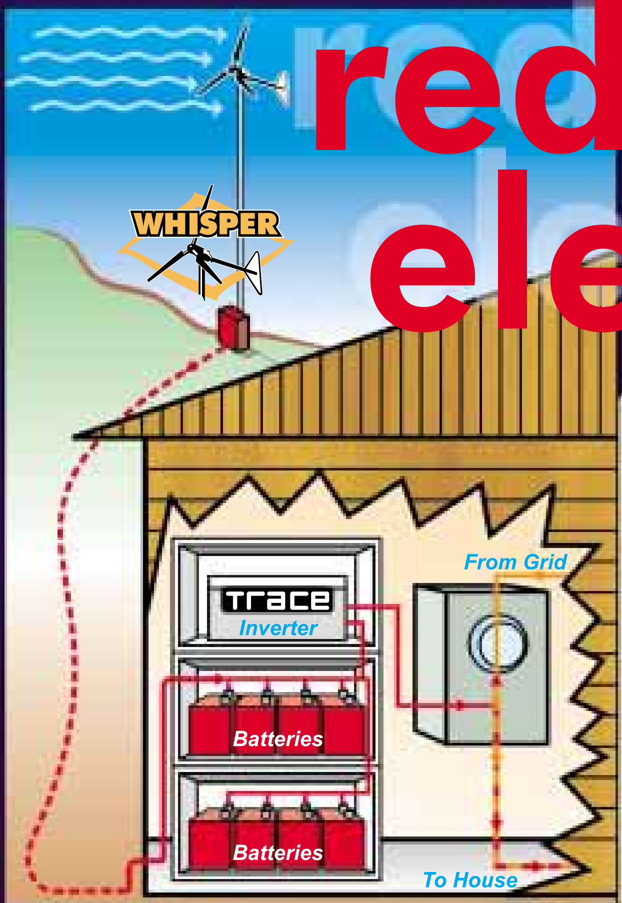

this is hot

reduce your electric bill



The Wind Electric System supplies power to a personal power station, which directs electricity into your home before drawing power from the power company.

Introducing Wind Electric Systems from Southwest Windpower

FREE ELECTRICITY FROM THE WIND! Have you ever wanted to reduce or eliminate* your electric bill? Now you can. Today's technology makes wind-powered electricity more affordable than ever before. Save money and help clean up the environment.

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Southwest Windpower is proud to announce that Models Air 403 Land, Marine and Industrial Wind Turbine Generating Systems now comply with all safety and design requirements as outlined in IEC 61400-2 and have earned the right to bear the Underwriters Laboratories Inc. (UL) Classification Mark. For more information on UL, its services, or UL product certification, visit their Web site at www.ul.com.

The innovative ***AIR*** *wind module* is a reliable addition to any battery charging system.

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* Annual average wind speed at 30' above sea level

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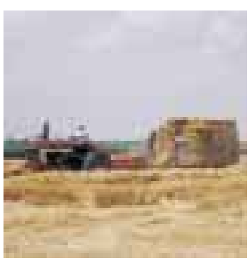
HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

Issue #81 February / March 2001

Features



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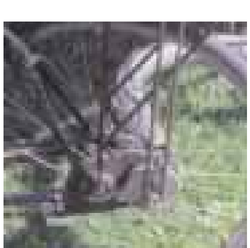

Features

Homebrew

Cover: Three stages in the evolution of Jon and June Haeme's RE-powered straw bale home in Illinois. See page 30.

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Recycled Paper

Recyclable Paper

Not everything about spreading the word on renewable energy is volts and amps. At *Home Power's* business office, a little artistic expression enlivens the daily workspace. Special thanks to artists Amirah Said (left, daughter of *HP* team member Connie Said) and her pal Caelin Johnson. They did a fantastic job, incorporating many renewable and sustainable technologies into their huge mural of ecotopia.

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Solar Guerrilla 0013

"Think about it..."

What you do to the Earth, you do to yourself.

–Julia Butterfly Hill

Home Air Conditioning on a Renewable Energy System

Ed Sheldon

Eighteen Solarex VLX80s power the Hoovers' home, including the fan, pump, and igniter for the air conditioning system.

Bill and Carol Hoover live in a remote California mountain canyon, isolated from the hubbub of city streets and highways. Their concrete house is cut into the canyon wall, overlooking a stream and pond. Wildlife regularly visits this sanctuary, especially deer, raccoon, wild pig, and bird life of all sorts. The Hoovers' home has been independent of the utility grid since it was built. They chose renewable energy sources to avoid ugly and expensive power lines intruding into the canyon.

In trying to cool the house, the Hoovers tried some portable swamp coolers. These helped some, and for more improvement, they changed to window-mounted swamp coolers powered by Siemens solar panels. These worked just well enough to be teasers. The water source had enough mineral salts to rapidly build deposits (mostly magnesium). Maintenance was a problem, so they decided to search for something better.

In 1998, Bill came to me asking about air conditioning. For several years, I have been his consultant on their renewable energy system, and I designed the original power system for their home. When Bill discovered an Internet company selling air conditioning that could run on solar panels, I was skeptical, thinking of the energy demands of a typical compressor.

After some research, I found the Servel name on three to five-ton chillers using a gas absorption process. (By definition, the standard ton of refrigeration is defined as

288,000 British thermal units per day, or 12,000 BTU per hour, or 200 BTU per minute.) With this system, a significant portion of the energy demand was transferred to natural gas or propane.

Feasible? Yes! Gas refrigerators have been doing this for years. The Servel name is well known. Bill and Carol already had a 500 gallon (1,900 l) propane tank for the gas appliances in their home. Gas chillers have been serving the air conditioning demands of commercial installations for a long time.


The Servel three-ton gas-fired cooling unit behind the house.

The upshot of this is that Bill and Carol now have a three-ton air conditioning unit powered by solar energy and propane. House temperatures are now in the comfort zone, despite outside temperatures that are typically in the 90s during summer days, sometimes reaching as high as 110°F (43°C).

Air Conditioning System

The air conditioning system has two major components—the chiller and the cooling coils. Robur Corporation, using the trade name Servel, manufactured the Air Cooled Absorption Water Chiller model ACD 36-00, a three-ton unit with a delivered capacity of 36,000 BTU/h. It uses up to 75,000 BTU/h of propane together with 875 watts of electrical power at 120 VAC. It delivers 45°F (7°C) chilled water at 7.2 gpm (27 lpm), and is mounted outside the house.

The heat exchanger to cool the house was provided by Edwards Engineering, Inc., and consists of cooling coils mounted along internal walls adjacent to the ceilings. These valance cooling coils are completely passive, requiring no fans to move the air. The air is circulated throughout the rooms by natural convection currents.

Edwards Engineering sells these valance units in a number of configurations, each cut to the desired length. They consist of parallel finned copper pipe enclosed in a sheetmetal cover ducting warm air in at the ceiling and cooled air down the wall.

The valances are well made and attractive. The configuration we received has two rows of finned 1/2 inch (13 mm) pipe—one row of five and one row of four. To our knowledge, this is the first usage of valance cooling coils with the Servel chiller. Connected to the chiller, this air conditioning system operates quite effectively.

One unexpected side benefit of the valance system has to do with the family cat. Before the installation, he used to climb up on the bookshelves and get into the dropped ceiling. The valances block his access, so the Hoovers no longer need to worry about him getting up there. Only one other significant feline problem remains. The cat likes to play with the new thermostat….

Inside the Servel air-cooled absorbtion water chiller.

The Hoovers' all-concrete house, in the mountains of California.

Approximately 40 linear feet (12 m) of valance cooling coils were installed. The back half of the house receives little cooling when the doors are closed, but it is not as critical there since it is not the main living area and is mostly below ground.

The House

The Hoovers' house is of poured concrete construction—floors, walls, and roof—and has approximately 1,440 square feet (134 m^2) of floor space. A second tile roof is fitted above the basic concrete roof, with an air space separating them. The original roof was flat concrete. When some leakage started to occur, a second sloping tile roof was installed above the original. This solved the problem of the leaky roof, and increased the total roof insulation value as well.

Floor to ceiling double-pane windows and sliding glass doors take up much of the front, which faces south. The front half of the house is partitioned into the kitchen, dining room, living room, and master bedroom. Down the middle of the house is a lengthwise partition with doors leading to rooms in the back half of the house.

Though it is normal to install hydronic heating and cooling around the perimeter, the floor to ceiling glass precluded this. So the valance cooling coils were installed along the top of the center partition, with exposure to the dining room, living room, and master bedroom.

Planning the System

In planning this air conditioning system, the big question was the heat load and losses of the house, which would dictate the size of system required. Bill Hoover did this study, and I cross-checked his data. Bill acquired a couple of recording thermometers, and monitored the internal and external temperatures. We then had the temperatures and the time lag between the two environments, as well as the heat conductance of building materials and contents. From this, we could make the calculations to give us the information we needed.

A three-ton air conditioning unit was called for. From the data sheets of the Servel unit, the gas and electrical demands were established. The existing propane tank would be adequate, though Bill was prepared to upgrade to a 1,000 gallon (3,800 l) tank if necessary.

The solar-electric system needed to be enlarged if it was still to meet other electrical demands placed upon

The valence hides the hydronic cooling coils—Bill Hoover likes how it looks.

Looking down from the ceiling—the cooling fins create surface area for maximum air contact.

Nine finned copper pipes carry cool water through the heat exchanger.

it. The valance cooling coils required some study, since they were new to us. Edwards Engineering was very helpful in giving specifications based on our household dimensions and heat load data.

Solar-Electric System

The objective was to remain completely independent of the grid, and with no supplemental generator. The six Solarex MSX-53 50 watt panels were replaced with eighteen Solarex VLX-80 80 watt panels, a nearly five-fold increase. The eight Trojan 205 AH golf cart batteries were replaced with sixteen 350 AH Trojan L-16s, an increase of nearly three and one-half times the capacity.

The wiring was changed from a 12 VDC to a 24 VDC configuration. The Trace U2012 inverter was replaced with a Trace DR3624. The Trace C-40 controller is now operating at its maximum. All wiring, disconnects, and fuses were upgraded to the new capacity. The wiring from the powerhouse to the main house, a 150 foot (46 m) run, was changed from #12 to #6 (3.3 to 13.3 mm^2).

Sixteen Trojan L-16s make up the new battery bank.

The Trace DR3624, C-40, fuses, and disconnects.

The Harris system was corroded beyond repair.

A new circuit breaker panel at the house was added, with two 20 A circuits, one feeding the new chiller. We changed the motor in the water pump (a Dankoff 1305 Slowpump) from 12 to 24 VDC. Water is pumped from a spring to a tank up the hill that gravity feeds the house.

Ancient History

The powerhouse started out life as an 8 foot (2.4 m) diameter steel culvert turned on end and set into the ground. A concrete floor with drains was added, along with a wooden roof covered with asphalt roofing. A hatch and a ladder provided access through the roof. A Harris Hydro Pelton wheel driving a Delco alternator provided 12 VDC output to charge a battery bank through an Enermaxer diversion load controller. The battery bank used eight GNB 6 V golf cart batteries. A Dynamote square wave inverter provided 120 VAC to the house.

All of this equipment was located together below ground in the powerhouse. Several problems soon became apparent. The hydroelectric system was quite troublesome, largely because the water pickup was designed for a rather docile summer stream. High water from winter storms, coupled with surges of debris, sand, and gravel plagued the system from the pickup point all the way to the jets for the Pelton wheel. Tapping the stream, which ranged from a dry bed in summer to a raging torrent in the winter, became too much of a fight. The intake had been rebuilt several times, but with no long-term success. The original 50 watt solar panels were only installed to augment the hydro, but proved to be far more reliable.

Fumes from the battery bank immediately started to corrode virtually all equipment in "the hole." For three or four years, we cleaned the hydro intake every season, sometimes multiple times, until we started looking for another source of energy. The corrosion told us, "Get those batteries out of the hole," so we built an aboveground battery box.

The square wave inverter was very bothersome to radios and audio equipment. It was also getting very corroded, so we replaced it with the Trace U2012. Though it was not a sine wave inverter, everything worked better thereafter.

With temperatures ranging from just below freezing in winter to well over 100°F (38°C) in the summer, the batteries were hard to regulate. So the controller was changed to a temperature-compensated Trace C-40, since the Harris Hydroelectric system was by then out of service. The C-40 also provided a periodic equalization charge, which previously had to be done manually.

The new array of six MSX-53, 50 watt Solarex PV panels replaced the hydro system and the older PVs. These changes proved quite stable. The GNB batteries lasted about six years, before being replaced with equivalent Trojans and new battery cables.

Corrosion finally got the best of the Slowpump on the water system, so Dankoff sold us a new one. At one point, the Trace U2012 inverter had to be flushed with distilled water and baked dry before resuming its operation. The Harris Hydroelectric system was yanked in the spring of 1999, prior to upgrading for the air conditioning system. It was so badly corroded that it was unsalvageable.

A Sola power conditioner was necessary to operate the Servel igniter on mod-sine power.

Delays

Numerous delays plagued the hardware acquisition phase of the air conditioning project. In the end, we worked with Edwards Engineering's main office in New Jersey. Within days after we sent our check, they shipped exactly what we wanted. Shipping this large unit was also troublesome, and took some special arrangements. Finally, after over eight months of trying to get the air conditioning system, we got it and were able to use a local contractor to do the installation.

Meanwhile, we were working on the solar-electric installation. We first received a quote from a respected Arizona company. They had been involved in a number of home air conditioning installations in Mexico using the Servel chillers, but with supplemental gasoline generators. Their proposal looked good, and only needed minor changes, since it was designed for a 4 ton chiller and used an auxiliary gas-driven generator. The quote also specified a 230 VAC system, and a full sine wave inverter. The engineers at Trace felt that we could get by with a modified sine wave inverter, which would save about a thousand dollars.

The three-ton chiller used 120 VAC, as compared to the four and five-ton units that required 230 VAC. Rather than going with the Arizona outfit, I went to a California solar distributor I had been using for years and gave their rep a complete order for what we wanted. This was a mistake! The California company was in the middle of changing ownership, and the rep I liked so well had left the company. The order was lost.

Regardless, I stubbornly stuck with this distributor, and re-ordered. The parts came piece by piece, each with its own billing. Every week I had to call them again and check on or re-order the next components. After over six months of continual negotiations, we finally got most of what we wanted, though we had to go to a second distributor to get cables and some other minor components.

A number of substitutions were made. Instead of the twelve 120 watt Solarex MSX-120 modules we had ordered, our supplier shipped eighteen 80 watt VLX-80 modules. The mounts for these were delayed over two months, and arrived short on parts, which took another week to arrive by air.

Installation Problems

The system was installed piecemeal as components arrived, and went together without significant problems. The chiller did not appear to have an installation manual with it, and we had to make minor plumbing changes after seeing what we had. Without directions, we initially overcharged the system with antifreeze solution and had to drain some.

Air Conditioning Performance Measurements

	Temperature (degrees Farenheit)			
Time	*Inside*	*Outside*	*Input Water*	*Output Water*
14:40	82	102	82	82
14:50	82	102	79	82
15:00	82	102	60	62
15:10	82	102	54	54
15:20	81	102	53	54
15:30	80	102	53	53
15:40	79	103	52	53
15:50	78	103	52	53
16:00	78	103	52	53
16:10	78	104	52	53
16:20	77	104	52	53
16:30	77	103	52	53
16:40	77	103	52	53
16:50	76	102	52	53
17:00	76	101	51*	52

*Continued down to 45°F as the thermostat started cycling.

The most significant problem after installation was that the chiller would not fire up when the ambient temperature was over 90°F (32°C). The electronic spark igniter was failing. A serviceman came down to look at the problem, but was puzzled. He did give us a lot of good advice, and left us a service manual. We substituted two new igniter modules, but continued to have the same problem. Lighting the gas with a match (which we were advised not to do) proved that all other parts of the system worked.

Why was the igniter failing? The igniter was powered from the 24 VAC control transformer. On a hunch, we disconnected the control transformer from the system power, and powered it separately from a portable generator, and *voilá*—everything worked. Why? Putting an oscilloscope on the circuit, the only change we observed was the modified sine wave from the inverter, versus a relatively smooth sine wave from the generator.

I called Fenwal, the manufacturer of the igniter module, and discussed it with their engineering department. They agreed that the waveform was the culprit. They suggested putting in their 12 VDC igniter, which is widely used in motorhomes and similar installations. This looked like an attractive solution.

Next, I called Trace, ready to bawl them out for saying I could probably get by with the modified sine wave inverter. They suggested that I put a small power conditioner ahead of the control transformer. So we tested a Sola 60 W Power Conditioner3, which worked

The Servel ACD 36-00 makes the summer heat bearable.

Carol Hoover and kitty enjoy the cool home.

like a charm. We installed it, at much less cost than changing the inverter from modified sine wave to sine wave, and even lower cost than putting in a DC igniter. Problem solved.

Off-Grid Air Conditioning

The solar/propane air conditioner works just as we dreamed it would. Careful calculations in sizing the system paid off. Now we can laugh at those who said it wasn't practical, and the contractors and companies who were reluctant to get involved because they had never worked on this kind of installation.

The gas input for this system is 75,000 BTU/h. Though the propane usage should be measurable, the total number of refills per season has not increased and the owner does not yet have a figure. Since the electrical system does not have to drive a compressor, the only electrical loads are a condenser fan motor and a circulating pump motor.

We were disappointed with some members of the industry, who could not deliver on a timely basis. We were pleased with the people at Robur Corporation and at Edwards Engineering, where we got encouragement and advice. Though we had planned to have it working in the springtime with the long hot days of summer ahead of us, we were pleased to have the system functional for the last hot days of summer before the coolness of fall set in.

We feel like pioneers, since we haven't encountered another system like it. While there have been other installations using this cooling equipment, as far as I know, this is the only one in the U.S. that is totally off-grid using solar energy.

Access

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Valance cooling coils

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From sea level to summit—Dallas Pass, Rocky Mountains, Colorado.

Early last year, I built a solar-electric bicycle. On this solar and human powered rig, I rode from San Francisco, California, to Carbondale, Colorado, arriving just in time to start a summer of classes at Solar Energy International. In the summer of 2001, I will go to China, and continue solar cycling around the world.

I was installing residential PV systems in the San Francisco Bay area when I had the idea to build a solar cycle. In January 2000, I decided to not only build it, but to live with it. The primary motivation was (and still is) the satisfaction of living and sharing a sustainable lifestyle free of materialism. I get to meet new people in new places, share ideas, spend days outside using my body, sleep under the stars, and allow life to unfold as taking the risk of the unknown pays off.

Ultimate Test

The trip was also the ultimate test for developing the solar cycle. After the first 30 miles, I realized that I needed a stronger PV mount. After 100 miles, I realized that I needed brakes for the trailer. After 1,000 miles, I realized that I needed a trailer with spoked wheels. And after 1,500 miles, I finally decided that I needed a more powerful motor.

Cycling is the best way to see the world. It takes time, so you experience the places you ride through. Although I took roughly three and a half months to ride the 2,000 miles (3,200 km), I spent less than half of that time actually traveling. The rest of the time I spent hanging out in towns, modifying the rig, meeting people, backpacking, et cetera.

The coast was good training. I started with 30 mile (50 km) days, and was fine with 60 milers (100 km) by the time I hit the mountains in Prescott, Arizona. The looks I got from cars while riding over passes were priceless. It sounds like a lot of work, but the riding simply put me in the necessary shape, and then kept me there. Of course it took about two weeks to fall out of shape once I stopped riding.

I rode mostly on two-lane highways (50–60 mph; 80–100 kph speed limit) that were generally not overly congested. Still, cars were a constant threat to my life. The few roads that were two-lane, with no shoulder and heavy semi traffic going 65 mph (105 kph), forced me to come to grips with my mortality. On one of these roads, a semi forced me into the sand shoulder. Luckily, I was able to lay the bike down as my trailer tipped, and the car behind him pulled over to make sure I was okay.

I often camped out in national forests, but there were many nights out in the desert, a quarter mile off the highway. I also stayed with kind people I met along the way. I am still so inspired by all the people who reached out to do whatever they could for me, and took serious interest in my journey. Some were people who have been living with PV systems for years, but there were also people who didn't know that solar-electric systems really work.

Extremes

I got a taste of extremes in Springerville, Arizona, allegedly the windiest town in the country. I rode into record (for the day) winds up to 75 mph (120 kph)! I also rode through record heat (for those days in April) in the Mojave Desert. I drank five gallons (19 l) of water in a day and a half, crossing the totally remote 120 mile (190 km) stretch on highway 62 from 29 Palms, California to Parker, Arizona. It was not until I arrived in Parker caked with salt that I was told that I'd done it in 110 degree (43°C) heat.

The following day, my original motor overheated after 5 miles (8 km). So I rode another 30 miles (48 km) in 100+ degree heat without any assist at all. I practically passed out before I decided to hitch a ride out of the low desert.

The next morning I was picked up by a pickup truck and dropped off outside of Prescott—50 miles (80 km) down the road, 1,000 feet (300 m) higher, and 15°F (8°C) cooler. After running out of spare tubes for my trailer in between towns a few times, I became pretty confident that I could get a ride from a pickup truck whenever I needed it.

Once I arrived in Carbondale, I landed in a teepee belonging to an SEI employee, and lived there on a picturesque hillside for the summer. During this time, I disconnected my trailer (it takes a matter of minutes). I used it as the power source at the off-grid SEI campground, while using my bike to commute to classes.

The SEI workshops I took were excellent opportunities to further my renewable energy education. They included *Renewable Energy in the Developing World, Microhydro, Wind Power,* and *Advanced Photovoltaics.* I found out that intense training in renewable energy is

PVs charge the solar-powered bike at camp—in Los Padres Mountains, California.

only part of the SEI experience. It also includes making friends, having a blast, and networking for future projects.

In fact, I would not be riding through Asia so soon had I not met my solar cycling partner, Colin Mitchell, at SEI over the summer. When I finished up at SEI, I took a train back home to Vermont, where I will be until next summer, when the Asian tour begins.

David Clay, spreading the renewable word.

Performance

The rig has a 24 VDC system. In full sun, the array of four Solarex MSX Lite modules produces 4 to 5 amps. My trailer weighs 190 pounds (86 kg) empty, and I pulled an additional 85 to 100 pounds (39–45 kg) of gear. On flat ground, I can cruise at 18 mph (29 kph) without pedaling, with the motor drawing 13 amps.

I tested the range of the bike on flat ground, with an unloaded trailer and a 150 pound (68 kg) rider, from full battery to empty battery (100% SOC to 20% SOC). With no pedaling and no sunshine, it has a range of 25 to 30 miles (40–50 km). With no pedaling, but with good sun, the solar cycle has a range of 35 to 40 miles (55–65 km). When pedaling, the rider's fitness level becomes the only limit.

On my journey, I averaged 45 miles (72 km) a day on my travel days, pedaling consistently at a moderate pace, averaging 12 mph (19 kph). Typically I would start the day (late morning) with the batteries at about 24.5 volts, and finish the day at dusk at about 24 volts. I would often reach 25+ volts by midday, because I didn't rely heavily on the motor until later in the day, when I was tired, and also more confident in the battery's state of charge.

Components

This solar cycle consists of a cargo trailer with a canopy of PV. The trailer is manufactured by Bikes At Work, and is 2 feet wide by 6 feet long (0.6 x 1.8 m), plus a couple feet in the trailer tongue. It has an impressive 300 pound (135 kg) capacity, and is mostly aluminum. The trailer carries the batteries, which power a 24 V pedal-assist electric motor on my bike, which in turn drives the bike's rear wheel.

