterns buried behind our house. When we need it, the water is pumped through a pressure tank and a filter system into the house.

The Water System Costs

Qty.	*Component*	*Cost*	*%*
30	Carrizo 105 watt PVs	$11,550	29.1%
6	3000 gallon storage tanks	$ 7,800	19.6%
1	Straw bale building	$ 6,000	15.1%
1	Custom water trailer	$ 3,500	8.8%
1	Wires, pipes, array mounts	$ 2,650	6.7%
1	3600 watt vanner inverter	$ 2,100	5.3%
1	Well pump & controller	$ 1,800	4.5%
1	Custom APT power center	$ 1,650	4.2%
1	Module rack	$ 1,200	3.0%
20	220 amp-hour batteries	$ 1,000	2.5%
1	65 gpm sump pump	$ 325	0.8%
1	AC main with breakers	$ 95	0.2%
1	220 VAC timer	$ 40	0.1%
	Total	$ 39,710	

Most of us use SunMar composting toilets. Two houses use low flush toilets. All of us reuse greywater (wash water) for watering trees. We are able to garden and provide water for appropriate landscaping for our arid land. My family's gardens—inside and out—provide fruit and vegetables year-round.

Lifestyle Implications

The beauty of off-grid systems is that they allow you to live on undeveloped land. To anyone shopping for land, this means really good deals on beautiful, clean, and uncrowded land. Undeveloped land often comes with fewer building restrictions, which means you can build a house you can afford instead of one that the bank thinks it can resell once you've defaulted on your mortgage.

I want to emphasize the importance that we place first on water conservation and then on water catchment and storage. We only use the well water in time of need, not to have green lawns in the desert. Solar powered off-grid living is not going to be the answer if we try to emulate our lifestyles from the city.

The ability to find and deliver water to a house is often an issue that dissuades people from buying undeveloped land. Through my solar system design and sales business, Taos Green Solar, I'm now able to help people in northern New Mexico deal with water pumping problems. You're welcome to call me for advice on deep well pump power systems. We have found that it *is* possible with solar electric technology.

Access

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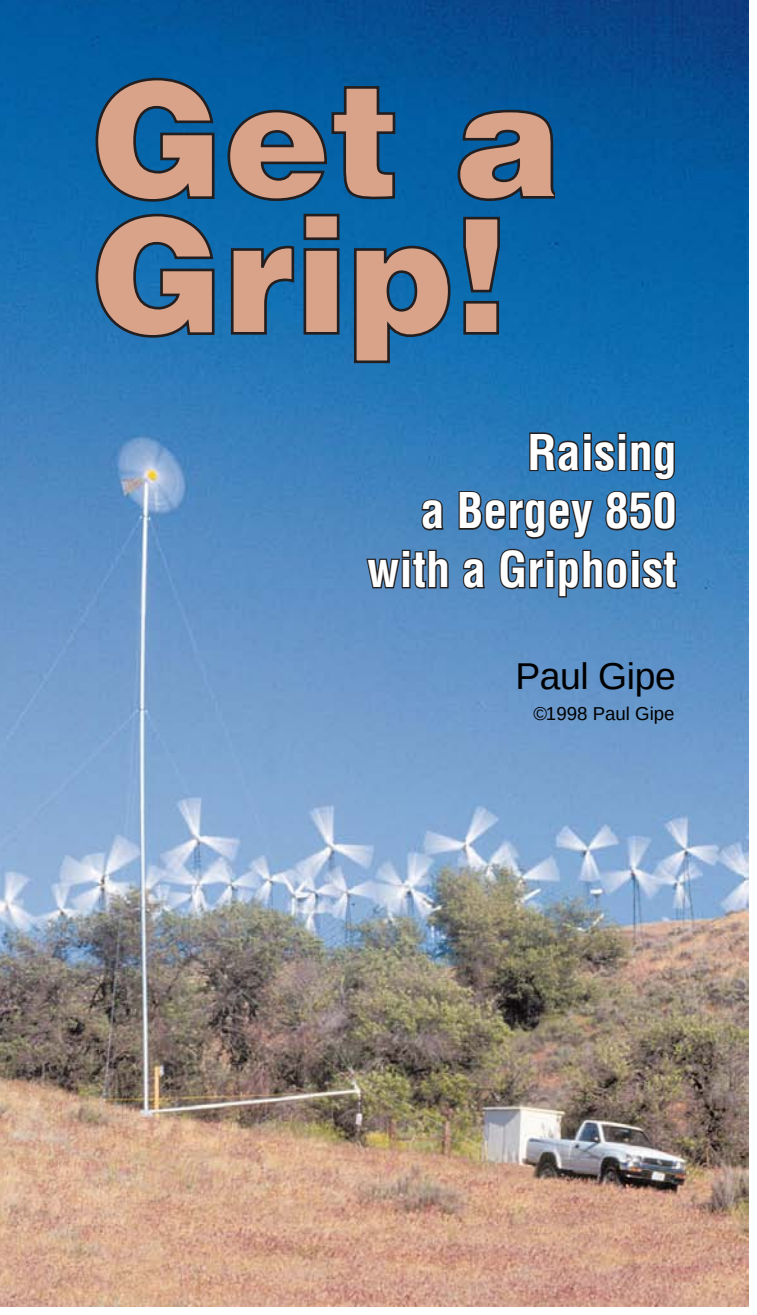
Get a Grip!

Raising a Bergey 850 with a Griphoist

Paul Gipe



Above: A Bergey 850 installed on a 64 foot NRG tower. One of the world's largest wind farms is right next door.

Many users of small wind turbines opt for guyed, tilt-up towers because of their simplicity and lower costs. And everyone who has chosen a guyed tower to support their small wind turbine has had to face a difficult question: How do I raise it? Next to servicing a wind turbine atop a tower, there is no more dangerous aspect of using wind energy than raising and lowering a wind turbine and its tower.

The most common technique here in the United States is to raise the tilt-up towers with a truck or tractor. I've never been a fan of this approach and I've long wondered if there is a better way. The griphoist, a simple hand winch, may be the answer. While no system is foolproof, using a griphoist can reduce the chance of accidents when raising and lowering a tower.

For me, this question came to a head when my wife Nancy Nies and I decided to install a Bergey 850 (BWC 850) on a nearly inaccessible site in southern California's Tehachapi Mountains. Ed Wulf, a local pioneer of off-grid living, provided the site so that we could experiment with small wind turbines.

Because of the difficult access and our desire not to bulldoze any roads, we chose NRG's lightweight, guyed, tilt-up tower system that uses thin-walled steel tubing. These lightweight towers are easily transportable and don't require concrete anchors. Today they are widely used in the wind industry as meteorological (met) masts. The BWC 850 was designed specifically for NRG's 4.5 inch (114 mm) diameter mast.

Considering our site and our inexperience, we chose the 64 foot (19.5 m) tower. We thought that NRG's 44 foot (13 m) tower probably was too short to clear nearby trees, and we felt that their 84 and 104 foot (26 and 32 m) towers were more than we wanted to handle in our first project.

The quest to find a griphoist suitable for raising the Bergey 850 on NRG's tilt-up tower began when I saw Niels Ansø use one to lower a Whisper 1500 at the Folkecenter for Renewable Energy in Denmark. It seemed like an ideal way to raise and lower small wind

Right: Author Paul Gipe begins to install one of the five screw anchors.

Above: The screw anchors can be driven by hand.

turbines on hinged towers. So when I began planning to install our own BWC 850, I naturally thought of using one myself.

"It's a good way to raise a windmill," says Scoraig Wind Electric's Hugh Piggott. It gives you "plenty of time to check things." Zephyr North's Jim Salmon agrees. Salmon, a Canadian meteorologist, uses a griphoist to raise 164 foot (50 m) NRG anemometer towers in Canada. "They are easier to control" than either electric winches or vehicles, he says, "and in some cases much safer."

Griphoists

A griphoist is a compact portable winch which passes the hoisting cable through the body of the device rather than wrapping the cable around a spool. The griphoist is operated manually by using one of two short levers protruding from the top of the hoist. One lever is used to pull cable through the hoist, the other to pay out cable in controlled increments. A griphoist also includes a detachable handle that fits over either one of the hoist levers. The length of the handle is governed by the rated load of the hoist, and special shear pins are built in to prevent overload.

With the help of Hugh Piggott, Niels Ansø, Jim Salmon, and NRG's Dave Blittersdorf, I was able to track down this hoisting tool that I'd seen used in Denmark. To Hugh this tool is a tirfor. To Niels it's a wire talje (hoist). Jim calls it a griphoist.

It's all of the above, and more. Tractel, the manufacturer, officially calls this hand winch a griphoist-tirfor-greifzug product. Griphoist

Above: NRG tower sections slip fit together and seat firmly when the tower is raised.

pretty much says it all in English. But the tool was originally sold as a tirfor, which in French says much the same thing. "Tir" comes from the French for pull, but it can also mean heave as in the maritime expression "heave ho." "For" is probably a shortened form of fort, French for strong or powerful. Greifzug is the German equivalent "greif" for taking hold or gripping, and "zug" for pulling.

This tool, whatever you call it, was patented by Simon Faure in 1945. Tractel began manufacturing them in 1948. Today, Tractel claims 70% of the griphoist market worldwide with plants in France, Luxembourg, Germany, Canada, and Brazil. Griphoists are used throughout the world for a variety of applications that include raising wind turbines and met masts. Griphoists are also used in the United States, mostly in industry. However, most folks here still raise tilt-up towers using a truck or tractor.

Risky Business

Using a vehicle for tower raising is just too risky for me. I've used a truck with block and tackle to salvage wind machines back in the 70s and I had one or two near misses that I've never forgotten. And I've installed Bergey 1000s on guyed towers in Pennsylvania using a truck and gin pole. It was always, shall we say, exciting. The NRG tower looks like a long strand of steel spaghetti. Raising it with the jerky motions common to a vehicle-driven lift seems like a recipe for disaster.

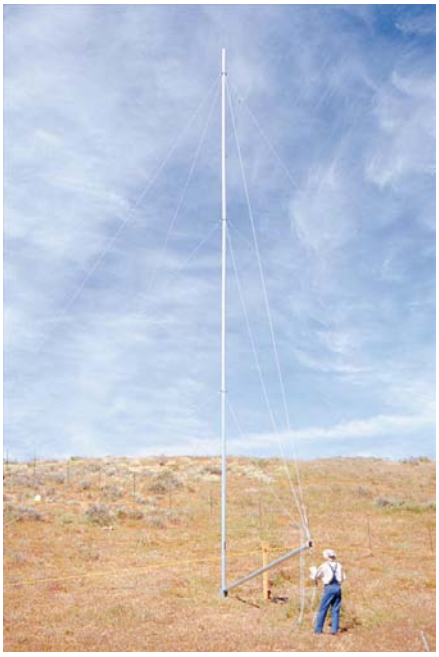
Below: Unreeling the guy cables. All attachments to the guy bracket are swaged, simplifying assembly.

Above:The gin pole bracket showing the hoisting cable (left), nylon rope for steadying, and three lifting guys to tower (right).

Properly using a vehicle for raising a tilt-up, guyed tower also demands a large crew. Altogether, I'd need half a dozen people. Mick Sagrillo recommends two on the truck and one for each anchor. Also, our site is remote. Crew members would have had to hike in or be trucked in. Once there, they'd be there all day. We'd have to feed and entertain them while I was readying everything. Then if there were any glitches, I'd be in the awkward position of either forging ahead and taking some chances I'd rather not take or asking everyone to come back another day.

As it turned out, my fears were justified. There was indeed a glitch. When we went to connect NRG's prefabricated lifting cables to the gin pole, one was too short. These measured lifting cables are one of the three key elements in NRG's tower system. The other two key features are the use of hand-driven screw anchors instead of concrete, and tower sections that slip together without bolts. Without the correct lifting cable, we had to postpone the tower raising one week while NRG air freighted a new set of top guy cables. Since there were just the two of us there that day, we were under no pressure to continue so we spent the rest of the day frolicking among the wildflowers.

Another facet of the communal approach to tower raising is often overlooked: you can quickly wear out your credit with friends and family. Communal tower raising is like Amish barn raising, bringing people together for a common purpose. But barns last indefinitely. You put it up and it stays up. Not so with a wind turbine. Whether we like it or not, small wind turbines do need repairs



Above: Raising the tower the first time, without the wind turbine, using the griphoist.

and we have to bring them down before we can haul them off to the local windmill doctor. Some turbines are up and down a lot. Gathering six people together every time you want to raise or lower your turbine would get old quickly. Since our purpose was experimentation, we wanted a system that would allow us to raise and lower the turbine as needed, with as few people as possible. A hand winch seemed like the best solution.

Now, I haven't raised a tower or installed a wind turbine in fifteen years. I am basically a paper pusher—keyboard pusher is more descriptive—and my tool skills are a bit rusty. I lost my spud wrench in the mud at the base of an 80 foot (24.5 m) Rohn SSV tower in 1983 and I haven't seen a spud wrench since. So, I wanted to take my time to ponder my next move. I didn't want a bunch of our friends standing around twiddling their thumbs and asking, "Hey, are we going to install this windmill or not?"

Electric winches are usually used here in the States to install the NRG towers for met masts. Installers typically power the winch with a truck battery. I didn't want our new truck in harm's way during my first attempt at raising an NRG tower. Of course, we could have lugged a battery up there to power the winch. But that didn't seem like a great idea either. Battery, winch motor, cables, connectors—seems like a lot of places for something to go wrong. With an 1100 pound (449 kg) load on the winch line, and a $2,000 BWC 850 at the end of a 64 foot

Below: Using the Super Pull-All to lower the tower. The cable passes through the body of the griphoist.

(19.5 m) fishing pole, I didn't want any surprises. By comparison, the hand operated griphoist seemed like such a simple, straightforward, and safe way to raise a tower.

Winches and Come-alongs

Before I got the terminology straight, I made the mistake of calling a griphoist a "come-along." This is a lightweight tool found in North American hardware stores that uses a small spool for coiling a short length of wire rope, often only ten feet long. Ranchers, for example, use come-alongs to tighten fencing, and for that they don't need much cable.

It's the spool or drum that sets come-alongs as well as winches in general apart from griphoists. Technically, griphoists are not winches. Winches use a drum to spool the hoisting cable, like the large drum on a crane. Griphoists, in contrast, pull the hoisting cable directly through the body of the hoist, without rolling it up on a drum. Tractel likens the locking cams inside the griphoist to the way we take in a rope "hand over hand." To use a griphoist, you move a lever forward and back. This pulls the cable through the tool. The hoisting cable for a griphoist can be any length since there is no need to spool the cable on a drum. Capstan winches can also use cables of any length, but they pass the cable over a drum.

Like come-alongs, griphoists can "float" between the load and the anchor for the hoist. Electric winches and hand-cranked mechanical winches are all intended to be mounted to something solid, like a boat deck or the frame of a sport-utility vehicle. Griphoists are also portable. You can lug them into places you wouldn't want to haul an electric winch and battery or where you can't drive your 4x4. All in all, the griphoist sounded good, but then I'd never actually used one before. After consulting with Dave Blittersdorf at NRG about the hoisting loads, I ordered Tractel's Pull-All.

Below: The tower almost down. The forward lever on the griphoist is used to pay out cable.

Above: Adjusting cable tension. The NRG tower system doesn't use turnbuckles which allows for quick adjustments under less than ideal site conditions.

Tractel's Pull-All

You could call the Pull-All an entry-level griphoist. It was inexpensive and it would have done the job except for one serious drawback: neither the hook on the hoisting cable nor the hook on the body of the griphoist had safety keepers. You can never predict what may happen when you're raising a load; often there are some jerky movements despite your best efforts. Safety keepers or latches keep the hooks engaged when there's unintended slack in the cable. NRG's Blittersdorf as well as our local Tractel reps offered to replace the stamped metal hooks with hooks using keepers, but I wanted to test the griphoist right out of the box, so we sent it back.

Above: Tightening wire rope clips. Remember, "Never saddle a dead horse."

Next we ordered the Super Pull-All, the Pull-All's bigger brother. It's a real tool. At 8.3 pounds (3.8 kg), the Super Pull-All weighs twice as much as the Pull-All. It has twice the working load (1,500 pounds / 680 kg), and it comes with safety keepers on both forged hooks. At $390, The Super Pull-All isn't cheap, but good tools never are. It's shipped with 10 meters (32.8 ft) of 1/4 inch (6 mm) wire rope and two wire rope slings. You can order a longer cable if you need it.

Tractel also makes three other sizes. For example the T-508 griphoist is suitable for raising the BWC 850 on NRG's 84 foot (26 m) tower, and the T-516 is suitable for raising the BWC 850 on NRG's 104 foot (32 m) tower. If it included safety keepers, the inexpensive Pull-All would be ideal for raising the BWC 850 on NRG's 44 foot (13 m) tower.

Using the Griphoist

To use NRG's tower system, the

Above: Raising the tower again, this time with the Bergey 850, takes some effort. Going slow allows time for double checking.

hoist or the hoisting tackle must be anchored directly below the gin pole when the tower is fully upright. The twenty foot long gin pole is comprised of two ten-foot sections. If the hoisting anchor is farther than the length of the gin pole from the tower base, the sections could come apart, endangering the lift. NRG provides a safety cable to prevent this from happening, but no one wants to tempt fate.

The 44 foot (13 m) tower, which uses a 20 foot (6 m) guy radius, uses the forward guy anchor to secure the hoisting tackle or winch. Because the guy radius is larger on NRG's taller towers, they require a separate lifting anchor. So our 64 foot (20 m) tower, with its 35 foot (11 m) guy radius, uses a separate lifting anchor 20 feet (6 m) from the base of the tower. There are five anchors altogether, one for each of four guy cables, and one gin pole or lifting anchor. We attached the griphoist to the lifting anchor with one of the wire rope slings.

When raising a tower with a gin pole, one of the first challenges is raising the gin pole itself. We attached the hoisting cable to the top of the gin pole with a shackle. With the sling, the hoisting cable was just long enough to thread through the griphoist while the gin pole was still horizontal. Nylon ropes from the top of the gin pole to the side anchors kept it from tipping either way. We first used the griphoist to raise the gin pole upright. That was a piece of cake. Then we slowly raised the tower, inch by inch. While I operated the griphoist, Nancy kept tension in the rear guy cable with a tag line, standing well clear of the fall zone.

Below: Not quite up yet. Using the griphoist allows for taking in or paying out cable as needed.

Above: Checking the tower for plumb. The turbine will only yaw properly on a plumb tower.

The griphoist pulls a few inches of cable on each stroke of the rear hoist lever, both on the back stroke and on the forward stroke. Because it's a simple mechanical device, you can actually feel the tension in the cable. This gives the operator a tactile sense of the load. When the loads are high, the lever is harder to move than when the loads are light. The loads in tower raising are greatest when the tower is just off the ground and least as the tower nears the vertical. Operating the griphoist takes the most effort when the tower first begins leaving the ground.

Griphoist ratings

Griphoist Model	*Capacity lbs (kg)*	*Cable Dia. in (mm)*	*Weight lbs (kg)*	*Cable Length ft (m)*	*Price $*
Pull All	700 (318)	3/16 (4.75)	3.9 (1.8)	32.8 (10)	115
Super Pull All	1500 (680)	1/4 (6.3)	8.3 (3.8)	32.8 (10)	390
T-508	2000 (907)	5/16 (8.3)	14.5 (6.6)	32.8 (10)	495
T-516	4000 (1814)	7/16 (11.5)	30 (13.5)	32.8 (10)	679
T-532	8000 (3629)	5/8 (16.3)	51 (24)	32.8 (10)	1170

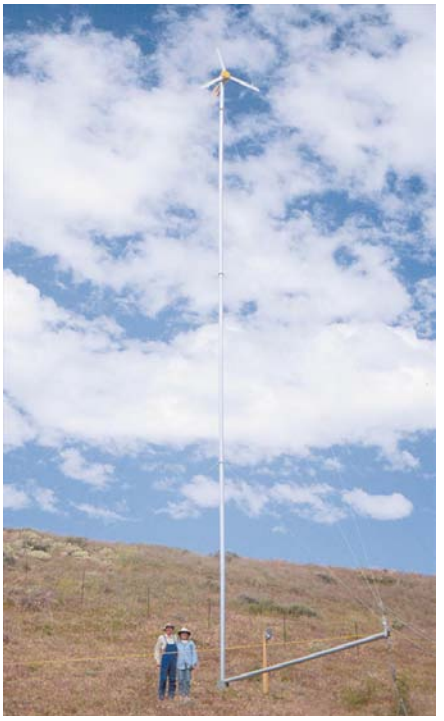
We spent a whole day on the initial tower raising. It took a lot of time because our site is far from ideal. In fact, it's on the side of a hill! I've never tightened and loosened wire rope clips so many times in my life. After we practiced plumbing the tower, we lowered it. It was easy to use the griphoist to let the tower down. The griphoist has two levers, one for pulling in cable, and one for letting it out. You simply use the forward lever to operate the hoist in reverse to pay out cable.

On the next visit, we mounted the turbine on the tower and repeated the raising sequence. The eighty pound turbine increased the weight of the lift by 60 percent, and I could clearly feel it in the griphoist. It took a lot more muscle than raising the tower alone. Rather than grumbling about the frequent adjustments to the guy cables, I found myself using the adjustments as an opportunity for a short breather. "Ah, I think those cables need adjusting," I found myself saying.

We raised the tower in less than one hour. It took another hour to plumb the tower and tighten the guy cables in a stiff wind. Though it wasn't a stroll in the park, physically operating the griphoist during the early part of the lift wasn't very difficult. It became much easier once the tower reached about 45 degrees. After the tower was upright and the Bergey began whirring, Nancy said, "I thought there was going to be a lot more to it than that. It was a lot simpler than I thought." That was the whole idea.

Adjusting Cable Tension

Unlike traditional towers with anchors at exact positions relative to the tower, the NRG system was designed for quick installation under field conditions. The guy cables are tensioned by hand. As the tower is raised and lowered, the guy cables may need adjusting. This system can't use pre-formed wire grips or turnbuckles unless the anchors and tower are all perfectly aligned. Because of the frequent and sometimes large adjustment necessary in guy cable tension, we used wire rope clips. Pre-formed wire grips require so much unwrapping and rewrapping that they lose their effectiveness in this sort of application.



Above: The new American Gothic. The griphoist allowed us to slowly and safely raise our BWC 850 on a difficult hillside site.

In our case, the anchor eyes were at different elevations and slightly out of perfect alignment. This was due to the slope of our site and because I screwed some anchors down closer to the ground than others. These misalignments cause tension in the cables to vary during the lift. The thin-walled tubing used on the NRG towers easily buckles. So it's necessary to adjust cable tension as the tower is being raised and lowered. If everything was perfect this wouldn't be necessary. But our site was far from perfect.

Tower Height

Since I've been such a stickler about adequate tower height in my books, I was concerned that the 64 foot tower wouldn't clear nearby obstructions. But I didn't want to work with a taller tower either, at least until I gained some experience with the NRG tower system. Fortunately, the 64 foot tower was sufficiently tall and gives us about twenty to thirty feet of clearance above some nearby willows—our only trees. It also gave us sufficient clearance from the hilltops overlooking the site.

Turbine Thrust

After the installation, we returned to the site to check on the turbine, which is a good idea. One of the wire rope clips had slipped and the tower was no longer vertical. A stiff wind was blowing and the tower was pulling against the top cable that had slackened.

In the NRG system, the guy cables are tightened by hand. Let's just say that I wouldn't want to try this with a BWC 1500 in a strong wind. Nor would you ever want to make the mistake of not using the friction of pulling through the guy anchor eye to help hold the cable after loosening the wire rope clips. While it was never in danger of getting away from me, I was immediately conscious that I had to really lean into tensioning the cable and not make any mistakes. As it was, the thrust on the turbine was too great for me to get the tower top back to vertical. I got it to where I was comfortable with it and we left well enough alone as we were planning to lower the tower a few days later.

Lowering the BWC 850 with the Griphoist

Because we would be traveling for an extended period, we didn't want to leave the turbine unattended and thought it best to lower the tower. Though we've raised and lowered the tower only twice, we are quickly

becoming proficient. The lowering went smoothly. As I developed a sense of how the tower behaves, I found it necessary to adjust the guy cables much less often. The down side is that there were fewer breaks from operating the griphoist lever. The cable moves only a few inches with each stroke of the lever. So, to lower the tower you need to operate the lever quite a few strokes. As an office type, I am not accustomed to all that activity and my shoulder muscles were sore for a few days afterward. But lowering the tower was uneventful, which is the way we like it.

Griphoists for the Rest of Us

While little has been written about griphoists, it's surprising the number of people who have used or are now using them. Bergey Windpower, for example, has been using griphoists for remote installations since 1993, when they used one to raise a 10 KW Excel on an offshore platform. Though you won't find any mention of griphoists in Bergey's installation manual for the 850, they recommend griphoists to their overseas clients, says Pieter Huebner, Bergey's field technician. When a heavy-duty drum winch isn't available, Huebner prefers the griphoist to raising a turbine with a vehicle. The griphoist "is much safer and gives much better control," he says. It "eliminates the possibility of miscommunication" between the vehicle driver and the tower crew.

The experience of Scoraig Wind Electric's Hugh Piggott mirrors that of Huebner. A griphoist is "hard to beat for erecting tilt-up towers, because it is slow and fail-safe," says Piggott. "Unlike using a truck or other vehicle to raise a tower, the operator of the winch has full control of the operation, and there's no dependence on hand signals or risk of missed cues." If you have to buy any tool for your off-grid wind system, Piggott recommends buying a griphoist. After using one myself, I agree.

Paul Gipe is the author of *Wind Power for Home & Business* (Chelsea Green Publishing, 1993), and *Wind Energy Comes of Age* (John Wiley & Sons, 1995). Gipe introduces griphoists in his new book *Wind Energy Basics: A Guide to Small and Micro Wind Systems* scheduled for release in early 1999 by Chelsea Green Publishing.

Disclaimer: I paid for all the components mentioned in this article and I have no affiliation with the manufacturers. In the mid 1980s I did some work for NRG. In the early 1980s I was a Bergey dealer. —Paul Gipe

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Access

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The Solar-Powered WASTE RECLAMATOR

Chris Laughton

Above: The Reclamator with one of its three PV arrays in place.

While staying with friends in Scotland during the Christmas break of 1996, I met the owner of a rather unusual piece of equipment: The Waste Reclamator. This machine is a flat-bed trailer holding a four meter (13 ft) long conveyor belt to sort out waste at fairs and festivals around the UK. Collected trash from an event is tipped into a galvanized steel chute at one end of the moving belt, allowing a line of people to pick reclaimable items. Remaining debris tumbles off the conveyor and into waiting bins.

During its first year, the belt had been powered from either the 240 VAC grid mains (the utility grid to Americans), using a long flex (a flexible round cord), or with a portable 1 KW gasoline generator. The final drive was a 370 watt (1/3 hp) star-wound motor with a 1:36 reduction gear pulling up to 1.5 amps. There was a Siemens MicroMaster NN37 drive controller in series with the supply. This rather clever item allowed a smooth motor start-up under load, but also variable conveyor speed, adjustable with a user-set knob.

Bright Idea

Despite the winter conditions of the Scottish surroundings, a bright idea came to us over the Christmas turkey—to apply some renewable energy to the Waste Reclamator. This would not only enhance its appeal as an attraction but also improve its environmentally benign credentials. I based the design on my previous stationary PV systems. I wanted to provide an on-board inverter to eliminate a generator on remote sites, and to charge the batteries during storage, traveling, and whilst operating.

First we had to decide where to mount the PVs. My first preference was to create a new framework over the trailer to make a horizontal PV roof which would happily charge no matter which way the trailer was parked. However, the clearance required for people to work underneath on the conveyor would have meant a very high structure which would not fit in the Reclamator's garage. Also, the thin trailer sides were not strong enough to hold the PVs while traveling. This left us no option besides a removable array.

BP Solar Donation

At this stage BP Solar generously donated twelve BP160 65 watt framed modules, which seemed like the maximum number for a movable array. To ease the constant re-making of the array at each site, sets of four modules were bolted to 50 mm (2 in) aluminum U-channel. We had three sections in all, each weighing 35 kg (77 lb)—just light enough for one person to lift. The

weight of arrays was taken by the trailer bed, using galvanized 40 mm (1.6 in) steel tube. The removable subarrays pivot to allow angle adjustment at each site.

Heavy Problems

The challenges of designing a mobile PV system were now becoming clearer. Not only did the array need to be easy to dismantle and store on the trailer, but the trailer offered no natural protection for the equipment. This was quite an issue considering the inevitable road salt spray behind a towing vehicle. But the biggest hurdle was the accumulating weight of gear. The location of the conveyor on the trailer bed meant that the weight distribution was already badly skewed to one side, and the battery location had not yet been chosen. Our first tasks were to upgrade the suspension, add close-coupled tyres, and a hitch with up to 3500 kg (7,716 lb) capacity.

A Tight Fit for the Batteries

The 300 kg (661 lb) of lead-acid batteries had to be slung under the trailer bed well away from the proposed inverter location, and all of the weight had to be balanced. Flooded cells were out of the question because of ground clearance and maintenance issues, so we chose sealed-gel batteries. We purchased used 6 volt DC cells from a Telecomm project, with a capacity of 100 amp-hours at a 10 hour rate. They are entirely cased in hard yellow plastic with threaded M6 posts. We laid two rows of four on their sides, so that all interconnects would be accessible.

Below: The Reclamator power panel showing inverter, charge controller, AC breaker and MCB, and shunt. The back of the E-Meter can be seen in the folded down door. At right are the three plugs for the PVs.

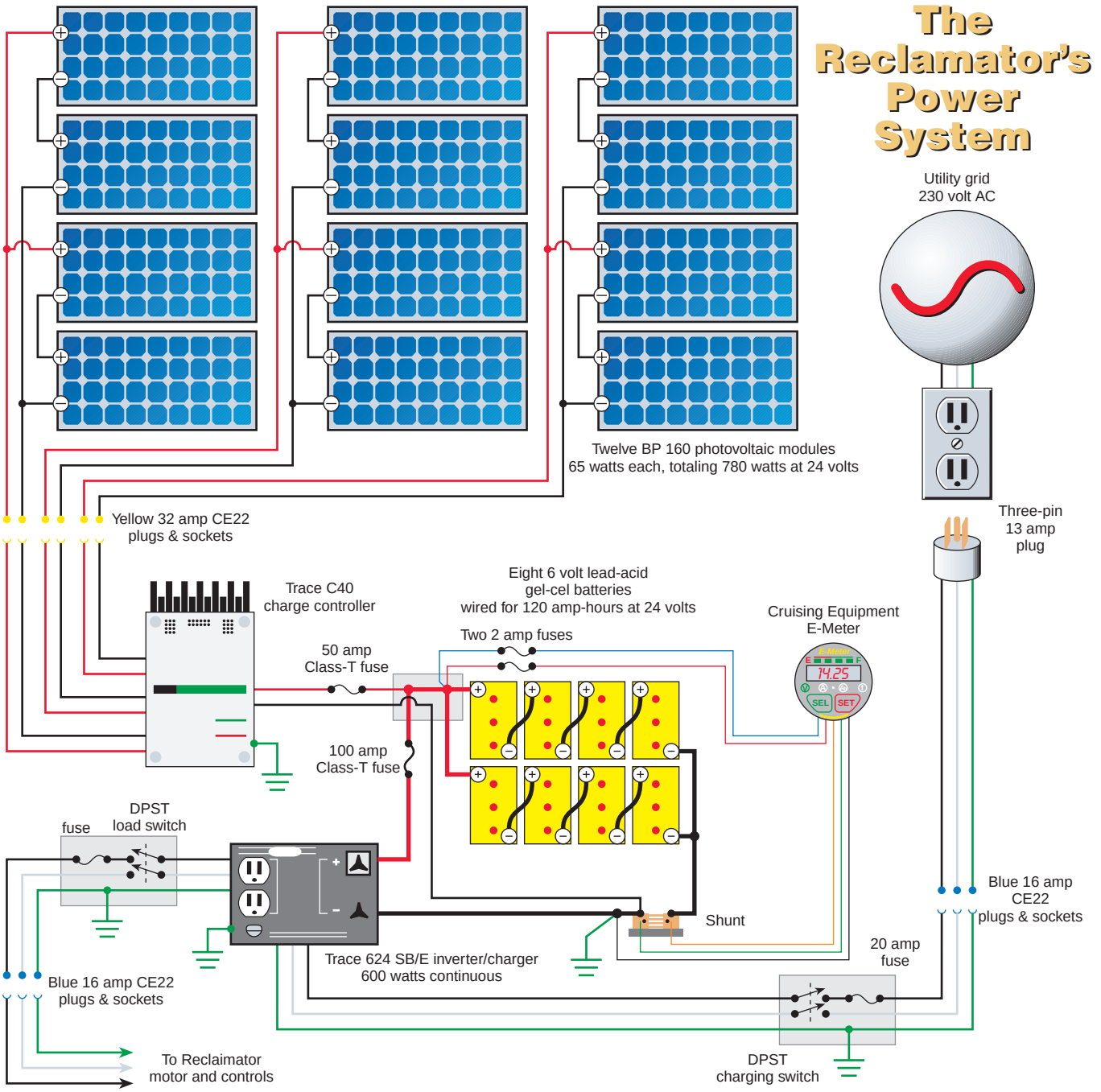
Above: The feed end of the conveyor belt. Local solar techie Phil Evans shows the power panel.

A battery case was constructed from welded angle steel and 25 mm (1 in) exterior plywood. One side was cased in Perspex (trade name for a type of clear acrylic sheet) to allow the public to see the wiring. We bolted a 160 amp fuse to the positive terminal to protect against a short between the inverter and the battery bank. We terminated all cables with crimped terminal ends, with wing nuts on the battery posts. Two long bolts came through the plywood of the box, one for positive and one for negative, to allow easy removal of the main connections. Then the battery case could be lifted on a hydraulic jack and bolted to the trailer chassis as one unit, without any cables attached.

System Components

This battery layout worked well for the 24 volt system, resulting in a total 100 AH capacity to 50% discharge. It also suited the PVs and the choice of a Trace 624 SB/E for the inverter/charger. A Trace C40 served as the PV charge regulator and an E-Meter was used for monitoring the system. The harsh environment dictated a high-integrity lockable IP65 steel cabinet for this equipment. We bolted two pull-out Class-T fuses (50 and 100 amp respectively for the PV array and battery) to the sides of the cabinet as emergency disconnects. We bolted three yellow 32 amp CE22 sockets to plug in the arrays and a blue 16 amp CE22 socket for mains battery charging to the other side. Finally, we mounted another blue socket externally as the 230 VAC inverter output, via internal 5 amp RCDs.

We ran the battery cables into the bottom of the cabinet through steel bushings penetrating both the cabinet and trailer chassis. We were concerned about the possible heat build-up in the sealed cabinet, but the large metal



surfaces were likely to dissipate the heat. The Trace inverter was given extra lower supports to protect it from road vibration. It may be worth noting that here in Europe, a gradual harmonization of voltages is taking place such that the UK 240 VAC is being lowered to 230 VAC, so this E version of the Trace is set at the lower voltage.

Grounded

The principal hardware we used is undoubtedly familiar to *Home Power* readers. But spare a thought for how this system could be grounded. In particular, should the inverter neutral be tied to the chassis/battery negative and the PV negative and frame? Bear in mind that the grid mains might also be connected at times. At first, the neutral was linked to the earth ("ground" to Americans) terminal in the 240 VAC distribution/disconnect box, which is common practice in portable generators in the UK. This earth terminal is linked to the chassis and to both negatives. However, this would trip the obligatory RCD earth protector when charging the batteries via the grid mains. So the link was removed and the neutral only becomes linked to earth by the utility at its sub-station. A future solution for

this may be a triple pole changeover switch on the charging circuit. The UK regulations covering low voltage systems are not as well defined as they are in the USA NEC code, especially for portable PV generators. Strictly speaking, a copper grounding rod should be used at each site and all extraneous metal parts in the system linked to this point, which is a problem on pavement.

Cable Notes

The round trip distance from the furthest PV module to the C40 regulator was measured as 16 meters (52 ft). We used 10 mm square (between 6 and 8 AWG) stranded conductors. All three flexes were cut to equal lengths to balance the arrays. However, this was a tight fit into the gland (a rubber seal) cut into the box at the back of the BP160. The final drive motor was theoretically rated to draw a maximum of 1.5 amps at 240 VAC which meant a possible 15 amps on the DC side over the 10 meter (33 ft) round trip to the inverter. This meant that two lengths of 35 mm square (2 AWG) for each polarity should be ample. Imagine my horror when I connected the clamp-meter of my Fluke 123 oscilloscope and saw peak currents of 10 amps on the AC side!

Further analysis revealed the reason for this. The clever Siemens drive controller was in fact causing problems with the volt-current phase relationship. This was not surprising, as it is principally a large set of capacitors powering an inductive load. Amazingly, the AC side was happily at 1 RMS amps (full conveyor speed), 287 peak volts, and 228 RMS volts. This compared to 326 peak volts and 235 RMS volts when using the grid mains, indicating the flat top characteristic of modified sine wave voltage curve. Measuring the DC side indicated that the Trace inverter was coping admirably with this strange load, with peak current at 18 amps within each 10 millisecond cycle (equivalent to 50 Hz on the AC side), and 10 RMS amps.

Reclamator PV Upgrade Costs

Description of Materials	*Cost in £*
Twelve BP160 PV modules (retail & freight)	4500
Steel galvanized subarray	423
Trailer wheels and hitch	435
Trace 624 E/SB	470
Trace C40, Class-T fuses, E-Meter	490
Plugs, sockets, aluminum, fixings	250
Sundry	100
Eight Telecomm batteries, box, cables, load center, AC distribution & charging	811
Total	7479

Above: Phil Evans (L) and author Chris Laughton (R) in front of the donated PV array.

Having already commissioned the battery and inverter, it was time to test the PVs. With the sun gloriously beaming in the June sky, I slipped each array plug into the sockets. Watching the E-Meter, I saw a very pleasant 32 DC amps flowing into the batteries causing the green “Full” lamp to start flashing in no time.

Problems

The first reported problems came about 8 months after the owners started using the solar-powered system. The inverter was occasionally cutting out, requiring a manual restart of the Trace. Eventually, the problem became worse, and we had done all we could over the phone. We arranged to take the Reclamator out of service for a few days so I could give it a thorough inspection. The battery under no load was showing 24.6 volts, but this quickly dropped to 23.2 volts under load, and the inverter was then switching off as part of its protection circuitry. No restart was possible until ten minutes had passed.

A problem with the batteries or cables certainly seemed likely, and yet the E-Meter (with an historical recording function) indicated an 82% charging efficiency, much higher than one would expect considering the abysmal battery voltages. All was explained by the next readings of the E-Meter. The charge/discharge cycles totaled

only thirteen in twelve months of use, and the deepest discharge was 71%. It turned out that the owners had never charged the batteries from the grid and had only used a third of the PV array at the best of times, even in the depth of winter. This guaranteed the destruction of the battery! The high efficiency figure was due to the fact that the E-Meter will only re-calculate when the batteries become fully charged.

Cracked Batteries

The voltage of each individual 6 volt battery was recorded under maximum load and charge, which revealed two particularly poor batteries. We were not surprised when their removal revealed split cases with gel peeking out of the cracks! With these replaced and an overnight charge from the grid mains, the battery under no load was starting at 25.2 volts and dropping to 24.3 volts under maximum load. The final charge setting for the Trace inverter was left at 27.0 volts. The C40 was set for 27.6 volts for the bulk charge and 26.4 volts for the float charge.

When the owners were further challenged over the battery abuse, they claimed that the E-Meter ampere-hour meter and time-to-run feature never indicated a problem. This is a good lesson: These indicators are misleading unless the battery is regularly brought to a full state of charge to allow the E-Meter to recalculate. The owners also reported that they rarely used the full 12 module array due to the inconvenience, which shows the practical limitations of removable arrays.

A secondary problem was then addressed regarding the auto-search facility of the Trace inverter. Originally this was left in a medium search mode, which became energized when the conveyor was switched on. For safety reasons, this switching was controlled by a contactor by the original builders of the Reclamator. However, the owners reported that they could feel the contactor points bounce when using the inverter power, and that the coil would then slowly "suck in" allowing full power to pass. Fortunately, the bouncing turned out to be the pulses from the auto-search circuitry. By defeating this and manually switching the inverter to full output, the bouncing disappeared.

The Reclamator continues to reduce the waste put into landfill sites and brings the idea of solar power to even more people. Technically, it was quite a challenge to design, and engaged the thoughts of several solar engineers. Given the severe environment, the equipment has fared well. The owners no longer hire a generator—this alone is reason to celebrate.

Access

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C12 (Shown with cover removed)

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*Scheduled availability Sept. 1 1998.

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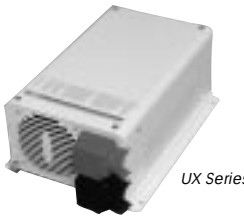

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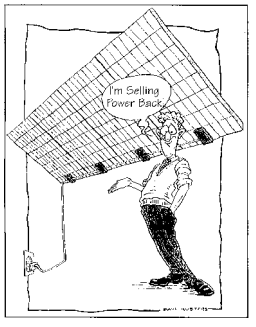

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MPS shown with cover removed.

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Surviving the Ice Storm of '98

Bob Ellison

Above: One of thousands of power poles that went down, leaving millions without power.

January 8, 1998—It Was a Dark and Stormy Night... Actually, it was rather peaceful that evening in the town of Theresa in upstate New York. But when I woke up the next morning and turned on my TV, I knew something was wrong. I was picking up Syracuse, New York (95 miles southwest of here), Ottawa, Ontario, and other distant stations, but no local stations. I looked outside towards my neighbor's house about a quarter of a mile away. Usually I can see a living room light, but not this time. And there seemed to be a nice glassy coating on my car. "Cool—an ice storm!" was my first thought.

I picked up the telephone and called my neighbor. "Hey Chuck, you got power down there?" That elicited a response that no one would print. So being the nice guy that I am, I asked him if he wanted to buy a cup of coffee, for say, fifty bucks (this guy drinks a lot of coffee). The response was more unprintable noise followed by a growl that sounded like he might be coming over. A short while later he came in asking if the coffee was done yet. That should have told me how bad things were, as no one would want *me* making coffee because I don't even drink the stuff.

Power System

My power system is a diesel-wind hybrid. Solar is not very useful here for much of the year, because we are just twenty miles from Lake Ontario. We get a lot of solar shading from clouds that the lake generates due to "lake effect" storms. A 10 KW Chinese diesel generator charges eight Trojan L-16 batteries, running three to four hours on a gallon of fuel. A Whisper 1500 wind generator on a tilt-up tower rounds out the system. With no wind, the generator runs three hours per day, but when it's windy I have gone for up to nine days without running it. One Heart Interface Freedom 2500

inverter gives us AC power, and a second one runs as a charger to cut generator run time. An E-Meter monitors the system and helps me make intelligent decisions about when I need to charge the pack.

Chuck has often discussed installing a power system at his home, but the expense is more than he can handle all at once. We decided to increase efficiency first—always a smart move anyway. But the thought of replacing all of his power-sucking appliances at once was too much to bear. I mean, we're talking about damn near everything in his old house that he had just spent ten years remodeling and insulating. He did it right too—no cheap short cuts. Now, sitting down with his cup of coffee, we began to talk again about the wonders of inverters, battery packs, and wind generators.

Hard Traveling

Our conversation was interrupted by the sound of the phone ringing. It was my girlfriend Chris saying that she was heading this way. Chris likes her hot showers daily, and she also likes her coffee. She ended up calling four more times on her way over. Every time she ran into a roadblock and the police turned her back, she called and I gave her directions around it. The normal twenty minute trip took over an hour and three quarters. When she arrived, we started to get an idea of how bad things really were.

The northern New York area was devastated—hardly a power pole was standing and many that were had the lines ripped off by the weight of the ice or toppled trees. It was becoming clear that we had a real problem—including this area, parts of Maine, Vermont, and New Hampshire, as well as large parts of Ontario and Quebec, Canada. Early estimates were three days to a week to repair the damage. But I could see that just getting power back on my road would take at least a week.

The storm started during the night with heavy ice accumulating rapidly on power transmission lines and anything else that wasn't a heat source. It was a gentle steady rain that turned to ice on everything it touched. When I woke, there was almost an inch on the front deck of my house and on my car. The freezing rain continued for three days under a weird silence that was broken only by the sound of power poles and trees snapping like match sticks.

Reconnaissance

Chuck and I went for a ride to scope out the damage. This was one mother of an ice storm and it hadn't stopped yet. We had a digital camera and a 35 mm camera with eight rolls of film, and we took a lot of photos. We took shots of road signs with twelve inch beards of ice, wire fences that were solid with ice, and power poles that were snapped like match sticks. At one point, I counted 39 broken poles in a row before I lost count. Clearly, it was going to be a while before things got near normal again.

My Whisper 1500 was a solid sculpture—the blade tips were twelve inches wide with ice before it was over. We actually had to use a hammer to break an inch and a half of ice off my car doors to open them. Then we had to hammer Chuck's sixteen foot insulated wood garage door to open it. Electric garage door openers don't work when the power is out, and that beast was really heavy, but we finally got his truck out. After that first reconnaissance, we returned home to find that the phones were down. After what we had seen, that was no surprise. At least my cell phone still worked. But it turned out that emergency crews, fire departments, and other heavy hitters had tied up the lines—sometimes it took over two hours to get an open line, only to find the other end was busy.

Provisions

At 2 PM, a New York State Police car appeared in my driveway—good news, it was a friendly visit. Adam's a state trooper and he and his wife also own a convenience store with gas, kerosene, videos, and other needed items. His wife Shauna went to Sam's Club and bought the last generator they had. It was a medium quality 8 hp 3,500 watt gas rig, not enough for the whole store, but it would run a register and the gas and kerosene pumps. Chuck and I grabbed some tools, testers, and assorted goodies and left in about five minutes. On arrival, we found no cable to use for wire,

Below: Ah, the luxury...Chris makes coffee.

Above: Bob's Whisper 1500 frozen solid.

so we ended up using a couple of extension cords, the only thing available. When we left it was dark but the store was open, running and lit.

The next day Adam and some friends took three trucks to Syracuse, New York to buy supplies for the store. They picked up water, propane bottles, batteries, and most of the things you need if you're not prepared (probably 95% of the people were not). At my place, the only things we almost ran out of were coffee—we used six pounds of the stuff in two days—and creamer. We had several members of the local fire department taking hot showers and doing laundry at our place. Needless to say, the battery bank took a beating. But, according to the E-Meter, we still didn't take it below 50%. My hat's off to Heart Interface and Trojan Battery for building such dependable and durable equipment.

Getting Worse, Not Better

Two days after the storm, Arsenal St. in Watertown—the nearest place that can even pretend to be a "city"—had power, after some false starts. The hotels and motels on Arsenal St. were housing power crews from as far away as Michigan and Georgia. Niagara Mohawk (NIMO), the local power company, had over 3,000 visiting crews helping repair the massive destruction. These crews were working nineteen hours a day for the first week. I can't say enough about these dedicated people—they were fantastic!

The *Watertown Daily Times* put out its first storm special edition. But parents of most carriers in Watertown refused to let their children deliver it because trees and lines were still falling. Over 130,000 homes and businesses in the area were still without power. Basements were flooding everywhere, without power for their sump pumps. A Red Cross official said that all city shelters were full and couldn't handle the influx of residents. NIMO said that the situation was much worse than anyone expected, and that reconnection might take several weeks. The 765 KV line that crosses northern New York had towers collapsed in several places.

Disaster Area

On the third day of the storm, President Clinton declared much of upstate New York a disaster area, making some federal emergency funds available. Emergency generators started arriving, and people waited in line up to five hours for a chance to buy one. Farms with generators were dumping milk because plants couldn't process it without power. Some cows began getting sick because they couldn't all be milked by hand. Hundreds of emergency personnel swarmed into northern New York. There was no heat in the school shelters at first, but at least you could shiver with a few hundred people you didn't know! Over 5,000 state employees arrived to help in the cleanup along with 1,700 National Guard troops.

Shelters Are Open, but Supplies Are Low

Before long, Jefferson county had 34 shelters in operation, St Lawrence county had 44, Franklin county 20, Essex county 13, and Clinton county 12. FEMA (Federal Emergency Management Administration) informed the Governor that a caravan would be coming from Georgia carrying needed supplies. They brought 5,000 cots, 6,000 blankets, bottled water, diapers, and batteries, none of which had been available in stores since the first day of the storm. Friday, January 9th, 1998 was the first issue the *Watertown Daily Times* did not publish in 137 years. In Jefferson and St Lawrence counties, 225,000 utility customers were without power. The latest count was 22,000 poles snapped off. Replacements came from as far away as Oregon and Washington State.

Running Water Is Not Always Good News!

With heavy rains and melting ice, the Black River in Watertown crested at over sixteen feet above flood stage, washing out streets and flooding houses and cars. Some bridges had water several feet over the

road bed. The Black River is normally only a quarter mile wide but reached over a mile wide due to the flooding. We went to the fire department to see if we could get Chuck's basement pumped out before he lost the equipment that was too heavy for us to move. At 1 PM we got on the long list of people waiting for pumps. We called at 4:30 PM and were told it would be another hour and a half. At 11:30 PM we got a call from the Jefferson County Emergency Management Center telling us to go in and pick up a water pump.

We arrived at 1:30 AM only to find out that they were only giving pumps out to fire departments. They promised to have the Theresa Fire Department stop and pump Chuck's basement. They arrived at 3 AM, and it was done by 4:30. Then we decided to get some sleep. We had been up for about 24 hours straight and were getting kinda goofy. We slept until 6:30 AM. Being this short on sleep and dealing with the mess around us was no picnic. But we were warm and the house was lit, so I didn't dare complain.

So being the nice guy that I am, I asked him if he wanted to buy a cup of coffee, for say, fifty bucks.

All night we got to listen to the sound of huge pines snapping, one breaking and taking three or four more with it. The sound is something you have to hear and see to believe. I can't describe it—it's too overwhelming to see 60 to 80 foot trees and poles snap like toothpicks. When one power pole snaps, it takes a bunch with it, just like dominoes. We heard that the Governor and head of FEMA would be flying over looking at the damage. So I got four cans of bright yellow paint and put a large smiley face at the base of my Whisper 1500 and wrote "Home Power" in large letters. We never did hear if anyone saw it but we had a few good laughs.

Road Trip

We woke up at 8 AM the next day. It felt good to get some sleep after several days of two or three hours of sleep a night. We decided to attempt to go to an Amish friend's to see if he had a spare pump to pump out the basements that were flooding. We were bored and a travel ban was in place—no travel except for emergency traffic. But while pumping, we became emergency personnel. It's only a 35 mile drive to my friend's place, but it took two and a half hours to get there. My Chevy Sprint has four studded snow tires and was small enough to fit under or around most of the trees and poles. A four wheel drive truck would never have fit through the holes that we went through—it would just be too big. It was like driving through tunnels of glass. Ice surrounding tree branches a quarter inch thick was three inches thick by the third day.

My friend Dennis, the Amish man who owns a machine shop, was building generators and pumps out of anything he had that would generate or pump. He's lucky he has such a collection of equipment to work with. We left with a diaphragm pump and suction hose. Dennis never charged a single dollar for a pump, generator, or labor during the storm or recovery. We returned home and set the pump up at Chuck's place. We then went to the fire department to see who else in our area needed to be pumped out.

Pumping

They gave us a list of four others and we started making rounds. By the time we got to the last one, the first one needed pumping again. The fire department gave us fuel and changed the oil in the pump every night, and as long as we were pumping, the travel ban didn't affect us. People were starting to get arrested for being out on foot or in cars. One couple in Watertown told the officer they had an emergency, they were out of cigarettes. They got two tickets and I hope one was for stupidity!

The engine quit on the pump so we went back to Dennis, hat in hand, wondering what that Honda was worth. Dennis explained that it had previously been frozen, backed over, and generally abused plus that it was around ten years old. He put a new engine on it, sent me back with a 4400 watt generator, and wished us good luck. It was starting to look like a few hundred thousand people were going to need lots of it! After six days, only a part of the city of Watertown had power on most of the time.

Fire!

The next morning at 6, Chuck pulled in the driveway at a high speed, ripped the door open, and yelled, "Call 911! I've got a fire!" His dog, a huge Rotweiler/Great Dane cross, had knocked over a lantern. Fortunately, I was able to get a line on the cell phone. I gave them the info and was out the door in under two minutes. By the time I arrived, the front of the house was fully engulfed in flames. I called 911 back and advised them to send everything they had. We ended up with nine departments there before it was over. They had it almost out when they ran out of water, and when a new pumper got backed up to the tank, everything had frozen up. At 15 degrees below zero, it's hard to keep the water in the pumps, hoses, and hose ends from freezing.

Within an hour we figured it was all over for Chuck's house. Theresa Fire Department had a great response time, but everything else went against them and the other eight departments that responded. Several of the

guys had showered, drank coffee, and done laundry at my place and they felt real bad that things hadn't gone better. The fire was out by 10:30 AM, but it was a total loss. We had gotten Dennis' pump and generator out before they had arrived, so we started pumping out his basement to see if we could get to his fire file (a steel wrapped concrete box, very much like a safe with drawers) that was in the basement. If you ever find one of these concrete files, buy it. They weigh several hundred pounds but they are worth it for the protection. After six hours of pumping, we got into the file. We brought the drawers to my place and Chris started peeling papers apart and drying things out.

Good News—At this Point Anything Was an Improvement

With lower temperatures, water stopped running into basements, so we stopped pumping. Most of the fun had gone out of it by then, anyway. Much of Watertown had power part of the time by then, and it was improving daily. Outlying areas would have to wait five or six weeks for power, according to a NIMO spokesmen. No one had a clue when telephone service would be restored.

The utility companies did a fantastic job. They built an entirely new power grid from scratch in three to four weeks. On January 28th, power trucks were all over our three mile long road. By dark, they had two places connected and powered up. Then I had to help my neighbors with their frozen water pumps and pipes. One pump was cracked badly enough to need replacing. On the 29th, the power company was out at my pole looking things over. With all of the poles that were needed but fell over, this one *wasn't* needed but *didn't* fall. I went out to talk to the power company crew, and asked them to disconnect the transformer because I didn't need it. That got me some strange looks!

After I explained that I had an independent power system, they agreed and unhooked the transformer and feed lines. They even asked for some cards to give to people who ask about other power choices besides the grid. Lots of people in the area are interested in having backup power systems. We have had three storms with long power outages in the past decade: an ice storm in 1991, a microburst in 1995, and this mother of all ice storms in 1998. You would think that everyone would at least own a generator by this time. A customer who had me build a 22.5 KW diesel genset to power his grocery store called me and told me that he was so happy he could kiss me. He was the only store open for 35 miles and was cooking for the Fire Department's shelter across the street. They also ran a line next door to run the furnace, and a line 200 yards to get the local bar open. I think it's a law in this village that a bar has to be open no matter what—there isn't a lot to do here, even on a good day.

Power's On!

Power wasn't on in all parts of Jefferson County until twenty-five days after the start of the storm. Even after power returned, it was not stable and went off frequently. It took another two to three weeks for all telephone service to be restored. Telephone service was also unreliable for some time. After a rain there were no dependable connections—the lines were lying along the roads being driven over for up to seven weeks. According to a *Watertown Daily Times* article, on February 2nd, there were still over 1,400 customers without phone service. Bell Atlantic had over 1,100 crews working in the region to restore service, and expected to have phone service restored within a week. That was really good news for my wallet, since my cell bill was $256 for the first ten days of this mess. At this point, as many as 50,000 homes were without power in Quebec and Ontario, Canada. At the peak of the outage, about 3,000,000 people were without power.