The solar canopy consists of four Solarex MSX-30 Lites (30 W each). They are glassless and frameless polycrystalline panels. Initially, I had them mounted directly onto angle aluminum. But they are not rigid, so when I rode over a bump they would flap, which damaged some of the conductor joints.

My month's rent in Berkeley, California ran out the day before I finished building the rig, so rather than waste a month's rent, I decided to work out the bugs on the road. In Santa Barbara, I finally received my new modules. This time I mounted them on plywood, and suspended it from a rigid perimeter, first with latex tubing, which lasted about a month in the sun, and then with bungee cords.

This fall, I mounted the modules on plywood, and mounted that on angle-bar, similar to my first rack. The backing keeps the modules from flapping, which appears to be sufficient protection. Next time I will use a single 120 W framed module.

The 10 A Solar Converters charge controller (model PT 12/24-5) was originally a 5 A controller, but the manufacturer put in a 10 A diode and fuse, and said it would be fine. It is a maximum power point tracker, with

David Clay's route to Colorado (in red).

Four Solarex MSX-30 Lite PVs keep the batteries (in the plastic box) charged.

standard three-stage charging. It works with 12 to 24 V input and output, and is over 94 percent efficient.

The battery pack consists of two Dynasty 33 AH, 12 V, sealed lead-acid batteries in series. They lie on their sides with the control/fuse board on top of them, while snugly contained in a mini Rubbermaid Action Packer.

Trailer Tales

Hitching the trailer to the rear wheel axle area (as opposed to the seat post) with a universal ball joint gives great stability and tracking. Unfortunately, the 16 inch (40 cm) plastic rimmed wheels frequently blew tubes and ate through tires, although they were problem-free for the first 800 miles (1,300 km). I tried to get spoked wheels for the trailer, but could not find any that were compatible.

The bike's Curtis controller and Scott motor.

My trailer weighed 280 pounds (127 kg) with all my gear, which posed a great threat to my safety when going down steep, winding hills. I learned this in Monterey, California when the trailer jackknifed and I flipped going 20 mph (32 kph). After a day of white knuckles and sheer terror on the steep winding cliffs of Big Sur, I hitched a ride in a pickup back to Monterey, where I put brakes on the trailer.

A friendly machinist (one of many along the way) supplied me with a piece of aluminum bar, which we laid across the trailer behind the wheels. We bolted the brake mount horizontally on the bar. A local bike shop set me up with a little brake cable component that splits a single brake line into two lines. So I had a single brake lever for the trailer that pulled on the brakes for both wheels simultaneously. I think the heat from friction of the brakes warped the plastic rim, which might have led to the frequent tire problems. But the brakes were essential.

Motor

Originally I had a pedal-assist motor setup called the US Pro Drive (model B-CTI-3VP-K), made by Currie Bicycles. It is a 400 W brush-type motor, with an integrated controller. The motor is mounted on a drive train that mounts onto the spoke base of the rear wheel, and provides a 14 to 1 reduction, with the help of a built-in planetary gear. It is a very tidy and compact setup, but I found that the motor would overheat on a daily basis, even when it was running below 16 A (400 W).

Solar Bike Loads

Load	WH / Day	Weight (lbs.)
Motor (DC)	300–800	20
Boombox	10–50	5
Computer	0–70	7
Cell phone	0–5	1
Total	310–925	33

It wasn't until I was in Durango, Colorado, on the doorstep of the trip's most brutal passes, that I finally got the Scott 1 hp motor (model 4BB-O2488). I removed the Currie motor from its drive train, replaced it with a sprocket on a shaft, and mounted the motor and controller on the bike's rear rack (which needs reinforcement for long-term use).

The Scott is also a 24 V brush-type motor. Even with my fully loaded trailer, it never overheated going over 11,000 foot (3,350 m) passes. For both motors, I used a 5 K ohm potentiometer, with a volume dial mounted on my handlebars for a variable speed throttle.

Electronics

The 175 A Curtis motor controller (model 1204/5) was more than the rig required. A 60 A controller would have been sufficient. But when I was rebuilding the motor setup in Durango, it was easier to get both the motor and the controller from the same supplier. I found that both the Curtis and my original controller attempted to maintain a constant motor rpm. This meant that when I hit an incline, the motor drew more current, though I would have preferred my pedaling to absorb the change in terrain. As a result, I found myself having to fiddle with the throttle in order to reset the rpm.

I chose the E-Meter because I had planned to use the RS232 port to download data onto my laptop (though I never got around to it). It was small enough for my handlebars, once I found the right plastic jam container to put it in. All the bike really needed was a digital volt/amp meter, at a quarter the price of the E-Meter I used.

I carried a battery charger with me in case of prolonged periods without sun. Although I spent countless nights where I had access to the grid, I never used it after I got my PV array working. On the other hand, charging from the grid is what got me from San Francisco to Santa Barbara, after I broke my first PV array. Luckily, most of those nights were spent at coastal campgrounds where the grid is often found in the bathrooms.

Loads & Loads

The majority of the extra weight was in the PV backing and rack (which ended up being steel, after meeting a friend in Santa Barbara who had steel and a steel welder, and not aluminum). Wire, hardware, fuses, lugs, bungees, and the plywood underneath the battery box all add up to a lot of weight.

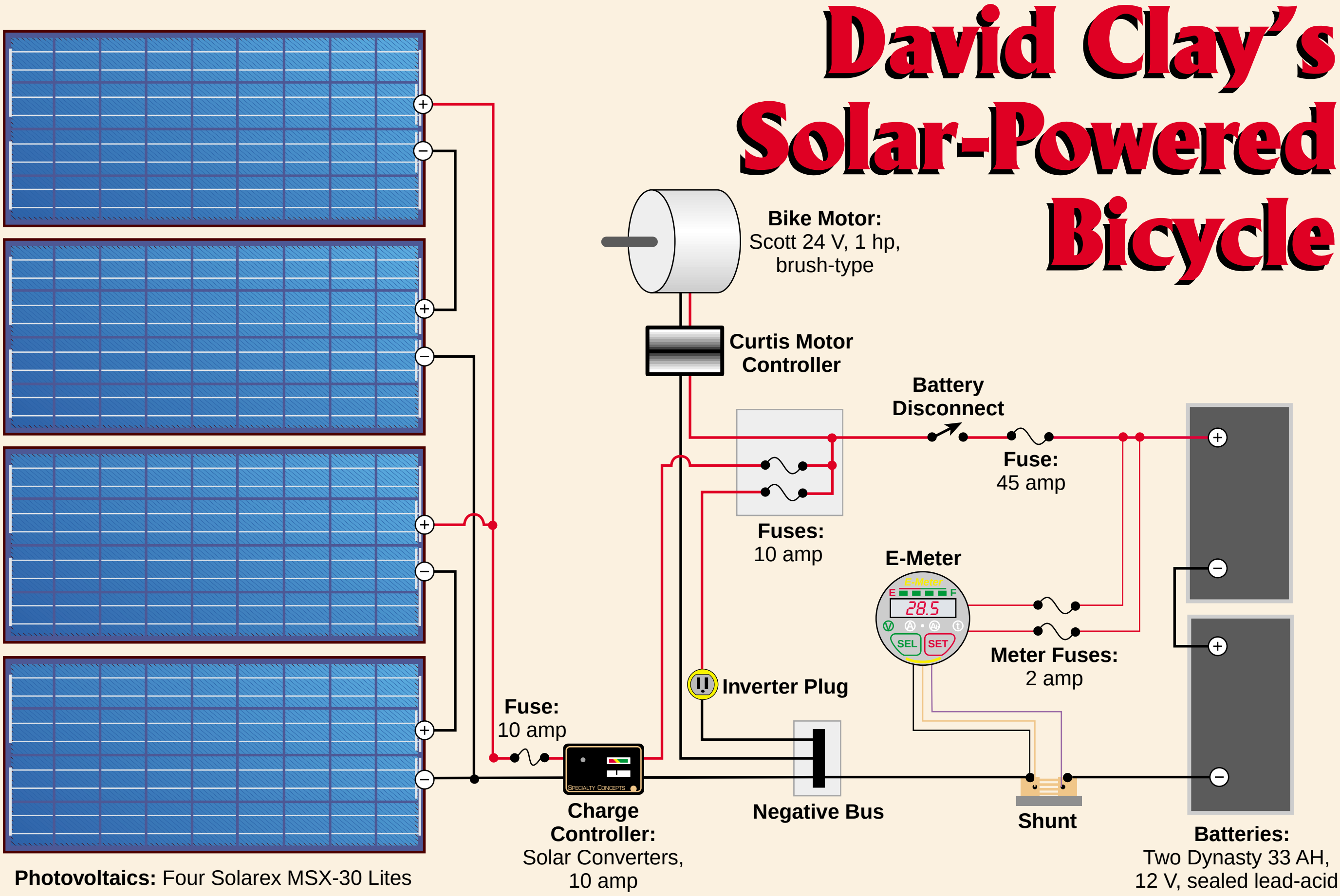
Solar Bike Costs

Item	Weight (lbs.)	Cost (US$)
4 Solarex modules, 120 W	32	$620
Bikes at Work trailer, 6 foot	35	400
Scott motor, 1 hp	20	250
2 Dynasty batteries, 33 AH	60	200
Curtis controller, 175 A	5	200
E-Meter	1	200
Miscellaneous	35	100
Amcamex inverter, 140 W	2	90
Charge controller, 10 A	1	55
Battery charger, 2 A	5	50
Total	196	$2,165

My Taiwanese-made Amcamex modified sine wave inverter, 24 VDC to 110 VAC (model MP-140X), gave

An E-Meter monitors battery state of charge.

David Clay's Solar-Powered Bicycle



me the ability to power AC electronics off the solar panels. The boom box was the only load that got consistent use besides the motor. I found pedaling to the rhythm of my personal music selections to be blissful—it made riding even more enjoyable than it already was.

I used my laptop computer in conjunction with my cell phone to wirelessly connect to the Internet. I also have a special analog modem that allows me to go online where a digital signal is not available, which was necessary considering I was out of digital range as soon as I left the coast. I mostly used my wireless capability for email. I would save my Web surfing for when I had access to a land line, since wireless data is still very slow (under 1 KBPS).

I also started the journey with an AC compact florescent light, and an AC, AA battery charger for the nickel-metal hydride AAs in the bike lights. Both of these appliances were soon sent home in one of my frequent attempts to ditch weight. I never used either of them when I had them, and never missed them when they were gone. Candles provided all the illumination I needed at a fraction of the weight and twice the ambiance. And I never rode with my trailer after dark, so a single charge on my bike light batteries lasted the entire trip.

Solarcycling.com

I am starting a small business selling solar trikes and trailers over the Internet. Initially, I am focusing on the solar-powered recumbent tricycle. Rather than having the PV canopy over the trailer, as my first solar cycle had, the PV is over the trike, providing shade and rain cover. Recumbent trikes have two wheels in the front, and because they are very low to the ground, they are incredibly stable. Like the solar trailer, the solar trike is also a contained and mobile power station.

Other than selling solar cycles, the main objective of solarcycling.com is to teach people how to build their own solar cycle. My real goal is to spread inspiration, creativity, and knowledge, so people can be empowered to make lifestyle changes.

Asian Tour

Any profits made by solarcycling.com will help fund a planned journey through Asia. My friend Colin Mitchell and I are going to ride a couple of solar trikes through China, Southeast Asia, India, and possibly into Europe, beginning in 2001. It is an open-ended journey that may take years—anything might happen. Lifestyle speaks so much louder than words, while the adventures and revelations are endless.

We plan to hook up with as many alternative organizations as we can. We will be checking in with the rest of the world by posting regular updates, photos, and possibly video on the solarcycling.com Web site. We seek publicity, contacts, support, ideas, and wish to involve as many people as possible. We are also considering the possibility of like-minded sponsors to help fund this adventure. Anyone with any kind of interest is personally encouraged to get in touch with us.

In an ongoing attempt for personal development, solar cycling has become more than low-impact transportation. Solar cycling is my way of life, based on empowerment and unified love—free from the self-enslavement and unobserved devastation of consumerism.

Access

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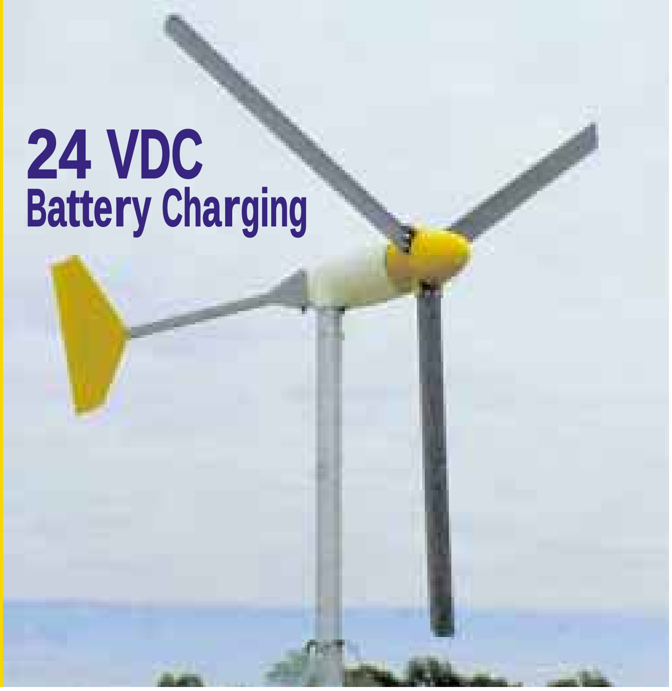

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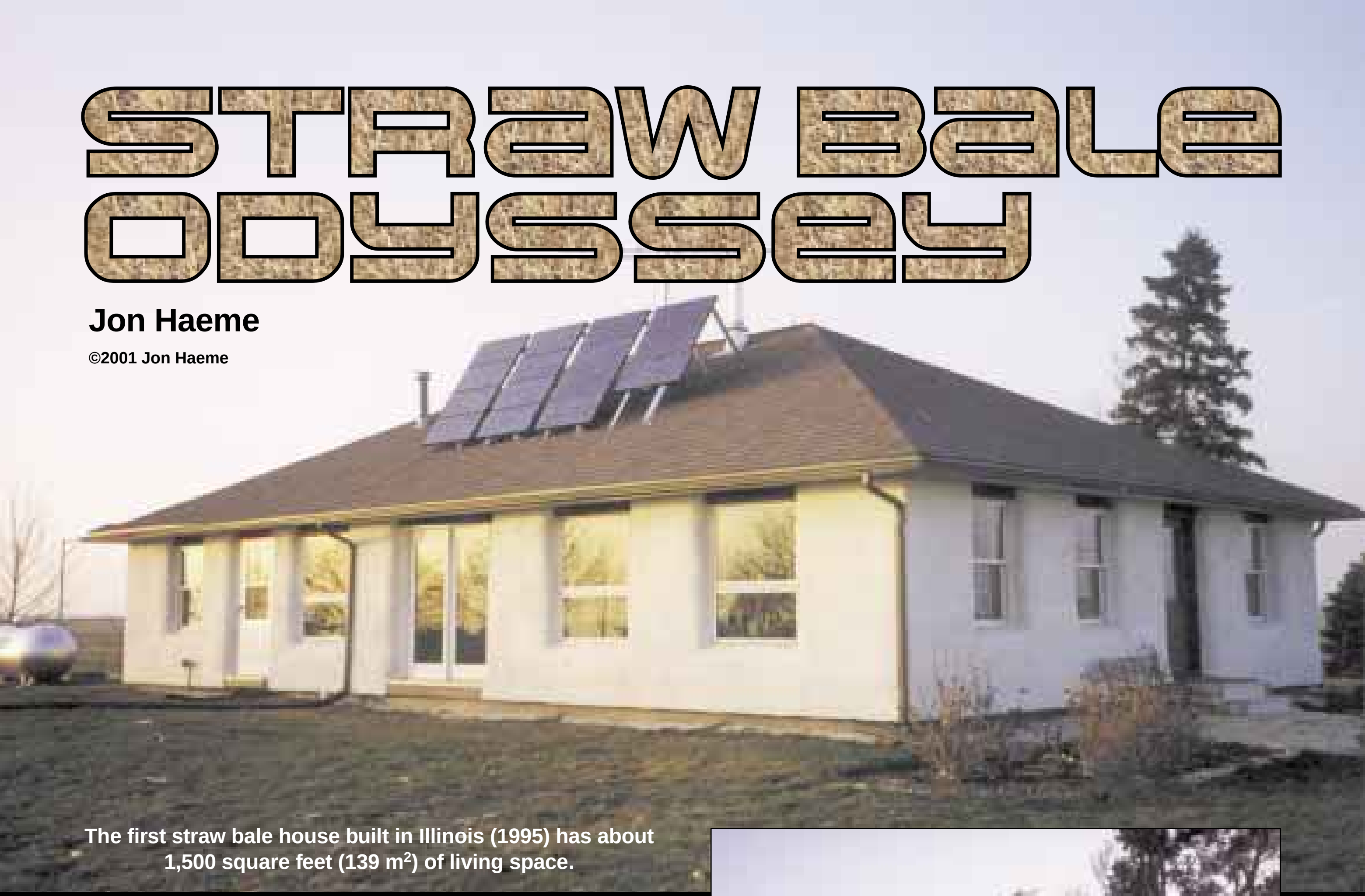
Straw Bale Odyssey

Jon Haeme



The first straw bale house built in Illinois (1995) has about 1,500 square feet (139 m^2) of living space.

We had been renting an old farmhouse, freezing our butts off every winter, when an opportunity to buy a five acre farmstead came our way. It had an old rundown house, which we considered fixing up. But as we tore into it, we realized that we would have to spend a lot of money, and still wouldn't have a very energy-efficient house.

We tore down the 100 year old farmhouse on the site and salvaged the limestone cellar, cistern, and as much of the lumber as possible.

The old house was in much worse shape than it appears in this picture.

The wheat straw was harvested four miles (6.4 km) down the road by a local farmer, and transported directly from the field to the construction site. We used 200 bales at US$1.40 each.

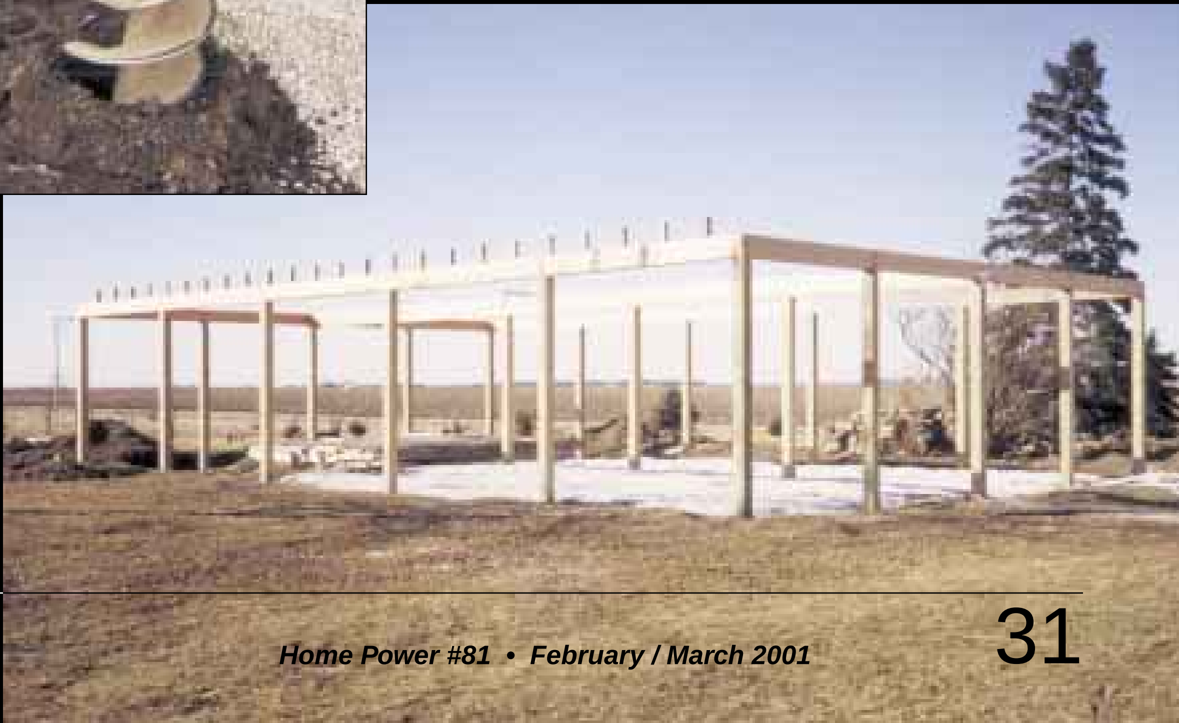
At about the same time, I read an article in *HP35, Straw and Solar,* by Mark Hawes. Something just clicked, and I told my wife June that I wanted to build a straw bale house.

Here the cellar and cistern are being rebuilt using treated lumber sill plates.

The cistern collects rainwater for the garden.

Post auger digging post holes.

She thought I was losing my mind. I suggested that we travel to Arizona and see one. We contacted the good folks from Out on Bale in Tucson, and signed up for one of their weekend workshops. After seeing a straw bale house and attending a workshop, we were both convinced that it was a good idea. This photo essay shows the project as it unfolded...



Post and beam frame. Built like a pole barn, 6 by 6 treated posts are buried 4 feet (1.2 m) deep on concrete footings and backfilled with gravel.

The framed hip roof has a 6/12 pitch with 2 foot (0.6 m) overhangs.

The kitchen, living room, and dining room fill one large passive solar room on an insulated slab.

The rest of the house is framed over the cellar and crawlspace.

1/4 inch (6 mm) galvanized hardware cloth is buried in gravel around the perimeter as a rodent shield.

Detail of rebar placement.

I built a frame to support the straw around the perimeter of the slab, to be consistent with the other foundation-to-wall detail.

Straw Bale Construction

The framing finished. Simple 2 by 6 frames were built for doors and windows.

The floor joists were drilled, and rebar was inserted to impale the first course of straw.

Chicken wire was tacked up, and later pulled over the straw.

Tar paper was put under the straw as a vapor barrier.

Stacking bales begins. Some bales were cut and retied to fit between posts and window frames.

Bamboo was used to pin the bales vertically.

Dowel rods were pounded into the straw from the door and window frames.

Interior walls are 2 by 4s, framed 24 inches (61 cm) on center.
Both the slab floor area and the wood floor over the cellar are visible.

The loose ends of straw were shaved using a 4 inch (10 cm) grinder with a chainsaw blade.

The bales in place. People slowed down as they drove by and asked what we were doing.

We called on our friends from the nearby community of Stelle for the wallraising. About thirty people came to help, despite temperatures over 100°F (38°C).

Window in place in the straw. 100 square feet (9.3 m^2) of low-E thermal pane glass on the south side lets in the sun.

Old circular saw blades and threaded rod tie connecting interior walls to the straw.

The stucco goes on—three coats, hand troweled. This was the most labor-intensive part of the project.

Tarps keep the stucco from drying too fast in the summer sun, and protect the straw from getting wet in the rain.

AN RE SYSTEM TOPS IT ALL OFF

I used my solar-powered workshop trailer (see *HP47)* to provide all the power for construction. We tore down the old farmhouse and salvaged as much of the old materials as was practical. We set posts in the late fall of 1994 and started construction in early spring of 1995. We moved into our new house in early spring of 1996 with many details yet to be completed, but it was ours. We are still working on it.