Disaster Humor

There were some things that may seem funny to *Home Power* readers. The power company set poles and ran wire all day on one local road. When they got to the last home on the road, they couldn't find the meter. As you may have guessed, the owner returned home and told them that he hadn't been on the grid for almost twenty years! This is only funny if you weren't on the crew who did the work. Then there was Theresa Highway Superintendent Jerry Reynolds who got his power back on after days of listening to his generator. He said that on the first night with restored power, he finally went to his garage and started his lawn mower beside his porch, just so he could sleep!

There was also the FEMA rep who met Chuck to survey the damage at his home. Chuck brought him to my house to do the paperwork. I had a friend's small generator we were testing under load (charging batteries) to see if it would misbehave. While the FEMA rep was here, it quit, but the lights barely flickered. He looked at the lights and at Chuck several times before he had to ask, "Wasn't that the generator?" We just love these questions! Chuck explained the system to the curious rep. After a while we just take it for granted that our energy systems work smoothly. Then something like the ice storm happens and it wakes you up to how lucky you are to be making your own power.

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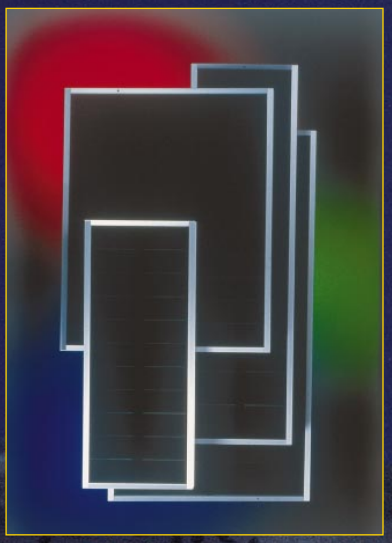

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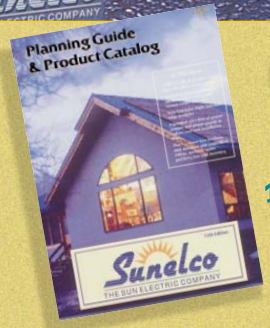

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The Solar-Powered Bluesmobile

Tom Snyder

Above: IRENEW's 1000 Watt PV array supplying electricity to the Blues Bus in a farmer's yard during RAGBRAI.

RAGBRAI (The Des Moines Register's Annual Great Bike Ride Across Iowa) is one of the biggest gatherings of bicyclists in the world. Each summer, thousands of bikers from across the USA and from foreign countries come together for the ride, and to enjoy blues music concerts along the route. The Iowa Renewable Energy Association (IRENEW) decided that this was a perfect event for displaying and using alternative energy. Our Solar Power Trailer was rolling proof of the power of the sun as it supplied all of the electricity for daily blues concerts for the entire seven days.

Bikes—Another Form of Alternative Energy

RAGBRAI started in 1972 with about 500 bikers traveling east across Iowa from the Missouri River to the Mississippi River. This bike ride was organized by two Des Moines Register writers. Covering about 500 miles (805 km) over seven days, the ride has grown to about 25,000 riders total, including 10,000 officially registered riders. This traveling circus (as some have called it) enjoys many things: good food, good ale, and excellent blues music. In the spring of 1998 we brought our own Alternative Energy Tour vehicle to this event—an old school bus with a stage on the top, and the Solar Power Trailer for electrical power. Different blues musicians from across Iowa used the stage as we traveled across the state.

Recycling 5,000 Watts of Surplus PVs

In the spring of 1996, my son David, Don Laughlin, and I traveled to Brookhaven National Laboratory in New York to dismantle a 5 KW PV array that had been donated to IRENEW. Most of the 116 panels were then transported back to Iowa by the Iowa National Guard. IRENEW is an educational non-profit organization, so these panels were to be used specifically for education and demonstration. We have now completed two projects with 48 of these PV panels: the Indian Creek

Nature Center in Cedar Rapids, Iowa (see *HP63*) and the Solar Power Trailer. Future projects scheduled for some of the remaining panels are two straw bale guest houses for the Prairiewoods Nature Center in Hiawatha, Iowa.

PV Power Trailer Construction

We started building the Solar Power Trailer using a seventeen foot (5 m) boat trailer as our base. This trailer needed new brakes, new tires, and a new brake master cylinder, among other things. After the basic running condition was improved, IRENEW members Dennis Pottratz, Don Laughlin, Kirk Boyd, Tim Reynolds, and Pat Mulligan installed the power system. The system included twenty-four PV panels, sixteen 6 volt Exide batteries, and an Exeltech 4000 watt sine wave inverter, as well as all controls, hardware, and wiring.

The weight of the sixteen batteries—over half a ton—required them to be mounted directly over the two axles and between the frame rails. This arrangement has proven to be very stable for highway travel. The trailer has traveled extensively across Illinois and Iowa with no problems. Tires have been replaced as needed, but no other major repairs or replacements have been necessary.

The eight main upright posts for mounting the PV panels were constructed out of two inch (51 mm) square tubing welded to the boat trailer. At about four and one half feet (1.4 m) from the ground, angle iron was welded horizontally between all uprights. The angle iron forms the support for the bottom three strings of modules. It also serves as a roller guide when they are pulled out and lowered for use. The top three groups of modules are raised after the bottom three are pulled out and lowered.

Below: The back of the trailer, showing batteries and the red weatherproof control center.

Right: The trailer with one third of the array set up for charging and the other two thirds in travel position.

Power Trailer Wiring

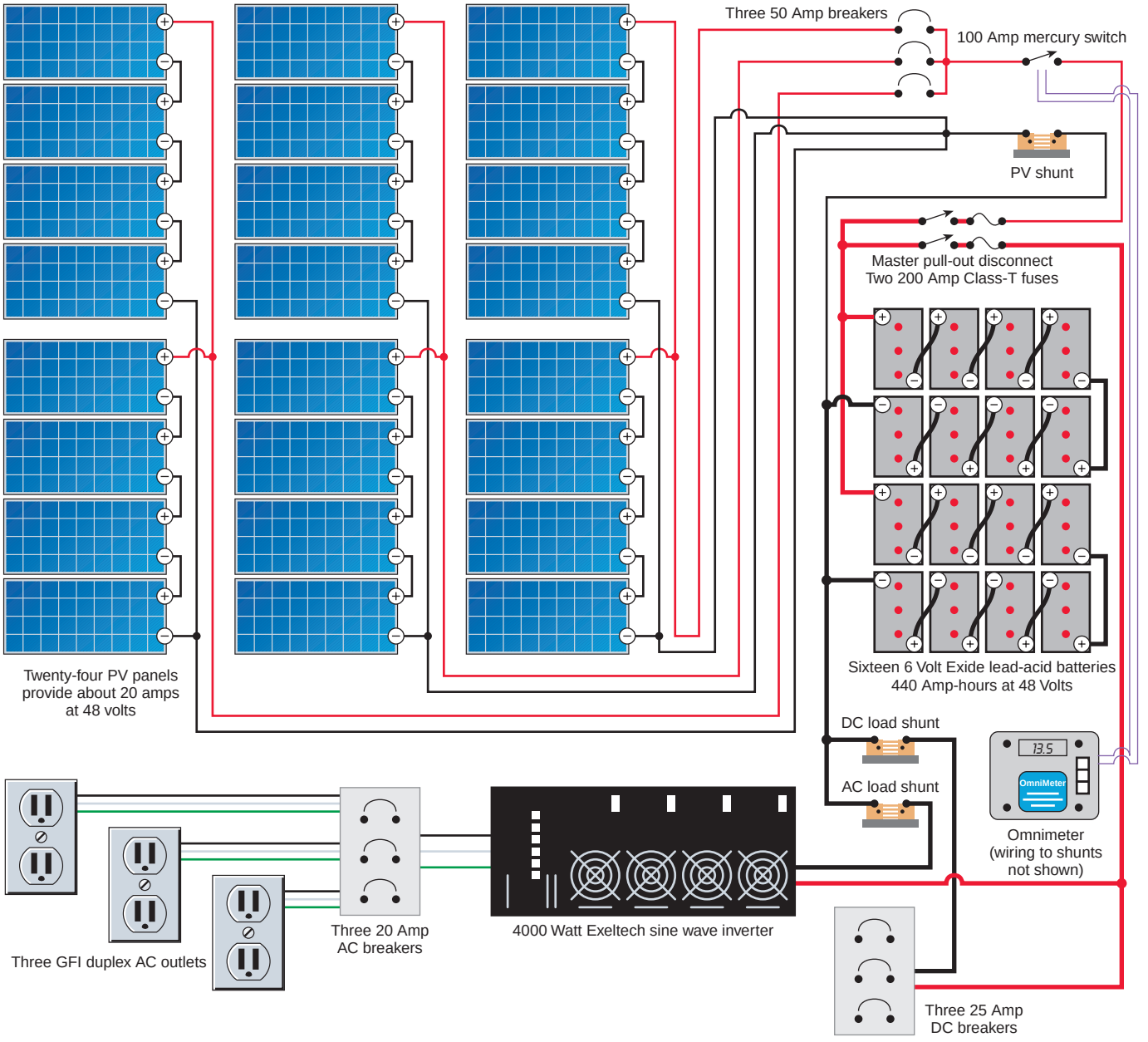
Dennis Pottratz was instrumental in arranging donations of wiring and electrical components for the Solar Power Trailer. Bobier Electronics in West Virginia donated the Sun Selector DC Master power center. The 4000 watt sine wave inverter came from Exeltech in Texas, and the PV panels were from Brookhaven National Laboratory in New York. Most of the wiring on the trailer was done by Dennis Pottratz and Don Laughlin.

The twenty-four PV modules are wired in groups of four in series, for a system voltage of 48 volts. The six series strings are then wired in parallel in groups of two and wired to the three 50 amp PV circuit breakers in the DC control. The three sets then exit as one 48 volt system to a 100 amp mercury switch. The PVs from New York came with a large amount of very flexible 10/2 (5.3 mm square) wire with the designations SEO W-A CSA, Type STE, labeled “Polar/Solar.” This wire was used between the six series strings and the three PV circuit breakers. Output from the PV array is about 20 amps at 48 volts.

The three PV circuit breakers on the face of the DC Master are rated at 50 amps DC each. The system has a 200 amp main pull-out fuse, three GFI outlets, and an AC circuit breaker box with three 20 amp fuses. An Omnimeter from Bobier Electronics measures volts, amps, and amp-hours. With all of the fuses and breakers located next to the Omnimeter, it makes troubleshooting extremely easy. The whole system, or parts of it, can be shut down easily.

During RAGBRAI, we noticed a decrease in overall current from the PV array. By using the Omnimeter and switching the three PV breakers on and off, it was very easy to isolate one subarray that was lower in output than the others. One of the PV panels in the lower middle group had developed a break in an internal connection during the trip. The bad connection did not

The Solar Power Trailer's Power System



completely shut down the panel, which was replaced later.

The DC Master is connected to the PV array through the 100 amp mercury switch. When the Omnimeter senses PV voltage, the mercury switch closes. This completes the circuit to the master pull-out fuses, allowing PV current to flow to either the batteries or the inverter, or both. The schematic shows the three shunts in the DC Master—PV current, inverter current, and DC load current. These shunts allow the Omnimeter to read the different currents.

Production of Electricity

The Solar Power Trailer had already been used for similar functions around the Midwest before the RAGBRAI trip. Our experience with it at one and two day events at colleges and universities around Iowa proved it was well built and roadworthy. Last April, the PV trailer was at a two-day Earth Day event at Davis Caves in Armington, Illinois. This event included music and booths powered by our trailer. It rained constantly, but we saw that the trailer could provide as well as collect energy under adverse conditions. The battery bank started out with about 220 amp-hours available

(with a maximum 50% depth of discharge). At the end of two days, it was down to about 60 amp-hours. The voltage stayed between 49 and 46 volts.

It only rained for two of the seven days of RAGBRAI. Every day, the Omnimeter registered at least 221 amp-hours of storage in the sixteen batteries before the day's events (total battery capacity is 440 amp-hours at 48 volts). The music usually started around noon and continued throughout the afternoon and late into the evening. The PV system produced a surplus until about 5:30 in the afternoon. For about the next two hours, the production matched the power usage, and then the batteries would carry the load for the rest of the night. Reading the Omnimeter regularly showed that the musicians required at least 3,000 watts quite often during every concert. Whenever the bass guitars played, you definitely could see the wattage go even higher and the cooling fans on the inverter would turn on.

One night, the bands played until about 1:30 AM and they forgot to turn off the system when they had finished. The next morning, the amp-hours had dropped to 171. During the next day's events, we gained energy until the meter read 221 amp-hours, while still producing enough for the bands.

The Ultimate Test

Traditionally, the last night of RAGBRAI is the big event—the crowd swells to about 25,000. On that Friday night, our trailer proved how well solar-electric systems work. The bands never stopped playing and the music was loud and fast. During and after the concerts, the sound guy was constantly smiling! Later, he told me how skeptical he had been before the day's events. His comments after the concerts: "Perfect waveform, no variance in voltage during the whole day's events! No noise or pollution! A perfect 116 volts all day!" I guess a professional sound person can actually hear the effect a change in voltage makes in the music as more instruments are added. All I know is that he was impressed enough to agree to come back and help us with eighteen bands—all powered by the sun—at our seventh annual Energy Expo in September!

After the final night of the event, the Alternative Energy Tour decided one last hurrah was in order. About 35 miles into the last leg of our trip to the Mississippi River, we parked our blues music bus and Solar Power Trailer in a farmer's field next to the gravel road the bikers had to travel on. We wanted to display the PV array doing its thing out in the middle of nowhere. It was a traffic jam the rest of the afternoon. People stopped and ate and sat and listened one last time to solar-powered music.

Above: Inside the control center lives the Sun Selector DC Master power center, Omnimeter, pull-out main disconnect, and Exeltech 4KW inverter.

Final Observations

I was impressed with the way the PV panels, Exeltech Inverter, and DC Master held up. Just ask the sound guy if solar power works and is durable! This was a week of testing PV equipment under very adverse conditions. It works!

Field of Dreams was filmed here in Dyersville, Iowa. The statement from the movie, "If you build it, they will come" seems close to explaining the week of RAGBRAI. The ride was started 26 years ago. Now, people come from Australia, England, Scotland, and all over the United States. If you want to promote alternative energy, find an event like this in your area. *Do It!* Don't wait for "them to come" first.

Access

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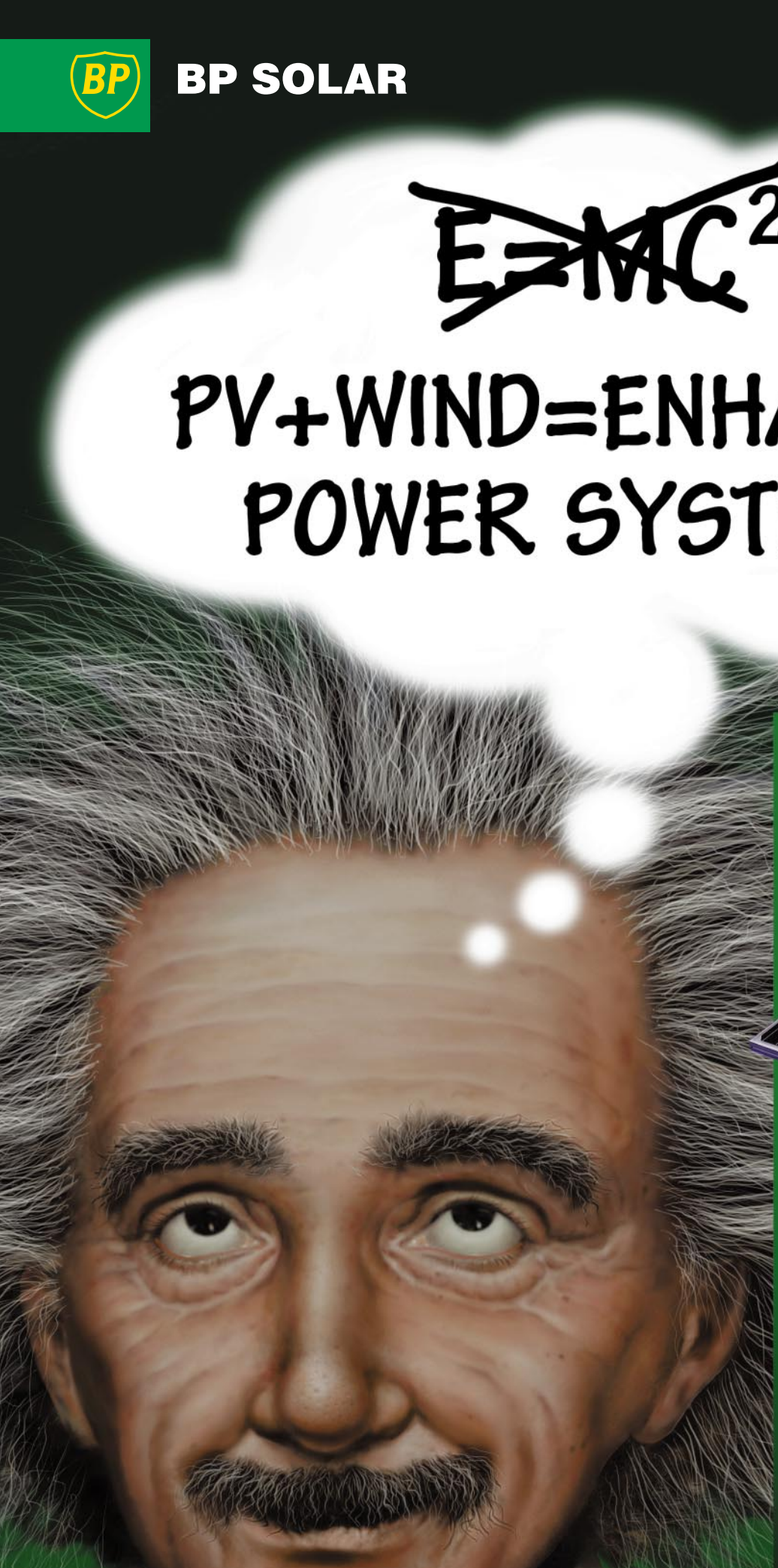

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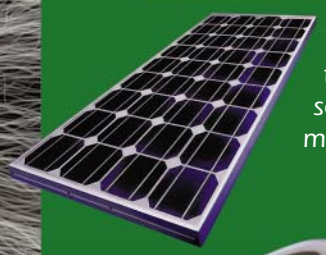

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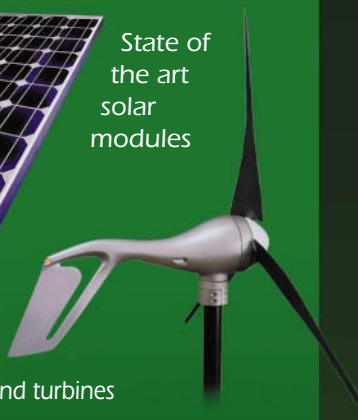

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Solar...

In the Frozen North

Bill Layman

Northern Saskatchewan is a rugged landscape of rock and trees located in the Precambrian Shield of Canada. It is scattered with clear, cold, deep lakes that are filled with trout, pike, and walleye, and people are few and far between. A lease on one of these lakes can easily find you thirty miles away from your nearest neighbor with moose and wolves as your only visitors. Winters are long, with the mercury dropping to -40° C (-40° F) on many days. "Freeze up" of the lakes comes early in November and "break up" not until the end of May. My partner, Lynda Holland, and I had long wanted a remote seasonal home on one of these lakes.

And Then We Found Our Own Place in the Woods

When we acquired our lease on Bob Lake in northern Saskatchewan ten years ago, my knowledge of electricity was limited to a vague remembrance of something in high school about *volts x amps = watts*. Our lease is located thirty miles from the nearest grid power and is accessible only by chartered airplane (floats in the summer and skis in the winter).

When it comes to power, the prevailing mindset of others with leases up here was an old adage I often heard repeated: "If it ain't diesel, it ain't jack squat." In plain English: a diesel power plant was the only way to go. But we just couldn't see ourselves sitting in our home watching the northern lights and listening to music on the radio with the racket of a generator in the background! Besides, it seemed a crime to be using total daily loads of less than 700 watt-hours on a power plant which could easily service an urban home or two. When asked what to do if (or *when*) the power plant should break down, the answer was simple—you have a standby unit ready to go at all times. No kidding!

The other downside of a remote power plant up here is the cost of flying the fuel to the site. Flying 100 gallons of fuel thirty miles from the nearest community (La Ronge) costs about $200. Amazingly enough, multiple

diesel power plants are still the most common power source for tourist camps throughout the North. We wanted to consider renewable energy sources for our electrical power. Not located near any flowing water and with limited wind, we knew solar would be the logical choice. Needless to say, there weren't a lot of people in the area to turn to for design help. In fact, most looked at me like I was an idiot when I said I was considering a solar power system.

Now, Where to Start?

Not knowing what else to do, I started to acquire catalogues, design guides, and library books. In fact, anything that had the word "solar" in it ended up scattered around our house in La Ronge. Months of reading later, with my head filled to overflowing, I started to design our system. Of most help to me were the catalogues of Soltek, Solar Energy Ltd., Northern Alternate Power Systems, Sunelco, and Real Goods Trading Co. These catalogues have a wealth of basic renewable energy information and numerous design configuration schematics. They are well worth the price and a good starting point for anyone designing a renewable energy system. I have spoken or written to each of these companies and found them to be more than willing to answer my questions. Also of great assistance was Ron LaPlace of Photron Canada (now Sun Direct Energy, Inc.). Somehow, I missed *Home Power* magazine and only discovered it when my system was complete!

Below: The power center/pantry.

Above: The power shed with nine Kyocera J43 panels.

Lately, more and more people are looking at solar as a viable option for remote homes in northern Saskatchewan. In fact, a new RE dealer/installer, Sask Solar Systems, recently opened in La Ronge. I guess there is light at the end of the solar tunnel!

Design Considerations for a Frozen North

I soon learned that stand-alone photovoltaic systems at a 55° latitude are not cost effective. An average 45 watt solar panel produces only about 80 watt-hours on a good day in the dead of winter up here. PV systems with a backup generator and charger are the more cost effective choice.

Our location also has another unique weather factor that makes such "photo-genset" combinations the best all around choice. During the freeze up of the hundreds of lakes up here, a tremendous amount of moisture is put into the atmosphere. This moisture means low overcast skies for about six weeks from early October until about mid-November. As I write this article at Bob Lake, we have had only three days of partial sun in the last three weeks!

Batteries

At a temperature of -20° C (-4° F), battery capacity drops to less than 50%. With winter lows hovering at -40° C (-40° F) on many days, our battery needed to be located inside our home if we were to get any reasonable amount of power out of it. Locating the

Above: The author with power!

battery in the house presented a problem. Regular charging of flooded lead acid batteries can produce small amounts of very explosive hydrogen gas. The necessary periodic equalization charging of these batteries produces large amounts of gassing. We were not keen on having hydrogen gas in our home. This concern was later addressed by our choice of an absorbed glass mat battery. This battery does not need periodic equalization charging and is very unlikely to vent hydrogen gas under normal charging conditions.

Our home at Bob Lake is unmaintained for weeks at a time, so any battery we picked had to be able to tolerate a very irregular maintenance schedule. Conventional flooded lead acid batteries would not be suitable. Four to five days of stand-alone battery capacity needed to be designed into our system. Why not just start up the power plant every other day to recharge the battery in a northern system? Because it is a real pain in the "you know what" to heat the power plant shed from -40° C (-40° F) for a minimum of three hours before you can even pull the starter cord! In the end, we chose GNB's Absolyte battery—more about that later.

Inverters

We had always planned to build a small guest cabin where we could house friends and "eco-tourists." The site for this cabin was about 300 feet from our main home. Adding an inverter to our system would allow the use of 117 volt power tools for construction of this cabin. The maximum load that this second cabin would use when completed was anticipated to be about 250 watt-hours per day. Transmitting low voltage DC power to the cabin was far too expensive a proposition—4/0 wire at $7.50 per foot would have been required! At 117 volts, however, the current could easily be transmitted through the supply of 10 gauge 3 conductor Teck wire I had on hand. Given the need for a battery charger in our system, it soon became obvious that an inverter with a built in transfer switch and charger was the best way to go.

Power Plant

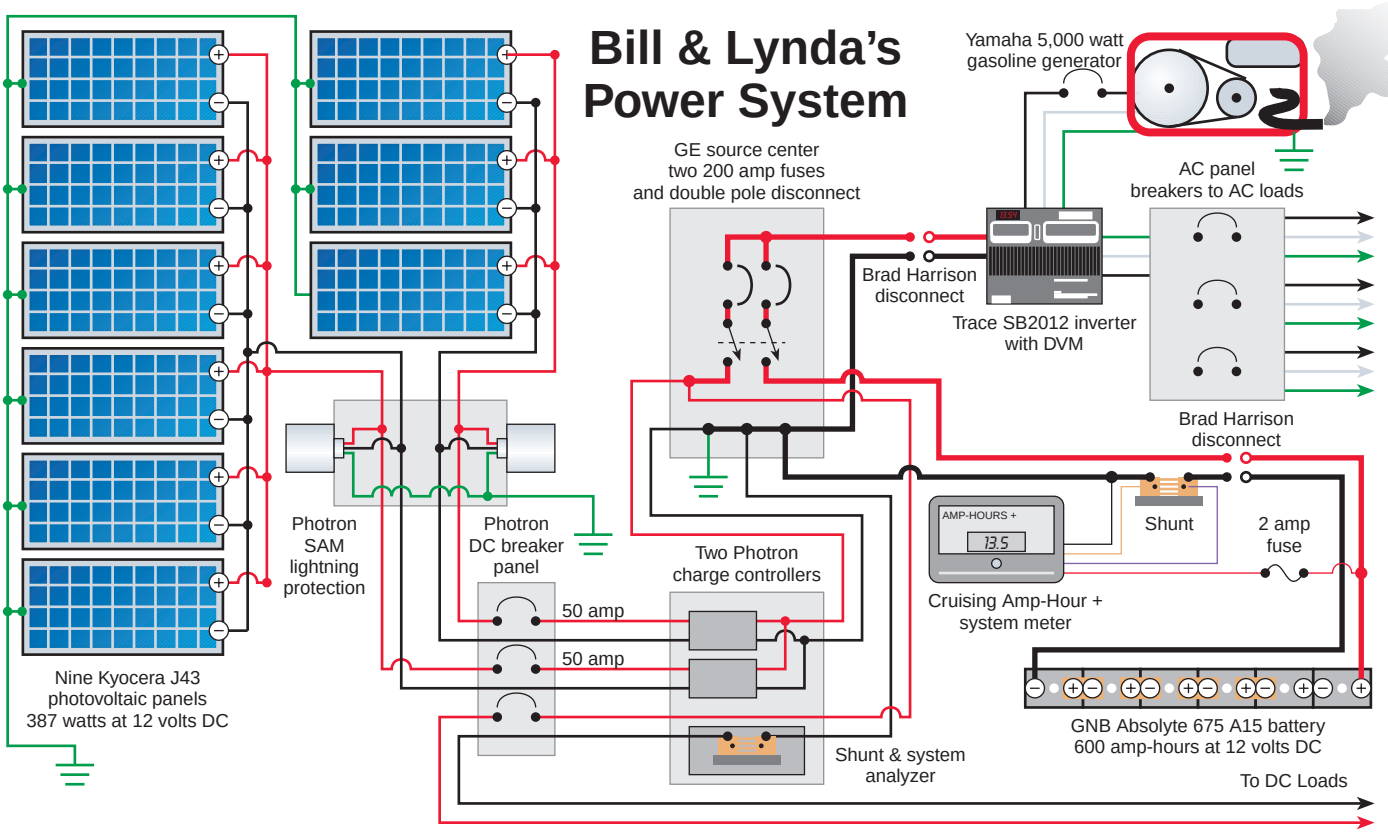
The Canadian division of GNB Batteries, Inc. recommends a maximum C/5 charge rate for their batteries. Trace recommends a rate of C/5 for non-sealed batteries and as high as C/3 for sealed batteries. Northern Alternate Power Systems recommends a maximum charge rate of C/10. We decided to split the difference and use a C/7 rate. Our GNB Absolyte battery has a 20 hour 630 amp-hour capacity. This results in an acceptable maximum charge rate of 90 amps (630 divided by 7 equals 90 amps).