We have installed a 1 KW solar array consisting of sixteen Solarex panels, eight MSX-60s and eight MSX-64s, mounted on the roof of the house, and an AIR 403 wind generator mounted in our son's playground. These combine to charge twelve Concorde 4-D batteries wired for 1,260 amp-hours of capacity at 24 volts. The solar array is controlled by a Trace C-40 charge controller, and the inverter is a Trace SW4024, connected to the batteries through a Trace DC-250 disconnect. An E-Meter is used to monitor the system.

The house also has grid power available. We use it for backup charging of the batteries and to run baseboard electric heaters as needed in the winter.

The passive solar design provides a large portion of our heating needs, and a woodstove does most of the heating during cloudy periods. We have burned one cord of mixed hardwood per winter for the past four winters. Our bills from the electric company run about US$10 a month in the summer, US$8 of which is the service charge, and approximately US$50 a month in the winter months, November through March.

We use propane for hot water, cooking, and a clothes dryer, which costs US$175 for a year's supply. We use an Aquastar tankless water heater and dry our clothes outside when the weather is good. So our total annual energy costs average approximately US$650.

For wiring in the straw, we used BX cable and metal boxes screwed to wooden stakes. Main wire runs are in the attic.

Plastic and the first sheet of insulation laid over foundation gravel.

A 7 inch (18 cm) thick slab was poured over 2 inches (5 cm) of extruded foam insulation for the thermal mass in the passive solar main room.

The finished home with the RE system.

Winter temperatures can dip well below 0°F (-18°C) in east central Illinois, with strong winds on this flat, open prairie. Our straw bale house has provided us with a very comfortable, energy-efficient home.

After living here for almost five years, we are very happy with our decision to build with straw. It has been our goal to show others through example that we can live comfortably without consuming excessively and polluting our environment.

Jon, Jared, and June Haeme with their straw bale home.

Efficiency and creature comforts go hand in hand.

Access

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DAWN / Out On Bale By Mail, Joelee Joyce, 6570 W. Illinois St., Tucson, AZ 85735 • 520-624-1673 dawnaz@earthlink.net www.greenbuilder.com/dawn

The Last Straw Journal, HC 66, Box 119, Hillsboro, NM 88042 505-895-5400 • Fax: 505-895-3326 thelaststraw@strawhomes.com www.strawhomes.com

Vanner

full page

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this is page 41

When Will The Joyride End?

Randy Udall,
with Steve Andrews

During the last century, oil has transformed the world. British coal launched the Industrial Revolution, but American petroleum put the pedal to the metal. No other material has so profoundly changed the face of the world in such a short time. Petroleum is black magic, the lifeblood of our civilization.

The petroleum industry provides 40 percent of the globe's energy, and is humanity's largest commercial enterprise. Oil is our most concentrated, flexible, and convenient fuel. Without petroleum, there would be no automobile industry and no tourism. Without petroleum, 2 percent of Americans could not feed the remaining 98 percent.

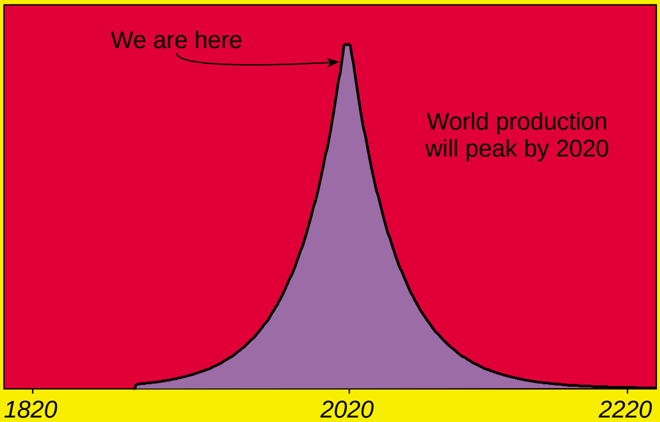
But oil is more than energy. It's the key feedstock for plastics, medicines, clothing, pesticides, paint, and thousands of other products. Fueling Toyota or fabricated into Tupperware, petroleum is the world's premier commodity. Soon, experts say, world oil production will reach an all-time high, an apex, a peak. Then, after a short plateau, it will decline forever. What historians will someday call the Oil Era will last only about 250 years. In 2000, we are closer to the era's end than to its beginning.

The Oil Tribe

In 1859, oil was struck in Pennsylvania. The magic fluid unleashed Yankee ingenuity, put America on wheels, and helped to create the world's richest superpower. The transformation was unimaginably swift. In 1859, Americans traveled on horseback; in 1969 they drove Mustangs and flew to the Moon.

Today it is difficult to overstate oil's importance to the American economy. We have almost five percent of the world's people, but we use 25 percent of the world's oil—nearly 20 million barrels per day. We are the Oil Tribe, the Petroleum Clan, imbibing about 3 gallons per person per day. The automobile is our most cherished icon, a new car our symbol of success.

The Oil Age: A Brief Fling in Human History



The local gasoline station is our secular temple, where each week 150 million Americans “fill ‘er up.” The average American drives 1,000 miles a month—12,000 miles a year, or the distance to the Moon every twenty years. The Oil Tribe numbers 280 million. Hungry for speed and addicted to motion, we consume our weight in petroleum every seven days.

Blessed by Geology

Cheap oil has always been an American birthright. Through fate and geology, the United States was extravagantly blessed. Our original cargo was about 260 billion barrels; only one country, Saudi Arabia, had more. Oklahoma alone possessed more oil than Germany or Japan. California had more than Germany, Japan, France, Spain, Denmark, Sweden, Finland, and Italy combined.

The U.S. has—or rather had—twenty times as much oil as India, ten times as much as Brazil, and three times more than China. Up until 1940, the U.S. produced two-thirds of the world’s oil. After Japan attacked Pearl Harbor in oil-starved desperation and Hitler failed to capture Russia’s Baku oilfield, American petroleum, and the industrial output it nourished, triumphed in World War II.

Strength Through Exhaustion

In 1950, the U.S. produced half the world’s oil. Fifty years later, we don’t even produce half our own oil. Domestic production peaked in 1970, thirty years ago, and today we produce just 45 percent of the crude we consume.

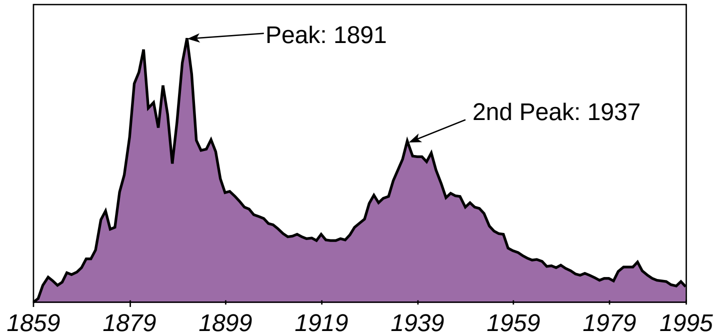
To fuel our economy, we’ve drilled more and pumped longer than any nation on Earth, pursuing an oil policy that’s been called “strength through exhaustion.” The U.S. remains the world’s third largest producer, but 65 percent of our known oil has been burned. It’s all downhill from here.

Like Death & Taxes

Perhaps for the same reason that State Farm sells life insurance rather than death insurance, oil companies shun words like extraction and depletion. Instead they prefer to say “production,” as in “Chevron produces oil.” This implies that we can manufacture oil at will, the way we do jeans or computers. In truth, petroleum reserves are finite and depletion is a reality like death and taxes.

To grasp this concept, consider Pennzoil. Our most famous motor oil honors the state where the Oil Era began in 1859. For the first 25 years of the Oil Era, Pennsylvania was the world’s leading producer. In 1891, the state produced 60 percent of America’s oil. Today, it provides just 0.1 percent. The brand name lives on, but the state’s oil is history.

Pennsylvania Oil Production: 1859–1995

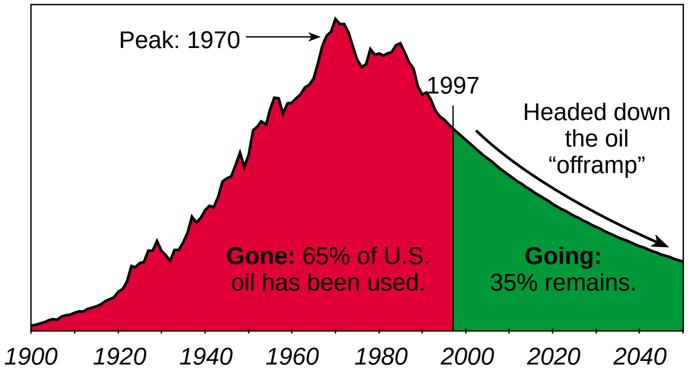


A Pennsylvania oil well produces 15 gallons per day; an average well in Saudi Arabia, 231,000.

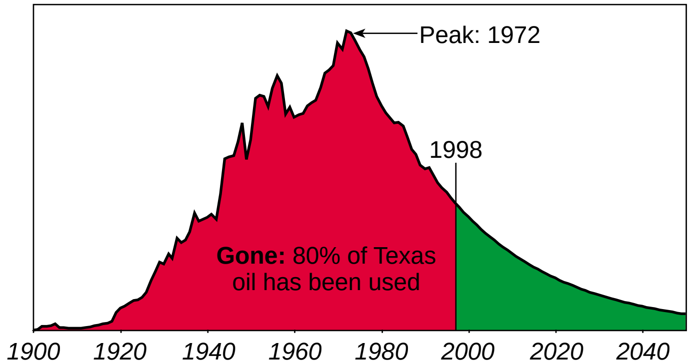
Gushers in Texas

As 19th century oil prospectors (some of them retired whalers) continued to harpoon the Earth, strikes were made in New York, Ohio, and then Texas, America’s first world-class find. If Texas had been a sovereign nation, its oil riches would have placed it in the world’s top ten. The state’s original reserves were six times greater than those of India, and twice as large as Brazil or Norway. For the last seventy years, Texas has been America’s leading oil producer.

U.S. Oil Production: 1900–2050



Texas Oil Production: 1900–2050



But production peaked in 1972, and has been declining rapidly since. According to the American Petroleum Institute, about 80 percent of all the oil that will ever be produced in Texas is gone. Indeed, the state now imports about US$5 billion worth of oil each year. Texas is not an anomaly. Thirty one states produce oil, and all are past their peaks. Oklahoma peaked in 1927, Colorado in 1956, Wyoming in 1970, Alaska in 1988, and California in 1985.

Swiss Cheese

Well, if Pennsylvania and Texas are played out, why not drill more wells somewhere else? In fact, the U.S. is already one of the most thoroughly explored and drilled countries on Earth. Of the 4.6 million wells worldwide, 3.4 million have been drilled in this country.

Very few prospects remain. With the exception of the Arctic National Wildlife Refuge and the deepwater Gulf of Mexico, we've been there and done that. From the oil industry's perspective, the U.S. is Swiss cheese. Indeed, tiny Kuwait has twice as much oil left as does the Lower 48.

The Last Hurrah

The oil industry employs hundreds of thousands of smart, inventive, and creative people. Many of their new exploration techniques, computer software programs, and drilling methods are being put to use in the Gulf of Mexico. There, the oil majors are drilling in an astounding 5,000 feet of water.

Analysts expect the Gulf to be America's last great bonanza. A mile under the ocean floor may lie 15 billion barrels. It's a lot of oil, but only as much as the nation uses every two and a half years.

Car Bomb

In 1900, oil married the automobile. Together they gave birth to a century of travel. Today most of the world's oil is consumed by cars, which are breeding like (VW) rabbits. In the last fifty years, the human population has doubled. In the same period, car numbers have grown tenfold from 50 to 500 million.

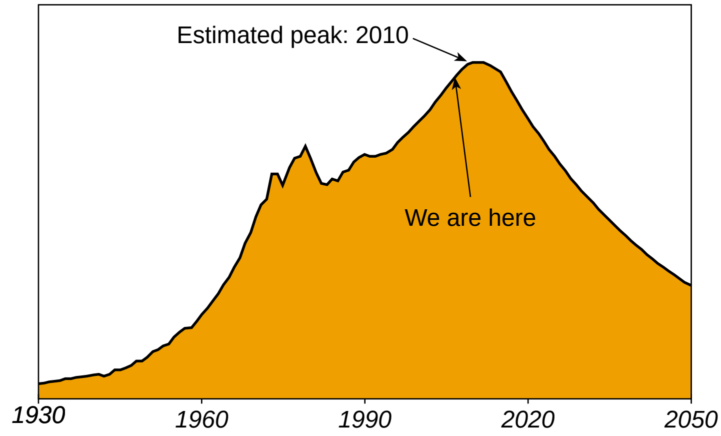
Autos are reproducing five times faster than people. A new car is born each second, and the global automobile population now consumes three times more energy in the form of oil as humans consume in the form of food.

The Coming Peak

The global economy uses 77 million barrels of oil per day. That oil propels every car in Canada, China, and Chile—every Boeing, every Airbus. Experts say that by 2010 the world may consume 90 million barrels a day, 20 percent more than today.

Sometime between now and 2010, world oil production will reach an all-time high, a peak. A plateau in production will be followed by a relentless, inexorable decline. The exact year of the world peak can't be predicted, since it will depend as much on economic and political factors as on geology.

World Oil Production: 1930–2050



The biggest wild card? Saudi Arabia, the world's most prolific oil province. If the Saudis invest hundreds of billions of dollars, they could increase their output to meet growing demand. But they may decide not to, choosing instead to produce less oil and charge more for it. Although predicting the exact peak is impossible, this momentous event is near.

Collision In Slow Motion

A decline in oil production? After a century of increases, what seems unlikely is now inevitable. The next crunch may arrive suddenly, or in slow motion. As former Energy Secretary Don Hodel says, "We're sleepwalking to disaster." When it happens, journalists will shout, "We're running out of oil." But that's not true. Rather, we are running out of *cheap* oil.

After production peaks, oil will be readily available at a higher price, though in declining amounts, for fifty years. No one will freeze in the dark (America's reserves of natural gas and coal should last 40 and 110 years respectively), but the transition to expensive oil may be bumpy.

OPEC's Return

American production has been declining for thirty years. As we produce less oil, we must import more. Indeed, America imports more oil than any other nation uses. Uncle Sam's appetite is gargantuan. And why not, because even at US$30 a barrel, imported oil is a steal. The tab for 2000 will be about US$100 billion, about 1.2 percent of the gross domestic product.

But this bargain may not last. As the population rises, more people will be competing for less oil. By 2015, only a handful of nations will be exporting significant quantities, and the Organization of Petroleum Exporting Countries (OPEC) will be able to control prices at will. Since Saudi Arabia, Iran, Iraq, and Kuwait can sustain their projected production past 2020, the world will not suddenly run out of oil. But US$25 a barrel will be a thing of the past.

They Have It, We Want It

Fully two-thirds of the world's remaining oil is in five Muslim countries. This explains why Iraq's Saddam Hussein gets press, why the State Department frets about Iran, and why the U.S. fought the 1990 Gulf War. (President Bush: "Our way of life is at stake.")

The energy future of America, Japan, Europe, and China are inextricably linked to the Middle East. In the Saudi deserts, the U.S. military has built fortified air bases. Ostensibly we are there to protect our Saudi friends. In reality, we are an occupying force protecting our access to their oil. Some Saudis are resentful of our presence, as we would be if they had air bases in Nevada. Would we leave if asked? Good question.

World Oil: Who Has It—Who Uses It

Has Oil		*Uses Oil*	
Saudi Arabia	26%	U.S.	25%
Iraq	10%	Japan	8%
Kuwait	10%	China	5%
Abu Dhabi	9%	Russia	4%
Iran	9%	Germany	4%
Venezuela	6%	S. Korea	3%
Russia	5%	Italy	3%
Mexico	5%	France	3%
U.S.	3%	England	3%

Left: Nine nations have 83% of the world's oil. Five countries in the Middle East have two-thirds of it.

Right: The world's top nine oil consuming nations. The U.S. uses three times more than Japan, eight times more than England.

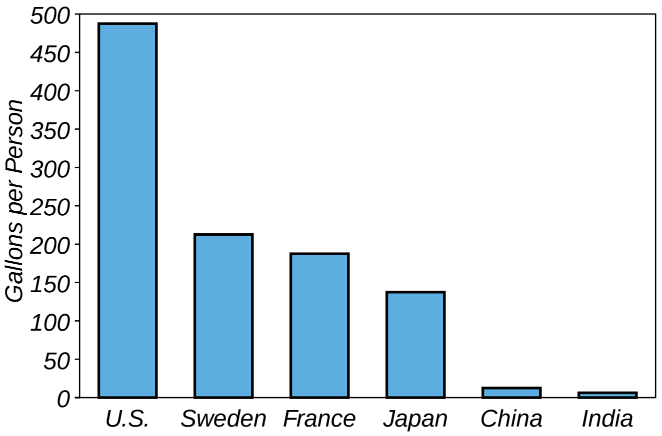
Road Warriors

Fish don't worry about water and Americans don't worry about oil. Instead, we swim in it. Think of your life: skiing on the weekend, Thanksgiving at Mom's, a conference in Chicago. Middle-class Coloradans do their Christmas shopping in Minnesota at the Mall of America. Texans drive 1,000 miles to shoot a Colorado elk—hunting-and-gathering taken to new extremes.

More than half of the world's oil—and 70 percent of U.S. oil—will be consumed during baby boomers' lifetimes. The boomers were conceived as auto culture kicked into overdrive. As teens they grooved on *Mustang Sally* and *Little GTO.* Getting a driver's license was their rite of passage.

During their lives, many baby boomers will drive and fly a million miles, equal to forty trips around the globe.

Annual Gasoline Consumption

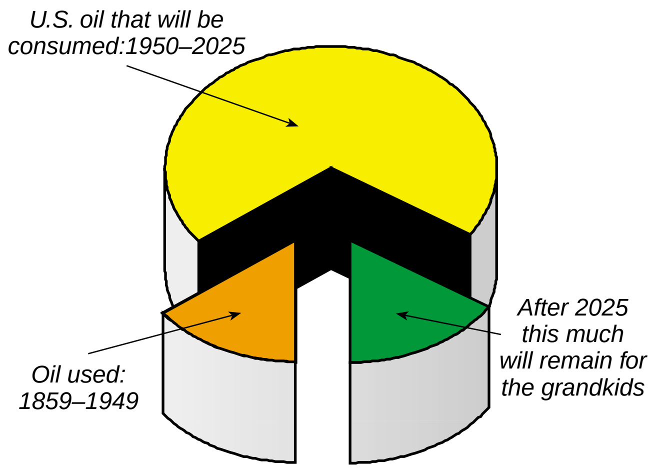


Magellan and Amelia Earhart were the famous circumnavigators of their day. Now every man is Magellan, every woman Amelia.

Of course, petroleum doesn't just propel us. It feeds us too. Oil is absolutely fundamental to agribusiness. Farm tractors burn diesel. Fertilizer comes from natural gas. Pigs can't fly, but salmon and lobsters certainly do. The average potato travels 750 miles.

Crops harvest sunlight, but oil is a modern farmer's most important resource. Planting, fertilizing, harvesting, processing, and delivering a bushel of wheat requires ten times more fossil energy than the calories its bread will provide.

America's Oil: Dividing the Pie



Who Will Fuel China?

From Asia to Africa, three billion people crave an automobile lifestyle, and who can blame them? Mobility is wonderful. But India has little oil and China's hopes for new discoveries have not been realized. If India and China imported as much oil per person as we do, world production would have to triple. It can't; there's not enough oil.

Looking ahead, the tremendous inequities in oil distribution—and consumption—are morally troubling and militarily worrisome. As Americans continue to guzzle, and more Asians take to the road, oil demand will eventually outstrip oil supplies. Prices will rise.

Economic jousting for oil—who can pay the most—is certain. Military confrontation can't be ruled out. With the U.S. using three times more oil than any other nation, future generations of young Americans may be forced to take to the battlefield once more for oil.

Life in 2050

Each year, the relentless aging of existing oil fields removes 4 million barrels per day from global capacity. Is there a miracle cure? Exciting advances include horizontal drilling and 3-D imagery to recover more oil from aging fields; technology to convert natural gas to a diesel-like fuel; innovative autos powered by hybrid drives and fuel cells; and telecommuting, the Internet, and other social changes that may reduce oil consumption. All buy us time.

But depletion remains a powerful foe. Every day, the world uses 77 million barrels, but only finds 15 million. By 2050, nine billion people will have only as much petroleum as three billion did in 1950. Oil will be more expensive, perhaps dramatically so.

Is this a doomsday message? No. A more sustainable world may be a better place to live. The challenge is getting from here to there. The longer we wait, the harder the transition will be.

Easing the Transition

Exxon, Shell, and British Petroleum own less than 10 percent of the world's remaining crude. This means that future prices will be largely determined not by CEOs in Houston, but by Iraqi dictators, Saudi sheiks, and the leaders of Iran, Kuwait, Venezuela, Nigeria, and Russia.

This does not mean that we are powerless. Indeed, when America gets serious about safeguarding its energy future, there are many things we can do. First, we need much more efficient cars. The physics of today's Pontiac (or pickup) are absurd. We already know how to build safe 35 mpg SUVs and roomy 50 mpg family sedans—let's do it! Congress must tighten federal fuel standards and close loopholes the size of a Ford Excursion.

The Perfect Storm

I recently flew to Houston to interview Matt Simmons, an energy investment banker who writes *World Oil* magazine's annual review of petroleum developments. Since 1974, Simmons' firm has been involved in US$42 billion of energy transactions. Throughout 2000, as oil prices leapt upwards, he was advising both Energy Secretary Bill Richardson and the Bush campaign about our energy predicament. The following are excerpts from a speech Simmons delivered on October 2, 2000. Find the complete text of the speech and other research at www.simmonsco-intl.com.

The limits to increasing supply of North American gas or worldwide oil—and the time, people, and capital required to eliminate them—will determine the severity of the energy crisis descending over the world.

The situation is grave. If you read The Perfect Storm, *where a freak storm materializes out of the convergence of three weather systems, our energy crisis results from the same phenomenon.*

The world has not run out of oil and North America has not run out of natural gas. What we are short of is any way to grow our energy supply. Oil and gas production could actually decline before solutions are implemented. I worry that OPEC has less than 500,000 barrels of excess capacity. [This is less than 1 percent of global production.]

North America has no excess natural gas capacity. It disappeared several years ago. What we do have is extremely aggressive decline rates, making it harder each year to keep current production from falling. The electricity business has run out of almost all spare generating capacity. A massive number of gas-fired plants have been ordered. But the gas to run them is simply not there.

We are out of energy cushions. There are only 120 idle drilling rigs in the entire world. Many are in terrible shape and lack trained crews. Superimpose a lack of spare refinery capacity. Add a worldwide lack of tanker capacity, which makes spare wellhead capacity in the Middle East irrelevant.

Each of these limits is "hard iron and steel" related. When you are out, you are out, until something new gets built. We are barreling into an era, at least in the U.S., where we have to cap growth in demand for all forms of energy. I hope we can keep the current energy supply from declining, but even this modest goal will not be easy.

Because so few decisionmakers understand that we have a critical problem, there is a great risk that we will postpone any corrective steps. Our financial markets seem convinced that today's high energy prices will soon go away. I fear the prices might go away, but not in a downward direction.