Transformer based battery chargers, which are found in inverter/charger combinations, need 164 peak volts to operate at full capacity. So the 120 amp charger in the Trace SB2012 inverter we chose dictated the size of power plant we needed. Power plants which can put out about 6,000 watts will generally deliver the necessary 164 peak volts. Since we only needed a maximum 90 amp charge rate, a somewhat smaller power plant would work for us. The used 5,000 watt gas fueled Yamaha unit we found easily handles a 90 amp charge rate.

Charge Controllers

As ambient temperature drops, a battery requires a higher charge voltage to allow for full recharging. Typically, this increase in required charge voltage is 3 millivolts (0.003 volt) per cell per degree Fahrenheit drop from 77° F (25° C). Wow! Our battery was to be left at lows of -40° F (-40° C), a drop of 117° F! To recharge our battery properly, we needed to increase our charge voltage by 117 times 0.003 equals 0.0351 volts per cell (2.106 volts for a nominal 12 volt battery). Obviously any charge controller for a northern system should be temperature compensated.

The high rates of charge required at low temperatures often take a battery beyond gassing voltage. To deal with this potential problem, we split our solar array into a six panel and a three panel subarray. We often leave our home unheated for an extended period of time when ambient temperatures are low. Before leaving, we make sure that our battery is fully charged with the



generator and charger while the battery is still warm. We then turn off the six panel subarray and leave the three panel subarray on. Even at the elevated temperature compensation charging rates, it is incapable of getting the battery charge above 15 volts, so there is no significant gassing.

Battery Energy Use

Our primary electrical energy uses are lighting, two computers, radio, radio telephone, TV and VCR, and a water pressure system. Used less often are a myriad of household gadgets—microwave, toaster, waffle iron, soldering iron, and vacuum cleaner. I also have a variety of 117 volt construction power tools—miter saw, jig saw, table saw, belt sander, circular saw, drill, etc. These tools were used to build our guest cabin, a power plant shed, and a utility shed, all powered by the sun!

Our electrical usage varies from season to season. Summer daylight hours are long and we rarely need to use any lighting. We also find little interest in inside activities when the fish are biting! However, in the fall and winter, we spend a lot more time inside. This time of year, our energy use skyrockets—just when we have the worst chance of generating any solar power! The best advice for anyone designing for northern Canada is to prepare for the worst case season. The figures in Table 1 detail our average fall and winter daily energy use, for our main cabin.

Table 1: Daily Energy Use (Main Cabin Only)

Item	*Watts*	*Hours Per Day*	*Watt-Hrs Per Day*
50 watt halogen light	50	3	150.0
2 Littlites	7	4	28.0
Thin-Lite 50 watt light	15	2	30.0
Radio	10	6	60.0
Motorola radio phone	8	2	16.0
TV and VCR	115	1.5	172.5
IBM notebook computer	35	1.5	52.5
Macintosh computer	50	1.5	75.0
Shurflo pump	100	0.25	25.0

System inefficiency (15%)	91.4
Total watt-hours	700.4
Total amp-hours (700.4 WH ÷ 12 volts)	58.4

System Design

Armed with the basic information detailed above, I packed my checkbook and a toothbrush and headed over to Colinton, Alberta to see Ron LaPlace of Photron Canada. We decided on nine Kyocera J43 panels (2.89 amps at 14.8 volts at maximum power point) configured in six panel and three panel subarrays, a Photron Universal Power Enclosure (UPE), a fused General Electric 200 amp source center (with a spring loaded double pole safety disconnect switch), and a Trace SB2012 inverter. The UPE included a six-channel user

configurable electronic DC voltage setpoint controller (UPC-6), a blocking diode, two shunts, temperature compensation sensor, and a system analyzer (which measures DC amps in, DC amps out, output circuit setpoints, and battery voltage). The UPC-6 is a neat piece of equipment! It can measure up to three different DC voltages as inputs and actuate up to six different 2 amp relays as corresponding outputs. Each of the six output circuits is fully adjustable which allows the user to configure a multi-function custom control. I set up our UP-6 to control each of our subarrays independently and to alert us to both low and high battery voltage. This still leaves us with two output circuits for future expansion.

I also acquired a used 5,000 watt Yamaha gas power plant, a Cruising Equipment Amp-Hour + meter and a Trace Digital Volt Meter (DVM) for the inverter. The latter two are excellent diagnostic tools—I really don't know how we could accurately analyze our system's performance without them. The Amp-Hour + meter tells us all we need to know about our battery, and then some. Before installing it, we did a lot of guessing. With a $2,100 battery hanging in the balance, the Amp-Hour + meter is well worth every penny it cost. The Trace DVM allows us to monitor power plant Hz, peak volts in, charge rate, and battery voltage—all very valuable information.

Battery Capacity Testing

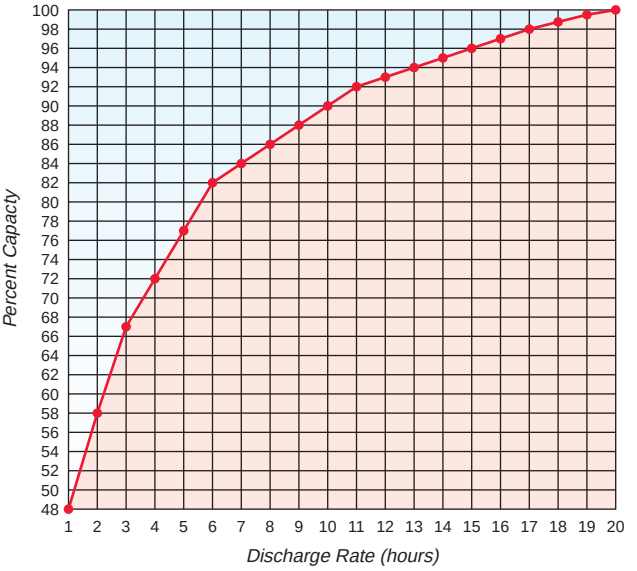
GNB recommends starting your test with the battery at full charge and after a minimum of seventy-two hours at a float voltage charge (13.50 to 13.68 for my battery, 13.2 for a flooded lead acid battery). The testing should be done as close as possible to the standard temperature of 25° C (77° F). This is the temperature at which the declared battery capacities are calculated. Obviously, few of us have our houses at 77°. If you do your test at 70°, it will be close enough (at 70° F your battery starts with about 99% of it's capacity). At 60°, however, your battery will only start with about 94% of its capacity, so don't do your test at this low of a temperature. Use the 20 hour rate for your test. For my battery, this is 630 amp-hours divided by 20, which gives a 31.5 amp discharge rate.

Of course you have to turn off your charging sources to do the testing. A resistive load such as an incandescent light or a toaster is the best to use as it is a constant load. An old toaster from the junk store can be easily set up to generate a variable load. Simply cut one side of the wire that leads into the toaster and attach a one foot piece of equivalent size wire to the live side. Now attach an alligator clip to the other end of this new wire. Take the body off the toaster and clip the alligator clip to the toasting coil inside. Plug the toaster in and check the amp draw on your multimeter or Cruising Meter. If the reading is too high or too low, unplug the toaster and move the alligator clip.

Once you find the location on the coil that gives you a current draw equal to the 20 hour rate for your battery, you can start your test. Plug in the toaster and monitor the battery voltage. The test stops when your battery voltage hits 10.5 volts. If your battery voltage drops to 10.5 volts 20 hours after you started your test, your battery has 100 percent capacity. Congratulations—you have treated it lovingly and it is rewarding you with a long and dedicated life. If the 10.5 voltage is achieved prior to 20 hours, the following graph and some simple math will allow you to calculate the battery's capacity.

In my case, if the 10.5 volt level is achieved in 16 hours, here's the math: The Amp-Hour + meter or multimeter will read 504 amp-hours (31.5 amp test load times 16 hour test duration). Dividing this capacity by the 16 hour percent capacity from the graph below, reveals that the true 20 hour rate capacity in amp-hours of my battery is 520 (my test capacity of 504 divided by 0.97 equals 520). If you want to confirm your data, recharge the battery and do the test over with the new 20 hour discharge amperage of 26 amps (newly calculated battery capacity of 520 amp-hours divided by 20 hours). This test capacity should see your battery drop to 10.5 volts in 20 hours if it is correct.

Capacity vs Discharge Rate (GNB 6-75A15 Battery)



Given the site-specific requirements for our battery, we decided on a GNB 6-75A15 Absolyte sealed battery (630 amp-hours at a 20 hour rate). Although considerably more expensive than an equivalent lead acid battery, the Absolyte battery offers several advantages for the frozen North. It is highly tolerant of freezing temperatures, does not gas during normal charging, requires no watering or equalization charging, has a lower self-discharge rate than lead acid batteries, and exhibits better performance characteristics in low temperatures. On the down side, you can't check specific gravity and if you gas the battery by overcharging it, you can't add water.

Above: Bill and Lynda, in front of their remote lakefront retreat.

The Absolyte battery is often used in remote non-maintained sites. Sunelco and Soltek both recommend this battery for installations such as ours. GNB claims up to 1,200 cycles at an 80% depth of discharge for this battery. However, to be on the safe side, we try not to discharge our battery more than 40 to 45% (59 amp-hours daily usage times 5 days without sun divided by the 630 amp-hour battery capacity equals 47%). Our battery is seven years old now, and seems to be performing as it was when it was new. Without the ability to do specific gravity tests with a hydrometer, the Amp-Hour + meter is critical for checking the performance of our battery. I plan to do a direct capacity test on the battery next summer to see precisely how it is holding out. The Cruising Equipment manual has a great section on doing capacity tests. In case you haven't seen it, and because so many people ask me how to do a battery capacity test, I include a brief overview on page 58.

Who the Heck is Rube Goldberg, Anyway?

The best general information I got from Ron LaPlace at Photron was to over-design the system to allow for future expansion and to "Do it right!" When presented with the initial cost of a total alternate energy system, many opt to cut corners and to undersize and "jury rig" the system. This is false economy and will cost you dearly when you find you want to expand your system in later years. I know I was initially inclined to cut corners and undersize our system when I was adding up the cost of my solar experiment. Take my advice—Don't!

Cutting corners is not only dangerous, but it often results in a real "Rube Goldberg" contraption which will fail, or at the very least, drive you crazy. I have seen too many systems with automotive voltage regulators, multiple connections to the battery bank making it look like an octopus, and panel interconnects made with solid core 14 gauge interior wire. I even saw a set of lead acid batteries installed right under a propane fired Paloma water heater one time. Holy Imminent Explosion, Batman! Trust me, *don't* do any of the above, or at least buy insurance policies for your loved ones if you insist.

Even low voltage DC electricity can be fatal if mishandled. If you don't believe me, go out and dead short the positive and negative terminals on your car battery with a crescent wrench. Congratulations, you have just discovered Ohms law and learned how to weld at the same time. Here's what happened: your wrench created a connection between the battery terminals with almost *zero* resistance (infinite conductance). Zero resistance results in almost *infinite instantaneous* amps. Infinite is a big number. Look out at space if you don't believe me. This is why your wrench is welded to your battery terminals. Your battery is probably wrecked. Don't blame me. Phone George Ohm's relatives—it's his law.

Other Energy Use

We pump water with a 1/2 hp 117 volt submersible Jacuzzi pump. Water is stored inside the house in two fiberglass holding tanks and fed into a 12 volt pressure system. Our storage tanks hold 180 gallons, and we need to refill them every three weeks. We use the power plant to run the pump, and at the same time, we use the charger on the Trace inverter to boost the battery bank.

Electrical System Costs
(1990 Canadian Dollars)

New

Qty.	*Item*	*Cost*	*%*
9	Kyocera J43 panels	$2,800	23.2%
1	Photron power enclosure	$1,200	9.9%
1	Photron six-panel mount	$300	2.5%
1	Photron three-panel mount	$150	1.2%
1	DC load center	$150	1.2%
10	DC breakers	$150	1.2%
1	GE 200 amp source center	$475	3.9%
1	Photron lightning arrestor	$125	1.0%
1	Trace SB2012 inverter	$1,600	13.2%
1	Trace DVM	$160	1.3%
1	Absolyte 675A15 sealed battery	$2,300	19.0%
1	Cruising Amp Hour + meter	$350	2.9%
2	Brad Harrison disconnects	$80	0.7%
3	Littlites	$120	1.0%
2	50 watt halogen bulbs	$50	0.4%
2	15 watt under-shelf Thin-Lites	$100	0.8%
2	20 watt Circline Thin-Lites	$100	0.8%
	50 ft. 10/2 UV direct burial wire	$75	0.6%
	20 ft. 2/0 multi-strand wire	$100	0.8%
	Misc. ground rods, clamps, nuts and bolts, plugs, etc.	$200	1.7%

Used

Qty.	*Item*	*Cost*	*%*
1	Yamaha 5000 watt power plant	$1,500	12.4%
	400 ft. 2 gauge copper wire	Free	0.0%
	1000 ft. 10/3 Teck wire	Free	0.0%
10	Waterproof junction boxes	Free	0.0%
2	AC panels and breakers	$10	0.1%

Total cost (1990 Canadian $)	$12,095
Total cost (converted to 1990 U.S. $)	$9,071.25

Propane plays a large part in our life at Bob Lake. Water is heated by an on-demand Paloma PH5 heater, and refrigeration is provided by a Sibir fridge and a Frostek freezer. All of these products have served us well and come highly recommended. We cook on a nameless propane stove we found at a garage sale for $50.

Boys and Their Toys
Everything in our system is working perfectly, but there is so much neat new stuff out there to buy. Following the dictates of my male genes, I have to keep adding to our system. In the long term, we would love to get a Sunfrost fridge, and I am interested in building a freezer from a Nova-Kool compressor kit. We are looking at the new generation of charge controllers now available. The Trace C12 is a great example of a charge controller with three stage charging, pulse width modulation, and adjustable float voltage setting. Our present Photron charge controllers use electromagnetic relays. Although they have served us without any problems, the points in these relays can wear out and burn. They also deliver only a simple *On* or *Off* charging regime.

I plan to add a Trace C12 in line with, and in front of, our present three-panel Photron charge controller. Why not just replace the three-panel controller? I am a paranoid sort and am constantly convinced that we are going to fly in to Bob Lake only to find our battery "fried" and a failed charge controller laughing at me. I plan to set the maximum charge voltage on the C12 controller slightly below the Photron three-panel controller. If the Trace unit fails, the Photron unit will still be in line and ready to go. The six-panel Photron charge controller will, of course, be manually turned off each time we leave Bob Lake. This may be overkill, but if it lets me sleep at night, what's the harm? Besides, I am a boy and I get to buy another toy. I would also love to buy a Fluke 87 multimeter. Then I could take measurements all over our system and drive Lynda crazy with all my new found data!

True Scavengers Keep Their Eyes Open
I got lucky when I got a summer contract involving monitoring of waste water flows at an abandoned gold mine site in the area. There was lots of wire and other great stuff lying around in the bush. My employer was more than happy to let me retrieve the wire as they were going to have to pay to remove it. I got 1000 feet of 10 gauge three conductor Teck wire (an almost indestructible, conduit-covered cable which can safely be laid directly on the ground) worth $4 per foot. I also got $250 worth of waterproof junction boxes and all kinds of other great stuff! It was just what I needed to transfer AC power to our shed, guest cabin, and Jacuzzi water pump. I got my AC panels (one for the main home and one for the guest cabin) complete with breakers at a yard sale for $5 each. My shower and all of the plumbing came from an abandoned mining exploration camp. I traded a $100 metal snowmobile sled to a mining drilling company for my Paloma water heater (they needed bigger ones). Keep your eyes open, particularly around industrial sites and companies.

Eureka, It Lives!
Thinking of the little train story of my childhood, I kept chanting the phrase "I think I can, I think I can, I think I can." Somehow, I muddled my way through the

installation. When I finally pulled the switch on the source center, it all worked! I couldn't believe it. There must be a solar god who looks after electrical Luddites! With chest swelled and still not believing I had done it, I told Lynda I knew all along it would work.

Seven years later, our system is still working just fine. Our guests are impressed as all get out with the things you can do with the sun's help!

If there is any message in this article, it is two-fold. Solar is a wonderful way to power a remote northern home. If I can do it, you can do it. Now, get off your butt and shut off your power plant, folks! As I now like to say, "If it ain't solar, it ain't jack squat!"

Access

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- Tracks power you produced and used, battery condition, and battery life based on present load.
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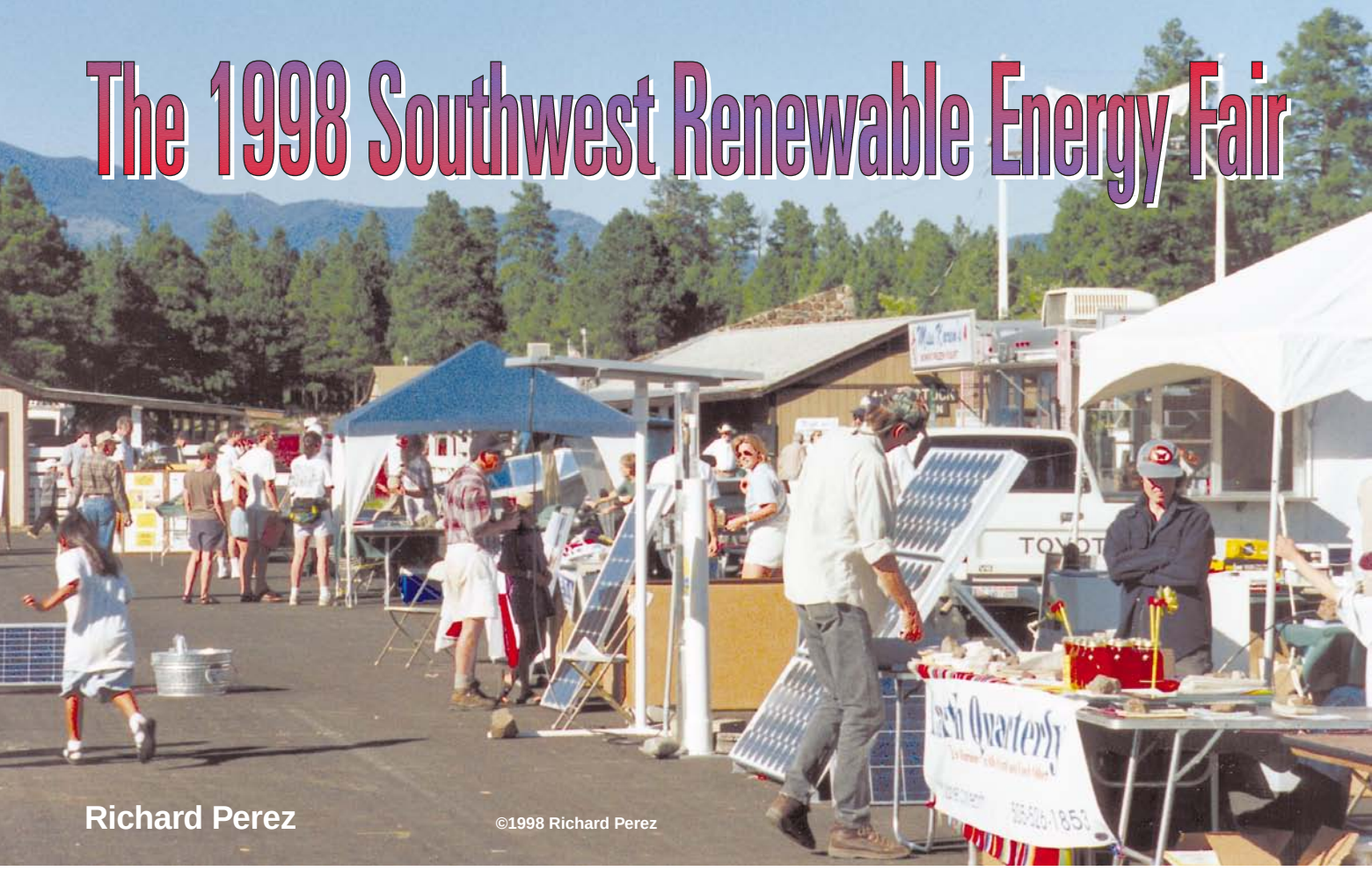
The 1998 Southwest Renewable Energy Fair



Above: The Southwest Renewable Energy Fair—first year and in full swing.

On September 19th and 20th, 1998, thousands of renewable energy folks gathered in Flagstaff, Arizona for the first annual Southwest Renewable Energy Fair.

Energy Fairs Everywhere!

1998 may become known as the "Year of the Energy Fair." Energy fairs were once rare events, happening only occasionally and only in special places. This past year, the concept seems to have sparked imaginations everywhere. There were more energy fairs this year than in the last five years combined. Folks are becoming increasingly interested in clean, dependable, and sustainable energy sources. While Energy Fairs were once the province of the "granola crowd," everyone now seems to find them interesting. These fairs are popping up everywhere.

Getting a fair off the ground for the first year is an immense job. The folks in Flagstaff had a leg up on the process because of the tremendous support they received from their local business community. Just as locally produced renewable energy is good for local economies, so are renewable energy fairs. Thousands of folks from all over came to Flagstaff for this fair, making motel rooms a scarce commodity. We met people from as far away as Washington, Maine, and Hawaii.

Karen, Don Kulha, and I represented *Home Power* at the fair. We met hundreds of long-time *Home Power* readers for the first time. This is the highlight of every fair for us—meeting RE users and discussing their problems and successes. The Flagstaff area is a hotbed of renewable energy activity because there is so much desirable off-grid property in the vicinity.

Below: Moppets learn about solar.

Featured Speakers

The Southwest Renewable Energy Fair (SREF) organizers arranged for some very interesting speakers. I was part of a panel discussion with Christy Herig of National Renewable Energy Laboratories (NREL), Anthony Gibson from the White House Office of Science and Technology, Daniel Aiello of the Arizona Solar Energy Advisory Council, and Amanda Ormond from the Arizona Department of Commerce. The topic was *Legislative Policy: Opportunities and Barriers in the Future of Renewables*. We discussed President Clinton's Million Solar Roofs program and how it could promote the use of RE.

In my opinion, the star speaker at SREF was Alan Weisman. Weisman is the author of the book *Gaviotas.* His presentation was a fascinating description of the self-sufficient eco-village in Colombia. His experiences are totally inspiring! In spite of a cranky slide projector, Alan held the attention of all who attended his lecture. I was so enthused with his presentation that I've reviewed his book in this issue of *Home Power* (see page 102).

Workshops

I consider workshops to be the lifeblood of any energy fair—that's where the real action is. The folks who organized this fair really did a wonderful job of securing great workshop speakers. There were experts in just about every aspect of renewable energy and they were ready to share their knowledge with all. There was something for everyone—PV, wind power, passive solar, electric vehicles, financing RE systems, alternative building materials, solar cooking, water heating, water pumping—the list went on and on! While I was able to attend only a few of these workshops, the ones I did attend made me realize how much more there was to learn.

Industry Booths

SREF had tremendous industry attendance for a first-year fair. Most companies who are players in the RE business scene were there, and there were a few new ones to boot. Industry biggies such as Golden Genesis, Siemens, Southwest Windpower, Trace Engineering, and UniSolar were there displaying their products. Smaller grassroots solar businesses were also on hand—AAA Solar, Backwoods Solar, Dankoff Solar Products, ETA Engineering, NativeSUN Hopi Solar Electric, Northern Arizona Wind and Sun, RV Solar, and many others.

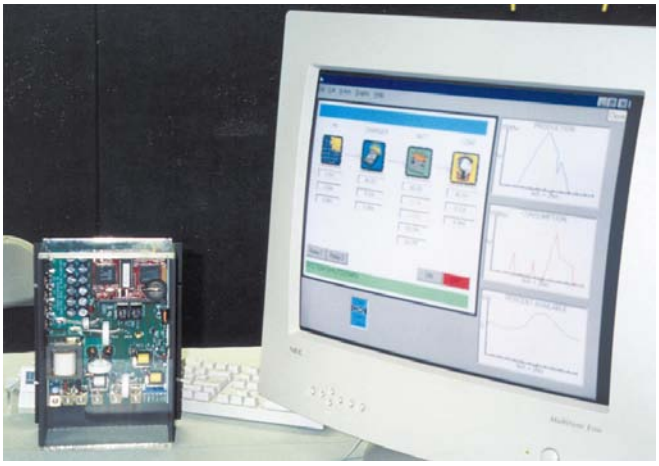
Above: Windy Dankoff "pumps-it-up" with a solar-powered SunRise deep well pump.

What really surprised me was the booth participation from several large megacorps such as General Motors and Honda. GM not only displayed their electric car, the EV1, but also offered financing of RE systems through their GMAC Mortgage Corporation. When megacorps such as GM show up for an event like this, you really have to believe that RE has finally arrived!

New Products

Every energy fair is an opportunity for manufacturers to display new products. There were many of these at SWEF, but one in particular attracted my attention. FireWind&Rain, a Flagstaff company, was displaying their new product—a maximum power point tracker (MPPT) for PV systems. The MPPT constantly adjusts the PV array voltage to maximize current output from the array.

Below: The only thing traditional is the color on GM's EV1.



Above: FireWind&Rain's MPPT / charge controller.

PV users have been waiting for a product like this. Bill Schlanger, president of FireWind&Rain, demonstrated the MPPT for me. I actually saw three series-connected PV modules deliver more current into a 48 VDC battery than four series-connected PV modules. All of the modules were identical Siemens SP75s (75 Watts), in full sun on a cool windy day. The only difference between the two PV strings was that the three module string was being electronically processed by FireWind&Rain's new MPPT product—the "Power Advantage 30"—while the four module string was being processed by a conventional, major brand PV regulator.

FireWind&Rain claims a 25% increase in power from PVs using their unit, and based on the live test I witnessed, this claim seems to be true. What PV owners would not want a 25% power increase from their modules? The Power Advantage 30 also functions as a PV regulator and data logger. It works in either 24 VDC or 48 VDC PV systems, and can handle up to 30 Amps of current. All of the data logging and control features can be easily accessed via any PC (which is not required to operate the unit as an MPPT/regulator). The unit has a 45 day nonvolatile memory which logs PV power production, system energy consumption, battery utilization, and temperature. The Power Advantage 30 automatically adjusts the PVs to obtain maximum power regardless of PV temperature or battery state of charge. This is a very slick, and well-developed new product that will soon find its way into many PV systems. It improves PV performance, and with a retail price of $699 it makes financial sense. Although I haven't tested it personally or seen it in long-term use, it's a promising product.

Below: Southwest Windpower's new AIR 403.

Southwest Windpower also had a new product on display. They were flying their new AIR 403 wind turbines. Since their booth was right next to ours, we had a great time visiting with them and discussing all the changes they have made in their turbines. We were so impressed that we decided to visit their Flagstaff factory after the fair.

A Tour of Southwest Windpower

It's not often that you find a cutting edge company with a totally self-made product. Finding such a company built and staffed by RE maniacs is even harder. Southwest Windpower is both. Their factory is a study in doing the most excellent job possible with appropriate and self-built tools. We took the factory tour with Steve and Elizabeth Willey of Backwoods Solar. Southwest Windpower founders David Calley and Andy Kruse were kind enough to show us around and give us the straight scoop on their new AIR 403 turbine.

The AIR 403 is not a radical departure from their original best-selling AIR 303, but it has many engineering refinements which together produce a more powerful and reliable wind turbine. It has increased heat-sinking, an improved regulator, a better blade design and materials, better arced permanent magnets in the alternator, and better materials for the blade hub. There are closer tolerances everywhere, and many other improvements. You'd think that after making and selling over 18,000 of these turbines that Southwest Windpower would be content to stop making improvements and just crank them out—but this crew is committed to quality and reliability. They are continually making their wind gennys better.

I've visited more than a few factories making RE gear. Among other things, I judge a manufacturer by its employees. The dozens of folks making the AIRs were indeed happy workers—they were all obviously enjoying their work. The crew is very diverse—I saw all ages, races, and genders working side by side making these new AIRs. As David and Andy guided us from assembly station to assembly station, I saw workers

paying meticulous attention to every detail of the manufacturing process. I realized that Southwest Windpower is indeed a family—from the rock and roll blasting out of the factory's sound system to the mad rush when the burrito lady showed up, these folks move and act together.

Flagstaff

Karen and I had never been to Flagstaff, Arizona before. We were pleasantly surprised—it's a wonderful town. The 7,000 foot (2134 m) plus elevation gives great performance for all solar devices. The wind blew constantly while we were there—we even ran short of rocks to keep our magazines from blowing off the tables. The high piney woods made us feel at home, and the folks there are as wonderful as the physical location. We didn't run into a single sour-puss!

The folks that organized this energy fair are wonderful, warm folks who are looking to the future. Kudos to the Greater Flagstaff Economic Council for promoting and funding this fair. Special thanks to Kim Poirier, the Project Coordinator—she did a bang-up job!

If you missed the Southwest Renewable Energy Fair this year, then you missed something special. We'll see you there next year! If you want to see a video of this year's Southwest Renewable Energy Fair, then check out the Robwood Publishing ad in this issue.

Access

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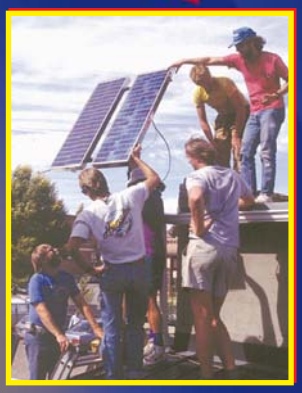

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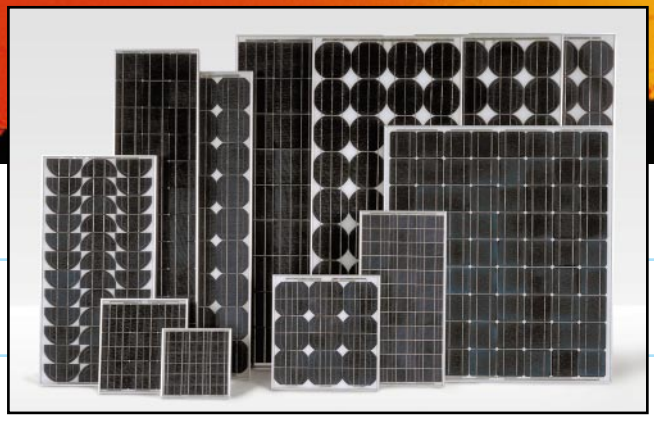

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Greenbacks for Green Wheels

Shari Prange

Whether you buy, lease, or convert an electric vehicle, it's probably going to cost you more than a comparable gas car would. It's a sad fact, but true—at least for now. All the money you will save on fuel and maintenance will help balance the scales in the long run, but the up-front cost can be tough to manage. And if you're doing a conversion, you can't get a conventional car loan, either.

So, how can you soften the bite? After all, EVs are clean and green. Surely, incentives and assistance are available.

Who's In Charge?

If you go in search of information on EV incentives, you will quickly find yourself mired in an unmapped swamp of verbiage that is both dense and vague. The problem is that there is no effective central clearinghouse for current information.

Incentives are offered at all levels of government, from federal to city, and there is little coordination among any of them. There are also non-governmental incentives, which are primarily from utilities.

While a few organizations attempt to publish information on these incentives, they are tackling an impossibly large job. All of this data was written by bureaucrats, and any of it is subject to change without notice. These lists tend to be incomplete, difficult to read and understand, and riddled with obsolete entries. Most incentives are aimed at fleets and commercial users, and many are written for natural gas or other alternative fuels. These won't do John or Jane Q. Evdriver any good. How do you separate the gold from the dross?

Search For Buried Treasure

Don't despair—you don't really need to know about *all* of the incentives offered throughout the whole country. You only need to know about the ones that apply to you. With a little investigation, you can track these down.

In this article, we will outline the places you should research, and the general kinds of incentives you might find there. We'll move from the largest jurisdictions to the smallest. Like a treasure map, this outline alone won't take you straight to the gold, but if you follow the directions it will lead you there eventually.

Read The Fine Print

This might be a good time to define a couple of terms that will come up repeatedly. One is "tax credit," which is better than a "deduction." A deduction is subtracted from the base number before tax is calculated. The base number is usually the amount of your income. For some kinds of incentives, it might be some other number, such as the assessed value of the vehicle. A credit, on the other hand, is subtracted after the tax is calculated. For example, a $1,000 income tax deduction reduces your taxable income. A $1,000 income tax credit reduces the actual tax you pay.

Another term is “incremental cost.” In other words, how much more did the EV cost than a comparable internal combustion vehicle? If you are buying or leasing a vehicle, it might be the difference between a gas Ford Ranger and an electric one. If you are doing a conversion, it would be the cost of the conversion process. Many incentives are defined as a percentage of the incremental cost of the EV.

You should also know that many incentives are one-time only, and must be taken in the year in which the car was placed in service as an electric. Sometimes, if you cannot use up the entire tax credit in one year, you can carry it over to the next year.

Federal Incentives

The good news is that the IRS offers a tax credit for electric vehicles. The bad news is that it applies to purchases but not to conversions. The credit is good for 10% of the cost of the vehicle, up to a maximum of $4,000, and is available to private individuals or businesses.

The law specifically states that the vehicle must never have been in service previously. Some people have taken the position, “Well, it was never in service as an *electric* before.” If you’re lucky and no one looks too closely at your return, maybe you’ll get away with it. But this is not how the IRS interprets the text, and they do not take kindly to creative interpretations of their regulations. Do yourself a favor, and don’t take the chance.

There is a different federal tax break for conversions, but it’s not as generous. It allows a business or individual to take a tax deduction (not a credit) of up to $2,000 for the cost of the conversion.

State Incentives

Not all states have incentives. Some, like California and Arizona, are more progressive than others. The place to start is at your state’s energy office. The exact title may vary—it may be listed as the Energy Commission, Energy Office, or Department of Energy. It might be inside another department, such as the Department of Commerce.

You might also try the Environmental Protection Department, or even Bureau of Air. Look for an agency involved with energy, air quality, pollution control, or the environment. Your local reference librarian, or your state government’s web site on the internet should be able to help you track this down.

State incentives might include income tax breaks, sales tax exemptions, or even grants. For example, the state of Georgia offers a $1,500 tax credit for the purchase, lease, or conversion of an electric vehicle. Illinois offers a cash rebate of 80% of the incremental cost of a new vehicle or a conversion, up to $4,000. In West Virginia, it’s a $3,750 tax credit, but in Utah, it’s only a $400 tax credit. In Oklahoma, the tax credit is good for 10% of the cost of purchase, or 50% of the cost of conversion.

Grants may apply to a portion of the cost of the vehicle or conversion, or to the cost of installing charging facilities. Pennsylvania offers Alternative Fuel Incentive Grants of 30% of the cost of conversion through the Pennsylvania Department of Environmental Protection.

Another area to explore at the state level is the Motor Vehicle Department. Incentives here include reduced registration fees and, of course, exemption from emissions inspections. Some states, such as Arizona, offer special license plates or stickers that allow electric vehicles to travel in High Occupancy Vehicle (HOV) lanes with a single person in them. Virginia offers free license plates.

(For those fortunate readers who live rurally and have not encountered them, HOV lanes are also known as “carpool” lanes. They are found on crowded multilane highways in urban areas, and are usually marked by some symbol, such as a diamond. During busy commute hours, it is illegal to use these fast lanes with fewer than two or three persons in the car, and fines are steep.)

County & City Incentives

At the local level, you may find a variety of possible incentives, but they are usually not large cash items. Instead, you may find free parking and exemption from bridge tolls.

One source of information is the Clean Cities Program. This is a classic example of “Think Globally, Act Locally.” It is a national project of the Department of Energy that encourages cities to develop their own grassroots pollution programs by sharing the experiences of other cities. If your city is part of the network, it will have a Clean Cities Coordinator. This is the office to contact for information on local programs that might benefit you.

To find out if your city is part of this program, see the access section at the end of this article.

Utility Incentives

Utilities are the largest non-governmental bodies actively involved in offering EV incentives. The most common offering is a reduced electricity rate. This is usually tied to a time-of-use program that encourages shifting electrical usage to off-peak demand hours, especially nighttime. This is perfect for EV charging.

San Diego Gas & Electric, for example, offers a rate of $0.07/kWh between 6:00 PM and midnight, and a rate

of $0.04/kWh between midnight and 6:00 AM. The standard rate is $0.10/kWh. You do have to sign up for the special time-of-use program to get these rates.

Some utilities also offer assistance with installing charging facilities. In addition, the utility may install public charging facilities in various locations, and may offer the charging free of cost. These are usually designed for the charging connections of major manufacturers, such as GM, Ford, or Honda, and may not accommodate conversions.

Sacramento Municipal Utilities District, Southern California Edison, and Arizona Public Service are very active in promoting EV use.

Pollution Control Districts

Some urban areas have failed to meet federal and state air quality standards. These areas are put under the control of Air Quality Management Districts (AQMD), or Air Pollution Control Districts (APCD), or some agency with a similar title. These can be a source of information and financial assistance.

For example, in California, non-attainment areas are allowed to collect an additional fee of up to $4 per vehicle for all motor vehicle registrations in the area. This money is then used for pollution reduction projects. These could take the form of incentives for private car owners who switch to electric cars, or for business owners who convert parts of their fleets. The money could also fund electric car programs in the schools.

Five of these districts (Bay Area AQMD, Sacramento Municipal AQMD, San Diego APCD, Santa Barbara County APCD, and Ventura County APCD), in conjunction with the California Energy Commission (CEC), have a $5,000 "buy-down" for the purchase or lease of new electric cars. In the case of a leased car, the $5,000 is applied to the theoretical purchase price, which lowers the lease payments. The South Coast AQMD has a similar program of its own, not affiliated with the CEC.

Seek And Ye Shall Find

It seems kind of silly to offer all of these "incentives" for alternative fuels without publicizing them, doesn't it? If a fee falls and no one hears about it, does it make a difference?

No one will come knocking on your door to tell you about EV incentives. There is no magic directory that will tell you everything you need to know about them. But with a little intelligent effort, you can ferret them out. The payoff can make the effort quite worthwhile.

For more information about available electric vehicle incentives and contact information for doing your own research, check out our web page.

Access

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Things That Work

Tested by Home Power

Feather River's Genny DeeCee

Richard Perez

This machine is the answer to that inescapable RE question, "What are you going to do when the sun doesn't shine, the wind doesn't blow, and the creek runs dry?" The answer? Burn some dead dinosaurs. What really counts is using those irreplaceable fossil fuels wisely and efficiently. When it comes to putting energy back into your battery, no generator even comes close to the Genny DeeCee for efficiency.

What is a Genny DC?

The Genny DeeCee is a marriage between a high quality Honda overhead valve engine and a modern automotive-style alternator. Instead of making 117 VAC like most conventional generators, the Genny DeeCee makes low voltage DC—either 12 or 24 volts. This energy is then fed directly to the battery for recharging. There are no battery chargers or power supplies involved in this process.

Using the Genny DeeCee is much more efficient than running a conventional 117 VAC generator. With a 117 VAC gennny, the energy is converted through a battery charger or power supply and then it's fed to the battery. In systems with a big modern inverter, the 117 VAC generator is rarely needed to power loads. The major need is battery recharging during periods of low RE production—and that's just what the Genny DeeCee is designed to do.

Testing the Genny DeeCee at *Home Power*

We installed our Genny DeeCee during May of 1997, and we've been using it whenever we needed more energy than our solar and wind energy systems could provide. Since we are using it as a back-up power source, we have only put 306 hours on it during the last eighteen months.

Above: The Genny DeeCee model 100-12.

We placed the Genny DeeCee outside of the battery room, and wired it to the Ananda power panel with #6 copper cable. The Genny DeeCee comes complete with a great control box, which we mounted on an outside wall next to the Genny DeeCee. This control box houses an ammeter (0 to 150 amperes on the model we tested), a rheostat to control the current output of the alternator, and a nifty multipurpose engine instrument called a "Maintenance Meter." The control box also has a zero to six hour mechanical timer/switch which can shut the Genny DeeCee off if you're not around to do the job. The Maintenance Meter has an LCD display which indicates engine RPM, time until next engine service (in hours), and total hours on the engine.

Feather River Solar Electric makes a variety of sizes of Genny DeeCees and has many custom options. We are using model number 100-12 with the optional larger 3.4 gal (12.9 liter) fuel tank. It has a Honda 6.5 hp engine (model GX200) which displaces 196 cubic centimeters. This small and efficient engine has overhead valves, automatic low oil shut-off, electronic ignition, and a manual pull starter. The Genny DeeCee is 24 inches (70 cm) wide by 24 inches (70 cm) high by 20 inches (50.8 cm) deep.

The alternator used on this particular Genny DeeCee is a 100 ampere model. The alternator is coupled to the engine by a high quality Vee belt. The cast iron pulley

on the engine is six inches (15.2 cm) in diameter. Feather River designed and built a unique belt tensioning system which insures high-efficiency power transfer between the engine and the alternator. This belt tensioning system is spring-loaded and dynamic—there is very little belt wear and no belt adjustments are necessary.

Those of you who are long time *Home Power* readers will know that I've published homebrew articles on similar generators I have built myself. All in all, I've probably gotten 15,000 hours of use out of similar generator setups. Many years ago, I also built these units for sale to my neighbors. In comparison, the Genny DeeCee is far more advanced than anything I ever built. The welded steel cradle housing the unit is vibration isolated. The belt tensioning system is also a quality feature—it's far better than anything I've ever done or even seen done.

Using the Genny DeeCee

Fill up the gas tank, check the engine oil, pull the starter, and allow the engine to warm up. Gradually increase engine rpm and load the Genny DeeCee using the rheostat. When you get the current output you are looking for, just let the unit run until your battery is fully recharged. Genny DeeCee is very easy to operate.

I've been keeping my eye on gas consumption and energy replaced in the battery, using a Cruising E-Meter to measure ampere-hours of recharge. To compare the Genny DeeCee with our big 6.5 kW Honda 117 VAC generator, I have been using a variety of battery chargers. Here, we have three Todd 75 amp models, a Trace SW2512 with battery charger, and a Statpower ProSine 2500 inverter with charger. I find that the Genny DeeCee puts almost two times the number of ampere-hours back into the battery for each gallon of gas burned. Efficiency is Genny DeeCee's strong suit!

Since the Genny DeeCee is only current controlled, the user is advised to keep an eye on battery voltage and reduce the charge rate as the battery becomes fully recharged. The plus side of this type of current-only control system is that the Genny DeeCee is very effective for equalizing lead-acid batteries and also for recharging the higher voltage NiCd and NiFe batteries.

Maintenance is simple—just change the engine's oil every 100 hours. I haven't had to do anything else.

Options

Call Feather River Solar Electric for info on their many other Genny DeeCee models. They also make 24 VDC units with current outputs as high as 110 amperes. Other options currently include an LPG (propane) conversion for $345.00. Because this is a factory conversion to propane only, there is little to no power loss, and the genny is easy to start. Electric starters are available for $175.00 extra, though you'll only get 85 amps of output, since the electric start model uses a 5.5 hp engine. If it's not going to live in a generator shed, a belt/pulley guard is a good option for $88.50. Remote exhaust adapters are available for $14.70, and an optional larger 3.4 gal (12.9 liter) fuel tank costs $100.00. Lastly, the noise enclosure (which I wish our unit had), also acts as a generator shed. It includes a 3.0 gallon (11.4 liter) fuel tank, and goes for $535.00.

Who needs the Genny DeeCee?

Anyone who has an RE system who can use a back-up generator needs the Genny DeeCee. With a price tag of $1485.00 (for the model that we tested), the Genny DeeCee is the most cost-effective way to recharge your batteries using gasoline or propane as a fuel source. For this purpose, it's the most efficient engine generator I have ever used.

Access

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Renewable Energy Terms

Volt—Unit of electromotive force

Ian Woofenden

Derivation: Named after Alessandro Volta, the Italian physicist who first invented the battery. The volt received official recognition as the unit of electrical potential in 1881.

Voltage is an electrical concept that is frequently misunderstood. In simple terms, it is electrical "pressure," analogous to pressure in a garden hose or a bicycle tire. It is also called "potential" or "potential difference."

If I said I might drop a piano on you from my 34th floor apartment, you'd know that it would hurt more when it hit you than if I only dropped it from my cousin's apartment on the 5th floor. However, knowing what floor I'm on would not tell you whether I have a concert grand, a spinet, or my child's toy plastic piano ready to drop. And you wouldn't even be sure that I would indeed drop it, only that it's possible. Likewise, voltage in itself tells us nothing about the flow rate (current) or the total quantity of electricity (though it does have a relationship to them). Voltage is roughly analogous to how many floors up my piano is, compared to a piano sitting on the sidewalk below.

Voltage is not flow rate, and it is not volume. We can measure high voltage when there is very little electricity available, and low voltage when there is a virtually unlimited supply. A capacitor the size of your fingernail can be charged to a potential of ten thousand volts, but the current flow when you discharge it will be minuscule. We can measure high pressure in a bicycle tire, but there is relatively little air there. On the other hand, a huge tractor tire can have a lot of air in it, but it may be at a fairly low pressure.

Let's not say that a PV module "produces" 17 volts, since having voltage doesn't necessarily mean you have electricity flowing. When you put your multimeter leads on the terminals of the PV, you are only reading the *potential* difference between the two points. Voltage alone doesn't give you the whole picture, and should not be confused with current, power, or energy. Current, which is measured in amperes, will be the topic for next time.

Access

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Mike Brown

"When I got home from work tonight, I smelled smoke coming from the front of the EV. When I checked under the hood, I noticed that the controller was hot. Is my controller going bad?"

This time, the voice on the phone was one of our local customers. "Oh goody," I thought, "a customer with a real problem—and he's even local. I can do a hands-on diagnosis instead of a remote consultation, and I'll get to see the results myself." Sometimes an EV troubleshooter feels a little like the Maytag repairman—we get an occasional phone question, we make recommendations, and we often don't hear the final results. We don't get much chance to practice our craft at close range.

Checklist

I questioned my caller a little. How were the tires? A low tire would cause more drag on the motor, and therefore more current from the batteries through the controller. Speaking of current, what was the ammeter reading? Had he checked the rest of the things under the hood, like the battery cables, battery interconnects, and terminals? He didn't have any answers to those questions, so I told him to check those things and call me back.

The answers came in a call the next day. He had driven the EV down to the foot of his hill and back up, which was about a half mile at a 10% grade. The current was the same as usual. When he checked the controller temperature, it was only warm to the touch, but he had not driven as far as he had the day before. There wasn't any smoke or burning smell this time, either. The tires were fine.

Meltdown

How were the battery interconnects and cables? He hadn't checked those—what could go wrong with those, anyway? He was sure something was wrong with the controller. I told him to go check them just to humor me and call back. He called back a few minutes later with the news that one of the terminals with a copper interconnect had melted. Instead of being connected with a nut and bolt, the interconnect and what was left of the terminal seemed to be soldered together. How did that happen?

There is only one thing that generates enough heat to melt a battery terminal—a loose connection. Loose battery connections have plagued the EV world, both commercial and hobbyist, since the first EV hit the road. In fact, one manufacturer went so far as to solder all of the cable interconnects to the batteries to eliminate the loose connection problem. They didn't melt any terminals, but it made replacing a failed battery a messy job.

The Wrong Battery Terminal

Most of the meltdowns I have seen in the hobbyist world have come from the use of the "universal" battery terminal. The universal terminal is a regular tapered automotive terminal with a 5/16 inch (8 mm) stud cast vertically in its center. The flat surface on the top of the terminal around the stud gives less than half a square inch (323 mm^2) of contact surface. This terminal comes on 90% of the golf cart batteries that are used in hobbyist EVs.

Failures occur because the lead terminals are subject to "creep." Under sufficient pressure, lead will flow at room temperature. So let's say a copper lug is crimped to a heavy piece of 2/0 (85 mm^2) cable. Then it's fastened to the terminal over the stud, using the spring-lock washer and nut that comes with the battery. The installer is careful to tighten the connection firmly—we don't want any terminal failures here! Over time, the stud will gradually move upward in the lead post and relieve the tension, loosening the connection. Then the connection is warmed up by some prolonged 350 to 400 Amp draws. At least one terminal meltdown is inevitable, usually at the worst possible time and place.

If you are diligent, you keep checking your connections and tightening them again. Meanwhile, the studs keep creeping upward—until one day, one creeps completely out of the terminal post. Then you're back to a puddle of lead. The safest way to use this style of battery terminal is with an automotive-style clamp on the cable fastened around the terminal post, ignoring the stud. However, this clamp for 2/0 (85 mm^2) cable will cost about $5. Multiply this figure by 32 to 40 terminals, and it gets expensive in a hurry.

The Right Battery Terminal

I prefer the "L" battery terminal. It's shaped like the capital letter "L" with a hole in the center of the vertical leg. This is a piece of lead approximately one square inch (645 mm^2) by 5/16 inch (8 mm) thick. The cable lug (or in our case, an interconnect made of one inch (25 mm) wide by 1/16 inch (1.6 mm) thick copper strip) is fastened to the broad contact surface of the "L" terminal. The bolt and a flat washer are inserted through the inside of the "L" terminal, then through the lug or interconnect, a Belleville washer, and a nut.

The Belleville washer is a slightly concave precision tension washer that avoids the creep problem. It should be installed with the concave face toward the lug or interconnect. With this hardware firmly tightened, the connection is almost failure-proof. With that said, since this car's batteries had "L" terminals and the interconnect was a copper strap with the correct hardware, why did it melt?

Diagnosis & Repair

This was the easiest part of the problem. The EV was a little over 4 years old, and had worn out its first battery pack. A new pack had been ordered, and the owner had installed them. The connection that failed must not have been tightened enough when it was installed. The loose connection heated up and the terminal started to melt. Then the shrink tube insulation on the interconnect started to smoke just as he pulled into his driveway after climbing the hill. Because he shut the EV off before the terminal failed completely, the molten lead cooled off and soldered the interconnect to the remains of the terminal.

The battery distributor soldered on a new terminal. A new interconnect was also installed. All the rest of the connections were checked for tightness. What about the hot controller, you ask? The hill he climbs on his way home is similar to one I have on my way home, and my controller gets hot to the touch. He admitted that he had never paid any attention to how hot the controller got before the incident. This was, in fact, a normal temperature for those conditions—the controller was fine.

Again, the First Rule of Troubleshooting applies: Resist the urge to blame the most expensive and most mysterious part of the system until you have checked the cheap, easy parts.

Send me some more questions to write about, so I don't have to take up washing machine repair.

Access

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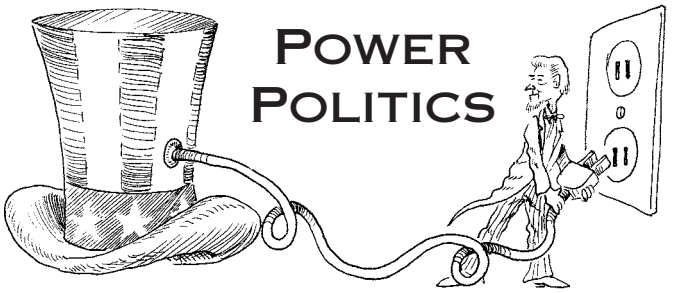

Report Blasts Green Electricity Companies

Michael Welch

I recently read a short piece in the business section of my local newspaper. It announced a new report about green energy marketing. The report is called *Green Buyers Beware—A Critical Review of "Green Electricity" Products.* It was written by seasoned consultant Nancy Rader, and commissioned by Public Citizen's Critical Mass Energy Project.

I have often reported on Public Citizen in this column. Out of all of the U.S. renewable energy organizations, Public Citizen is definitely the most respected and right-on. That's why I was very surprised and upset by the almost entirely negative viewpoint of this report.

Everyone even remotely interested in green grid electricity should read this report. I will post it on the *Home Power* web site in the download area. The executive summary and related press releases are available on the Public Citizen web site.

On the Edge of Comfortable

I have to admit that I have never been completely comfortable working with "green energy" corporations. For over a year, while reporting on and supporting certain programs, I have been walking the knife's edge, wondering how much good it is really doing. This extremely critical report has confirmed my concerns. But there is still enough to hold on to—to keep from falling off the wrong side of the knife edge. I still stand by the main principles of my, and Redwood Alliance's, recommendations—that any choice of a green energy provider absolutely must result in new RE sources being built. And Green Mountain Energy Resources (GMER) is still the only one doing that.

Wind for the Future

Rader complains heavily about GMER's Wind for the Future Program, claiming that it is deceptive to offer future RE sources and begin collecting money now. Sure, we all wish that we could have instant access to new RE sources, but the fact is that no company in its right mind will build these sources blindly. No start-up company has enough faith in the RE market to invest hard-to-come-by cash in new wind or solar farms on its own. And GMER is up front with the fact that the promised wind generators are future ones, hence the name, Wind for the Future.

Rader fears that Green Mountain and other companies will not follow through on their promises. Just one week before Rader's report was released, GMER celebrated the start of construction on two huge 700 kW wind machines. GMER has followed through on their promise, as I had expected. But Rader paints a dark picture of *all* RE suppliers, with one inexplicable exception.

Wake-Up Call

This report should serve as a wake-up call to the green energy industry. It outlines everything that is (and could be) wrong with green energy providers. It even complains about the things that *aren't* wrong with the industry.

The only semi-positive thing in the report relates to a particular green provider that purchases its power solely from independent power providers (companies not owned by utilities). One has to wonder about Rader's prejudices. Just because the energy comes from a non-utility provider, that alone does not make it better energy. The report appears designed to give this particular company a boost. This pseudo-recommendation bugs me enough to leave the company's name out of this column. We can't recommend them anyway, because using them will still not result in new RE sources being built.

I hope Rader's report will shake up the industry. Certainly, it is coming from the right group to do so. The report recommends that consumers watch out for themselves and demand their right to new green energy

sources and favorable policy. It reminds consumers that energy conservation and efficiency are still the best investments they can make. The report also calls for consumer protection agencies to police green marketing plans.

My Recommendations

In spite of the negative tone of her report, I think Rader's recommendations are excellent. GMER has proven to be an open organization. They have been willing to listen to California's grass roots activists and RE customers, and their programs have changed accordingly. But Rader even managed to find fault with GMER's flexibility and openness. For example, she chides GMER for raising the number of sign-ups it takes to trigger building a new wind machine from 3000 to 4000 new Wind For the Future customers. She failed to mention a mitigating factor. Instead of the mid-sized wind generators originally planned by GMER, state of the art 700 kW machines will be installed. There was no net loss in the watt to customer ratio, even though the required number of sign-ups increased.

My recommendations for GMER and other non-utility providers take a slightly different angle. They are currently spending most of their capital on marketing and advertising. Instead, I want them to spend their money on production facilities. Think of it—rather than just brokering power with a sideline in windmills, they could be investing their millions directly in the installation of their own wind machines. They could even contract with municipal landfills to cap them for their methane, and run big generators with the gas. That would mean less money for the marketing departments and more funds for RE.

I think this is the future for companies interested in selling RE directly to consumers. As the Rader report points out, there is a lot wrong with the industry and where it buys power. The answer lies in companies making their own power, getting good press about it, and then selling it to the customers who should be lining up to get the good stuff.

From the Front Line

I usually don't publish letters with my column, but this one is a great success story that I think you'll enjoy and find inspiring. Yes, small groups of people can still make a difference in their communities.

Dear Home Power,

Here is a story that you may find hard to believe. It tells about the unintended consequences of the Public Utility Regulatory Act of 1978 (PURPA) that supposedly allows us RE types to sell power back to the grid.

Before my wife and I had even moved into our home on the Cumberland Plateau in eastern Tennessee, we heard some disconcerting news. We were building a remote home and planning a solar/hydro system to run it. I was in the process of installing the components—six 75 Watt panels, a Trace 4024 and C40, a Trimetric meter, and six recycled 8 Volt railroad engine batteries. We have a magnificent western viewscape across the plateau and into the sunset. The bad news was that someone was planning a monster set of high voltage transmission lines right across our view.