It's time for everyone to take off their rose-colored glasses. We are about to get a real energy wake-up call.

Let's invest in mass transit and stop designing cities and suburbs around the car. Consumers need accurate signals about the true cost of driving. Pay-at-the-pump auto insurance, where liability coverage is rolled into the fuel cost, is one approach. Hiking gas taxes by 10 cents a gallon each year for the next ten years is another. (This tax could be offset by tax credits for low-income families.)

Our halfhearted efforts to promote natural gas and other alternative fuels could be strengthened. Of course, before such bold policies can be adopted, Americans must first come to recognize that petroleum is among the world's most valuable resources, a gift of geology, a precious one-time windfall, which we are wasting as if there's no tomorrow.

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OK, so we haven't been
around as long as our supplier…
…and the fact that it is
93,000,000 miles away may seem daunting.
But other than that, we **are** your best source for name brand alternative energy products. We offer five distinct areas of service:
• Government Contracts — GSA approved
• Residential/Commercial Development and Construction
• RV and Marine Alternative Energy Systems
• Consumer Products
• Product Reviews and Education about Alternative Energy Products
And it is all available to you on our website at:
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WRENCH REALITIES

Bob-O Schultze

From time to time I get calls to inspect systems that I did not sell or install. I recently got a call from a gentleman in Oregon complaining about an RE installation. This horror story is particularly interesting because the system in question was designed and installed by a licensed electrical contractor.

Mr. A requested an inspection of his renewable energy electrical system due to his displeasure with the system design and installation, and its failure to pass examination by the local electrical inspector. The system design and installation were performed by XX of XX Electric. According to Mr. A, the installation took place in late April or early May of 2000. My inspection was performed on October 27, 2000.

Qualifications

I hold California CSLB C-10 license #613554. I have been licensed since 1991, and specialize exclusively in renewable energy design and installation. I am a participant in the CSLB Industry Expert program, and a founding member of the Independent Power Providers (IPP) group. I have authored numerous published articles on renewable energy, and have been commissioned by the federal Department of Energy to report on the Utilities for Photovoltaics Group.

Observations

Mr. A's RE system is poorly designed at best. Numerous *National Electric Code (NEC)* and RE industry standards violations were observed. The worst violation observed is the lack of any kind of overcurrent protection between the batteries and the inverters. This presents a clear and severe fire danger.

XX Electric had clearly abandoned the job, since there has been no work performed by them for over six months. The job was left in an unfinished and unsafe condition. Mr. A has an invoice from XX Electric showing charges for components and labor. The description of the labor charges states, "hook up inverter, wire from batteries, set up charging room." But my observation shows that XX Electric did not complete the work that they billed Mr. A for.

Observed *NEC* Violations
Photo 1

- Single conductor wires not in conduit; *NEC* 300.3(a)
- No conduit box; *NEC* 300.15
- Conductors not protected from physical damage; *NEC* 300.4
- No overcurrent protection; *NEC* 240.3

Photo 2
- Single conductor wires not in conduit; *NEC* 300.3(a)
- No conduit box; *NEC* 300.15
- Conductors not protected from physical damage; *NEC* 300.4
- No overcurrent protection; *NEC* 240.3
- Incorrect marking of ungrounded conductor; *NEC* 310-12(c)

Photo 3
- Single conductor wires not in conduit; *NEC* 300.3(a)
- Conductors not secured; *NEC* 300.11
- Conductors not protected from physical damage; *NEC* 300.4
- No overcurrent protection; *NEC* 240.3
- No battery acid spillage protection; *NEC* 480-7(b)
- No guarding of live battery parts; *NEC* 480-8(b), 690-71(b)(2)
- Ampacity of 12/2 NM Romex between generator and inverter substandard; *NEC* 310-15(a)

Photo 4
- Conductors not secured; *NEC* 300.11
- Conductors not protected from physical damage; *NEC* 300.4
- No overcurrent protection; *NEC* 240.3
- No guarding of live parts; *NEC* 480-8(b)690-71(b)(2)
- #4/0 inverter wire terminal not protected from corrosion; *NEC* 310-9

Observed Industry Standard Accepted Practices Violations
- No load analysis of customer needs done prior to designing system.
- Incorrect tower height specified for wind generators. Generators must be a minimum of 30 feet (9 m) *above* trees and house.
- Size or number of wind generators incorrect for needs and site.
- Too many batteries to be supported by RE system inputs.
- Incorrect type of wire terminals at inverter end of #4/0 inverter feed wires.
- No anti-corrosion measures (heat-shrink tubing, tape) used on battery/inverter feed wire terminals.
- Inverter conductors installed on incorrect battery terminals.
- No antioxidant applied to AL/CU screw lugs at inverter terminals.
- No electrolyte containment provided in the event of a spill.
- No battery monitoring equipment specified or installed.
- Only one inverter hooked up to charge batteries.
- Battery charger temperature monitoring system not installed.
- Abandonment; Client states that XX Electric was last at job site in late April or early May, 2000. Job site abandoned in an unfinished and unsafe condition.

Mr. A's poorly sized and sited wind generators.

Reported Industry Standard Accepted Practices Violations

- 12/2 NM Romex used for connection from inverters to main circuit breaker box. Inverters are each rated for 33.3 A continuous output.
- 12/2 NM Romex used for connection from inverter to generator.
  Both 12/2 NM Romex wire runs were laid across the concrete floor, unsupported and unshielded from physical damage.
- Generator is rated for 30 A output. Inverter was on default program (never programmed by XX Electric) to draw 30 A for the charger.
- Input wire from generator attached to wrong AC input terminal in inverter.
- No overcurrent devices on AC output of inverters.
- No overcurrent devices on DC input from wind generators.

Caveat Emptor

I hope that people hiring a "professional" to design and install their system will question that person or company. Having an electrician's license or electrical contractor's license is obviously not enough. Is the person or company experienced in RE system design and installation? Ask for references and check them out. I strongly recommend that anyone considering purchasing their system from an installing dealer read Richard Perez's article, *What to Expect from your RE Dealer,* page 84, this issue. It's *your* money—spend it wisely.

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Texas Renewable Energy Roundup- Fact or Fiction?

Michael Perez

Over the last weekend in September in Fredericksburg, Texas, I had the great fortune to attend my first renewable energy fair. I did it with the premiere authority on homemade power—the *Home Power* magazine crew! I'm not a *Home Power* worker (or whatever name can be applied to people fortunate enough to do what turns them on). But I am a devoted follower, a reader of every issue since *HP1,* a stockholder, and it doesn't hurt to be the brother of the editor and publisher…

I live in San Antonio, not far from Fredericksburg. So I took the opportunity to not only rub elbows (the booth was a little too small for the great interest shown) with many enthusiasts, but a chance to hang with the gurus of *Home Power.* In attendance were Richard and Karen Perez, Connie Said, Joe Schwartz, and Michael Welch, all of whom know more about the business than I do.

The Texas Renewable Energy Roundup, a green living and sustainability fair, was a first in the area. For those who are wondering, there is an obligation for everything in Texas to have "Roundup," "Lone Star State," or "Long Horns" in the title. I guess that in the home of oil, big business, and a profusion of grid power, renewable energy is not the hot topic of the day. But judging from the turnout at this fair, it is one that will be soon.

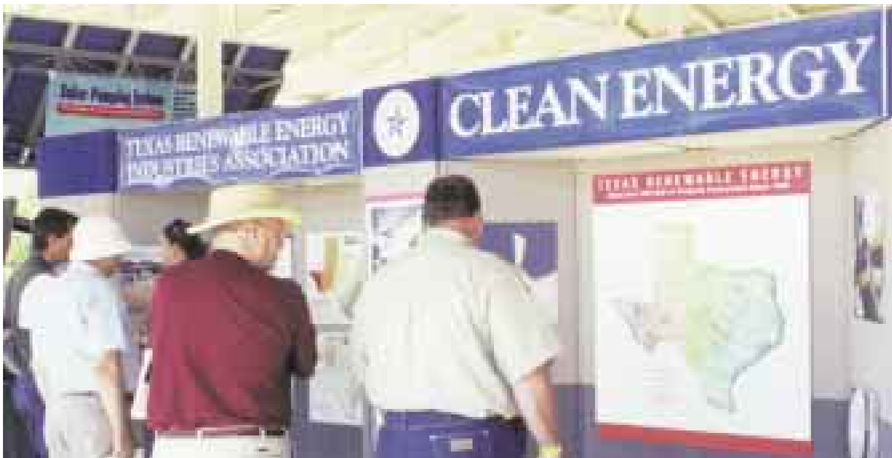
There was a wide range of exhibitors there, from the big grid boys to someone selling bat roosts. There was even a genuine Texas longhorn in a corral. I did like this solar steak exhibit, but the longhorn seemed ambivalent. One of the exhibitors had a water well pump that looked like an oilfield well pump just to impress the neighbors and establish the correct look. It was actually quite a good exhibit and drew a crowd.

Just Texas Folks

I was not sure what to expect from this fair. Would it be a bunch of solar bozos with calculators strapped to their hips, amongst the profusion of solar and wind technology? Or would it just be first timers like me, totally bewildered by the many options that were presented?

The majority of the folks that I met were a mixture of both. I saw young college students who had so many pierced items in their body they would set off a metal detector naked. But there were also retired folks following a natural Texas desire to be totally independent.

I must admit, I was interested in the bat roosts, the organic pesticides (hey, we have fire ants out here and we're losing the war quickly), the composting exhibit, and the rammed earth building blocks. But I was most interested in the energy exhibits. The combination of curiosity and the nice weather provided the ingredients for a large and diverse turnout.



Texans for clean energy.

RE is giving the big oil business a run for its money!

Fredericksburg is a tourist destination in the Texas hill country that hosts fairs and the like to double their local population every weekend. They do it well, and the town is interesting in an old-style Texas town kind of way. The lack of good espresso in the town was a minus as far as the heavily caffeinated *Home Power* crew was concerned. But through careful searching and patience, a store that had the right machinery was finally located.

Fredericksburg is populated by the descendents of German settlers who made a deal with the Comanche Indians to live in the area. I am proud to note that the treaty that was signed has never been broken (are you listening, Washington?), and to this day, the Comanches have returned for several powwows.

Part of the treaty was that any Comanche who needed lodging could stay in town at someone's house. Unfortunately, we had to stay at a local hotel. Its construction left no doubt that poor craftsmanship is alive and well in Texas. The fair food reflected the local tastes, with German sausage replacing the bland hot dog, and lots of fried everything.

The fair was held in the Market Platz on Main Street in Fredericksburg. The true meaning of Market Platz is a closely guarded German secret, and Platz is not misspelled, only misunderstood. It is an open-air series of covered display areas that has welcomed everything from powwows to Octoberfests. There are nice gardens on the grounds, a playground, flush toilets (a big plus), and statues commemorating the fact that the Comanches didn't slaughter the early German settlers.

There was plenty of space for all the displays, with tents erected for those who had too much stuff to fit under one roof. The setting was close enough that you could wander around the many shops and restaurants elsewhere on Main Street, if you wanted a break from the fair. Most people were probably searching for the elusive cappuccino machine.

RE Exhibits

The renewable energy exhibits at the fair were interesting, with the big boys giving away everything from Frisbees to candy and bottled water. The renewable energy exhibitors had their wares well displayed, and the products were varied.

One exhibit had a trailer complete with PV panels, batteries, and inverter, designed to replace low-income reliance on expensive electric generators. The system not only demonstrated how viable the technology has become, but also how in the long term it is more affordable than traditional solutions for off-grid living. I liked the Exeltech oscilloscope demonstration of the clean sine wave they produced compared with the clipped and distorted grid power sine wave.

There were a couple of sheds with complete systems, so people could see how the whole thing comes together. Unfortunately, most of the installations that I have seen have grown piecemeal, and do not look like the installations at the fair, but have a bit more "creativity" in their design.

There were several local groups that were trying to get the sustainability message out to the community. Here in Texas we are about five years behind everyone else in such matters. But hey, it's a start.

Inside Scoop

Now for those who have put up with all my drivel thus far in hopes of finding out the biggie…. What is it really like in the *Home Power* booth at an energy fair? In a word—exciting. Well, for some people, exhausting may be the word of choice, but let's hear it for semi-youthful (heavy on the semi) exuberance.

I tried to help in the booth, showing people the magazine, and explaining the message and the content as well as I was able as an "outsider." The stories I heard covered the whole range of the wonderful world of RE. There was a couple who had a system installed and it was a nightmare. Everything that could have happened, happened, and their contractor (who the gentleman, in the truest sense of the word, refused to name) basically bailed on them. I know the contractor could not have been a native-born Texan to have done so, and was probably from New York City—get a rope! The couple thought that they had researched the field fairly well, but…

This is why I recommended to everyone that they should memorize every issue of *Home Power,* get the CDs of the back issues, wear a *Home Power* T-shirt when meeting with contractors, and be able to recite Ohm's Law without hesitation. Beware all ye that are uninformed in life and learn by the college of hard knocks!

The *Home Power* booth—Texas style.

Grid Grunt Meets REtards

There were a few folks that came up to me and started asking very technical questions. As I have been into electronics and energy systems my entire career, the questions were recognizable. But this is where the conversation ended. For those who must know, I work for one of the local grid boys in the communications field. But I'm really a mole for the RE bozos, and pass out back issues of *Home Power* to all that I can. The answers the fairgoers wanted would have to come from a higher source, and this is where the *Home Power* gurus stepped in.

Richard, Joe, and Michael were like human answering machines. *"Oh yes, that is possible, however if the angle of the sun tilts another 4 degrees, the power flow factor rises exponentially by a factor of 2, unless, of course, the moon is in Aries; then the whole thing is up for grabs." "We have seen this done, however from reader response, we know that it is 47 percent less likely to succeed unless the widget is installed with #1 welding cable set at no more than 3 inches above the high water mark of the 1947 flood." "You can try that, but the entire battery set might melt into a foaming puddle on the floor, rendering all battery caps null and void."*

The answers rolled out with authority (this is *Home Power* we are talking about here!), and most people got what they wanted, or were steered in the right direction. Of course, this might be a back issue of *Home Power,* or a set of CDs, or maybe even the required *HP* T-shirt.

The number of people who came by just to meet Richard impressed me. Hey, my brother is a celebrity! I just thought he was this guy who delighted in terrorizing me as a child and carried a slide rule on his hip throughout the early '60s. These people had been long-time readers, correspondents, fellows in the field, and a few that had seen him at other energy fairs. Richard always seemed to have a nice word and was genuinely appreciative of the visit (I have to say this, he fed me the whole time I was at the fair).

RE Inheritance

There was even a guy there who had a copy of *HP1*—the only person I've ever met who has this issue. I had to get one from my mother's estate, and had to fight with my brother and sisters to get it. To hell with the Mercedes—who gets *HP1?!?* Let me tell you, for those who have seen #1 in the flesh, you

Gary Chemelewski demonstrating clean sine wave power against the local grid's choppy harmonic distortion.

can really understand how far not only the magazine has come, but the whole movement as well.

There was one gentleman who purchased the latest issue (they were sold out before the end of the fair) and asked Richard to sign it. How Richard managed to do this, I don't know. I assumed that his ability to write cursive had long since atrophied, judging from the amount of time he is chained to the *Home Power* keyboard.

On Friday night, back at the local hotel (we aren't Comanches, remember) while contemplating our collective navels, drinking firewater, and talking about the opening day, I asked a rookie question. Why in God's name did an enterprise that sold magazines offer the latest issue for free on the *Home Power* Web site? I heard the others in the booth mention this to people who may have bought the issue for hard currency then and there. This could not be good business sense. *Time, Newsweek, and Playboy* didn't do it, so why should *Home Power?* As a stockholder, red-blooded American, and innocent bystander, I had to know.

Spread the Word

Boy, did I find out. While I have been around *Home Power* via Richard for a long time, I guess that I really never understood the depth of commitment the whole crew has toward the concept of renewable energy. The magazine is the way to get out the message, not the end in itself. The message of renewable energy, of self-sustainability and its freedoms, are the reasons behind *Home Power,* and the magazine is the means to that end.

I guess the main thing that distinguishes *Home Power* from others is the level of commitment to the idea, the cause, and the ability to influence the outcome. But it also turns out that while *HP* doesn't charge for downloads, the mag indirectly makes money from them. They boost circulation, which in turn increases ad revenue. It's great for the end user who gets the info for free, great for the advertisers who get more customers, and great for *HP,* which gets to sell more ad space. This is one of the few cases where giving something away makes money. Richard says, "It's not capitalism per se, but more like a religious experience of casting bread upon the waters…."

The next day I was telling everybody who seemed interested that they could download the issue for *free* if they wanted to, and it felt soooo good! I could participate in the revolution by offering life-changing information to folks for free. All power to the people, right on, groovy, and all that!

On this same note, there were lots of people there who subscribed to the magazine, either for the first time or as a renewal. A few said that they were downloading it and wanted to subscribe to pay for the downloads, but didn't want the printed magazine. These subscriptions were accepted, but with the proviso that the printed copy of the magazine could be sent to the local library or other such institution.

This idea shows the commitment of the readers and people interested in the field. But it also shows the value an idea has to change the world we live in. Hell, twenty years ago, the only people into solar and wind were scientists and alternative folks that couldn't part with the Grateful Dead when they moved out into the country to find a saner way to deal with their lives…

I listened to Richard give a talk on the freedoms that RE offers to us. While I am biased, being Richard's brother and all, it was a talk that came from the heart. He had no notes, and this was not a canned lecture. I could hear the emotion and depth of commitment in his voice as he defined the freedoms that are available now and will have to be in the future for the sake of the environment.

Well Organized Blast
The fair was well organized and the staff helpful. When the jet-lagged *Home Power* crew arrived to set up, an extra table was needed and it was promptly produced. The magazines and *Home Power* supplies were neatly stacked in the booth, although the boxes resembled something that had been used in gorilla training sessions. While I am short on facts regarding actual names, the staff covered all the needs of the attendees and the folks in the booths.

The programs that were offered reflected this. There were several tents set up with chairs and tables for distinguished guests to deliver their talks in. The talks were scheduled, the schedules more or less adhered to, and the different tents identified by colored banners for easy recognition. There were even microphones, slide machines, and PC projectors to aid in this.

The tents got a little warm, but the some of this had to do with the “hot” topics that were being presented. There were some extra sessions and tours that were available for additional fees, and some of these were off site. I had more than enough to do at the fair itself and didn’t attend any of these, although some of them sounded interesting. The fact that I am a cheapskate at heart had nothing to do with this!

All things considered, the entire fair was a blast, and I hope that everyone had as good a time as I did. I saw two of my co-workers at the fair. One has already installed a small starter system on his house. The other is retired and has a wind generator at his house. He lives within sight of a generation plant and you can look at his wind generator and see the plant in the far background. That’s a powerful image!

There were an amazing number of people who live on-grid, but are installing a system of some type to help defray their grid usage and promote the entire concept. As Richard said in his talk, for every one kilowatt photovoltaic array that is up and working, there is 1 metric ton of CO_2 annually that is not released into the environment by grid generators. In Texas, where warm has another definition from most places, global warming should have a whole different meaning. I think that this fair was a good focus for that, a good jumping-off point for the area on these issues.

The utility that I work for now offers wind-produced power as an option to its users, and Austin Energy does the same. Maybe with more fairs and awareness rising, the path we are on may turn, and we as a people can latch on to what is really important.

See You in 2001
I have a stake in wanting this fair to succeed. If it continues, south Texas may see more homemade power, and an increase in clean renewably produced grid power. If it continues, Richard may come back every year and I will be able to see him on a more regular basis (putting *Home Power* out takes most of his time). Besides, he bought me dinners and lots of good coffee!

Y’all come down next year and, hell, there may be two full-time espresso machines in town by then. Remember, tell them you’re a Comanche and maybe you can stay for free….

Access
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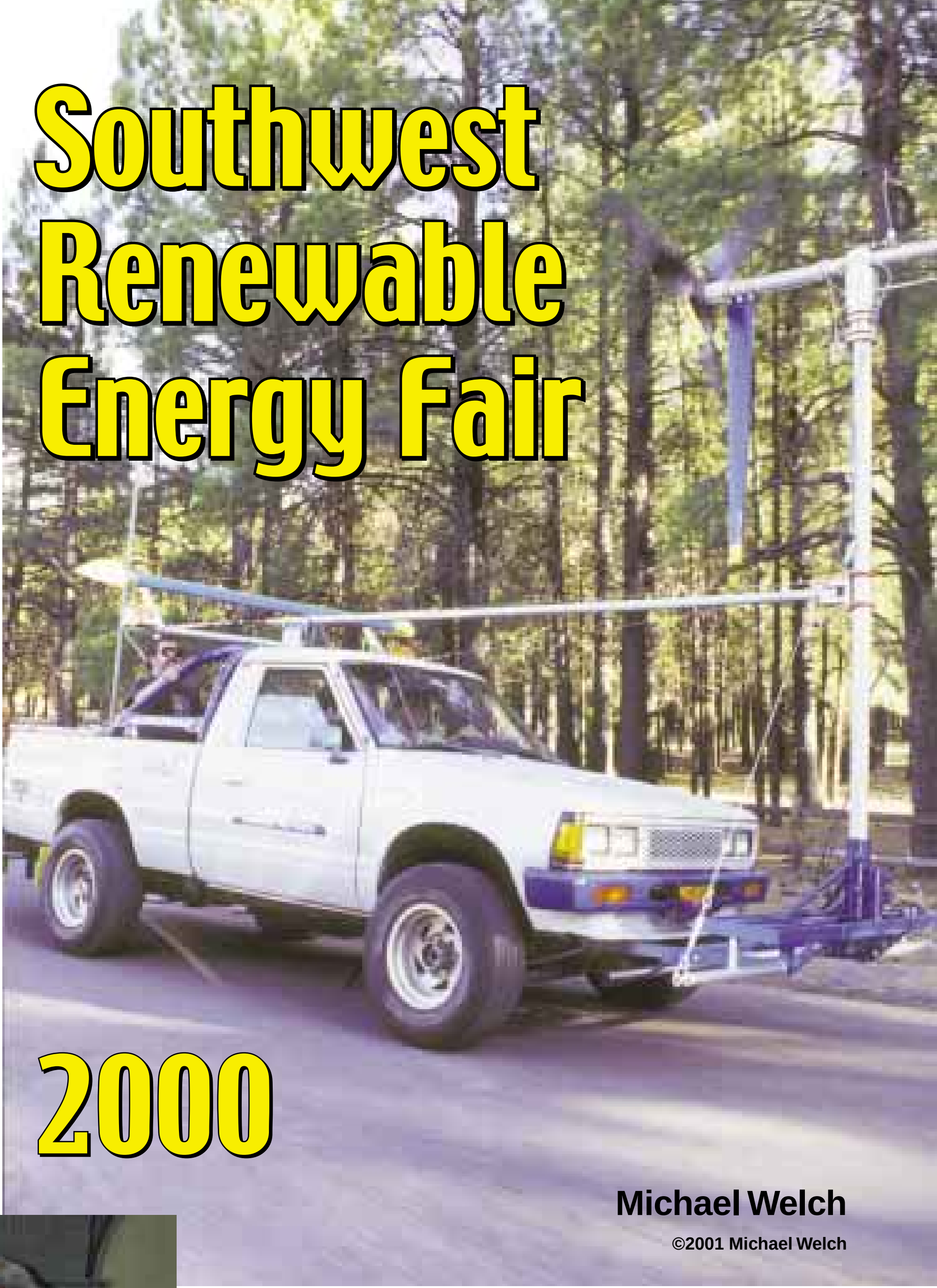
rainfall@swbell.net
The 2001 fair will be held in Fredericksburg, Texas on September 28–30.