The Tennessee Valley Authority (TVA) is the grid in these parts and they are all-powerful, pun intended. They have booted land owners off their own land over the years to build power plants of various kinds, including nuclear. They have run up a debt of over 25 billion dollars to finance these white elephants that they can't even finish. That is a whole 'nother story. They also string power lines wherever they want them.

But, TVA was not going to put up those wires. We were disturbed enough to want some answers, so we attended a meeting of a group of concerned citizens. What we learned that night and during other meetings made political activists out of a bunch of laid back country folk.

To start from the beginning, there was a small company in Pennsylvania owned by a man named Armstrong. This company had diverse interests in such things as cable TV and other operations unrelated to power production. But Mr. Armstrong had a fascination with the concept of pumped storage hydroelectric plants—pumping water uphill at night when power is cheap and then running it back down to generate power during peak daytime to sell at a net gain in price. Sounds good in theory.

Armstrong wanted to leave his mark. He wanted a monument. A man named Richard Hunt entered the picture and Armstrong Energy Resources was created and funded with $5 million. Hunt identified a site in the Sequatchie Valley of Tennessee as the best spot to build the proposed plant. The Sequatchie is a magnificent rift in the Cumberland Plateau. It is 140 miles (225 km) long, four miles (6 km) wide, and 1500 feet (457 m) deep. It has some of what you need for a pumped storage facility. You need elevation, water, and access to the grid. Many years ago TVA did studies in the area and identified numerous sites for possible development. They eventually built the Raccoon Mountain facility at Chattanooga. Then they got financially strapped due to their nuclear fiasco. Richard Hunt knew about the studies, and he picked the site he wanted.

One day Hunt arrived in our area and started courting the local county governments of Sequatchie and Bledsoe. He sold them on the idea of a $4 billion

project that would bring jobs and development to these rural counties. They signed on big time! They endorsed the project without even the slightest doubt about what a project like this would do to the quality of life out here.

There were actually two facilities planned—one on each side of the valley. Four reservoirs would be built, two on top of the plateau and two in the valley. Water from the Sequatchie River would be diverted via four foot pipes to fill and replenish the reservoirs. Transmission lines would be built to provide power for pumping and to carry the regenerated energy in peak periods.

Our group, which was then calling itself SOS for Save Our Sequatchie, was not happy. We gathered all of the information we could. We ran the numbers. We called and wrote every politician and bureaucrat from Al Gore on down. We went to TVA board meetings. We felt that the whole project was a scam on the part of Armstrong and would never work. But we would end up with our lives and environment damaged beyond repair. And we could get very little help from our "public servants."

TVA doesn't need to ask anyone's permission—they just take. TVA is "publicly owned"—that is government owned—operation. They have the power of eminent domain. But Armstrong Energy Resources was a private for-profit company. We said that over and over. No one should have the right to take what is rightfully yours if you don't want to give it up. Except the government. We may not like it but the government can and does, all the time. But where does this private company from Pennsylvania get off coming down here and telling people to get off their land?

The sites selected by Hunt were all privately held property. Some parcels were family farms that had been held since the first white people came into the valley. Aside from all the disruption and damage from these projects, the most stunning and painful revelation was that the Federal Energy Regulatory Commission (FERC) was prepared to evict owners in the way of Armstrong under the PURPA law. Armstrong would be granted the right of eminent domain. And TVA would buy the product.

We may never know what ultimately happened. We knew that the money did not add up. The projects would not be profitable. But one day, after a year of uncertainty, there was a quiet announcement that the project had been suspended. Hunt's office closed and he left town. They said that they might restart the project if the results of the impending deregulation are favorable. Personally I think that a combination of the efforts of SOS and the fact that the $5 million was gone was what ended the struggle.

But the valley is still there and the law is still there. In fact just down the valley on the Alabama line, the FERC has recently granted a private company, US Gypsum, the right to build a 24 inch (610 mm) gas pipeline across private land to fuel their wallboard plant in Bridgeport, Alabama. Yes, I do think there are many evils in the grid system—this is just one more I thought you might want to know about. Thanks, and power to the people!

Tom Phillips, tphillip@olanmills.com

Great job, and congratulations to SOS. In a subsequent email, Tom let me know of a further result of SOS' efforts. "…in our recent election of the Sequatchie County Commission, the county executive who fought us tooth and nail was booted out of office by just about the margin of the SOS membership." What a powerful group! Keep up the good work, and keep 'em honest.

Access

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Y2K

Don Loweburg

I first heard about "Y2K" approximately six months ago. A customer called and started asking questions like, "Can you run a house on solar?" and, "What would it take to power a well pump on solar?" By the tone of the questions, I could tell that this was not the usual renewable energy customer. This person was grid connected and looking for backup. As our conversation developed, he eventually felt comfortable enough to ask me if I had heard of the "Millennium Bug." I hadn't a clue, so my new customer proceeded to fill me in. My understanding of the situation is based primarily on conversations like this and augmented by some additional research of my own.

The Bug

The problem is due to the computer programming practice of using only the last two digits of the year in the date, rather than using all four digits, e.g., "68" rather than "1968." This was a simple way of using less memory, when computer systems were not designed to access large memory banks. This date is important because all time-dependent programs operating under this system will think that it's the year 1900 when the "99" rolls over to "00." Though it's a very simple problem, it exists in a large number of instances in programs and hardware all over the world. It is so huge that just finding and fixing the problem may be impossible before the year 2000.

The End of Western Civilization?

What will happen on January 1st, 2000? I've heard lots of different answers, ranging from "nothing" to "the end of Western Civilization." I have done some reading and some listening and have come to the conclusion that there will be an impact. Actually, there already has been an impact. Several months ago, my bank sent a notice. It read, "The year 2000 presents a major corporate-wide challenge for financial institutions, their vendors, business partners, and you, our customers. Year 2000 is much more than just an information system problem, it is pervasive and complex. To assist you in your preparation for this undertaking, the following Internet sites are available…."

I called my bank and asked, "What gives?" They assured me they were Y2K compliant and that the statement was made as a public service. My lawyer friends suggested that the bank was more concerned with reducing their liability than serving the public. In fact, one of those friends works in a law office that specializes in intellectual property. He tells me that they are gearing up for some real action around Y2K. Some big money will be changing hands.

It's Going to Cost

I found another example of the impact of Y2K in an October 13, 1998 San Francisco Chronicle article, titled "Survey Tracks Company Cost for Y2K Change." Focusing on the cost of the fix and on the fact that it will "sap investment in new technology, slowing growth for many computer companies," the author reports that as much as 44% of 1999 corporate computer budgets will be devoted to fixing the problem. This could be as much as $225 billion for the United States and perhaps $600 billion globally.

A Boost for PV

For our business, Y2K has been a boon, as it has been for the RE industry in general. At times, certain equipment has been on back order and lead times are increasing. Yet there seems to be a hesitancy to talk too openly about Y2K. When colleagues broach the subject, it's usually in the form of a toned-down question. They ask, "You seeing anything around Y2K?" When I answer affirmatively, they usually say things are "going like gangbusters." My customers are also usually reticent to tell me too much at first. But once they find out that I'm in the know, they open up. In spite of the muted acknowledgment, Y2K will be very big for the RE industry.

It's strange how quickly things change. Some PV marketers positioned themselves for the "green" market in grid-connected PV systems. Then along comes this Y2K problem. If there is a power disruption, PV modules on the roof without batteries will be just as useless as a two door energy-hogging refrigerator without the grid. Y2K is making off-gridders out of many grid-connected households. They are appropriately concerned about power reliability in the year 2000. They are concerned with independence and efficiency, just as the traditional off-grid customer is. Amazingly, we don't have to spend a dime on marketing to these people. In fact, it would be counterproductive to do so. Customers come to us because we are the solution to their problem.

Response to CoSEIA

I appreciated the comments by Colorado Solar Energy Industries Association (CoSEIA) in last issue's letters section (*HP67*, page 120)—they were well presented and are well taken. But I need to set the record straight on one matter. In the IPP article in *HP66* to which the CoSEIA letter referred, I alluded to possible influence of a SEIA agenda. Pat Osborne, board member of CoSEIA, assures me CoSEIA is solely responsible for the choices leading to the stipulated agreement with the utility. I was wrong.

On other matters, I think we can agree to disagree. As the directors point out in their letter, CoSEIA represents a wide and diverse body of interests, ranging from PV manufacturers to deregulated utilities. IPP, on the other hand, focuses strongly on the interests of service providers. Issues outside the scope of CoSEIA's action may well be of primary concern to IPP members. IPP looks forward to continued dialog with CoSEIA, their members, and other elements of the PV industry.

California PV Alliance

IPP has been working very productively with CalSEIA, The California Energy Commission, manufacturers, renewable energy companies, and others. We have been developing the Emerging Renewables energy program for California. The California PV Alliance successfully implemented a program that offers rebates to both residential and commercial purchasers of photovoltaic and small wind systems. The first phase of the project has begun and significant interest is anticipated. These systems must be installed at utility served locations but need not be interactive. Battery storage and autonomous operation is allowed!

The next Alliance project is to make sure that information about the program gets out to all Californians. A handbook describing the details of the program and what the benefits are is nearly finished. A listing of IPP and CalSEIA members who can sell and install systems will be included. Thanks to Alliance members Tom Starrs and Howard Wenger, who led this project.

Another more ambitious information project is in the works. As part of California's utility restructuring, approximately five million dollars are available for public education and information about the Renewables Program. The Alliance has initiated a plan to secure some of this funding. Quick action averted an attempt by large renewable generators to grab the entire fund. It is our position that the funding must be split equally between the large and small (emerging) renewable energy concerns. IPP represents the interest of installers on the newly formed Emerging Renewable Advisory Board. Other members include Mike Bergey and Ron Harmon (small wind), Howard Wenger (PV manufacturers), Joel Davidson, and Les Nelson (CalSEIA).

A Closer Look at Green Mountain

While working on IPP for *HP67*, Michael Welch and I had exchanged a few words concerning some of the new corporate marketers selling rooftop PV systems. Michael suggested that I contact Green Mountain Energy Resources directly to find out more about their program. Although our company operates primarily from an off-grid location, we do maintain a warehouse location in town that is grid served. Several months ago, we switched our utility service from PG&E over to Green Mountain, so I had the perfect opportunity to also check out their California rooftop PV program.

For the Customer

The customer package from Green Mountain contained a very clear description of the program, which offers a choice of single crystal silicon technology, polycrystalline, or thin film. The literature offers no battery options. Pricing is clear, though it is explained that site conditions will affect final cost. Financing is offered through a third party at less than 10% interest. The potential customer is given very clear guidelines regarding roof and space requirements. Shading concerns are also addressed.

Systems are designed and installed by Green Mountain's PV partner, Applied Power Corporation (APC), a subsidiary of Idaho Power. If the initial qualifications are satisfied, an APC installer will visit the customer's site and make a final evaluation and installation estimate. The printed materials are very attractive and well produced. Marketing focuses on environmental concerns, reducing pollution, and global warming. Included in the literature package is information on APC, detailing the company's significant solar projects and background.

For the Installer
The installer packet is also very complete and does a good job of describing the systems to be installed. Selections from the installation manual and schematics are included. The qualifications necessary to be an installer are also very detailed. The candidate must provide an extensive narrative of past experience, proof of insurance, and a copy of a contractor's license. There is no doubt that the program is seeking the most qualified installers they can find. The basic requirement is a contractor's license—PV installation experience is not mandated. Licensed contractors willing to be trained will be considered.

APC installers have considerable responsibilities. These include making the initial site visit and evaluation, producing a shading report, providing a firm installation quote to APC, obtaining all required building permits and utility interconnection agreements, being responsible for client billing and all paper work involved with obtaining California Energy Commission rebates, and providing warranty and service work for APC.

I spoke briefly with Craig Benton, program manger at APC. My primary concern was that the potential installer should be paid for the initial site visit. Craig told me they would not. If APC screens the customer applications well, this could be OK. From my experience operating our own company, I know this pre-screening is very important and we often spend several hours on the phone with a potential customer before scheduling a site visit. It is not uncommon for serious customers to pay for this service.

PVUSA Training Program
PVUSA (Photovoltaics for Utility Scale Applications) is a PV demonstration site located in Davis, California. At one time, the facility was devoted to large-scale utility systems. Now, the California Energy Commission administers the site and its purpose has been refocused towards residential and commercial "on site" PV systems. As part of this new focus, a training program is being offered, including a one day short course and a more intensive "hands on" session. The program is directed towards building professionals and inspectors. The cost is very reasonable. Contact Bill Brooks at PVUSA for a schedule of training.

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Web sites on the Y2K problem:
www.y2ktimebomb.com • www.garynorth.com
www.euy2k.com/note.htm • www.y2klinks.com
www.prepare4y2k.com • www.yourdon.com/index.htm
http://millennia-bcs.com/cassief.htm
www.wdcy2k.org

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Surfing through Breakers

John Wiles

Sponsored by The Photovoltaic Systems Assistance Center
Sandia National Laboratories

Breakers, the electrical kind—not those used for surfing—are used in electrical circuits as both overcurrent protective devices and as disconnect devices. This Code Corner will present some general information on circuit breakers and where they may be properly used.

Circuit breakers offer several advantages over the combination of fuses and disconnects and in many cases provide equivalent functions. They can be reset after they are tripped by overcurrents and do not have to be replaced, and they are usually more compact than fuses and switches with the same ratings.

Circuit breakers are found in nearly all modern residential load centers. While these breakers are rated for alternating current (AC) there are also circuit breakers rated for direct current (DC). The AC and DC breakers are not interchangeable (AC breakers should be used for AC circuits and DC breakers for DC circuits), although a few circuit breakers are rated for both AC and DC.

Branch Circuit vs. Supplementary

Like fuses, circuit breakers are used in branch circuit and supplementary applications. The branch circuit-rated breakers, like those found in the typical AC residential load center, are generally larger and more robust than the supplementary breakers that are used inside electronic equipment like radios, televisions, microwave ovens, and the like. It is generally required that both AC and DC supplementary circuit breakers be protected by a circuit breaker rated for branch circuit use nearer the power source.

In PV applications, the less expensive supplementary breakers may be used in PV source circuits. In these circuits they are used to provide overcurrent protection for the conductors to the modules while serving as a disconnect for these same source circuits. They can be used in source circuits because the fault currents from PV modules are limited. These breakers may also be used in these circuits because they are sufficiently far from the battery that the potential fault currents can be handled by these low-interrupt rating devices. Usually there is also a required current-limiting fuse located near the battery that may serve to further limit fault currents.

Some circuit breakers are also equipped with auxiliary switches that can be used in alarm circuits to signal when they are open. This allows breakers to be mounted in remote locations, e.g., on the roof (out of sight, out of mind), and have an alarm inside the house to indicate when they have tripped due to a fault or surge.

DC Rated Circuit Breakers

Listed, DC-rated circuit breakers installed in listed enclosures are generally not available to the individual but are manufactured by original equipment manufacturers (OEM) like Trace Engineering, Pulse Energy Systems, Heliotrope General, and others. These manufacturers are now producing assemblies of DC-rated circuit breakers in enclosures that can be used in renewable energy systems. Examples of these are the Trace Engineering “DC 250 Disconnect” which includes a 250 Amp circuit breaker to provide the disconnect and overcurrent protection for the circuit between the inverter and the battery bank. Up to four additional circuit breakers for either source or load circuits can be installed in the enclosure. Another example is the Trace ground-fault protection device which includes a dual circuit breaker and associated equipment to provide the PV array ground-fault protection required by section 690-5 of the National Electrical Code® (NEC).

When an OEM uses DC-rated circuit breakers in a piece of equipment, the ratings that apply to the individual circuit breakers may differ from the ratings that apply to the overall equipment. The equipment was fully tested for the application by an organization like Underwriters Laboratories (UL), and with laboratory testing of the entire product, ratings for the equipment may be in excess of the circuit-breaker ratings alone.

AC-Rated Circuit Breakers

Circuit breakers for AC use are usually installed in load centers made by the manufacturer that makes the breakers. These load centers hold a number of individual breakers and the necessary bus bars to connect them together. They are readily available in building supply stores and at electrical equipment supply houses. These AC circuit breakers and AC load

centers should only be used in AC circuits and never in DC circuits.

Dual-Rated Circuit Breakers
The Square D line of QO breakers and QO load centers are rated for 120/240 Volts AC, and they also have a lower voltage DC rating. When used in DC branch circuits (circuits from the battery to the load) they can be used on 12 and 24 Volt battery systems. Although rated for 48 Volts DC, the higher battery voltages (above 48 Volts) in normal charging and during equalizing pose stresses on these breakers and they should not be used in 48 Volt battery systems.

In PV source circuits there is the potential for higher than nominal voltages. A 24 Volt system with crystalline silicon modules may have an open-circuit voltage above 48 Volts. Because of this consideration, Square D QO breakers and load centers should be used only on 12 Volt PV systems. Some thin-film modules may not have open-circuit voltages this high and it may be possible to use these breakers in PV source circuits in 24 Volt systems. In both uses (source circuits and load branch circuits), the interrupt-current rating is only 5000 Amps and if they are placed in systems with large batteries and are located in the circuits near the batteries, they should have a current-limiting fuse between the battery and the circuit breaker. An analysis (beyond the scope of this column) of potential fault currents may be used to determine the need for a current-limiting fuse.

Disconnects
When circuit breakers are used as disconnects, their overcurrent rating must also be sufficient to handle the normal and expected operating currents. The OEM can obtain devices that look like circuit breakers, but have no overcurrent function, and are used only as switches or disconnects. These molded case switches, when they are used, must be accompanied by some form of overcurrent protection for the circuit.

In many cases, circuit breakers are more compact than equivalent fused safety switches. Like other devices used as disconnects, circuit breakers must be mounted so that the handles in the up position are no higher than six and one-half feet above the floor.

Current Limiting
There are no listed, DC-rated circuit breakers that are considered to be current limiting by US standards. There are some breakers on the market that are marketed as current limiting but they have been tested only to European standards and should not be used for current limiting in DC circuits that must meet NEC requirements. Wherever circuit breakers are used, the interrupt rating must be greater than the short-circuit current at that point. If the circuit breaker interrupt rating is less than the short-circuit current at the point where it is used, a current-limiting fuse should be used to limit the available short-circuit current.

1999 National Electrical Code®
The 1999 NEC® has been published and is available from most electrical equipment distributors in jurisdictions where the 1999 Code will be adopted at the first of the year. The National Fire Protection Association (see Access) also sells the NEC and will have the 1999 NEC Handbook® available by the end of the year. The next Code Corner will summarize the changes that appear in Article 690 in the 1999 NEC.

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 at the location below. Sandia National Laboratories sponsors my activities in this area as a support function to the PV Industry. This work was supported by the United States Department of Energy under Contract DE-AC04-94AL8500. Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy.

Access
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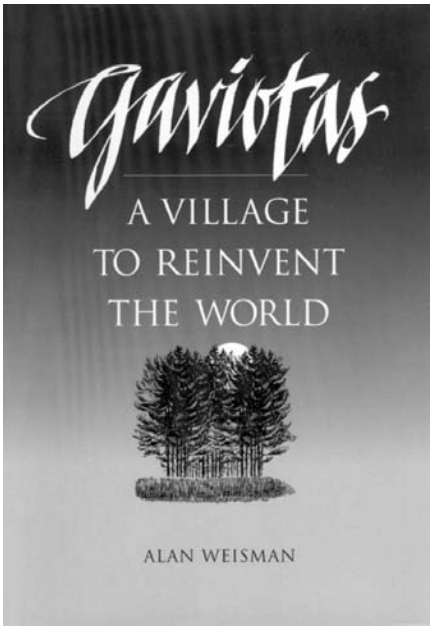
Sandia National Laboratories Sponsor: Ward Bower, Sandia National Laboratories, Division 6218, MS 0753, Albuquerque, NM 87185 • 505-844-5206
wibower@sandia.gov

National Electrical Code® and NEC® are registered trademarks of the National Fire Protection Association. The 1999 NEC and the NEC Handbook are available from the NFPA, 1 Batterymarch Park, Quincy, MA 02269-9101 • 800-344-3555 • 617-770-3000



Gaviotas—A Village to Reinvent the World

Written by Alan Weisman
Reviewed by Richard Perez

Gaviotas is a book that will make your soul sing. It is an incredible—but true—chronicle of doing the impossible.

Gaviotas is a remote village in Colombia that has reversed the ill effects of technology and deforestation. In the middle of the most inhospitable place imaginable, they have made their environment flower. The people who live in this unintentional community are reinventing their world with virtually no outside help.

Gaviotas is a village located in the barren savannahs, called llanos, of eastern Colombia. In 1971, a Colombian visionary, Paulo Lugari, started this community in a place which everyone considered uninhabitable. The land would not support agriculture or animal husbandry. The area was (and still is) smack dab in the middle of a guerrilla war between Colombia's government and a variety of revolutionary groups, both left and right. In this area, there are no real roads, no bodies of potable water, and no electricity. It's hard to imagine a more difficult task than establishing a village in the llanos of eastern Colombia. But build this village the Gaviotans did, and in doing so they triumphed.

If this was just a story of living in an impossible place, it would be interesting, but it would not be so important. The real story here is how the Gaviotans overcame the llanos, the guerillas, and the government—and by doing so, how they made their village a model for all of us to follow.

The Gaviotans are masters of appropriate technology. They made their environment inhabitable by developing new agricultural and energy technologies. They did all this on site with their own ideas, designs, and energy. They invented and built new water pumps, specialized wind generators which function in the llano's light winds, and solar water distillers and water heaters which function in their cloudy climate. There seems to be no limit to their mastery of homebrewed technology. However, the most important aspect of their accomplishments is not their new machines, but their agriculture.

The Gaviotans are growing new trees and plants in an area that was written off as an ecological disaster area, on the verge of becoming a desert. Through their novel and homegrown agricultural techniques, they have been able to reverse the deforestation which is taking place all over South America. What's more, they've done this all on their own.

While the new energy technologies the Gaviotans have developed are sure to interest *Home Power* readers, the most important lesson that they have for us is their spirit. They don't know the meaning of impossible. Alan Weisman brings this indomitable spirt to life in his book. Read it and this spirit will come to live in your heart as it has in mine.

Access

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Gaviotas—A Village to Reinvent the World, by Alan Weisman, 227 pages hardcover, ISBN# 0-930031-95-4 • US$22.95, CAN$32.95, UK£15.50

Publisher of *Gaviotas:* Chelsea Green Publishing, PO Box 428, White River Junction, VT 05001
802-295-6300 • Fax: 802-295-6444
Web: www.chelseagreen.com

From the Fryer to the Fuel Tank

Written by Joshua Tickell,
Edited by Kaia Tickell
Reviewed by Kelly Larson

From the Fryer to the Fuel Tank: How to Make Cheap, Clean Fuel from Free Vegetable Oil is a great primer on the how-tos and whys of biodiesel. These folks have driven over 25,000 miles in a van run on homemade fuel!

The first chapters are an excellent primer on petroleum, the greenhouse effect, and how biodiesel can solve both of these problems. Biodiesel uses the sun's energy instead of dead dinosaurs. The fact that widespread biodiesel use could actually reverse global warming is enough reason for me to consider cookin' some up.

A little diesel history lesson gives us the background to appreciate the scam the petroleum industry has pulled on us. Did you know that the diesel engine was designed to run on peanut oil, and that "diesel fuel" is actually a poor replacement for the diesel's original fuel? Biodiesel is much cleaner than petroleum diesel, runs in unmodified diesel engines, and can be mixed with petroleum diesel in any proportion. Biodiesel is non-toxic, biodegradable, renewable, and less likely to explode and burn. Best of all, it can be made by you, cheaply! When the Veggie Van visited my town, I could hardly wait to sniff the exhaust. Sure enough—it smelled like french fries.

Many *Home Power* readers use generators in the cloudy months. Inversion layers in our small pristine valleys hold in any pollutants we emit. Biodiesel can improve air quality in several ways. The exhaust contains no sulfur emissions. Carbon monoxide and hydrocarbon emissions are cut by 20 to 60%, and soot particulates (which send asthmatics to the hospital) are reduced by 40 to 60%!

To make the stuff yourself, turn to chapter five. Step by step, the reader is taken through the process of biodiesel production. The Tickells do it right—they make safety a number one priority. The necessary tools aren't intimidating, either. They include a scale, a blender, goggles, gloves, and some glassware. Even a chemistry wimp like me could follow the clear descriptions. And there are oodles of references, backing up claims and steering biodiesel students to more information.

The section on "Gretta," the greasy Jetta, is a crack-up. Who would imagine a diesel car could run on straight unprocessed fryer oil? I'm no mechanic, and even I was able to follow the simplified description of the diesel engine's inner workings. This book made me feel that anyone can do it. And if you decide biodiesel processing isn't for you, the Veggie Van web site can help you find suppliers of the fuel.

Simply put, I'm sold on biodiesel as a result of reading this book. It's an easy read—I got through it from cover to cover in three hours. You can get the book directly from the Tickells at GreenTeach Publishing. Better yet, call your local RE dealer and have them get it for you (and spread the word at the same time).

Access

Reviewer: Kelly Larson, Alternative Energy Engineering, PO Box 339, Redway, CA 95560
707-923-2277, ext 126 • Fax: 707-923-3009 Attn: Kelly
kelly@alt-energy.com

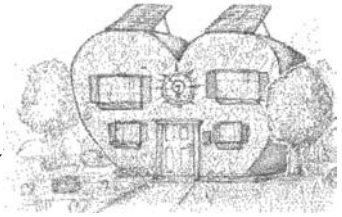
From the Fryer to the Fuel Tank: How to Make Cheap, Clean Fuel From Free Vegetable Oil, by Joshua Tickell, edited by Kaia Tickell, 1998. GreenTeach Publishing: Sarasota, FL. ISBN 0-9664616-0-6, 87 pages, 8 1/2 by 11 inches paperback, $19.95

Available from:
GreenTeach, Josh and Kaia Tickell, Founders and Directors, 15 Paradise Plaza, Suite 311, Sarasota, FL 34239 • 813-354-2377 • van@veggievan.org
Web: www.veggievan.org

Alternative Energy Engineering, PO Box 339, Redway, CA 95560 • 800-777-6609 • Fax: 800-800-0624
energy@alt-energy.com • Web: www.alt-energy.com

Bookmasters, PO Box 388, Ashland, OH 44805
800-266-5564 • 419-281-1802 • Fax: 419-281-6883
info@bookmasters.com • Web: www.bookmasters.com

Home & Heart



Kathleen Jarschke-Schultze

It's hard to be in the RE industry and not be swamped with Y2K information and questions. I personally don't think it will be as bad as some alarmists predict. However, I've found myself giving thought to preparation in the event of some services being interrupted. In the following article, you'll find some cheap and dirty preparations.

Why 2K?

At the changing of every century there have been dire predictions on the collapse of life as it was known at the time. Now that we are rolling over a millennium, the same is true to a more fevered degree. I really don't know what is going to happen. I have no desire to debate the question with anyone.

Be Prepared

Y2K or not, it's just good sense to be ready for any disaster—natural or man-made. As anyone who has been in a size large disaster knows, official help does not come right away. Medical and rescue personnel are all busy saving who they can. Here in California, we are told that we need to be able to care for ourselves, including food and water, for at least three days in case of an earthquake.

Taking Stock

What do you absolutely need to get by? Food, water, and shelter. How many people will there be? How long could you feed your family on what you have stored right now? If the power went out, would you be able to cook and have lights? Do you, or does anyone in your family, take medication regularly? Try to contemplate just your own bare necessities.

Cheap & Dirty

Buy the book *Heaven's Flame* and build a solar cooker for under $5. You may think I'm touting this book just because we publish it. I'm not. It is the best book on the subject I have ever read. You can make a couple of solar cookers, and cook with one while you pasteurize water with the other.

A backpacker's campstove and some cans of fuel would be a good backup, in case the sun doesn't shine.

Find a discount store and buy Novena candles for emergency lighting. These are the candles in a tall glass, sometimes with religious pictures on them. A Novena is a Catholic prayer ritual lasting nine days. These candles are made to burn for nine days straight. If you only use them for a few hours after dark, they could last for weeks. The wax doesn't drip because it is contained in the glass. We have a store around here where everything is 98 cents or less. I have a supply of these candles, even though I'm on an RE system and our personal power grid does not black out.

Get a solar shower. You know the kind—they are usually sold for camping. They are cheap, like $12 or so. In fact, they are so cheap, you should get two. I bought a friend one of those when her shower was broken, and now she won't be without one. You can shower with it, or just heat water.

Food

I've seen companies selling Y2K food supplies. I think you can do better on your own. Keep an eye out for sales on canned goods. Some grocery stores have an annual canned food case sale. Or, double what you usually buy. Bulk foods like grains and flours are good. Look around for a buying club where you can get better prices.

The best storage method I've found for bulk foods is five or seven gallon buckets. The lids that come with them are horribly hard to get off and on. Now, there is a really hip kind of lid system. First you place the outside ring onto the bucket. Then a locking threaded cover spins on or off easily. Air and water tight, bug proof—it's the best thing I've seen. I've seen them for about $10 each. It's an investment, but they will last a long time and keep your food clean and safe. A five gallon bucket will hold 25 lbs. of grain or beans.

I read a really good suggestion in a Y2K article. It recommended that you cook a meal using your emergency rations once in a while. This would be good as it would make you think about all of the little things you use to flavor a meal—spices, salt, oil, vinegar, etc. Bulk food is good, but it can be pretty bland by itself.

Renewables

Get a solar flashlight. Get a solar battery charging setup and some rechargable batteries. Make sure they are the right size for your flashlight and radio. For bigger systems, keep reading *Home Power*.

Communications

I've already mentioned a radio for listening. Now, take a no-code test and get a ham radio license. Amateur

radio operators are always informed and ready in any emergency. Join a ham radio emergency net like ARES (Amateur Radio Emergency Services). Don't just be a part of the problem, get ready to help out.

Medical Concerns
Get a bee sting kit from your doctor. Know how to use it. If you or any member of your family takes medication regularly, start filling your prescriptions a little earlier each time to build up a supply. Use the meds in order of date, so you use the oldest first.

Get a first aid kit, or make one. Get a good first aid book. If you can find a training manual for EMTs, that would be best. A Merck manual is good for diagnosing and for treatment recommendations. Some health organizations (like HMOs) have a book for members that identifies conditions by symptoms, suggests home treatment, and lets you know when you should seek professional help. A stethoscope and blood pressure cuff are good to have, too. Learn how to use them.

Gardening
Get open pollinated seeds so you can save them from year to year. Learn to utilize the growing space that you have to it's fullest. Get John Jeavons' book, *How to Grow More Vegetables Than You Ever Thought Possible on Less Land Than You Can Imagine.* I know it's available through his sister, Betsy, at Bountiful Gardens. They sell only open pollinated seeds there—no hybrids.

Conclusion
This is by no means the last word in preparing yourself for whatever. These are only some things that I have thought of. There are a lot of web sites dedicated to the whole Y2K thing. The site www.urbansurvival.com is a good one. There is a plethora of newsletters, articles and advertisements also. Try not to get too freaked out. Some ads are really made to scare you. My favorite alarmist ad said, "call while there is still a dial tone." Really.

Lastly, remember that toilet paper is like firewood—you can't have too much, because you will use it eventually.

Access
Kathleen Jarschke-Schultze is playing with her new Airedale puppy, Emma Rushingheart, at her home in Northernmost California, c/o *Home Power*, POB 520, Ashland, OR 97520 • 530-475-0830
kathleen.jarschke-schultze@homepower.com
or: kjs@snowcrest.net

Duluth Trading Company, 5200 Quincy St., St Paul, MN 55112-1426 • 800-505-8888
Web: www.duluthtrading.com

Lehman's Non-Electric, PO Box 41, Kidron, OH 44636
330-857-5757 • Web: www.lehmans.com

Seeds of Change, PO Box 15700, Santa Fe, NM 87506-5700

Bountiful Gardens, Ecology Action, 5798 Ridgewood Rd., Willits, CA 95490

The Encyclopedia of Country Living, by Carla Emery, 8 1/2 by 11 inches paperback, $24.95.

Available from:

Sasquatch Books, 1008 Western Ave., Ste 300, Seattle, WA 98104 • 800-775-0817

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
Web: 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
Web: www.solarenergysociety.ca

The "Alberta Sustainable House" is open on 3rd & 4th Saturdays (except holiday weekends) from 1-4 PM free of charge. Emphasizes 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
Web: www.ucalgary.ca/~jdo/ecotecture.htm

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, Canada V7J 1H2
604-987-6188 • Fax: 604-253-0644
rcameron@statpower.com

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

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

NICARAGUA
Jan. 4-15, '99: Help bring light to Nicaragua. Course for North Americans in Nicaragua. $650 per person, $150 of which subsidizes PV systems in villages. Taught by Richard Komp. Info: Leslie Cockburn, PO Box 43233, Cincinnati, OH 45243 • 513-891-3139
cockburn@gateway.net • Course content info: Richard J. Komp, Skyheat Associates, RR 1 Box 775, Jonesport, ME 04649
207-497-2204 • sunwatt@juno.com

NATIONAL US
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
Web: www.ncsc.ncsu.edu/dsire.htm

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.
Web: www.sandia.gov/pv

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

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

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

Energy Efficiency & Renewable Energy Clearinghouse (EREC) BBS, free access to text files, share/freeware programs & utilities, & a free publication ordering system.
Web: erecbbs.nciinc.com
Modem: 800-273-2955

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.
Web: www.eren.doe.gov • 800-363-3732

Energy Efficiency and Renewable Energy Clearinghouse (EREC) offers free info: 1998 Fuel Economy Guide (SD404), 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
Modem: 800-273-2955
Web: www.eren.doe.gov

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
Web: www.ftc.gov

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

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 $US15 ppd (make checks to ASES) to Interstate RE Council Distribution Center, c/o ASES, 2400 Central Ave Ste G-1, Boulder, CO 80301

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 • Web: www.nsea.org

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).
Web: www.green-power.com
other web sites: www.greendesign.net
www.greening.org
Sustainable energy info: www.crest.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
Web: www.execpc.com/~teba

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
Web: 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

Dec 3–4: North American Electric Vehicle & Infrastructure Conference & Exposition, Phoenix, AZ. Info: EVAA, 601 California St Ste 502, San Francisco, CA 94108
415-249-2690 • Fax: 415-249-2699
ev@evaa.org • Web: www.evaa.org

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
Web: www.humboldt.edu/~ccat

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
Web: www.solarpv.com

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
Web: www.cruzio.com/~solar

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
Web: 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
Iowa Renewable Energy Association 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

The Iowa Renewable Energy Association (IREA) sponsors workshops this spring on straw bale houses, 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

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
Web: 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
Web: 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
Web: 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

OHIO
Solar/Wind classes, every second Sat. $55 per person, $75 per spousal couple, incl lunch. Tech info, system design, NEC compliance, efficient appliances. See equipment in use. Info: Solar Creations, 2189 S.R. 511 S., Perrysville, OH 44864
419-368-4252
Web: 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
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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
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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
Web: www.balewolf.com

WISCONSIN
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

Dec 1–4 '98: The University of Wisconsin-Madison offers Principles of Effective Energy Management, incorporating energy considerations into your facility & how to benefit from utility deregulation. Power Quality Problems in Industrial Environments, covering basic analysis techniques, solutions to voltage disturbance problems and monitoring. Info: Katie Peterson, Department of Engineering Professional Development, University of Wisconsin-Madison, 423 N Lake St, Madison, WI 53706 800-462-0876 Fax: 608-263-3160 custserv@epd.engr.wise.edu Web: epdwww.engr.wisc.edu/

the Wizard speaks...

Gravity

It is believed by many that gravity is essentially a type of electro-magnetic phenomena. If this is true, then mass and the gravitational constant G may need to be formulated in terms of the electro-magnetic properties of space.

Mass can be conceived to have its origin in the interactions between crystallized charge and the two components of the zero point field. These two components are the charge potential field and the scalar energy field. The interaction will take the forms of distortion, interception, and displacement.

The gravitational constant G can be formulated as a function of four electro-magnetic properties of space plus a dimensionless constant. These four properties are the magnetic permeability, the electric permitivity, the charge density, and the energy density. Eventually, it should be possible to express the permeability and permitivity in terms of the charge and energy properties of space.

With these above ideas, a step can be taken towards the understanding of gravity as an electro-magnetic phenomenon.

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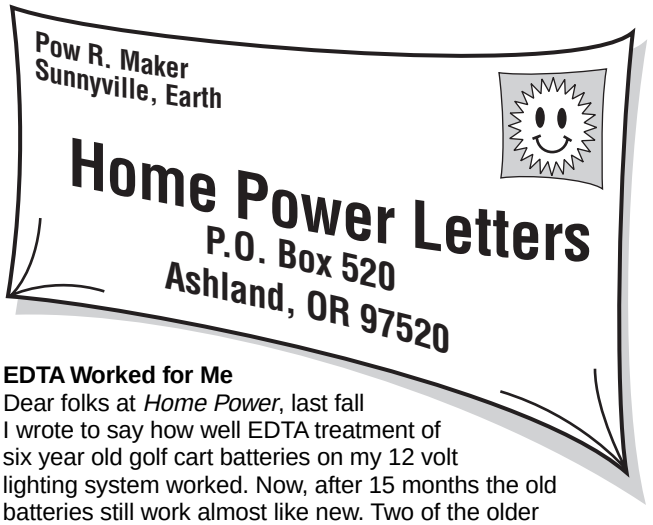

EDTA Worked for Me
Dear folks at *Home Power*, last fall I wrote to say how well EDTA treatment of six year old golf cart batteries on my 12 volt lighting system worked. Now, after 15 months the old batteries still work almost like new. Two of the older batteries exploded when I made a spark when they were gassing. The two new batteries work better than the older ones of course, but the old, EDTA treated batteries take only a couple of hours more of equalizing charge at around 10-20 amps to match the new. The six year old batteries that wouldn't charge beyond 1/2 capacity have come up to over 90% capacity in a few months and after a year have maintained that performance.

Recently while equalizing the six 6 volt batteries, I made that spark and blew the tops off the two oldest batteries. After replacing, I drained their fluid, flushed them and dried them out, and carefully as I could with hammer and chisel, dismantled them. Well, the grey negative plates looked like new, but the red positive plates were completely shot. Nothing left of the red lead pasted plates, almost no grid material left. The red lead was merely being held in place by the rubber separators, and these batteries had worked almost like new after EDTA treatment.

The old lead acid batteries, being the "weakest link" in wonderful wind power, had me convinced to use inverter powered fluorescent lights to save the batteries from being charged and drained more than twice as much as when using the old style Edison bulbs, which I prefer. For me, EDTA revitalization has allowed me to return to my favorite lights, incandescent, warm and glowing in this cold climate.

In four years, my 800 watt inverter had been replaced four times on warranty. Each time it took a month or more to replace and I used the old 12 VDC incandescents and like it much better. Now, if I could only find a 12 VDC VCR. Alex Mageski Jr., Krakao, WI

Hello, Alex. EDTA is amazing stuff and many readers report battery rejuvination successes such as yours. In my opinion, proper cycling, the use of an electronic desulfator, and EDTA are helping all of us get more service out of our lead-acid cells. I've been seeing many 12 VDC VCRs, and TVs with integrated VCRs, in truck stops lately, so check it out. While these VCRs don't have all the high tech features of their 117 VAC cousins, they run directly from battery power and often consume far less energy while operating. Richard Perez

RE Rebate Challenge
As I read of the RE rebate programs in very few states (maybe just two), and having encouraged Colorado to offer an RE rebate without even a reply, I would like to challenge all *Home Power* readers to pressure their home states to declare all RE products tax exempt. Not as good as a 50% rebate, but simpler and better than nothing.

While we can currently mail order out of state and avoid sales taxes, that may be short lived. Plus, we are shooting ourselves in the foot environmentally by promoting unneeded shipping (more air pollution).

If we all call or write our elected officials, they will take action. Each call and letter does make a difference. Names, addresses, and phone numbers are available from county clerks. F. D. Huff, Silt, Colorado

Hello there. What a great idea. If we let the regulators know how much business is being lost to out-of-state RE dealers, they may be more willing to remove the sales tax on these products. Or, they might backlash and take a hard look at trying to tax out of state sales as well. While local (city and county) sales taxes are a factor, the lion's share of sales taxes are levied by the states, so it might be more effective to work with a favorable state legislator to introduce a bill to do this job. Home Power *encourages readers to take up the banner on this idea and go for it! Michael Welch*

Trace Tech Support
Dear *Home Power* crew, some comments on your latest endeavor and other thoughts. Issue *HP67* is excellent, as usual. Your ability to maintain the consistent high quality of your mag and add improvements as you go makes you one of a kind. You also do the little things right, no "insert" cards all over the place and your articles are never "continued on page…", a thousand thank yous.

The article on hydrogen purification will take at least three readings to absorb and I immediately called to order one of the digital power meters you reviewed. That is a product long overdue and greatly appreciated. I also appreciated your kind words for BP Solar. I have worked with them for a long time now and have found them sincerely interested in their customers and tremendously dedicated to the PV market. Their hard work deserves a lot of credit.

I couldn't help but notice on my first perusal of the issue (I read through it at least two or three times, lest I miss anything) some comments in an article and a letter about Trace Engineering. I know you guys are great supporters of Trace but comments such as the ones in this issue must be addressed if you are to really serve the needs of the renewables community.

The guerrilla solar guys said, "We had a bad experience calling and emailing Trace to find out the scoop. We asked the voicemail tech support to call back with information on the Windows version of the software that was supposed to be available. All in all, we left three messages in three different voice mailboxes, but no one ever called back. Email was answered, but the person who replied didn't pay attention and answered the wrong question."

In a letter, Dave Schmidt commented about leaving voicemail and email messages with Trace and having neither returned. My own experience with Trace is that, even if you do get through, unless you are a volume dealer or major customer, you are at best insulted and at worst ignored. Trace may make good equipment (not perfect by any means), but in their

warped view of themselves their products are above reproach and without problems. I was told so (in so many words), "you can't be having that problem because no one else ever had that problem so therefore the problem doesn't exist" (which allows them to say the same thing to the next guy). It should be noted that when I finally sent my unit in to them it was "fixed" and it was like pulling teeth to get them to tell me what they had done.

You would do the industry, consumers and ultimately even Trace a service by truthfully and fully exposing this horrible customer service and putting some much needed pressure on Trace to clean up their act. As it is now, Trace SUCKS at customer service. That may be a by-product of being the only kid on the block, but I would hope that this industry, as it grows, would be able to get beyond the heartless corporate attitude that so permeates this company's approach to its individual customers.

I can only hope that someone will come along to provide some real competition to Trace and make them sit up and take notice.

On another note, I have followed with interest the give and take with CoSEIA in the last two issues. I just finished getting information from CoSEIA concerning their "rebate" program for PV installations and I must say I am appalled. For an organization that wants to be considered at the forefront of renewable energy promotion, they are doing little to actually promote the overall concept and acceptance of RE and lots to promote their own narrow self interest.

The "rebate" program in Colorado for PV involves *only* grid-tied installations. It is ostensibly state-wide, but in reality, the only real hope anyone has of getting a utility to make it affordable is to work with Public Service Company and then only in the large metro communities along the Front Range. Rural RE users and potential users need not apply.

Now, I happen to think that grid intertie is a horrible idea. There is little justification, even at net metering rates, for an intertie system when it means that at best you break even, at worst you pay twice, and, especially for systems that use the grid for "storage," you are still completely dependent on the grid for your power. If the grid goes out after sunset you're out of luck. Even worse, in terms of this ridiculous CoSEIA sellout to the utilities, Colorado is not a net metering state and there is little chance that it will become one in the near future.

The only thing CoSEIA has to gain is the *potential* for more work for their members. It does little or nothing for the average guy and blatantly discriminates against the rural residents who are the majority of RE power users. If CoSEIA were doing this in conjunction with other groups who were working for the benefit of the rest of us, I would have no problem with it. But because they have striven to put themselves in the limelight as *the* representatives of the industry, they are doing far more harm than good for the future of renewable energy in Colorado. They should be roundly condemned for their narrow self-serving attitude.

Oh, and just how successful is this program of theirs? As of the end of September, when I spoke with Karen Renshaw, they had just three applications for rebates, one for solar heating and two for PV. And the program has been in effect since June. This amounts to a maximum potential as of that date of $6,000 in rebates out of the $250,000 available in the "rebate" program.

According to the data Karen gave me, CoSEIA calculates that 90% of the PV users in Colorado are off-grid, and that CoSEIA is not really interested in helping them finance their systems. They are purposely aiming this at the grid-intertie market and ignoring the rest of us when there is no real hope of any kind of realistic grid-intertie market in Colorado in the near future—certainly not within the one year time frame of the "rebate" program. I wonder what they plan to do with all the money they will have left over?

I have never supported the idea of grid-intertie, but certainly have no objection to someone doing it if they really want to. However, it is beginning to look like the emphasis is shifting from truly independent power producers to grid-intertie systems. I have been dismayed at the unquestioning support you have given this concept in your magazine. Let's face it, when the renewable energy industry begins to cave in and define itself in "grid" terms, we will have lost any real opportunity to bring any real concept of conservation to the marketplace, the kind of conservation that doesn't involve "sacrifice" but rather common sense.

Our off-grid home is fully equipped, from hot tub to home entertainment center to computers, and we use (at current IREA rates) less than $7 worth of power a month. That is a level of conservation that you won't find designed into even an "efficient" grid-intertied home with fewer amenities. Grid-intertie is the lazy way out.

OK, OK, I'll get off my soapbox now.

I also never thought I'd ever say this, but the increase in advertising in your mag is great. That you can benefit from the increased exposure and market created by giving away your issues over the Web is the best use of the Web I've seen yet. I agree with including pricing in your ads and your advertisers get a lot of credit for limiting the hype and often for being nearly as informative as some of the articles.

I don't have to agree with everything you say in *Home Power* to know that you are the best designed, best managed publication available and you deserve high praise for your dedication and quality. I've just gotten my Solar3 CD-ROM and can't say enough about it. I recommend it to everyone and when our new library opens, my wife and I hope to be able to donate at least one copy of each CD for use in the reference computers.

The renewable energy industry is well-served by your efforts and would be nowhere near as well-respected without your participation. Tom Elliot, Guffey, CO
telliot@wagonmaker.com

Gee, Tom, thanks for the praise. Let's see if I can address some of your comments. I had a telephone conversation with Trace's Tech Support guy. Trace is painfully aware that they have a customer support problem and they are trying to fix this as quickly as possible. They are also distressed about all the butt-kicking they are getting in print. Trace has grown so fast that that they have had difficulty finding knowledgeable folks to populate their tech support department. And really, tech support, especially via telephone, is a very difficult job. I know this personally because I do technical problem solving for dozens of HP *readers every week. Trace promises that*

their customer support will improve quickly and I believe that they are doing all they can to make this happen.

On another note, your hope that Trace will have some real competition has been answered. I've recently been testing the new Statpower ProSine 2.5kW inverter/charger. To date, it's every bit as good as the Trace, and in some ways far better. Look for a Things that Work! article in the next issue. Meanwhile, those of you who do have to resort to customer support can really help by having your information together before you contact any company for tech support. It's a big RE world out there and every system is different, so have all the details about your system, and your specific problem, written down and ready to relay before you call a company for support.

You know, Tom, I really do agree with you about utility intertie systems. Why bother. I figured out that the cost difference between a utility intertie system and a stand-alone system is about $16 per month for batteries (about $2,000 over ten years). Going totally off-grid is really not that much more expensive than a utility intertie system. The reason I have been promoting utility intertie systems is that most folks live on grid. The major advantage to these systems is that folks can start small and gradually build up their investment in solar energy. When folks go off-grid, they're on their own and have to buy everything at once.

America's utilities are not hot on the utility intertie idea. They see us solar types encroaching on their turf—they want to continue to be the only source of electricity. They are fighting against paying us what we really deserve for our clean power produced on-peak. Hell, it's been an uphill battle to get them to even accept net metering. I feel that utility intertied RE systems should be paid a premium price for their power. And you are correct, if you are off-grid, then you have no choice but to conserve. If you are on-grid, then you can routinely consume more energy than you produce and just pay the bill. Karen and I have been off-grid since 1970 and we would never hook up even if the local utility brought in the lines for free. Richard Perez

Digital Data from Trace Inverters

I use two Trace 4024 Inverters and use about 8,000 watt-hours per day for our family of four in a new house off-grid. I have an extra PC and would really enjoy an article about how to record and analyze data from my inverters. I have written Trace about this but got no response other than a catalog.

I love your magazine and could not have completed my house and system (twenty-four 75 Watt panels and 24 big Trojans) without you. Thanks, Ron Cadenhead, Evergreen, Colorado

Hi Ron. We too would like to see some articles on logging and using data from PV systems. How about it, readers? We know that some of you PV nerds out there are doing this in a big way and we want you to write about it.

We suggest you write Trace's support again. After the article we printed on Guerrilla Solar in HP67 *which included a section about Trace called Tech Non-Support, they called to assure us that they have made marked improvements in their support. Ray Barby is the person there in charge of making it right. Drop him a line with your questions, he says that their tech support is getting better, and if glitches persist, he wants to hear about them. Michael Welch*

Homebrew Projects

I enjoy all of *Home Power*, and especially like the Homebrew articles. This summer we have enjoyed using the solar food dryer built from Dennis Scanlin's article in *HP57.* I'm now in the midst of a solar water heater project inspired by the same author in *HP58*. I also like the articles about use of solar power in other countries.

I sent you an article I wrote last spring about DC powered shop equipment. Hope it arrived OK and that you can use it. Keep up the good work. Bruce Johnson, Spencer, Oklahoma

Hi Bruce. Glad you found our Homebrew articles useful. We would like to print more. We have your article and like it. We hold on to such articles until we can use them, but sometimes it takes a while. If we feel that we can't use an article, we will send it back to the author along with all of the photos and materials. Michael Welch

Likes and Dislikes

Like: Practical projects to build, mechanical and electronic. Building from scratch with IC chips is fun and "easy," very interesting and not scary or hard.

Don't Like: High ratio of advertisements (I know, necessary economics). And sometimes an issue seems kind of interesting but not that useful.

Legal liability aside, I would like to see schematics for such things as chargers, monitors, controllers, and for other than lead acid batteries. With your broad range of topics, talk about Nickel-Cadmium. It has a high initial cost, but is it cost effective in the long term? The fallacy of this "green" PV world is that every few years each of us generates a pile of dead, sulphated lead and has to put another pile of cash down for more fresh lead. Am I wrong or am I wrong? Wally McColley, Penngrove, California

Hi Wally. Thanks for the feedback. We take every letter with such likes and dislikes to heart. Our advertising ratio may not be as bad as you think. Magazine industry averages for these ratios are much greater than our own. We try to keep it to 33% of our content. National magazine average for ad content is over 60%. When we get more ads, we add more editorial pages to the magazine to keep our ad content at about 33%. With the last two issues, our standard page count jumped from 112 to 128. To keep costs down, we have to wait before adding pages until we can do a full signature, which is a block of 16 pages. Our advertising climbed to the point that we needed to add a signature to keep the ad ratios to 1/3. Another reason you may feel like we have a lot of advertising is our publishing policy of not interrupting articles with advertising. That means that we have to place ads in contiguous areas which may make it seem like there's a lot of them, but, there's really not.

The thing about old lead acid batteries is that they are extremely recyclable, and the battery industry has done a pretty good job of it. Nearly everything in them, including the lead, electrolyte, and plastic cases, is reclaimable. Lead acid batteries are also readily available. The alkaline battery technologies like NiCd are not as available and, like you say, expensive. NiCd also has a toxic and hard to reclaim component—Cadmium. Home Power *would like to see Nickel Iron batteries make a comeback. Talk about environmentally friendly—we only wish they were more readily available. Michael Welch*

DC Air Conditioning
Dear *Home Power*, I live in hot, humid Florida and air conditioning is an important part of people's lives here. I am currently doing A/C repair and installation for my job. For several years I have been thinking about the idea of solar A/C. I am presently planning on making a low voltage DC chiller that would run from PVs whenever there is sunlight and would chill an antifreeze solution in an insulated storage tank. This cool solution would then be used to cool a house when needed.

Do you have any information about this that could help me in my experiment? Kenlyn Miller, Sarasota, Florida kenlynj@juno.com

How about it, readers? Send any info you have on this important project to Kenlyn. RE powered air conditioning has always been a dream. We'd love to get a good article on new developments in solar-powered air conditioning. Michael Welch

Forgot to Read His Label
Hello *Home Power* Crew, if it weren't attached I'd walk away without it. My head, that is. I am pacing around here with that feeling. You know, the one that one gets when it's time for the next issue of *Home Power* to arrive. Then like a bolt from the blue, it occurs to me to check the mailing label on my last issue. DUH. Now I remember what I was supposed to do with that sawbuck two months ago. Anyway, if you would be so kind as to start my subscription with *HP66*, you know, the issue everyone else has read and re-read already, I'd really appreciate it. Your most humble, John A Filewich, Valparaiso, Indiana

Embarrassed
Your magazine has always inspired and informed me of ways to reach energy self-sufficiency. I always look forward to receiving it in the mail. However, a few criticisms: "The Wizard Speaks" column is embarrassing to read. Whoever writes it should put their name to it and own up to their own ideas. Perhaps that would force them to make a point or think more completely.

Also, recently the column "Wrench Realities" has turned more into what seems like a personal vendetta against John Wiles and the NEC. Like or not, he's just doing his job. Opinion, like this one, belongs in the letters section and not so much in the main body of the magazine. Thanks for listening. Erik Berall, Tehachapi, California

Hello Erik, thanks for your opinion. Actually, we have been discussing Wrench Realities recently, and brainstorming some new directions that the column could take. We would like it to become more of a tips and tricks advice column—things that other Wrenches have learned the hard way, so you don't have to. Readers, if you have some good advice, please send it in. Joy Anderson

Lighten Your Load
Richard, I just had an experience that may be interesting to share. Last night I was working on my washing machine. It is an old device, but still too good to throw away and buy a more efficient one. Suddenly I noticed a little drawing on the back of the machine, showing how to re-wire the machine from the standard 2850 watt heater into 1900 or even 950 watts. I realized that the machine is controlled by thermostat, so the program simply waits until the water gets hot enough. The heater element consists of two spirals, one 950 and one double that, which are in parallel in standard configuration. In the shop the technician told me that they often replace heater elements for lighter ones when a machine must be used at an installation with limited power, usually camping places, which are equipped with either 4 or 6 amp outlets (220 volts).

Now, if you're dimensioning an RE system, one of the factors is the maximum load in your system. Apparently some loads can be controlled and re-wired internally. If this reduces the peak load then you could allow a smaller inverter. Another consideration when balancing an RE system?

On another note, I detected a flaw in your argument against buying green power from the utilities, when you say this means that all other customers get a little less green power.

This is of course *only* true as long as few customers request green power. When more and more people ask for "green" then two things will happen:

1. Utilities will be forced to expand their production of green power, when more 'green' power is requested than they can deliver (of course, first everybody else will get 100% "fossil" power, but green will grow in the end!). The only concern here: there is green and then there is *green*.... I don't want to go into details, but I am not sure whether mega-hydro could ever be called green.

2. When utilities discover the trend of their customers asking more and more for green power, they will follow with their production planning. A market only exists when buyers are active, otherwise the 'sellers' will stop providing the product.

Still I think that there is a fair place for home power, soon I will generate approximately as much as I 'consume' at a yearly basis in my suburban home! Everybody selecting a 'supplier' of electricity that offers really "green" power will also help our environment, as well as expanding the power-market a bit into a brighter direction.

When I build my PV system as grid-intertie, then the utilities see their "green" market grow, I am sure that my power is really "green" and I don't have to pay the utilities (except the fixed connection fee) and if my system fails or falls short in power, I still get a kind of green power from the utilities, because that is what they deliver me already today.