Southwest Renewable Energy Fair 2000

Michael Welch

Not quite warp speed—the ATMV at 30 mph, with Richard Perez in the engineer's seat, taking data on the OB1.

The *Home Power* crew migrated to Flagstaff, Arizona for the third annual Southwest Renewable Energy Fair, which took place September 15–17, 2000. The fair was a fun and memorable experience for us all.

It was not as well attended as the previous fairs in Flagstaff. The first, in 1998, was well organized, with over 2,000 people visiting booths, buying RE equipment, and attending great workshops. The second fair saw attendance more than double and had even more exhibitors and workshops. *Home Power* reported that it was "a growing event."

But due to an organizational shake-up within the Greater Flagstaff Economic Council (GFEC), important details like publicity and an aggressive exhibitor sign-up effort were not up to snuff. The attendance was down by over 50 percent from 1999, and the exhibitor count was down by over 20 percent.

Would you trust these guys with your electrons?

But still, I think this is among the best fairs that *HP* attends. The locals are great and energetic when it comes to RE, and the commitment level of the GFEC is still apparent. The 2001 fair could again be at the level of previous fairs, but it will take extra effort to convince exhibitors and presenters that things will be better in 2001. I have no doubt that they can pull it off.

Fair Highlights

The keynote speaker was John Perlin, author of *From Space to Earth: The Story of Solar Electricity.* John gave an excellent talk on the history and usability of solar cells in our society. If you get a chance to see one of John's presentations, go for it.

There were more workshops than previous fairs, and they were thoroughly enjoyed. As in school classrooms, the fewer people in a workshop, the more each person gets out of it. On the other hand, when I walked out of my sparsely attended workshop, there were twenty people outside my door listening to a cookware sales pitch. That's a pretty big distraction from RE.

Don Harris of Harris Hydro, Ed Eaton and Johnny Weiss of Solar Energy International, and Chris Molello of AstroPower—RE Heroes!

Many of the usual fair suspects showed up, and since attendance was down, we had plenty of time to touch base and catch up on industry news. We had further opportunity at the wonderful after-hours party hosted by Southwest Windpower, Kyocera Solar, and Trace Engineering. After a good dinner and a couple of local brews, we fixed all the world's ills and found out what *really* is going on among our friends in the RE industry. And I will never tell who I saw kissing whom! It was a great party.

Windblown

One of the most prominent attractions at the fair was Aeromax's Accelerated Mission Test Vehicle (AMTV) with their prototype OB1 1KW wind genny mounted on the test frame. Who needs a wind tunnel? They mount a wind genny on the frame, stick an engineer in the bed of the truck surrounded by test gear, and run it down the road. Both Richard and I got a tour of the setup at 30 mph (48 kph), sitting in the engineer's seat next to the real engineer, Andreas Zill, who showed us the ropes.

The AMTV has a computer that can help analyze a wind system. It has weather monitoring systems, multiple data loggers, and can simulate operating conditions—from crosswinds to unsteady wind situations. According to Aeromax, it tests in conditions more similar to real conditions than a wind tunnel can. We look forward to the availability of their wind machines.

Cool Electric Motorbike

Caleb Breazeale of IE Designs was there with Valence, his new electric motorbike. It has a range of up to 25 miles (40 km), and tops out at 27 mph (43 kph). Ben Root kicked its tires and liked it a bunch. I heard concerns that having the batteries mounted above the top tube would create too high a center of gravity, but Ben said it handled well. It features a pulse-width modulated controller, a permanent magnet motor, and 26 AH of 24 V storage. It weighs in at 108 pounds (49

Caleb Breazeale (left) and the thoroughly sporty Valence.

It spins! A youngster makes a solar discovery and the future looks brighter.

kg). Stick the chain guards on there, Caleb, and you've got a great product.

Big Blowout
In fairness, part of this year's SWREF problems can be blamed on a freak accident that happened Thursday, just a couple of hours before *HP* arrived for setup. In perfectly clear weather, a tornado touched down on the fairgrounds, destroying the tents and sending three exhibitors to the hospital. (Everyone's going to be OK.)

It took until Friday afternoon, well after the fair was supposed to start, before replacement tents could be brought up from Phoenix and installed. Some of the old buildings at the fairgrounds had asbestos roofing, and because of tornado damage, portions of the grounds had to be restricted until after the fair when a hazardous materials team could finish cleaning up.

But the fair organizers worked hard to recover from what could have been a fair-cancelling disaster, and they kept a positive attitude throughout. Great job, gang. In spite of the problems, the fair was big fun. The accommodations in Flagstaff were wonderful, and we look forward to going back next year to the renewed SWREF.

Access
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Can't wait—tomorrow's drivers check out today's electric vehicle technology.

Left: Bubba the battery greets fairgoers.

Right: The tornado caused delays and even a few injuries, but the fair went on.

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805-563-5342 • Fax: 805-966-1344 • solarperlin@aol.com
From Space to Earth: The Story of Solar Electricity US$32 from aatec publications, PO Box 7119, Ann Arbor, Michigan 48107 • 800-995-1470 or 734-995-1470 • Fax: 734-995-1471 • aatecpub@mindspring.com

Caleb Breazeale, IE Designs, 5580 Forest Drive, Flagstaff, AZ 86004
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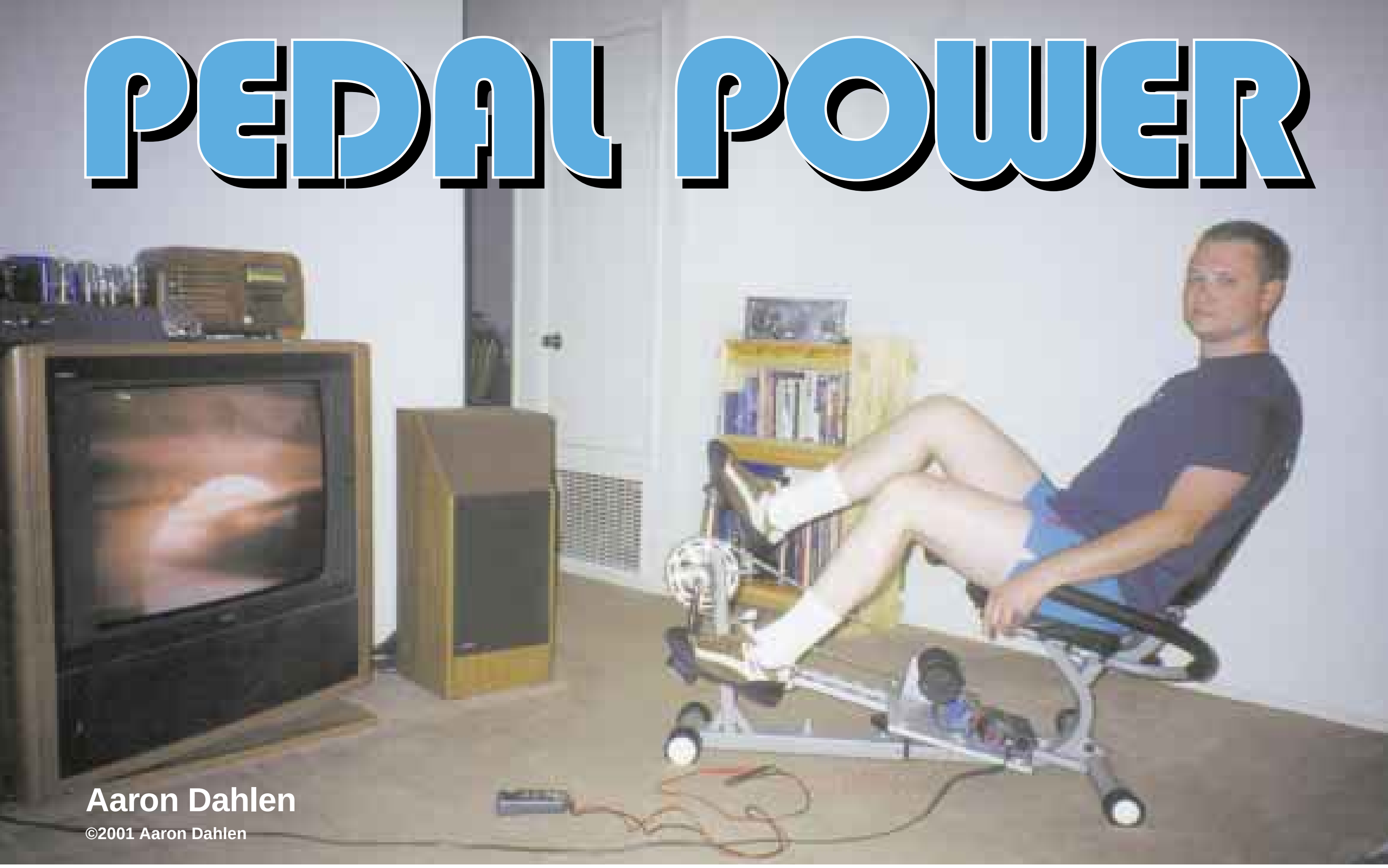
PEDAL POWER

Aaron Dahlen



The author in his livingroom powering a 31 inch (79 cm) TV. Notice the volt meter on the floor. Voltage should be monitored to prevent damage to the inverter.

Getting into a regular exercise program isn't easy. My solution was to permanently connect my television to a pedal-driven generator. The machine born out of this idea turns out to be quite useful, providing over 100 watts of power (depending on your strength). I use the generator to power a TV, but it could have many other uses: lighting, charging batteries, and powering small appliances.

The Bicycle

Since the primary use of my machine was to power a TV, I wanted to be as comfortable as possible. I purchased a recumbent exercise bicycle, and it turned out to be a good choice. As a plus, it uses standard bicycle parts. I had no problem converting it from belt to chain drive.

Don't underestimate your strength when purchasing a bicycle. After about forty hours of use, the crank on my exercise bike fell off the frame. I made a quick trip to a welder, and was back to pedaling.

Generator #1

Selecting and installing a generator was the most challenging part of building the machine. I tried three different types of generators. The first generator I tested was a large 36 VDC motor. It develops 50 watts (at 12 VDC), with a shaft speed of about 100 rpm. Most permanent magnet DC motors make good generators.

The motor was salvaged out of a large battery-powered floor buffer machine. A standard 43 tooth bicycle sprocket on the recumbent bike coupled to a 20 tooth sprocket on the generator completed the transmission.

Generator #2

Generator #2 was actually a car alternator mounted in a professional-grade exercise bicycle. The results with this alternator were disappointing. It took all my physical strength to power the 31 inch (79 cm) television. My opinion—don't bother with car alternators!

Automotive alternators are not self-starting. A separate power source is required to "flash the field." In normal operation, the car battery provides field excitation. For this application, I temporarily connected a 12 VDC battery to the output of the alternator. The battery was disconnected once the alternator was functioning.

The power consumed by an alternator field winding is inversely proportional to the speed of the alternator. You must keep the alternator rpm high, or the field winding will consume a significant portion of your pedaling power. This makes for a difficult machine to pedal. If you slow down, your pedaling is almost guaranteed to stop.

A battery connected to the output of the alternator would prevent the machine from stopping. However, you would have to remove the battery when done exercising, since the field winding would drain the battery. Also, when a battery is connected, voltage must be maintained religiously or battery damage will result.

Generator #3

Generator #3 was salvaged out of an electric wheelchair. This unit is a beautifully machined, 1/4 horsepower, 24 VDC motor. It is mated to a 10:1 gear reducer which contains two bevel-cut gears. The gear box is then connected to the main pedal crank via a 1:2.8 ratio (15 to 43 tooth sprockets) sprocket and chain set.

Of the three generators I have experimented with, this one works the best. Detailed side-by-side comparisons with the other generators are found in the table on page 73.

The Chain

The local machine shop was not able to provide bicycle sprockets or chain. However, they did have #41 chain and sprockets. Bicycle chain is about the same as #41, but bike chain is half the width. I purchased 10 feet (3 m) of #41 chain and the sprocket. It worked, but the chain twisted and moved around a lot on the crank sprocket.

I had two choices—machine the small sprocket to accept the smaller bicycle chain, or widen the larger crank sprocket. Surprisingly, it was easier to widen the crank sprocket. Since the #41 chain is twice as wide as bicycle chain, I simply added another 43 tooth sprocket. The sprockets are mounted side by side with no space between them.

To mount the sprockets, I first removed the crank from the frame, and then the bearing cone. I mounted the new sprocket flat next to the old one, and aligned the teeth. Only one sprocket needs to contact the pin on the pedal. I then reinstalled the sprockets. With the two sprockets side by side, chain twisting and movement was eliminated.

The pedal and crank set used in this project is often found in children's bicycles. The crank is a one piece design. You won't find these parts on a 10-speed bike.

DC to AC

Given the choice between an AC or DC load, I recommend AC. It's true that DC takes the 90 percent efficiency of the DC to AC inverter out of the equation. But running pure DC removes the regulating function of the inverter. Without this regulation, a DC load can easily be damaged.

Generator #3, capacitors, and inverter mounted and ready to install. A 1/2 inch (13 mm) thick aluminum plate serves as the base. The generator is bolted on while the capacitors and inverter are held on with Velcro.

If DC devices are to be powered by the pedal generator, I recommend a 12 VDC lead-acid battery be installed instead of the capacitors. A battery will smooth out the voltage fluctuations. If your pedal effort is insufficient or if you pedal too fast, the battery will limit the minimum and maximum voltages.

In my project, a 300 watt Tripplite brand power inverter converts the 12 VDC to 120 VAC. I connected the inverter directly to the generator, but found the results unacceptable. Humans do not pedal at a constant

**Close-up of the side-by-side sprockets.
The white sprocket is behind the chrome sprocket.**

torque. Maximum torque is delivered on the down-stroke, resulting in a voltage surge twice each revolution. There is also a period (twice each revolution) where no torque is produced.

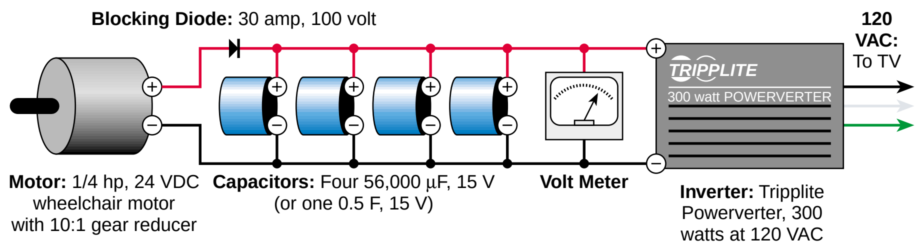
This produced wild voltage fluctuation on the output of the generator. These voltage fluctuations are passed through the inverter to the load. I found the television picture width changing with each revolution—not good. It was annoying, and would probably result in a damaged TV.

A mechanical flywheel would have solved the problem, but it would have added weight and complexity. Instead, four 56,000 microFarad (µF) 15 VDC capacitors were installed in parallel with the motor and inverter. This eliminated most of the voltage fluctuations. The car audio folks also make a single capacitor that is perfect for this application. It is rated at 0.5 Farads at 15 VDC.

The voltage delivered to the inverter must be monitored. Ideally the voltage would be held at 13 VDC. In actual use, input voltages as low as 11 VDC or as high as 18 VDC will work. But the voltage must be maintained above 11 VDC. If it drops, the inverter will "flutter," turning on and off rapidly. If this is allowed to continue, the inverter and TV could both be damaged. The maximum voltage should also be monitored. With a light load on the generator, the voltage will easily rise to over 20 VDC, damaging the inverter.

Remember, you are the regulator! You must monitor voltage and adjust your pedaling effort accordingly. Maintain as close to 13 VDC as possible. If you find yourself pedaling too fast or too slow, adjust the gear ratio by purchasing a larger or smaller sprocket. If you find that you can't maintain voltage, change to a smaller load.

Pedal-Powered Generator Wiring



Pedal-Powered Generator Costs

Item	Cost Range (US$) Low	High
Exercise bicycle	$150.00	$400.00
Generator	100.00	1,500.00
Inverter, 300 watt	75.00	150.00
Misc. electrical and hardware	50.00	50.00
Bass boost capacitor, 0.5 F*	49.95	49.95
Chain, #41, 10 feet	16.35	16.35
Sprocket, #41 (9 to 20 teeth)	7.64	16.17
Second sprocket for crank	Gleaned	
Total	$448.94	$2,182.47

* Used in high-power car audio applications.

Inverter Modifications

The inverter will have to be modified. I found this out the hard way. After two hours of operating at 16 VDC, the cooling fan died. It was rated at 12 VDC. Then the next week, the inverter's 16 VDC capacitors exploded!

The Tripplite inverter had two electrolytic capacitors that required replacement. They were easily identified by their 16 VDC rating. I recommend replacing these capacitors with 25 VDC units available from Digi-Key. Using a micrometer, measure the installed capacitors. Purchase capacitors of the same physical size as found in the 25 VDC section of the catalog. The rated value (µF) will be smaller than the capacitor you removed, but that won't cause problems. These modifications will void the inverter warranty.

I've had no problems in over 150 hours of use since I replaced the capacitors. And I don't anticipate further problems, since the inverter is running at less than 50 percent capacity and displaying no signs of overheating, even with the cooling fan removed. Most inverters in this class are identical in circuit layout and function. If possible, find an inverter that does not have an internal fan.

The Television

I started pedaling using a 19 inch (48 cm) Sony Trinitron, model number 20S42. The picture was perfect; there were no interference problems from the inverter. After greatly improving my strength and stamina, I am now able to pedal a 31 inch (79 cm) RCA television, model number G3164CK.

All color TV sets are sensitive to magnetic fields. These fields cause color abnormalities and strange picture distortions. The purpose of the degaussing coil in a TV is to nullify the effects of these magnetic fields. You can hear it operate as a loud 60 Hz buzz for a moment when a TV is first turned on. The coil consumes a large amount of power—several times more than the TV set requires in normal operation.

There are a couple of options to getting around the difficult startup:

A. Use a smaller TV. The degaussing coil is smaller and requires less power.

B. The degaussing coil on most TVs will not activate again if the unit loses power for less than 30 seconds. To trick your TV, perform these steps:

1. Connect the TV to main 120 VAC power.
2. Turn on the TV and let it warm up.
3. Unplug the TV—Do not turn it off!
4. Turn the pedal generator inverter off.
5. Connect the TV to the pedal generator.
6. Start pedalling, and get up to normal speed.
7. Turn the pedal generator inverter on.
8. Watch TV!

C. Live with the hard startups. This could cause damage to the TV and or the inverter.

D. Modify your TV by disconnecting the degaussing coil. *This is a dangerous operation and should be undertaken only by experienced personnel.* The accelerating power supply in a TV is usually over 20,000 VDC. This lethal voltage may be present, even with the TV unplugged! The high voltage power supply can also retain a charge for hours. It only takes one mistake and you'll never make another. Unfortunately, disconnecting the degaussing coil is not something you can have done at a TV shop. The TV set cannot be moved after this modification is made, since the magnetic fields of the earth could magnetize the picture tube causing distortions.

Performance

Before you connect a TV or other sensitive load to your generator, you should know your limits. Purchase several 25 W, 120 VAC light bulbs. Start small; connect one 25 W bulb to the output of your inverter. Pedal for twenty minutes. If this is easy, add another bulb the next day.

Try to do this at least three times a week. When you know how much power you can develop and you are comfortable with your generator, then and only then connect up a TV. Make sure that the TV you select requires less power than you can develop.

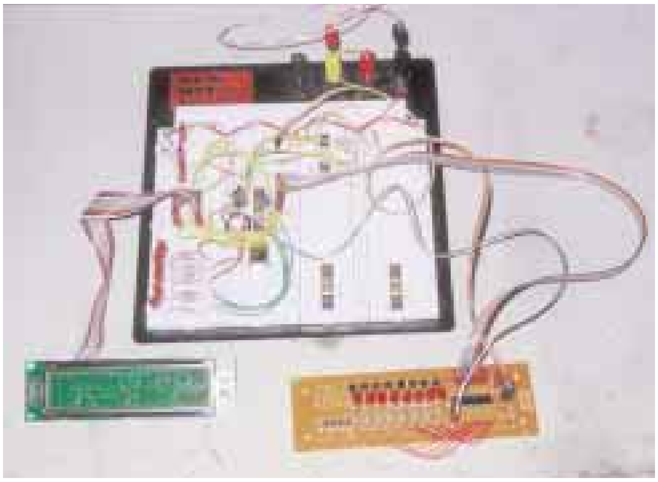
Newer TVs will require less power than older sets. The power requirements as found on the back of a TV are usually maximums. For example, my 31 inch (79 cm) TV is rated at 140 W; actual power consumed in operation is about 90 W.

Output power is dependent on your strength and stamina. I am 28 years old, 6 feet 2 inches (188 cm) tall, and in excellent health. The first night I had the pedal generator operating, I was able to power the

Pedal-Powered Generator Comparison

	Generator #1	*Generator #2*	*Generator #3*
Efficiency	Best	Poor	Good
Regulation	Fair (manual)	Best (electronic)	Good (manual)
Noise	Fair Brush noise.	Fair High speed alternator and transmission noise.	Good Dominated by chain.
Cost new*	$500	$100	$1,500
Strength	Good Take care not to drop this heavy motor as the magnets will be easily damaged.	Best The alternator was made to operate in an inhospitable environment. Virtually bulletproof.	Good No problems encountered in 50+ hours of use. Don't drop the motor, or the magnets may be damaged.
Author's recommendations	Good Simple chain drive. If you can find the motor and put up with the weight, this is a good choice. Be careful not to pedal too fast; the voltage will rapidly rise to over 20 volts.	Not worth the effort! Complicated transmission and poor efficiency.	Best Simple chain drive, low noise, light weight, and good regulation make for a simple, functional machine. Avoid right angle gear heads. The worm gears used in these units will result in short life and poor efficiency.

* Cost is an approximation for newly manufactured units. The author spent less than $50 at a recycling center for all the generators discussed in this article. If you build this project, you may have problems finding similar units. Look for the Windstream Power Systems Inc. advertisement found elsewhere in this magazine. They manufacture a small pedal generator system that can be used as is. Or the crank and generator could be remounted on a bicycle frame.



A work in progress. Microchip 16C73A controlled monitoring and control system, with LCD readout. The circuit in the lower right is the light-tree driver.

Sony TV for half an hour. The back of the TV indicates that it requires 90 watts. I measured 77 W at 16 V, with 4.8 A input to the inverter. Today I am able to power an entire two hour movie on the larger TV, and can do it again the next day!

The maximum power output of my machine is more than I can pedal. As of November 1, 2000, I am able to power a 100 watt light bulb for over an hour without any flickering. I can maintain 150 W for 2 minute intervals, and 210 W for about 15 seconds. These values are all observed by operation of light bulbs at the 120 VAC output of the pedal generator. At best, I estimate the machine efficiency to be 85 percent due to losses in the frame, transmission, generator, and inverter.

Although not required, an ammeter could be added. This will let you do power calculations. Multiply the voltage reading by the current reading to obtain power (volts x amps = watts).

I had always assumed the power consumed by the TV would be constant, but this is not so. Brightly-lit scenes or white backgrounds require substantially more pedaling effort. Remember, you are the regulator. Keep the voltage as close to 13 VDC as possible. If the voltage drops, the inverter or the TV will shut down.

Future Improvements

I want to purchase or build a better frame. The one I am using was never built to stand up to this abuse. The frame flexes with each push on the pedals. Thicker or stiffer metal or a better quality design would work. Also, it would be nice to sit about 10 inches (25 cm) higher relative to the pedals.

I'm also working on a "light-tree" to visually indicate voltage. Voltage, current, and wattage will be shown on an LCD display. Five lamps will provide the light-tree indicating voltage. I based this circuit on a microcomputer. The circuit is mostly complete, and the code has been written and tested.

But this aspect of the project has turned out to be academic. When the machine was first built, I monitored the voltage every minute. With practice, it was unnecessary to monitor voltage all the time. I can *feel* what the machine is doing, and how much power is required.

I'd also like to add an automatic battery assist to take over for quick breaks. If the voltage falls below 11.5 VDC, a PIC circuit will automatically connect a battery to the inverter via a relay. The peripheral interface controller (PIC—microcomputer) is a powerful device. If readers are interested, refer to the Microchip Web site (www.microchip.com).

Thanks

A big thanks to my wife Robin, who assisted in testing and building the machine. Thank you to the people at my local recycling center, where I found many parts at low cost. Without your service, this project would never have been completed.

I hope I've given *HP* readers some ideas about how to design and construct a pedal-powered generator. Please share your results with *Home Power,* and keep on pedaling!

Access

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Things That Work

Tested by Home Power

The Continua 2000 LED Penlight

The CC Expedition LED Flashlight

Tested by Richard Perez

When it comes to making light from electricity, nothing is more efficient than light emitting diodes (LEDs). Here are two flashlights that make wonderful use of white, high-intensity LEDs. In comparison to an incandescent lamp, the LED offers about 30 to 100 times the battery life, and over 10,000 times the lamp life.

The Continua 2000 LED Penlight

I've always been a big fan of penlights. They are small and handy. Just clip one into your pocket, and it's always there when you need it. The only problem is that penlights use the tiny AAA batteries that have very short operating lives when powering incandescent bulbs. This LED penlight has solved that problem.

The Continua 2000 LED Penlight uses a single high-intensity, white LED lamp. The penlight measures 5.5 inches (14 cm) long and is 0.5 inches (1.3 cm) in diameter. It weighs just over an ounce (32 g) with two AAA alkaline cells installed. There is a switch in the removable cap that unscrews for battery replacement. The switch is positive acting—push "on" and push "off." A convenient clip keeps the flashlight secured to a shirt pocket. The penlight is constructed of aluminium, and is available in a black or teal green finish.

I've been using this flashlight for four months now, and I use it a lot. It functions as my primary flashlight—I carry it in my shirt pocket all the time. I've had no problems with any intermittent operation or switch malfunction, and I use it at least twenty times a day. Though it is not designed to be held in the mouth, I do this regularly. The switch continues to work in spite of doses of drool.

The single LED provides enough light for use inside a vehicle, navigating inside a house, or walking on familiar paths outside. After four months of regular use, I have not exhausted the original pair of AAA alkaline batteries.

The retail cost of the Continua 2000 LED Penlight is US$17.95 including two AAA cells, and it has a limited lifetime warranty to repair or replace the light should it fail due to workmanship or defect in materials.

The CC Expedition LED Flashlight

While the LED penlight is my constant companion, there are times when I require more light than it can deliver. Some nights, the dogs are barking at some indigenous critters, and I have to go outside to chill out the scene. Then I reach for the big LED flashlight.

The CC Expedition LED flashlight is really bright. It has the same illuminating power as a standard two or three cell incandescent flashlight, but offers thirty times the battery life and over 10,000 times the lamp life.

The CC Expedition measures 7.8 inches (19.8 cm) long and is 2 inches (5 cm) in diameter at its head. It weighs 11.5 ounces (326 g) with three C-sized alkaline batteries installed. The CC Expedition uses seven high-intensity, white LEDs. This flashlight is made of heavy black plastic with a transparent lexan head. To activate the flashlight, simply twist the head. To replace the batteries, unscrew the head. This flashlight is equipped with a rubber O-ring gasket, making it watertight. It comes with a very effective, adjustable wrist lanyard.

I have been using the CC Expedition for over nine months now and I still have the same three C-sized alkaline batteries in it. The flashlight is rugged—it's survived being dropped numerous times. It is easily capable of illuminating objects over 75 feet (23 m) away. At closer quarters, it's super bright. Switch action is entirely positive, and I've experienced no intermittent connections.

This is a super-heavy-duty outdoor flashlight. With long battery life and virtually infinite lamp life, it is aptly named. It is so bright and lightweight that I have abandoned my heavy, battery-sucking incandescent "cop light" for outside activities. The CC Expedition flashlight costs US$59.95, which includes batteries and shipping.

Access

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Continua 2000 LED Penlight: Premiere Electronics, 765 North Bluff St,. Suite A, St. George, UT 84770
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CC Expedition LED Flashlight: C. Crane Co., 1001 Main St., Fortuna, CA 95540 • 800-522-8863 or 707-725-9000 • Fax: 707-725-9060
ccraneco@aol.com • www.ccrane.com

TOP SECRET

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

PROFILE: 0013

DATE: December, 2000
LOCATION: Somewhere in the USA
INSTALLER NAME: Classified
OWNER NAME: Classified
INTERTIED UTILITY: Classified
SYSTEM SIZE: 476 watts of photovoltaics, 130 watts grid-intertied
PERCENT OF ANNUAL LOAD: 40%
TIME IN SERVICE: 6 months

About six months ago, power rates in my hometown went through the roof. Demand was high, and rolling blackouts were being discussed. The utilities were charging 22 cents a kilowatt-hour, and everyone was petitioning the government to do something! It started to bother me. The ability to lower demand, and therefore rates, didn't lie with the government--it was really in the hands of the people. We used the power, and we had to live with the results of using too much.

And here I was with a garage full of old PV panels, not doing anything with them. I realized that I was part of the problem, and got out the circular saw to correct this state of affairs.

As it turned out, the frame I built wasn't big enough for all my old PVs. I was surprised at how many I had--I'd lost track over the years. Like a box of old pictures, each set of panels brought back memories:

* Six Arco Tri-Lams, surplus from the Carrizo plant. These were my first panels, and they lived on the roof of my parent's house for four years. They did nothing more than charge a deep-cycle battery and run a 12 volt light, since I didn't have the experience to set up a full PV power system at the time. But they got me started.

* Two anonymous thin-film panels encased in plastic. These powered the appliances in my van for several months as I drove around the country with my girlfriend, taking a sabbatical from the world of big business and expensive city apartments.

* Two Solarex panels, 20 and 30 watts, both used once upon a time to charge batteries for bicycle touring. They were indestructible, fortunately.

* Two 45 watt Solec panels that I got for $3/watt at a solar fair. I didn't need them, but it was too good a deal to pass up.

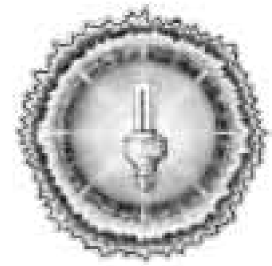
* A Solarex MSX-60 and Siemens SP36, both refugees from 12 volt remote power testing.

It came to a grand total of 476 rated watts. I wired 130 watts of these PVs for 24 volts, and hooked them to a Trace Microsine to feed power back to the utility. The remaining 346 watts of PV charges two surplus telecom batteries and runs a small refrigerator via a PROsine 1000 inverter.

On a good day at noon, I get about 75 percent of rated power out of these old panels. I find that I get about five hours of unobstructed sun per day on my array. (I'm renting a house, so I can't mount racks on the roof.) That's around half a kilowatt-hour a day fed back to the utility, with about 1.5 kilowatt-hours a day to run the refrigerator.

This is a fairly small system, and it only covers about 40 percent of my electrical needs. But at least I can read all the rhetoric about power prices and high demand and know that I'm not just another complainer--I'm doing something about it.

Home Power's Business



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

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What to Expect From Your RE Dealer

Richard Perez

Every renewable energy (RE) system begins its working life as a pile of equipment. Preparation, planning, and proper installation are all essential if the system is to be a success. You can do it yourself or you can get help from an installing dealer. Here is what to expect from your dealer. And here is what you may miss if you decide to do it yourself.

It's often said that good advice deserves to be repeated. This article was first published in 1997, in *HP61.* We're publishing it again because this needs to be said again.

Load Analysis

Every renewable energy system should begin with a complete, accurate, and thorough analysis of the appliances to be used in the system. If the load analysis is not properly done, the system is bound to disappoint its users. If the system's energy consumption is estimated too low, power shortages and dead batteries will soon follow. If the estimate is too high, the user will be wasting money on unneeded equipment.

Who does this load analysis—the system's user or the person who sells the RE equipment? In most cases, both contribute information. The user lists and gathers data about each appliance (don't leave out even the smallest one, and don't forget to plan for future appliances). How much and what type of electrical energy does the appliance consume? How long will the appliance run? The dealer usually enters the appliance data into a computer and generates an estimate of daily energy consumption. A good dealer will also recommend appliance changes to reduce the system's energy use.

The golden rule is: Every buck spent on an efficient appliance saves three to five bucks in system components. A good dealer knows this and will suggest replacing inefficient appliances (such as incandescent lighting and self-defrosting refrigerators that spit ice cubes out the door) with the most efficient types available. Listen to your dealer. He's not trying to sell you an expensive refrigerator. He's trying to save you three to five times the cost of that fridge in solar-electric modules, controls, batteries, wiring, and inverters.

Sad to say, many systems are purchased without ever doing a load analysis. Anyone who does this is wasting money, and is apt to be disappointed with the system. A good renewable energy system dealer will insist that a load analysis be done before selling you a system. If you haven't done the analysis, your dealer will nag you into it, or visit you and do the analysis with you. The dealer deserves to be paid for this generously because he or she is really doing your homework.

A Budget Is Not a Load Analysis

Don't buy a packaged system just because it's within your preferred budget. Do the load analysis, and if the system needed to power these loads is too expensive, modify the loads. Replace inefficient appliances, and, if need be, eliminate appliances until the system is affordable.

It is not unusual to go through the load analysis and system design phases three or four times before the right system is found. A properly designed system costs what the user can afford to spend on the system, and the load analysis details the energy consumption of each appliance.

If you don't know how to do a load analysis, see Ben Root's article in *HP58,* page 38. If you are hiring a dealer to do the load analysis, make sure all the criteria shown in Ben's article are taken into account.

Site Survey

A site survey is an analysis of a specific location for its renewable energy potential. Every place is different, but your system is going to be installed in a specific location. You need to determine what types and amounts of energy are available to you. Site surveys vary from simple to complicated. Let's first look at surveying a site for photovoltaic potential.

Sunlight is the fuel used by PV modules to make electricity. The PV array needs to be located where it will receive the maximum amount of sunlight. With seasonal variations in the sun's declination, daily constant changes in the sun's azimuth, and possible shading from hills, trees, and buildings, finding the best spot for the PV array can be difficult. What is needed here is an instrument such as the Solar Pathfinder.

The Solar Pathfinder makes it easy to find the best spot, producing a sun chart of your site's solar insolation potential. If your dealer shows up to survey your solar site without a Solar Pathfinder or similar instrument, fire him or her. If you are doing your own site survey for PV, borrow, rent, or buy a Solar Pathfinder and learn to use it. See *HP57* and *HP21* for specific information on solar site surveys.

Wind is a difficult resource to survey. You can see the sun and falling water; wind is more elusive. We used to suggest that people spend a year with expensive data logging equipment, measuring their site's wind potential. But this isn't really necessary.

Instead, talk with oldtimers in your area, check out the vegetation for "flagging" (more growth on the downwind side), and look into local recorded wind data. Another approach is to install a small generator at the exact place and at the same height as the proposed big generator. Monitor the small genny's performance for a period of a year or so and use this information to estimate the performance of larger gennys. See Rudy and Jill Ruterbusch's article in *HP80* for an example of this approach.

While experienced wind dealers don't know your site's measured wind potential, they can make a very accurate guess. They can also help you find a suitable location for the tower, and encourage you to make it as high as possible. See *HP40* and *HP41* for specifics on wind site analysis.

Hydro is the easiest renewable energy source to survey. Surveying for hydro can be done either by the system owner or by the dealer. All that counts is accurate head and flow measurements and some historical data on the seasonal output of the water source. See *HP21* for hydro siting information.

Many installing dealers combine the load analysis and site survey into one trip to their customer's site. In addition to working on the load analysis and siting the RE equipment, the dealer also gleans more vital information such as wiring lengths and battery location. From the site survey, the dealer can estimate how much RE potential is present. This RE potential coupled with the load analysis is all the information needed to proceed to the next stage—system design.

System Design

Designing a renewable energy system means using the system's energy requirements and the site's RE potential to generate a specific list of equipment. This RE equipment supplies the needed electricity within the limitations of the load analysis and site survey. Put into sentences it sounds easy, but really there is just as much art as science involved in system design.

Consider that a system designer can choose between at least eight different brands of PV modules, with each brand having at least four models. Consider that you can choose many different battery types, wind genny models, inverter kinds, control makes, and instrument types. There are literally thousands of different combinations of equipment.

Good system designers have learned through experience what works and what doesn't. They know which equipment plays well with other equipment. They know details such as what kind and size of cable/wires are required, inverter/appliance compatibility, whether a PV tracker should be used, what size pipe to use in hydros, how tall the tower should be, and how the battery should be configured.

They know your local RE environment. When you pay someone to design your system, you are buying their expertise. In almost all cases, professional help with system design pays off. Mistakes in the design phase are expensive to fix after installation.

Every system, regardless of size and without exception, should be safely designed. Overcurrent protection devices, disconnects, and proper conductor use make for a safe system. If your dealer doesn't do *NEC*® compliant systems, find a dealer who does. If you are doing the design yourself, learn the *NEC* and follow the rules. Renewable energy is real. It can burn down your home as easily as the grid.

Once the system designers have a specific list of RE equipment, they find out an essential bit of information—the system's hardware cost. At this stage, the system's customer usually chokes and says, "I can't afford that!"

Does the system's designer begin deleting PV modules and batteries to bring the system down in cost? *No!* A good system designer goes back to the load analysis. Can we do anything more efficiently? Can we do without some of the luxury appliances? The system's user and the designer work on the load estimate until the system becomes affordable.

A good designer will revise the design until it satisfies the load estimate and the customer can afford all the hardware. This is an essential give and take process. One very important result of this process is that the user is made aware of the system's capabilities. If the designer knows what he or she is doing, the customer will know what the system will power before it is installed and operational.

System Purchase

With the load estimated, the site surveyed, and the system designed, we have arrived at the first big milestone—where you get to part with your hard earned bucks.

Now is a good time to pause. Are you comfortable with your dealer/designer? Do you trust him or her? If you have doubts, now is the time to get a second opinion. If you decide on a second opinion, pay the first dealer/designer at this point. Pay for the help in load analysis, the site survey, and the work in designing your system. This makes the design yours—you just bought it. If you decide to buy from another dealer, this essential information is still yours to use.

Most dealer/designers charge from a measly US$200 to about US$600 or more for the load analysis, site survey, and system design. Many will refund this charge if you buy the gear from them and have them install it.

If you designed your own system and are shopping around for the cheapest deal in hardware, which you intend to install yourself, you should get a second opinion. Hiring an experienced designer/installer to review your load analysis, site survey, and system design is money very well spent. Most designer/dealer/installers will do this for less than 5 percent of the money you are planning to spend for hardware. A second opinion before purchasing your first-time design can save thousands of dollars later.

It is not uncommon for installing dealers to ask you to pay for some or all of the hardware prior to installation. This allows them to use your capital to finance the job. It is not uncommon for installing dealers not to have all the equipment for your system in stock. Inventory costs money, and a little patience on your part keeps installing dealers from having to charge you more for your system. You should never have to pay for installation labor until the system is installed and working to your satisfaction.

It is not uncommon for installing dealers to refuse to install hardware that they did not sell. Installing dealers are working on very slim profit margins. Installing dealers are beset on all sides by competition from companies that offer low prices instead of quality, on-site service. If you appreciate the help that your installing dealer has given you and will give you, show it by paying enough for him or her to live on.

At this point, money changes hands. Everything must be on paper, one copy for the installing dealer and the other for the system customer. In this packet of paperwork you should have:

- A copy of the final load analysis
- A copy of the site survey complete with sun chart
- A printout of the system design
- System schematic
- All estimated RE production data
- Manufacturers' spec sheets for all components
- A copy of the hardware bill

Don't sign the check until you have all of this paperwork.

Your installing dealer will now take your check, order your gear, and prepare to return to your site for installation. This entire process may take two to six weeks, so be patient.

Shipping

At this point, those of you who are acting as your own designers and installers are getting ready to accept the equipment you have purchased from a company that doesn't install. Check every box and every item for damage before you accept shipment from the carrier. Once you've signed off and accepted the shipment, claims for damage are very difficult. If you notice any damage, refuse to accept all the damaged goods and have them returned to the shipper. Let your supplier and their carrier discuss who is to pay for the broken equipment.

If you purchased your system from an installing dealer, you can forget shipment hassles. The dealer will show up at your site with all the equipment in good condition. You have already paid the dealer to take care of any broken batteries or smashed PV modules. This is their problem, not yours.

Installation

This is the phase that really determines if you were right in deciding to install your own design, or whether you should have hired an installing dealer to help you. This is where months of planning and many dollars should become electricity.

If you are installing your own system, I can only hope that you have done your homework. We at *Home Power* have tried to help with technical information, schematics, and everything we can think of to make you well informed about renewable energy systems. What we cannot supply through *Home Power* is experience. Only time and many systems installed and working can do that.

If your system is being installed by an installing dealer, you should consider becoming his or her shadow. This person has done dozens, maybe hundreds, of these systems. The installing dealer is a wealth of information and will explain every wire and every device, if you have sense enough to ask.

The installing dealer should show the user how to do battery watering and any other routinely required maintenance. The dealer should also explain how to operate the system's controls, how to use the inverter, and how to understand the information displayed by the system's instruments.

Most installing dealers will let you work with them. Most dealers would rather have you dig the wiring trenches or wind machine tower foundation holes. You can also save money by building the power shed to house the PVs, batteries, and inverter. Sweat equity pays off here. Installing dealers are highly skilled and mostly very busy. You can pay them to dig trenches at about US$50 an hour, or you can do it yourself.

As I mentioned above, most installing dealers will not install hardware that they did not sell. Please don't shop around for a cheap deal on RE equipment and then ask your local dealer to install the system. If you want installation, pick a dealer and involve him or her from the very beginning. Installing dealers must both sell the hardware and install it if they are going to make a living. Respect this, and your local dealer will be a terrific resource.

At this critical installation phase, the self-installer should consider every cable, wire, connector, overcurrent device, and disconnect in the system. Is it designed properly? There is no such thing as an unimportant connection. Every wire and connector must be done right.

For example, it takes a US$300 crimper the size of pruning shears to properly attach the connector to a #4/0 copper cable. It takes a set of punches costing over US$200 to make holes in electrical boxes. It takes a conduit bender to make bends in EMT conduit. While the bender is cheap, it's easy to waste US$200 worth of conduit learning how to use it. Installing dealers have all these tools and know how to use them.

Passing Electrical Inspection

Many installing dealers are also state-certified electrical contractors. Those who are not, hire an electrical contractor to oversee their work and show up for the electrical inspection. Chances are that your installing dealer has met with the local electrical inspectors before, and knows what they are looking for. If the system is done to local specs, there will be no problems.

If you installed your system yourself, expect critical examination by your electrical inspector. Don't be offended or angry—the inspector really has your best interests at heart. He knows that this is the first system you have done. He is merely safeguarding your home and family. If the electrical inspector finds problems, listen to him. Make any changes he requires regardless of what they cost. If there are substantial changes at this stage of the process, you have only yourself to blame—you did not do your homework.

Dealer Support

Your installing dealer should support you. If any component fails while under warranty, the dealer should remove it from your system and seek warranty repair on your behalf. When the component is repaired or replaced, the dealer should reinstall it in your system at no charge to you. You should be able to call your dealer and ask questions about your system's operation. If you are not getting this type of service from your dealer, change dealers.

If you designed and installed your own system, you have little recourse to service. If things go wrong or don't work when installed, calling the catalog business that sold you the hardware may not do much good.

Troubleshooting a botched installation requires an on-site visit by a sharp technician. Many mail order companies are not equipped to spend hours on the phone with you trying to figure out what is miswired or improperly applied. If you are going to install your own system, you should learn enough not to need outside technical support.

System Buyers, Treat Your Installing Dealer Right!

Your installing dealer is your best avenue for getting a system that works well at a reasonable price. Full-service installing dealers cannot compete with discount mail order firms. Don't ask them to. Instead of a cheap deal, the installing dealer offers you expert personal service.

Please realize that your installing dealer has overhead and expenses. It is not uncommon for them to wear out pickup trucks like you wear out toothbrushes. Expect your dealer to charge you mileage, and understand that they must do this in order to stay in business. If this personalized service is worth the approximately 15 percent extra that the system's hardware will cost when designed by, purchased from, and installed by professionals, then your dealer is your man. If not—grab the phone and you're on your own.

Installing Dealers, Treat Your Customers Right!

This article details your responsibilities to your customer. If you are not providing this level of service, you are in the wrong business. Have patience with non-technical customers who call in the middle of the night saying their batteries are broken because their voltage went down at sunset. Not everyone is a tech weenie, and most customers will need considerable schooling from you before they understand how their systems work. This is your job. Your customers are part of your family—treat them as such.

Still Want to Design & Install Your Own System?

I don't mean to discourage you. In fact, we do our level best here at *Home Power* to give you all the information you need. But you must do your homework. Take a hard, honest look at your abilities and available time. Failing in this leads to expensive, barely working systems that are often safety hazards.

Renewable energy is not rocket science. You can construct systems properly and safely if you take the time to learn everything thoroughly. Be prepared to buy or rent some expensive tools as mentioned earlier. Be prepared to make mistakes and pay for those mistakes. While the information in *Home Power* is as complete and thorough as we can make it, it is not a substitute for on-the-job experience.

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Wŏrd Pow´ẽr

Renewable Energy Terms

Rated Watt— Specified output of a generating source

Ian Woofenden

Derivation: The watt was named after James Watt, who developed an improved steam engine. "Rated" is from Latin "rata," according to a fixed part, *from Latin "reri,"* to consider or reckon.

What does it mean when you read that a renewable energy generating source is "rated at x watts"? Well, that depends on the device. This term can be pretty confusing.

If you're looking at photovoltaic (PV) panels, they are rated at 1,000 watts per square meter (full sun), at 25°C (77°F), and at their maximum power point. Since this point is where the voltage is generally at 17 or 18 volts, and your system voltage will be 12 to 15 volts, it doesn't represent what you'll get out of your PV panel in a battery-based renewable energy system. The real-world temperature of a PV panel in operation can be 45°C (113°F) or higher. Since PV output drops in higher temperatures, the rated output can be even more misleading.