And if my system has power surplus, the utilities can sell this as *really* green power! Positively biased by the sun, Cor van de Water, Hooiraamhoek 71, 7564MD Enschede, The Netherlands
Cor.vande.Water@emn.ericsson.se

Reader Requests…
Dear *HP*, please re-up my subscription for another two years. *HP* is by far my favorite magazine, you are all doing a wonderful job and your enthusiasm is always infectious. However, as a loyal follower, I'd like to make a few comments.

1. I would like to see the content dominated less by feature articles on peoples' new whole-house, contractor-built, dealer-installed PV and wind systems. I know these are the materials the readers send you and hence are indicative of the market out there, but most of them are pretty standard technically and must be old hat to the dedicated readership, as they are to me. I'm not suggesting that these types of stories aren't educational and shouldn't still be featured, I just feel that

they've come to occupy most of the pages to the exclusion of Homebrew, product testing and comparisons, Things that Work!, and stories about really creative solutions people have devised to the challenges of independent living.

By complaining thusly I present a challenge to the readership, myself included: tell the rest of us how you keep warm, get water, have a light to read by, and dispose of your shit at your little hovel in the woods. I really want to know more about hydrogen production, storage, and use, thermoelectric generation, solar thermal, refrigeration alternatives, and anything new on the communications front (thank you Richard for your excellent pair of articles in *HP56!*).

3. I wish Bob-O Schultze would lighten up and present his case in Wrench Realities without resorting to character attacks. I feel Mr. Wiles is a public servant far more valuable than most. Be glad that we've got anyone doing objective research in RE, demand more of them, and if you want to attack anyone go after the NEC and the whole issue of residential building codes.

4. Could the people that email their letters tell us where you live, so we can put what you're saying into some context? All these disembodied voices from the unknown are giving me the creeps (closet Luddite, I know. Maybe I can get into a therapy group).

5. Learn "loose" from "lose."

With that I'd like to wrap up my little critique, which I hope you won't take as criticism. On the contrary, it is "The Good Work" you are all doing, and it makes me feel all warm and fuzzy inside to know you're up there doing it. Thanks, Chris Corkins, Abiquiu, New Mexico

Thanks for the appreciation and feedback, Chris. In reverse order, sometimes things are a little bit loose up here and we lose the ability to edit well. Actually, we now have two people on the editing front, Joy Anderson and Ian Woofenden. On point number 4, we promise to continue to include regional info next to email addresses if we have it.

A lot of our readers and many installing dealers are less than pleased when Code Corner info is presented strictly "by the books" even when there may be other easier or cheaper ways to do things that remain safe. Let us agree that John does provide a valuable resource that helps make our systems safe. On the other hand, John is the number one RE person that shapes the NEC code that our systems are supposed to live up to. This is by virtue of his column in Home Power *and his contacts with the RE industry and government. Some feel that he and his fellow NEC advisors have been making the NEC standards unnecessarily stringent and hard to meet. That is a reason why we gave the "Wrenches" a voice in the magazine. They are the folks who are out there every day doing it, and their frustrations with the shaping of the NEC deserve a spot in our pages.*

Your comments about our content are good ones, we feel much the same way. You drive home a point we try to make often—we rely on our readers to provide most of the magazine's content. We have recently increased our staff partly to meet the need of doing more testing and hands-on articles, but that is nowhere near enough. We will reward writers kindly with a byline in an internationally read magazine (this one), give you a bunch of HPs *so you can show off your article to your aunts, add a couple of years on to your subscription, and maybe even send you a t-shirt. Michael Welch*

What I Want Is…
I like the current info. Love the comparisons, love the "how-tos." Need the "what worked" and the "what didn't." I can see that last part is harder to get from people, who wants to dwell on the bummers? I sure appreciate someone telling me what to expect before I stick my hand in the fire, though.

Would like to see a Homebrew PWM controller for my golf cart batteries, even more emphasis on the "Hands-on" part of the "Hands-on journal," comparisons of old panels vs. anti-reflective coating and shadow tech, etc., a Homebrew 12 volt hydronic flow heat controller, and an update on pulse battery maintenance technologies.

Thanks for the free back issues at the Oregon Country Fair. Ray Griswold, San Anselmo, California

Wind From Scratch
I enjoy *HP* very much. It provides lots of very useful information. Particularly, I like all the details of how things are put together so I am able to duplicate it for my own use.

My first exposure to wind power was many years ago. The guy carved his own prop, built a tower, and used a car alternator. This charged seven 12 volt batteries which provided all their electricity. I'm sure the new wind systems are state of the art, but they also carry a healthy price tag. I would like to see the details on how to make your own and how to carve a prop. You're doing a great job and I really enjoy *HP* . Keep up the good work. Darwin Hall, Turner, Oregon

Building a wind genny from scratch is the subject for an entire book. Speaking of books, check out Windpower Workshop*, written by Hugh Piggott. Paul Gipe reviewed this book in* HP65*. Also, while you're in that issue, browse through the index—we've featured a lot of wind articles throughout the years. Better yet, check out the* Solar2 *and* Solar3 *CD-ROMs. You can use the search engine to quickly find specific info, up through* HP60*. Joy Anderson*

Small and On Grid
I would like more info on smaller PV and similar projects for people not off-grid, but trying to minimize the use of grid power, and/or trying to find ways to use solar power.

I like the articles on use of PV and alternate energy in developing countries, as they appear to be the future of energy throughout the world. At some point I feel we will distribute the generating processes, depend less on huge coal and nuclear-powered generation, and more on distributed generation and many small, vs. few large, units. *HP* is the best source of information and ideas I have found and I hope you keep on publishing for a long time. While I occasionally look online, I still like the printed magazine and the CDs for immediate access. Also, it is hard to take the PC into the john or along on a trip. Thanks, Mac McLean, Valparaiso, Indiana

Go Guerrilla Solar
Thanks for the years and years of smiles at photos of other people that make me feel "normal." The newest catch-phrase that I love is Guerrilla Solar—the fact that "we do it because we can" lifts my spirits immensely in the presence of nay-

sayers. It was great chatting with your crew at MREF 98. Keep up the good work. Ted Bohn, Cleveland, Wisconsin

More Guerrilla Solar
Hello Richard and the *Home Power* crew, the latest issue of *HP* has arrived and I was pleasantly surprised to see that I am not the only guerrilla solar expert out here fighting secretly against the "powers that be." There rises an interesting view when it comes to grid interties. If, at the end of the month, I owe the electric company money, have I really put any energy into the grid? Of course I have, for when the sun shines the most there is no one at home (school, work, etc.) using this energy that is tied to the grid. And unless the meter reader notices the meter going backwards, it is hard to say whose energy is whose.

I currently have a 720 watt solar array feeding into my house which also happens to be connected to the grid. Is this fair? Legal? Moral? Well, I happen to see it as fair and moral, even if it is not legal. I called the electric company and either no one has heard of net metering or they were playing dumb to avoid getting involved.

The array installation is up to NEC code except for the GFI in the PV DC circuit, which I will not install because it is stupid, not to mention expensive. But that is another issue altogether. The funny thing is that the solar array is in plain sight, and the meter reader guy even asked me questions about it. That was over a year ago, and nothing has been said about it since. Well, until net metering is seen as an asset to the grid and not as an encumbrance, I will continue to snicker in secret every time I get the $30-35 electric bill. More power to the little guy who stands before the giant and offers the sign of defiance! LONG LIVE *HOME POWER!* name and address withheld

Hello, we faxed your letter off to the authors of the article (yes, even guerrillas have fax machines these days) and here's what they had to say:

Right on, comrade, do it! Even if they do get their stuff together and start net metering in your state, it's not likely to make a bit of difference in your economics. The only thing you'll get by "legitimizing" your already operating system is the headache of having to deal with utility and inspection department bureaucrats. As long as your system is safe, shine them on. But, safety is the key. For those thinking about cobbing together a guerrilla solar system without paying close attention to making it safe: forget it, you'll only ruin it for the rest of us. Maka Rukus and Jenny Freely

Excellent Magazine… but…
Home Power is an excellent magazine. However, I am un-mechanically inclined and usually information provided in articles goes over my head. You obviously cater to a clientele that is mechanically oriented and technologically savvy.

I am most inclined to purchase a system from a professional and have it installed. Maintenance would be done by the installer, etc. I would largely have to rely on the advice, expertise, and honesty of the local contractor. Most of us are not technically minded and would be forced to depend on locals for support. Please continue to provide technical information, but include practical advice for the novice like myself such as how to pick a contractor, rating systems like consumer reports does, and providing cost and payback projections. If you want to make an impact on the average American (the majority of the population), you will have to condense info into palatable form. Many thanks. John Banaghan, Tallahassee, Florida

Hi John, in HP61 *Richard wrote a great article entitled "What to Expect from your RE Dealer" which should answer many of your questions about hiring a professional. Yes, we try to keep the info in* HP *technical for the readers who want to do it for themselves. We know that we should have more articles on the basics, but frankly, we've done so many over the years that it feels repetitious to us. Use the index or the CD-ROMs to find those past articles. Also, just stick with it—over time the information will piece itself together. Ben Root*

Lactose-Free Web Site
After hours of searching the internet for information about solar power, I was delighted to discover your site. I not only found the information I was looking for, but in the few minutes I learned much more than I had in all my previous hours of browsing/searching/cursing/searching-again.

By the way, your decision to make a huge amount of your information available for free download was generous, unexpected, and fulfilling! (Did I mention it was also low-sodium, low-fat, and lactose-free?) Suffice it to say that I was very pleased with the info and services your web site provides. Jim Paine, Aliso Viejo, California
jwpaine@thorby.com

Hi Jim, and welcome to Home Power. *For the first fifteen issues we published, we gave the magazine away for free. We had to start charging for subscriptions so we could afford to live. Now because of the internet and electronic publishing tools like Acrobat, we can give it away again for those who are content to have the electronic edition. Enjoy. Michael Welch*

PV Shingles
I enjoy the vast amounts of information contained within your pages. I would like to see an article on the PV roofing materials. Are any commercially available at this time? How are they wired up? What is the cost per watt? Bernard Opiela, Corpus Christi, Texas • bgliz03@intcomm.net

As PV shingles are just now becoming commercially available, we haven't got our hands on them yet. How 'bout it, readers? Does anyone out there have these in use? If so, write an article! Richard Perez

For British Readers
The Guardian on Tuesday 27 October reported that John Prescott, the Deputy Prime Minister and co-ordinator of government 'Green' policy - among many other things - believed Britain would receive about £1000 million for the sale of Britain's carbon credits under the trading scheme favoured by the United States interests. Whether this trading will affect the world's output of carbon dioxide is a question to be argued but if the British government does indeed receive this money we need to campaign about how it should be used.

Before the election, at a SERA (Labour Party Green Campaign) conference I asked John Battle, now the minister for energy, to consider Net Metering for small providers. He behaved as though he had not heard of it before and wrote it down. Before entering parliament he was an enthusiast for Combined Heat and Power projects in Council owned blocks in Leeds, where he was prominent in Local Government. I have also mentioned it again to government spokesmen since the election. I think people interested in renewable energy

may need a campaign to keep the idea in the minds of ministers.

At the SERA conference earlier this year, I asked a minister whether we could expect reduced VAT (sales tax) for solar investments. The answer was negative. However, if the Treasury is now thinking about receiving all this money for carbon credits, they ought to pass some of it down to those who help to reduce carbon emissions.

The money would come from the US where the corporations don't want to sign up to any actual reduction by the US, so will buy other countries' reductions.

The following letter to the Guardian was not printed:

Sir, John Prescott hopes for 1000 million pounds of carbon credits from reducing emissions in the UK. Good. Will he now persuade the Treasury ministers to reduce the VAT on solar equipment and electric vehicles? At present, solar water heating, wind generators and other non-carbon emitting equipment are taxed at the standard rate of VAT. Let the government pass these carbon credits down to ordinary citizens when they install the appropriate equipment.

Another step he might take is to discuss with the energy minister, John Battle, Net Metering by which small solar and wind producers can be paid the retail price of the electricity they export to the grid, by using a meter that can go backwards when they are exporting electricity. Many American states have laws to compel public utility producers to accept power from these sources. We need these laws here.

George Matthews, 20 Brookside Road, Wimborne, Dorset BH21 2BL United Kingdom, Tel: 01202 885388 wimtalk@compuserve.com

Hello George. Thanks for the info printed in the Guardian (a British newspaper, for you Yanks who may not know), and your response which the Guardian did not print. We'll print it! We encourage you to roast the local politicians until they give you the deal you deserve on your RE gear and on net metering. It's very interesting to me that the same battles are being fought on both sides of the Atlantic.

Carbon credits accurately portray the depth of our environmental problems. The fact that an industrialized nation can buy the right to pollute from other nations who are not producing their allotted "share" of pollution is nauseating and down-right wrong. *It's no wonder that this planet is in the shape it's in.... Richard Perez*

Stormy Weather

Dear Richard, since my article was published in your fine magazine, I have gotten many very nice messages from people who read about our small system in Belize. I have tried to thank each one, but have gotten floods of email, and a few letters. All of them are appreciated.

Since my article was published, Central America has been battered by Hurricane Mitch. Hurricane Mitch was headed directly towards Northern Belize. Needless to say, we were quite worried. We closed the "office" in town, left for the farm, and listened to the radio as Mitch headed west northwest, then west, then southwest, directly towards us in southern Belize, then it turned South and devastated Honduras, parts of Nicaragua, El Salvador, and Guatemala.

When we came in to town for a visit to the office, we heard that a Hurricane was bearing down on Belize. We packed up, and bought extra supplies in case our local supply infrastructure was damaged. Then we went up to the farm, peeled the two 53 watt panels off the roof and bolted the "lawn chair mount" that holds the 90 watt panel to the ground in anticipation of major winds. We had one week of rain (mostly a steady drizzle), a bit of wind, but nothing too heavy. We had lights all the way through the long week.

I was very worried about our chances of surviving the hurricane. Our "office" is close to the coast in a low-lying area, and if we had gotten a glancing blow from Mitch, the whole neighborhood of Hopeville in Punta Gorda would have disappeared. Our house on the farm is well built, we think, but not against a hurricane. In the end, we lost nothing but sleep, and nobody in Belize died, as far as I know.

We were very, very fortunate in Belize. The country has breathed a great collective sigh of relief that we were spared from most of the worst effects of the storm. However, our joy at being spared is tempered by the knowledge that an estimated 9-10,000 people died in our neighboring countries due to flooding, high winds, and mudslides. According to the VOA, an estimated 13,000 are still missing. The death toll may be much higher.

At this time, there is a serious need for assistance, especially in Honduras, and food is going to be a major problem. This is the time of year when clearing for and planting of corn occurs. The food situation is critical. Right now, Belizeans are sending thousands of pounds of this years rice crop to help our neighbors along with lumber and dried food items. Crews are leaving here with supplies to help rebuild every day. It will be very hard to reach remote areas cut off by washed away and buried roads, and by bridges that have disappeared.

There is a huge need for food, clothes, medicine, and lights. Everybody can help by contacting the Red Cross/Red Crescent, or using whatever aid agency is available. In the coming months, the needs will shift from emergency food problems into rebuilding the devastated infrastructure. For many areas, PV may be the way to go. Certainly a big improvement in quality of life for the hundreds of thousands of homeless people would be lights.

If you know of anyone who is considering sending PV equipment to help remote villages or clinics rebuild, I would like to help. There is a serious need to improve the quality of life for the victims of Hurricane Mitch.

If you would publish my letter in your December issue, perhaps someone who reads this will have an idea of how to help. If you or anybody else out there wants to help the affected populations with a plan to send solar components and batteries, let me know. I would like to help. I can build basic photovoltaic systems, swing a hammer, or whatever. Thank you, Christopher Nesbitt, PO 153, Punta Gorda, Belize, C.A., Ph/Fax: 501-7-22891, toucanpro@btl.net

Ozonal Notes

Richard Perez

Guerrilla Solar

The guerrilla solar article in *HP67* has generated a flood of mail. I had no idea that there were so many solar guerrillas out there. While I knew that guerrilla solar was possible and relatively inexpensive, I had no idea that so many folks were already doing it. We even received mail from a fellow in Connecticut who attended a utility meeting where guerrilla solar was being discussed by utility people. Apparently, the local utility folks were agitated that there might be solar guerrillas in their neighborhood. From the volume of mail we have received, I can only conclude that they may be right.

Guerrilla solar is the unauthorized placement of solar electricity on the utility grid. In practical terms, guerrilla solar involves putting up some PV panels and then sending this solar power onto the grid without utility permission. It means de facto net metering whether your state has a net metering law or not. If the energy being used is less than the amount being consumed, it means turning the electric meter backwards.

Many of the solar guerrillas who have contacted us have much larger systems than the one we featured. The most common system involves many PV modules, one of the Trace SW series inverters, and the presence of the utility grid at the location. The owner of such a system has only to push the "sell back" control on the Trace inverter and solar energy will flow onto the grid.

I find it amazing that utilities are so upset by guerrilla solar. In terms of actual guerrilla solar energy placed on the grid, the amount is miniscule. It's the basic idea that scares the utilities—solar guerrillas could be anywhere, and they wouldn't know how many or where they were. I think this is a control issue, and we all know how much utilities like to be in control.

We've received lots of email and letters requesting both the identity of the solar guerrillas and the location of the guerrilla solar system that was published in *HP67*. Sorry, but we can't say. A key element in guerrilla solar is its secret nature. We want to hear from even more solar guerrillas. We will keep your names and locations confidential.

Many folks have asked, "Does *Home Power* have a guerrilla solar system?" No, we don't. In order to go guerrilla solar, the utility grid must be present at your location. We are located over six miles from the grid, so guerrilla solar is not possible here.

Oregon Net Metering

We are entering into the final stages of organizing for the proposed Oregon net metering bill. Readers, if any of you would like to give input on this bill, or would like a copy of the proposed bill before it is finalized, please contact me soon.

We are encountering less utility opposition to this idea than we had anticipated. Now that net metering is the law in 26 other states, perhaps Oregon's utilities can read the writing on the wall. In fact, we even had some utility folks say that the bill doesn't go far enough. One municipal utility suggested that the bill should actually offer more than net metering—they suggested rate based incentives. Rate based incentives means that the RE we put on grid would receive a payment of greater than the going maximum retail rate. Hey, these folks are starting to change my mind about utilities!

We are still gearing up for the big publicity campaign and legislative petition for this bill. Even though Oregon's utilities are not currently obstructing this bill, we are not counting on their support during the upcoming legislative session. We still need folks inside Oregon to circulate petitions, write their legislators, and organize in their own neighborhoods. We need you. Please sign up to help promote this bill. Write, email, or call us at *Home Power.* Grassroots support for this bill has made its success possible. This is the final stretch—we need to sprint to the finish!

Energy Fairs

We have attended four energy fairs this past summer. What was once a rare occurrence is now becoming a regular event. Even more new fairs are being proposed for next year. The energy fair is an idea whose time has finally arrived. I've been amazed at the expertise of the people attending these fairs. These folks know what a watt-hour is, they know how much energy their appliances consume, and they have reduced their energy consumption. They are going solar.

I want to encourage those of you planning new energy fairs for next year to contact us as soon as possible.

We can help you network with other energy fair organizers, secure industry support, and provide publicity and advertising. We will support your efforts in any way we can. In order for our help to be really effective, we need to know about your proposed energy fair at least six months in advance.

Find the Schwartz

All of the entries in the Find the Schwartz contest are in. The randomly selected winner is Anthony Rossman of Oxford, Ohio. Congratulations, Anthony! We've renewed your subscription, and your T-shirt is on its way! For those of you who also entered the Find the Schwartz contest, Joe's picture appeared on pages 4, 19, 71, and 74.

Access

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Q&A

Off-Grid Phones
I would like to know what other off-grid people are doing about telephones. We can't receive cellular at our location. We do have a mobile radio phone which is expensive and often breaks down. We don't have $10,000+ to put into our own system. Are there any other solutions out there? J. Sabia, El Prado, NM

Hello J. Sabia. Radiotelephones can be expensive items. See HP56*, pages 42 thru 48 and pages 50 thru 54 for an overview on off-grid communications, especially radiotelephones. The major factor in any radiotelephone (R/T) system is distance. How far are you from the nearest telephone hard line? If you are within a mile, then modern 900 MHz cordless telephones can span this distance easily, for less than $500. When the path distance gets to be several miles, then a special R/T system is required. The cost on these depends on the path distance, how many lines you require, if you need a high speed data link for computer modems, etc. The cost varies from about $4,000 to over $7,000.*

I suggest that you contact two companies for solutions to your communication problems. One is C. Crane and Company, a regular advertiser in Home Power *(see the ad index in this issue). C. Crane has the long distance cordless telephones at reasonable prices. If you need communication over longer distances, the your best bet is TeleMobile at 310-538-5100. Or contact them via telemobile@telemobile.com • www.telemobile.com While owning your own R/T system may seem expensive, it's far cheaper than paying cellular phone bills if you use the phone extensively. Richard Perez*

Clean PV?
I see a lot of comments about the cost of using fuels vs. using renewable sources of energy. The cost of producing the hardware is ignored. How much fossil fuel goes into producing PVs? Are there any hazardous wastes produced as a byproduct of PV manufacturing? Aren't PVs produced in a clean room, with disposable masks and shoe covers? Can we get some of these facts, or will they remain hidden costs? Rich McKinney, Conover, North Carolina

Hello, Rich. Making PVs is indeed expensive, but the major component of this expense is energy. A modern PV module will produce the energy embodied in its manufacture within two years of exposure to the sun. Many PV manufacturers use PV energy in their manufacturing process, e.g., Solarex and BP Solar. Making PVs is not much different from making any semiconductor—nasty substances are used. If the maker is careful, then PV manufacture represents minimal hazard to our environment. The entire semiconductor industry, including the PV industry, has a very good (and well deserved) reputation for controlling the hazardous substances used in their manufacturing processes.

It always amazes me that people ask this question about photovoltaics, while no one seems to care about the embodied energy or hazardous wastes used in producing consumer appliances such as TV sets, hair dryers, automobiles, and washing machines. It baffles me that folks seem to single out PVs for critical analysis. Richard Perez

Oil Furnace on Inverter Power
My primary concern is to run my oil fired furnace on inverter power. I want to purchase a Trace DR2424 inverter, eight batteries, and all of the necessary equipment to run the furnace 8-10 hours at night as it is not practical to run the generator only for the furnace. As of now, I do not intend to add PV. I may eventually have a more elaborate system including PV and wind power.

I would like your opinion. Is this a practical undertaking? Would I need a capacitor on my furnace? I figure the furnace will require about 1000 watts. It uses 2.6 amps for the combustion motor and 5.9 amps for the air blower. Sometimes they run intermittently, but part of the time they run together. Would a 440 amp-hour battery be large enough?

I understand that the Trace inverter will charge the batteries off the grid. Is the inverter equipped with a charge control when charging from the grid, or will I need to purchase a C40 controller?

I was also reading that the ground rods from the DC system and the AC service panel need to be wired together if the inverter does not have an internal ground. Does the DR2424 have this ground?

I thank you for your excellent publication. Keep up the good work! G. B., name and address withheld by request

Hello G.B. First, what you are proposing is a simple job using off-the-shelf RE gear. Don't buy that DR series Trace inverter—it's mod sine wave and won't work nearly as well as a sine wave inverter for your purposes. Instead, consider either a Trace SW series or a Statpower ProSine inverter for this job. You want to power two things—both of these are motors, which are inductive loads. Years of experience have taught us that

inductive loads like sine wave power. They perform poorly, if at all, on mod sine wave power. So go sine wave and you won't have to worry about adding capacitors to the motors to make them work!

You mentioned that the entire furnace setup consumes 8.5 amperes at 117 VAC. This is about 995 watts, so the minimum inverter size to even consider is a 1,000 watt unit. I'd buy a bigger inverter to have power left over for other appliances. Assuming a 50% duty cycle, the furnace will consume about 5 KWH during the ten hour period you specified. Assuming a battery voltage of 24 VDC and assuming that we always leave 20% of the energy in the battery, then you will need a minimum of 250 ampere-hours of storage in the battery. Your estimate of 440 ampere-hours is better, since it would work the battery less and give you extra stored energy for lights, TV, and what-not.

Both the inverters I mentioned above have great battery chargers which can be sourced by either the grid or your generator. They are regulated—so you don't need a charge controller until you add PVs to your system. These inverters are already set up to be wired into your existing 117 VAC ground system, so there shouldn't be any grounding problems.

Your questions, G.B., are typical of hundreds I have been receiving from folks concerned about keeping their homes going during extended power outages (Y2K?). An inverter/charger and battery can easily accomplish this job. You can source the system with the grid, a generator, or preferably with an RE source such as PV or wind. Remember to include essential details, such as overcurrent protection and instrumentation. You should buy and install an overcurrent device such as a Class T fuse or DC rated circuit breaker for the DC input side of the inverter. You should also purchase and install an ampere-hour meter (the Cruising E-Meter or the Bogart TriMetric) to inform you of your battery's current state of charge. Neither of these items are frills. They are essential equipment if you wish your system to be safe and effective. Richard Perez

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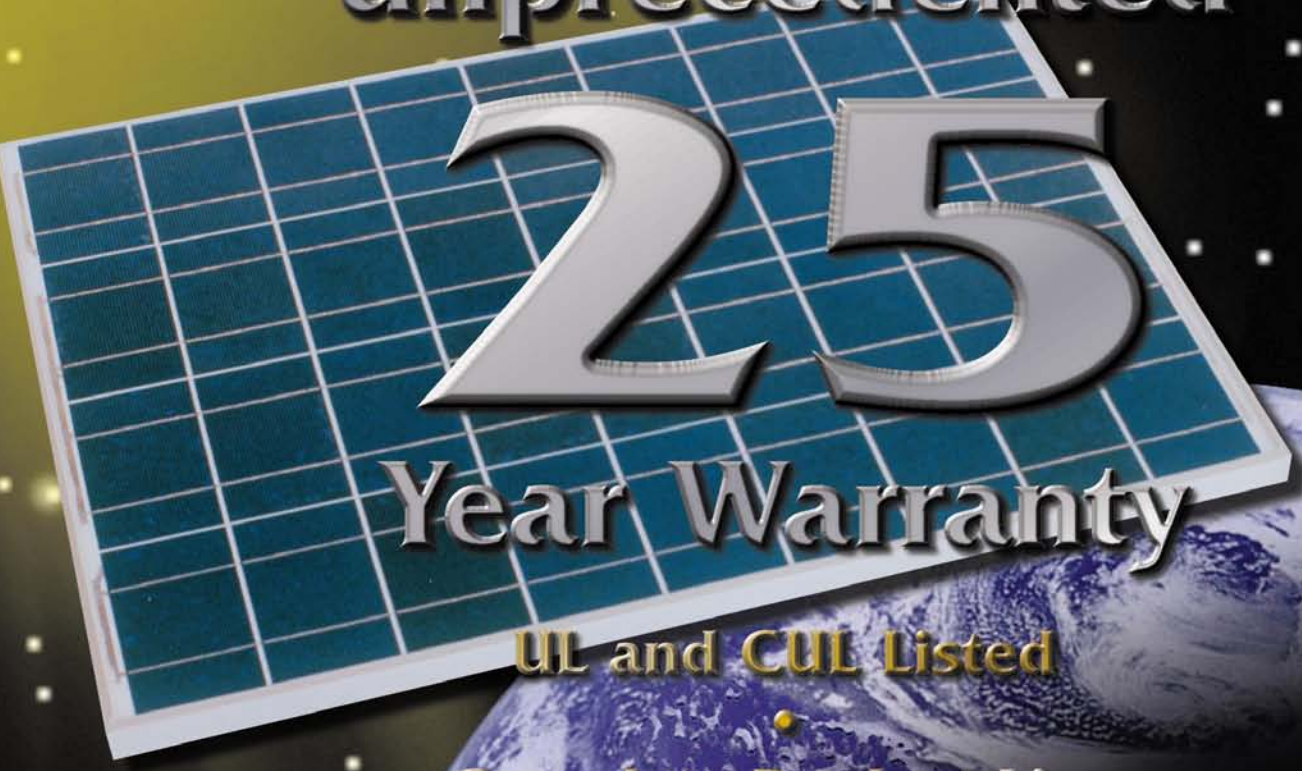

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