If the panel generates 5 amps at 17 volts, we're talking 85 watts (amps x volts = watts). But if your battery is at 12.5 volts and the panel is still generating 5 amps, the wattage will only be about 62 watts. So when you see an advertisement for a 100 watt panel, you should bear in mind that it will only generate at about 75 to 85 watts when you connect it to your battery bank. Typically, you will get rated *amps* any time the sun is clear and strong from a deep blue sky. But you will not get rated *watts.*

If you're considering a hydro turbine, you're looking at a different situation. Though these machines do have an operating range, their output is determined by the head and flow available at the site. Ask hydro turbine suppliers what their turbines are rated for, and they'll start asking you what your head and flow are. This is fairly straightforward. The resource drives the output, and the relationship is very predictable.

Of course, you want a turbine that can handle your flow, and a generator capable of continuous output at that level. But asking for a certain size of turbine before you know your head and flow is putting the cart before the horse.

When it comes to wind turbines, the term "rated watt" is not very meaningful, though the manufacturers spend a lot of time and money trying to get you to focus on it. A wind turbine is rated at a certain wind speed, often (but not always) at the speed at which it generates the most. And since manufacturers use different rated wind speeds, it's hard to compare one machine to another.

The "rated watt" generally refers to the *peak* output of the wind generator. But wind generators don't spend a lot of time humming along at peak output. So focusing on the peak as a selling point or comparative measure is rather like shopping for a car based on its top speed.

What you should be more concerned about is the total energy output (KWH per month). But there is no standardized testing of small turbines, so we are at the mercy of the manufacturers' marketing departments. For now, the easiest way to compare wind turbines is not by their rated output at all, but by the swept area of their rotors.

The rotor is the "collector," the engine that drives the generator. Though there are some variations in efficiency, rotor diameter is the simplest and best comparative measure for output, whether you're talking about tiny turbines for sailboats, or gigantic, utility-scale machines.

Comparing the outputs of the three generating technologies is treacherous. A rated watt of PV has little relation to a rated watt of wind power. I can say that I have a 1,000 watt wind turbine and an 800 watt PV array, but I haven't told you much about their relative usefulness in my system at my specific site. It depends on the number of sun hours I have, and how much wind goes through my turbine's rotor.

Maybe we should put a little pressure on the manufacturers. Is it unreasonable to expect that PVs being sold for battery-based systems should be rated and advertised for what they will actually put into our batteries? Will wind turbine manufacturers acknowledge that customers want watt-hours in their battery banks, not bragging rights for the highest peak output?

Both of these industry segments could take a lesson from the hydro folks, who provide us with straightforward answers if we provide them with good information about our energy resource.

My advice? Take all the talk about rated watts with a grain of salt. Quiz the manufacturers and suppliers. And talk with experienced dealers. They have the knowledge and feel to tell you what to expect from your PVs, wind generators, and hydro turbines. Crunch your numbers, but be conservative, and allow for error. Make sure you get the energy (watt-hours) you need, not just mysterious "rated watts."

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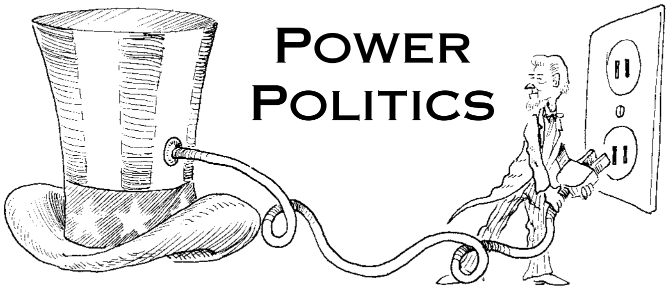

Greenhouse Gas Talks Failed, But There's Hope for the Future

Michael Welch

I guess we should have expected it. Even the U.S. government's lukewarm stance in 1997 at the Kyoto, Japan climate change conference was too good to be true.

That United Nations conference set the targets for a modest rollback of greenhouse gas emissions, primarily CO_2. The plan was to decrease the gas levels a total of 5.2 percent from 1990 levels. In late November, 2000, nations met again in The Hague, Netherlands to set the rules for implementing the Kyoto levels of greenhouse gas rollbacks.

Greenhouse gases act just as their name suggests. Like the glass-enclosed room that is used to heat homes and provide a warm winter environment for plants, greenhouse gases in the atmosphere let warmth in the form of sunlight pass through to our world. But the gases act like insulating glass, preventing some of that heat from escaping again. The earth gets warmer and warmer, and normal weather patterns get radically disturbed.

Corporate Influence

These U.N. conferences are made up of a bunch of bureaucrats, each negotiating in the name of a specific country. They are there to get the best possible deal for their nation, while still attempting to make the international 5.2 percent rollback target.

But therein lies the problem. The U.S. negotiators work for the federal government, which is quite beholden to the two major political parties, which to a large degree work for the corporations that control the parties. The corporations are more concerned about their short-term profits than seeing real decreases in global warming. They would just as soon see the whole greenhouse gases issue go away.

What they are ostensibly trying to do is set up a fair system that will give "credits" for certain gas-saving situations. Then those credits can be applied to other greenhouse gas-producing activities. As you might imagine, the negotiating for thousands of little details in this give-and-take relationship can be quite complex. But the major stickler in the way of an agreement was the U.S. negotiators insisting on large credits for "sinks," which are farm and forest lands that soak up CO_2 from the atmosphere.

The U.S. claimed that these sink credits are acceptable because they take credit for less gas than they really do soak up. But on the other side of the argument is the European Union, which views this particular ploy for credits as a way to avoid the Kyoto commitments, not a way to meet them. I tend to agree; it looks like the negotiators have been doing the bidding of corporate polluters, not trying to prevent global warming.

Nuclear Power & Greenhouse Gases

And here's another devious ploy. One of the original tenets of the U.S. position at a previous meeting in France is that nuclear power should be treated the same as renewable energy (RE) under the Clean Development Mechanism (CDM). The CDM would allow developed nations to achieve greenhouse gas emissions reduction credits by providing low-emissions technologies to developing countries.

That's right, the U.S. would get credits for providing nuke plants to other countries. In all fairness, the Clinton Administration seemed to be backing down on this one, at least in the early days of the Hague conference. According to the Nuclear Information Resource Service (NIRS), this U.S. position is opposed by the European Union and numerous other nations throughout the world, which have proposed a CDM that does not include nuclear power.

World Energy Modernization Plan

There is another anti global warming movement gaining momentum. An ad hoc group made up in part of energy company executives, energy policy experts, economists, scientists, and energy policy commentators met in 1998 to develop a set of "accelerated solutions" to the global climate crisis.

The group was "united by its impatience with both the pace and reach of the Kyoto process" and is "motivated by a common belief that, contrary to the economically defensive posture of many nations and industries, a global energy transition would substantially expand the stability, equity, and total wealth in the global economy." They hope their plan—the World Energy Modernization Plan (WEMP)—will help serve as a guide for policymakers.

The WEMP and its proposed funding mechanism, Tobin taxes, are gaining in popularity throughout the world. This is because of its clear focus, and the very real probability that if implemented, it could avert the environmental disaster that we are heading towards. The plan is constantly undergoing changes and refinements by interested parties and supporters, so it is something of a moving target.

WEMP Highlights

The World Energy Modernization Plan calls for an immediate elimination of national subsidies for fossil fuels, a deployment of equivalent subsidies for renewables, and job training for displaced fossil fuel industry workers. This will raise the price of fossil fuels to discourage excessive consumption, and will create significant financial incentives for major corporations to become developers of renewable energy.

According to WEMP committeemember Ross Gelbspan (author of *The Heat Is On*—see the book review in *HP78),* the U.S. federal government provides more than US$20 billion in direct and indirect subsidies to the fossil fuel industry every year, with a global estimate of US$300 billion annually. Imagine what that amount of money could do for the renewable energy industry.

The plan includes adoption of progressively more stringent fossil fuel efficiency standards and renewable content standards within the U.S. This is a complement to the emissions cap and credit systems of the Kyoto Protocol. Most U.S. electricity generating facilities operate at an efficiency of around 35 percent, yet modern gas-fired co-generation achieves efficiencies of 70 to 90 percent. A better efficiency standard should also include improvements for the end user. Renewable content standards relate to the percentage of renewable energy that energy producers are required to have.

The plan includes an elimination of regulatory barriers to create freer competition in energy. As it is now, these barriers impede competition and support wasteful, inefficient fossil fuel technologies instead of competing according to the more important criteria of cost, efficiency, and low CO_2 content.

The WEMP includes creating a new agency or authorizing an already-existing agency under the Kyoto Protocol to help transfer technologies and expertise according to the other goals of the plan. The new agency would certify that the plan's funding would only go to further fossil fuel efficiency and low-CO_2 based energy sources in recipient nations.

Tobin Taxes

The final part of the WEMP is its method of funding. The plan's developers are promoting Tobin taxes as an answer. These are taxes on foreign currency and international financial transactions. According to Gelbspan, "Those transactions today total about US$1.3 trillion per day. A quarter-of-a-penny tax per dollar on those transactions would yield about US$200 billion a year to build windmill factories in India, solar assemblies in El Salvador, and fuel cell factories in Russia."

The Tobin tax idea was conceived by Dr. James Tobin, a Nobel Prize winner and an economic advisor to the Kennedy administration. Its original intent was to help stabilize international capital flows, but WEMP's designers chose it because they believe it to be more equitable, non-discriminatory, and broad-based than other types of taxes.

The plan's founders are not completely pinning their hopes on this tax, though. They recognize that there are other methods that could provide the needed funds, such as taxes on carbon-based fuels (carbon taxes), and diversion of those portions of defense budgets dedicated to protecting the security of oil commerce.

The Tobin tax idea is rapidly gaining in popularity in Europe, where Tobin tax organizations are springing up with many thousands of supporters. According to a recent article in the *New York Times,* a Tobin tax came within six votes of being adopted by the European Parliament this year. That same article stated that France's Association for the Taxation for Financial Transactions for the Aid of Citizens (ATTAC) has 27,000 members. This and other organizations were founded specifically to promote Tobin's tax idea.

Tobin taxes are not without detractors, however (surprised?). U.S. conservative economists hate it. And, according to the *NY Times* article, the *European Wall Street Journal* compared its resurgence to a vampire that keeps rising from the dead.

Personally, I think it's a great way to implement the plan. Not only could it raise lots of funds, but it also might help chill the corporate globalism that is eating away at the world like an uncontrollable cancer. That is the main reason why U.S. conservatives don't like it. Anything that might interfere with the growth of international markets into third world countries is considered taboo. That may make it a tough tax to push through.

Push Anyway

But the plan is too important to give up on. It is clear to many scientists and activists that the Kyoto Protocol is too little, too late. And with the stonewalling that killed the talks in The Hague, even the lukewarm Kyoto Protocol is troubled.

The World Energy Modernization Plan (WEMP) presents a vision for successful change. Folks, this is the big one. We will end this world as we know it if we don't get off our butts and turn global warming around. We in the home-scale RE world understand this. Sure, most of us find taxes and subsidies distasteful, but the bottom line is that if we do not implement a major push to decrease greenhouse gases in the next few years, it may be too late.

Quotes From the WEMP Web Site

"Many business leaders and policymakers believe that any meaningful attempt to address the climate crisis will result in global poverty. We believe the exact opposite is true. A properly financed, public-private global transition to high-efficiency and renewable energy technologies holds the potential for an unprecedented worldwide economic boom."

"A global public works program to rewire the planet would create millions of new jobs all over the world. It would begin to reverse the widening gap between the North and the South [global hemispheres, with the northern being relatively overdeveloped compared to the southern]. It would raise living standards in developing nations without compromising the economic achievements of industrial nations."

"And in a very few years, the renewable energy industry would eclipse high technology as the central driving engine of growth of the global economy. What is missing is neither the technology nor the know-how. What is missing is the vision."

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The Heat Is On, Ross Gelbspan, 1998, ISBN 0-7382-0025-5, 288 pages, paperback, US$14 from Perseus Books Group, Customer Service Department, 5500 Central Ave., Boulder, CO 80301 • 800-386-5656 or 303-444-3541 • Fax: 303-449-3356
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Don Loweburg

Good News—Bad News

Most *IPP* readers know about the mess of deregulation in California. For the average utility ratepayer, there are dark clouds on the horizon. For the renewable energy industry in California, there are some bright spots.

The picture is varied and complex. To understand what is going on, a brief historical review is warranted. Actually, the history ought to start with the early development of the electrical energy industry. The pattern of utility behavior has not changed. However, that story is beyond the scope of this article. Two excellent references for the big picture, Berman's *Who Owns the Sun?* and Wasserman's *The Last Energy War,* are recommended.

A Brief History of California Deregulation

Early in 1994, the California Public Utilities Commission (CPUC) issued a series of recommendations stating in general terms that the generation of electricity in California should become competitive (deregulated). This document is referred to as the Blue Book.

In order to move towards that goal, a number of workshops and hearings were initiated by the CPUC. Participation in these efforts included a spectrum of interests and stakeholders—there were utilities, environmental groups, renewable manufacturers, electric service companies, and public interest groups.

Because of the diversity of these groups, the process was contentious at times, and protracted. Issues being hammered out during the next year included low income assistance programs, renewable energy portfolios (they set percentage benchmarks for renewable energy content in the electricity mix), and questions of utility "stranded assets" (how to value power plants that would not make it in a competitive environment—mostly nukes).

Meanwhile, a quiet group in the California State Legislature, shepherded by the utilities, introduced AB 1890, California's deregulation law. This was behind the backs of the hundreds of people who had spent huge amounts of time and resources in the public process to craft recommendations for the CPUC. The legislation was signed in September of 1996.

Thus I learned a fundamental operating principle of utilities: "If you can't get what you want from the regulators, take it to the legislature." What didn't utilities like about the participatory process initiated by the CPUC? Two things: there were strong efforts to limit the utilities' stranded assets recovery, and the renewable and environmental interests were crafting strong portfolio standards for renewably generated electricity.

What were the promises of AB 1890 as enacted? Recovery of stranded utility assets, competition and consumer choice, rate reductions, reliable electric service, and support for renewable energy generation.

The Scorecard

What did the utilities get from AB 1890? The most significant prize was a US$28 billion recovery for stranded assets. The amount of this settlement benefits them in two ways. First, it recapitalizes the utility holding company so that it may acquire new unregulated generation resources outside of its own regulated territory. Second, and perhaps more significantly, it stifles competition from other electricity providers within the utility's service territory during the transition period.

This is so because the bailout is funded by a competition transition charge (CTC). This charge is a monkey on the back of every KWH sold by a competitive electricity provider, since the CTC is again passed on to the customers in their energy bills. On the basis of this analysis, it should be no surprise that in California, competition, as measured by the number of customers getting electricity from a nonregulated provider, is a failure. Less than 1 percent of California's residential utility customers have switched from a regulated utility to a competitive power supplier.

Another promise of AB 1890 was a 20 percent rate reduction for consumers by 2002. The mechanism set up to accomplish this was a bond scheme to borrow money and give it to the utilities so they could reduce rates. The repayments for the bond are recovered from an additional charge on the utility bill. In spite of this Ponzi-like scam, utility rates are going up.

As I write, our local utility, PG&E, is in federal court attempting to pass on to its customers a US$3.4 billion rate hike. The same thing is going on in Southern California with the other large utilities, Southern California Edison and San Diego Gas and Electric. Yet—and this is true for all three major utilities in California—profits for the unregulated holding company are significantly up, while the regulated distribution companies cry poor and demand rate increases!

How about reliability? This summer, we saw at least a few rolling blackouts in California. Even more frequent were electric alerts, a daily occurrence during heat spells. During the alerts, electricity consumers were asked to curtail consumption. If the system-wide load did not drop sufficiently, rolling blackouts were initiated. Electric system reliability since the enactment of AB 1890 has declined.

Renewables Under Restructuring

How have renewables done under AB 1890? Restructuring has been good for renewables. During the transition period (1996–2002), 540 million dollars has been allocated in support of renewables. The bulk of these funds support existing and new renewable sources such as wind farms. PV receives support as part of an Emerging Renewables account (PV, Small Wind, and Renewable Fuel Cells).

The total allocated for PV from this account is around US$30 million, about US$6 million per year. There is no doubt that this has been a benefit to the PV industry. Approximately 395 buydown systems have been installed to date, with a capacity of about 1.3 million watts.

It is illuminating to put the renewables support program under AB 1890 in perspective. Let's imagine that a renewables portfolio approach had been adopted (the path not taken). A portfolio approach stipulates a certain percentage of renewables in the energy mix. California's average renewable energy content is now about 12 percent. A portfolio approach may have increased the existing percentage to 20 percent over ten years. The US$540 million for renewables provided by AB 1890 provides less than a 1/2 percent increase in renewable capacity. This is far short of the modest goals envisioned by the portfolio approach.

Another perspective is to compare AB 1890's renewables allocation to the utility stranded assets bailout. Comparing renewables' US$540 million to the US$28 *billion* bailout works out to 2 cents spent for renewables to every dollar spent on the utility bailout.

Remember that the utilities are buying combustion-powered generation plants with these dollars. Imagine what a different outcome it would have been if things were turned around—US$28 billion for renewables. That's the kind of investment needed if renewables are really going to have an impact in California. In short, the renewables support component of AB 1890 is window dressing.

The utilities got everything they wanted, while the ratepayers got no real competition, higher rates, a less reliable electrical service, and token support for renewables. AB 1890 served to transform regulated monopolies into unregulated monopolies, all at the expense of the ratepayers.

Recent California Legislation

In the last issue, I mentioned that renewables got another boost from recently signed AB 995 / SB 1194. This bill will continue the public benefits charge, the funding mechanism currently in place for AB 1890. Additionally, the amount for the support of renewables is increased to US$135 million per year for ten years beginning in 2002.

This bill recognizes that the support for renewables in AB 1890 was inadequate. The US$1.35 billion over the next ten years is a very welcome step in the right direction. However, SB 1194 is really a Trojan horse maneuver and has a second purpose. This second purpose is the price tag paid for extending renewables funding.

SB 1194 reasserts, legislatively, that the distribution and transmission functions shall remain within the regulated utility franchise. To understand why utilities would require the legislature to reaffirm what they already had, you must know that within the CPUC there were arguments for and interests pursuing deregulation of distribution. These activities were taking place in the ongoing hearings on distributed generation at the CPUC. It is quite obvious that the utilities did not want to go there.

Another measure, AB 970, is called the California Energy Security and Reliability Act of 2000. As window dressing, this act sports around US$50 million for demand-side management and energy efficiency. The real substance of the legislation is to allow for fast-track siting of combustion power plants. Local permitting authority and air quality standards will be waived. A system of "offsets" and fines will be allowed as mitigation for excessive emissions. The act stipulates that these provisions are temporary, and in three years the plants will be brought into compliance with the highest standards or they will be removed.

Analyzing these recent bills leads to the conclusion that legislation with huge benefits for utilities now must contain small benefits for renewables, energy efficiency, and demand-side management. The score again:

AB 1890
- Utilities—US$28 billion
- Renewables—US$540 million
- Ratepayers—foot the bill, higher rates, less reliability

SB 1194
- Utilities—legislated guarantee of distribution franchise
- Renewables—US$1.35 billion over a period of ten years
- Ratepayers—foot the bill

AB 970
- Utilities—fast-track siting, lowered emission standard
- Demand-side management—US$50 million
- Ratepayers—foot the bill, lower air quality.

My dream is to reverse this picture. Make major renewable legislation with small benefits for utilities attached. In both scenarios, the ratepayer pays. But if we reverse the picture, they get something for their money—a sustainable future.

The lesson for those in other states is to think carefully about what they see in California, and adjust accordingly. I've been talking about the energy politics situation in California, but this could happen anywhere. It's the "structure" in restructuring that counts….

IPP's New Web Site
Last issue we announced our new URL *(www.i2p.org).* We also introduced our dealer-installer network of over 80 renewable energy professionals who install systems. Other features of the IPP site include a history and purpose statement, an online application form, archives of past IPP articles, and a list of net metering states.

The Big Picture
A wealth of information about the U.S. PV industry is collected by the Energy Information Administration. They maintain a Web site with this information presented in table format. Here are some interesting items gleaned from those tables (1999 data). Total PV shipments by U.S. manufacturers went up 52 percent, to almost 77 megawatts. Interestingly, 72 percent (56 MW) was exported, with about 63 percent of that total going to Japan and Germany. Another big change was the continued shift to grid-interactive use. Grid applications went up 78 percent in 1999, compared to 1998. Average module price went down about 8 percent. Crystalline silicon remains the predominate cell material, accounting for 96 percent of the market. Much more information is available at this site—such as the number of PV companies and the number of people employed in the PV industry.

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Who Owns the Sun?, Dan Berman and John O'Connor, 356 pages, ISBN 0-930031-86-5, 1996, US$24.95 from Chelsea Green Publishing Company, PO Box 428, Gates-Briggs Building #205, White River Junction, VT 05001 • 800-639-4099 or 802-295-6300
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The Last Energy War, Harvey Wasserman, 64 pages, ISBN 1-58322-017-8, 1999, US$5.95 from Seven Stories Press, 140 Watts St., New York, NY 10013
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www.eia.doe.gov/cneaf/solar.renewables/page/solar/solarphoto_tab.html

Module Wiring Example

John Wiles

Sponsored by the Photovoltaic Systems Assistance Center,
Sandia National Laboratories

Selecting the proper cables and connecting them to a PV module seem like relatively simple tasks. However, as we have seen in the last three *Code Corner* columns, there are several steps involved. In this column and the next we will look at some typical PV systems. We'll examine how the module cables should be selected, sized, and connected to meet the requirements of the *National Electrical Code (NEC),* and to achieve a durable system that performs well.

Simple Example

Let's imagine that someone has given you a DC water pumping system consisting of a 24 volt submersible pump and two 75 watt, 12 volt PV modules. You have 90 foot (27 m) trees on your property, so you have to mount the two PV modules on the hill behind the house. The total distance from the PV array to the wellhead, and down the well to the pump, is 200 feet (61 m).

The PV modules have the following information printed on the back:

At Standard Test Conditions (STC):
Voc = 21.7 V, Isc = 5.8 A, Vmp = 17.3 V, Imp = 4.33 A

Maximum systems voltage = 600 V

Maximum series fuse = 15 A

#14-8 AWG conductors rated at 90°C required

Voc is the open-circuit voltage, Isc is the short-circuit current, mp refers to maximum power point, and STC refers to Standard Test Conditions of 25°C (77°F) and 1,000 W/m^2 irradiance.

Your area experiences 40°C (104°F) temperatures every summer. The modules are rack mounted, but frequently experience no cooling breezes. The normal winter low temperatures are about 0°C (32°F), and moderate winds are experienced in the winter. You choose to run direct burial conductors in the ground (24 inches (60 cm) deep), and choose USE-2 cable because a high-temperature, sunlight-resistant, wet-rated cable is required.

The required ampacity for the conductors is 9 amps (1.56 x 5.8 A = 9 A). The 1.56 safety factor is explained in *Code Corner, HP79,* page 112. The high ambient temperatures in the summer cause the module junction boxes and areas adjacent to the modules to operate at about 65°C (149°F). With USE-2 conductors rated at 90°C (194°F), the temperature correction factor is 0.58.

At this point, you could select (guess) a cable size, correct its ampacity with this correction factor, and see if the corrected ampacity was greater than the required 9 A. Or you could calculate the 30°C (86°C) required ampacity by taking the 9 A and dividing by the temperature correction factor. In this case, the calculation yields 15.5 A (9 ÷ 0.58 = 15.5).

From *NEC* Table 310-16, we see that #14 (2 mm^2) USE-2 cable has a 30°C (86°F) ampacity of 25 amps, meeting the requirement. Since #14 is the smallest cable allowed for use with this module, it is our first choice. Incidentally, #14 USE-2 is not a commonly available cable type and size, and would have to be special ordered in large quantities (500 foot (152 m) minimum) from a major wire distributor. Section 240-3 of the code restricts #14 conductors to a 15 A overcurrent device, so we are permitted to use it.

Voltage drop can now be calculated. From Table 8 in Chapter 9 of the *NEC* (or *Code Corner, HP80),* we find that a #14 (2 mm^2) conductor has a resistance of 3.14 ohms per 1,000 feet (305 m). For our 400 foot (122 m) circuit length (round trip), the resistance will be 1.26 ohms (3.14 x 400 ÷ 1,000 = 1.26). At a maximum power current of 4.33 amps, the voltage drop in the circuit from the conductors alone is 5.5 volts, which is 23 percent of the nominal 24 volts in the system—way too much for a renewable energy system.

The module maximum power point current was selected as a compromise between the short-circuit current of the module and other unknown operating points that require less current than Isc. Pumps and PV modules operate all over the current range of the module, depending on temperature conditions, system design, time of day, and other factors.

When we add a few milliohms (estimated at 0.005 ohms) for connections and a disconnect switch, we get even more drop. So we need to select a larger conductor size. Since #10 (5 mm^2) is more commonly available and is stocked by PV distributors, let's check it. The resistance for the 400 foot (122 m) run will be 0.496 ohms (1.24 x 4 ÷ 1,000 = 0.496), which yields a voltage drop of 2.14 volts or 8.9 percent. This is still too high.

Electrical supply houses and building supply stores normally stock #8 (8 mm^2) USE-2. The use of this conductor size would cut the voltage drop to 1.3 volts (0.778 x 400 ÷ 1,000 x 4.33 = 1.34), which is 5.6 percent of the nominal system voltage—still a little high.

The module terminals can accept a maximum conductor size of #8, so we must start getting creative. There are wire reducers made for just such applications. They are copper sleeves that fit over large cable sizes and reduce them to a smaller size that will fit into smaller terminals. We could also splice a larger conductor (used for the long run) to a #8 (8 mm^2) conductor that would fit the module terminals. The splicing devices would probably be split bolts, which need to be properly insulated with tape and installed in a protected (junction box) environment. There is usually not sufficient room in the module junction boxes to do these splices.

While we could continue to guess at larger conductor sizes, let's instead work the problem backwards. Assume that we want a voltage drop of no more than 2 percent, including wire drop and connection drop. We can solve for the necessary wire resistance per 1,000 feet as follows.

Maximum allowable voltage drop is 0.48 volts (0.02 x 24 = 0.48). This voltage consists of a drop from the connection resistance (0.005 ohms) and a drop from the wire resistance that is unknown.

At the operating current of 4.33 amps, the connection voltage drop is 0.022 volts (4.33 x 0.005 = 0.022). If we subtract this drop from the maximum allowable drop, we get 0.458 volts (0.48 - 0.022 = 0.458) that can result from just the conductor resistance.

We have an equation for voltage drop (V_d) and total resistance (R_t) that is $V_d = R_t$ x 4.33 amps. We can solve for R_t ($R_t = V_d \div 4.33$). The result is 0.106 ohms (R_t equals 0.458 ÷ 4.33 = 0.106) for the 400 foot (122 m) run.

We need to find the resistance in ohms per 1,000 feet of cable (R1000) so that we can look up the conductor size in a table. To solve for ohms per 1,000 feet (R1000), we use the following equation. R_t = R1000 x 400 ÷ 1,000. R1000 = R_t x 2.5. In this case, R1000 equals 0.265 ohms (0.106 x 2.5 = 0.265). From Table 8, Chapter 9 of the *NEC,* or *Code Corner* in *HP80,* we see that #3 (27 mm^2) copper wire has a resistance of 0.245 ohms per 1,000 feet (305 m), so it will meet our requirements.

Does it cost more than #10? Yes. Is it necessary? Yes, if you want to pump water. Will a smaller size work? Yes, but pumping performance will suffer.

Typical Copper Conductor Prices

	Range in US$ per foot	
Size (AWG)	*Low*	*High*
10	0.22	0.35
8	0.26	0.42
6	0.30	0.55
4	0.32	0.80
2	0.45	1.25

The table shows some typical prices for copper conductors in these sizes. Prices vary significantly depending on where and when you buy. No one source (PV equipment distributor, electrical supply, home building store, or hardware store) consistently has the lower prices, so it pays to shop around.

Want to use aluminum conductors with the hope of saving some money over copper? No problem. Since aluminum has a higher resistance than copper, a #1 (42 mm^2) conductor will be needed (resistance is 0.253 ohms per 1,000 feet or 305 m). Special splicing devices rated to connect copper to aluminum will be needed at each end to convert the aluminum conductors back to the copper conductors. Copper is required by the PV modules, many pumps, and some switchgear.

Grounding and Balance of Systems

Although this *Code Corner* primarily deals with module conductors, a few comments on the rest of the system are in order. The module location will require a ground rod to which module frames must be attached. The negative circuit conductor may also be attached to this ground rod, and if this is done, an equipment-grounding conductor must not be used between the modules and the pump. This grounding and bonding system is described in *HP74, Code Corner, Grounding the South Forty.* The Southwest Technology Development Institute (SWTDI) Web site has all of the past *Code Corner* columns in PDF format.

The negative conductor and the equipment-grounding conductors from the pump motor housing and the disconnect switch enclosure will be connected to a second ground rod at the pump.

Since there is no energy storage in the system, and there is only one string of two modules, there is no requirement for overcurrent protection in the circuit (see *NEC* Section 690-9(a) Exception). Only a disconnect switch (listed for DC and rated for load-break operation) will be required at the pump location.

Summary

It takes longer to describe these calculations than to do them. SWTDI is working on an interactive CD-ROM to do some of these calculations for PV systems, and an initial version may be available late in 2001. However, the calculations are relatively straightforward. All that is really required is a copy of the *NEC,* a calculator, and a little time to size conductors properly. In the next *Code Corner,* we will take on a more complicated system.

If you have questions about the *NEC* or the implementation of PV systems following the requirements of the *NEC,* feel free to call, fax, email, or write me. Sandia National Laboratories sponsors my activities in this area as a support function to the PV Industry. This work was supported by the United States Department of Energy under Contract DE-FC04-00AL66794. Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy.

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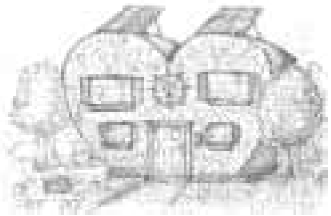
National Renewable Energy Laboratory solar radiation and weather data base:
http://rredc.nrel.gov/solar/old_data/nsrdb/redbook/sum2

Home & Heart



Kathleen Jarschke-Schultze

This November, Bob-O was gone for two weeks on a dad/lad camping trip with his son, Allen. I was left in charge at Chateau Schultze. I wanted to live up to Bob-O's admission that I was no longer "marginally mountain," but had graduated to "more or less mountain." I was doing okay without him until the first snowfall.

Murphy's Hydro

For some reason (I suspect Murphy's Law and Bob-O's absence), a PVC connection about 20 feet above the hydro turbine decided to come apart. I got home from taking the dog for her annual exam when I discovered it. As I got out of the car, I could hear the creek being very loud. Living next to a creek, you get used to the sounds it makes. This was an alarmingly unusual noise.

From a distance, I could see that there was a problem with the pipe. I came back to the house and grabbed the first pair of gum boots that I found, thinking they were mine. As I shoved my feet into them, I realized that they were Bob-O's, and way too big for me. But it was too late. I was on a mission, and climbed down to the creek in the snow. As I stepped into the ice water, I realized that the gum boots that I had chosen leaked.

I could see where the pipe had come out of the connection. It seemed like I might be able to line up the pipe again. I stood on one foot and pressed my other foot onto the wayward pipe and pushed with all I had. Never underestimate hydraulic power. The pipe realigned alright, with an eighth inch gap between it and the connector. This gap caused a blasting pinwheel of icy water to drench me from face to foot, and knocked me backwards onto my butt, waist deep on the rocks.

Emma, my 92 pound Airedale dog daughter, thought it great fun that Mom was going to play in the creek with her. She began grabbing fallen branches and jumping around me. I could see I wasn't going to win over Murphy, so I retired to the house to get warm and dry.

Creek Rescue

I called Karen at *Home Power* Galactic Central, hoping I could prevail upon some of the crew to rescue me. Not long after dark, Joe Schwartz, Eric Hansen, and Jason Powell showed up. As I led them down to the creek to view the problem, my flashlight went dim. I went back to the house for more flashlights, as we always have several on hand that use rechargable batteries. By the time I got back, the guys had surveyed the problem and had a plan.

Carla Emery once said, "The hero of the morning is the one who gets the fire going." Well, the hero of the hydro is the buddy who gets on his river sandals and wades into the creek in the dark and in the snow to fix your hydro pipe. This is just what Eric did. While he held one end of the pipe, Joe and Jason lifted and shoved the other end up past the connection.

Then Eric lifted the two ends and realigned them into one pipe again. Water still shot out of the connection, but I had enough getting through that I didn't have to run the engine generator. The guys then piled big rocks on and around the pipe to hold it in place until Bob-O got home.

The real fix came later. First we pulled the intake out of the creek to drain the pipe run. Bob-O then pulled the lower section of pipe up past the connection by about 6 inches (15 cm). He first moved the threaded PVC ring, and then the rubber ring, higher on the up-creek pipe. I held it up, steady, and in alignment, so we were able to reattach the two sections of the connector. We used a big adjustable wrench to tighten the fitting, and we were done.

Hydro His Story

When I first met Bob-O fifteen years ago, he was living on a gold claim and using microhydro power. He had been living on hydro power for fourteen years already. I quickly learned to climb the mountain behind the cabin up to the water ditch. It was one of the mine's water ditches used for ground sluicing for gold in the past. Once there, I would grab the MacLeod (a tool used for scratching fire lines), and walk the ditch cleaning out the fallen forest debris.

In the summer, I didn't have to climb the mountain much. In the spring, fall, and winter, the trip was sometimes daily. In the forest, a lot of leaves fall. Once, a bear pawed a lot of dirt from the bank into the ditch while digging for some sort of food.

The intake of a microhydro system is all-important, and must be kept clean and free to take in all the water it can. The walk to clean the intake can be enjoyable at best and a downright miserable nuisance at worst. But it's a very real part of using microhydro power.

Pipe Dreams

Our system here on the creek uses an Energy Systems and Design Stream Engine. Our penstock is about 800 feet (240 m) of 6 inch PVC pipe on the upper end, and 130 feet (40 m) of 5 inch PVC pipe on the lower end.

Bob-O's home-built intake made from drilled-out 6 inch PVC pipe.

Of course, we worked up to this present configuration through the years. When we first moved to the creek, all the pipe was 3 and 4 inch, and only about a 600 foot (180 m) run. It takes two things to make a hydro plant run—head (vertical drop) and water. If you have a lot of one you can get by with not very much of the other. But our total head is only 32 feet (9.7 m), which is not very much. So to make the system work well, we had to use more water than the small pipe could efficiently carry. Hence the upgrade.

It is normal for the water to travel through the intake into a spring box. In our case, we don't have a lot of head to start with. We were loathe to lose any at all in feeding a spring box, so we chose to put the hydro intake right into the creek. Bob-O has tried a number of pipe intake designs, mostly of his own do-it-yourself ingenuity. A little over a year ago, he came up with a really swell design. We have been through all four seasons with it, and it is the best yet.

Assembly

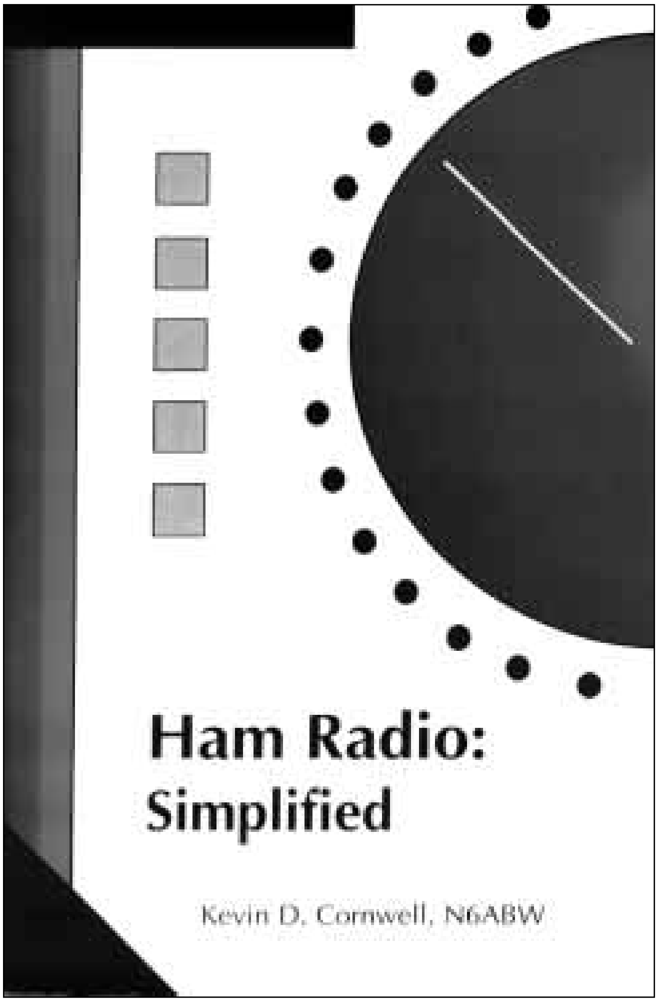
To assemble the intake, he used one 3 foot (0.9 m) length of six inch PVC pipe, a 45 degree elbow, a PVC end cap, and a 3/8 inch (10 mm) diameter drill bit. First he marked lines 1-1/2 inches (38 mm) apart down the pipe segments. The next step was to drill 3/8 inch holes every inch down the drawn lines. He assembled the pieces into one unit (see photo), and then attached the whole unit onto the upper end of the hydro pipe.

The first time he tried it, he put 1/4 inch (6 mm) hardware cloth around the outside of the last 3 feet of the pipe. It was a real pain in the neck to clean. We found that a toilet brush worked best. After a while, he realized that the screening wasn't necessary. With the system as it is now, the leaves brush right off of the smooth pipe. He says that he figured the size of the holes by figuring half the diameter of the smallest nozzle we might use.

When the leaves are falling, we clean the intake about once a week. If the wind has been blowing hard, we check it twice a week. Other than that, it can be months before we get up the creek to clean it. It just doesn't need very much attention. It works because with all the small holes instead of one big sucker, the leaves usually float by on the water. Simple and effective—just the way we like it.

Access

Kathleen Jarschke-Schultze is enjoying an occasional walk to clean her head at her home in Northernmost California, c/o *Home Power,* PO Box 520,
Ashland, OR 97520
kathleen.jarschke-schultze@homepower.com



By Kevin D. Cornwell, N6ABW
Reviewed by Louis Woofenden, KC7B

Ham Radio: Simplified is a basic non-technical handbook of things that a new amateur (ham) radio operator needs to know before venturing onto the air. It isn't really a license study guide, but it has a lot of good information about ham radio.

Ham radio can be fun and useful for people living far from the power grid and telephone lines. And because many people living off-grid are interested in electronics and other technical pursuits, ham radio is a natural fit, and a good way to meet other like-minded people. This book is a good start in learning the basics about ham radio.

Ham Radio: Simplified starts with a rundown of which radio is best for you. It explains what features are important in a transceiver—whether you want to use a radio in your home, car, or anywhere else. Operating practices are covered next. This information is great, since it lets new hams avoid sounding too much like newcomers when they get on the air.

The very high frequency (VHF) and ultra high frequency (UHF) bands are primarily used for short range communications. Two meters, a VHF band, is the most popular ham band in the U.S. This range of frequencies is great for short-range chats with other hams, keeping in touch with nearby friends or family who are hams, and many other activities. The book covers some of the tricks you need to know about two meters, and it'll get you up and running without any trouble.

The high frequency (HF) bands allow worldwide communications with other amateurs. In an hour or two on the radio, you might talk with hams in Japan, Spain, Russia, Brazil, or almost anywhere else in the world. The chapter on the basics of how to get on the air explains some of the terms and concepts that might be unfamiliar to a new ham.

There are many different types of antennas used in amateur radio. One chapter in this book describes most commonly used antennas, and tells how to make a dipole, which is an easy antenna to make for yourself.

Six chapters discuss the different "modes" used in amateur radio. Modes are the different ways hams use the airwaves to communicate. Morse code is a mode. So is the spoken word, which hams call "phone." There are many digital modes that rely on computers to help send and receive information. Some are appropriate for local use, and some are used over long distances. The book explains how to use all of these modes, as well as fax and slow scan television, which are the transmission of still images over ham radio.

The last three chapters are devoted to electrical theory, soldering, and the use of multimeters. The sections on theory are fine, but this information can easily be found in other books. The information on soldering and on the basic use of multimeters is good, as are the explanations of how to test resistors, capacitors, diodes, and inductors.

Rounding out the book are ten appendices of reference material. They include information on resistor and capacitor color charts, phonetics, abbreviations used in ham radio, different codes used in conjunction with the Morse code, a list of Web sites for hams, and other useful information. Throughout the book there are continuous sidebars that explain many terms, abbreviations, and concepts. If a word in the main text is bold, just look at the sidebars, and you'll see an explanation of that word.

This book is a good supplement to an ARRL (American Radio Relay League) license study guide. The main drawback I found is that things are sometimes simplified a bit too much. Just keep in mind that if you want a thorough technical understanding of some of the concepts, you'll need to find it elsewhere. I would recommend this book to both new and prospective hams. But even those who have experience with the great hobby of ham radio will probably learn something from this book.

Access

Ham Radio: Simplified, Kevin D. Cornwell, N6ABW, ISBN 1-888740-00-0, 90 pages, US$8.95 from PhotograFix Publishing, 2139 Hilt Rd., Hornbrook, CA 96044 • Phone/Fax: 530-475-0916 publish@photografix.net • www.photografix.net

Reviewer: Louis Woofenden, KC7B, PO Box 1001, Anacortes, WA 98221 • kc7hdc@arrl.net

HAPPENINGS

INTERNATIONAL
Free instructions, photos, drawings, & specs to build solar cookers & water systems with local materials purchased with local currency. Sunstove www.sungravity.com

AUSTRIA
Feb. 28–Mar. 3; World Sustainable Energy Day 2001, showcasing the globe's outstanding sustainable energy projects & initiatives; info on European & international policy development. O. Ö. Energiesparverband, Landstraße 45, A-4020 Linz, Austria • Fax: +43-732-6584-4383 • office@esv.or.at www.esv.or.at

CANADA
April 2–7, '01; Solar, Wind, & Water Power For Off-Grid Living; Lasqueti Island, BC. Site analysis, system sizing, equipment, appliances, lab exercises, & tours of local systems. US$550. Solar Energy International (SEI), PO Box 715, Carbondale, CO 81623-0715 • 970-963-8855 Fax: 970-963-8866 • sei@solarenergy.org www.solarenergy.org • Local housing & logistics: Melinda Auerbach, Morewater Road, Lasqueti Island, BC V0R 2J0 Canada • 250-333-8898 Fax: 250-333-8670 • melinda@lasqueti.net

Alberta Sustainable House: open house 3rd & 4th Saturdays, 1–4 PM. Cold-climate features & products for health, environment, conservation, RE, recycling, low energy, self-sufficiency, appropriate technology, autonomous & sustainable housing. Free. 9211 Scurfield Dr. NW, Calgary, AB T3L 1V9 Canada • 403-239-1882 • Fax: 403-547-2671 jdo@ucalgary.ca • www.ucalgary.ca/~jdo

The Institute for Bioregional Studies demonstrates & teaches ecologically-oriented, scientific, social, & technological achievements. IBS, 393 University Ave., Charlottetown, PEI C1A 4N4 Canada 902-892-9578

Vancouver Electric Vehicle Association. Call for meeting info. PO Box 3456, 349 West Georgia, Vancouver, BC V6B 3Y4 Canada • 604-878-9500 info@veva.bc.ca • www.veva.bc.ca

INDONESIA
Nov. 7–10, '01; Renewable Energy Indonesia, Jakarta. RE showcase, part of Electric Indonesia tradeshow. Overseas Exhibition Services, 11 Manchester Sq., London, U.K. W1M 5AB +44 (0)20 78622090/2000 Fax: +44 (0)20 78622098/2001 indonesia@montnet.com • www.montnet.com

NETHERLANDS
May 8–10, '01; Sustain 2001: World Sustainable Energy Exhibition & Conference, Amsterdam sustain2001@rai.nl

NICARAGUA
July 31–Aug 10, '01 (repeated Jan. '02). Special short course on solar energy in Nicaragua. An opportunity to offer your hands, heart, & a unique gift—electricity! Introduction to PV for developing countries, course offers lectures, field experience, & eco-tourism. Taught in English by Dr. Richard Komp & Professor Susan Kinne. US$850 plus airfare. Contact Barbara Atkinson • 215-942-0184 lightstream@igc.org

SWITZERLAND
May 28–30, '01; Montreux Energy Roundtable XII, Montreux, Switzerland. Montreux Energy Limited, 100 New Kings Rd., London SW6 4LX, U.K. (44-20) 7348 6083 • Fax: (44-20) 7348-6080 www.MontreuxEnergy.com

NATIONAL U.S.
May 19–26, '01; American Tour de Sol, solar race: Waterbury, CT to Pittsfield, MA to Albany, NY for midday festivals. Then east to Greenfield, and to festivals at Worcester & Boston, MA. NESEA, 50 Miles St., Greenfield, MA 01031 • 413-774-6051 Fax: 413-774-6053

Solar On-Line (SoL); Internet-based courses in RE. Hands-on workshops. For home or career. Mar. 19–Apr. 27, '01: PV Technology & Opportunities, PV Systems Design: Professional, Solar Homes, Solar Energy for Sustainable Development. July 23–Aug 31: PV Technology, Opportunities, & PV Systems Design. Solar On-Line, PO Box 217, Carbondale, CO 81623 • Fax: 559-751-2001 info@solenergy.org • www.solenergy.org

Pollution Prevention Video Series. Appalachia Science in the Public Interest offers 42 videos, incl. Solar Dry Composting Toilets, Solar Hot Water Systems, PV, Solar Space Heating, Solar Powered Automobile, Quilted Insulated Window Shades, & more. US$25 + S&H, broadcast-quality tapes available. ASPI Publications, 50 Lair St., Mt. Vernon, KY 40456 • 606-256-0077 • Fax: 606-256-2779 aspi@kih.net • www.kih.net/aspi

American Wind Energy Association. Info about U.S. wind industry, membership, small turbine use, & more • www.awea.org

State financial & regulatory incentives for RE: reports. North Carolina Solar Center, Box 7401 NCSU, Raleigh, NC 27695 • 919-515-3480 Fax: 919-515-5778 • www.ncsc.ncsu.edu/dsire.htm

Energy Efficiency & Renewable Energy Clearinghouse (EREC): Insulation Basics (FS142), New Earth-Sheltered Houses (FS120), PV: Basic Design Principles & Components (FS231), Cooling Your Home Naturally (FS186), Automatic & Programmable Thermostats (FS215), & Small Wind Energy Systems for the Homeowner (FS135). EREC, PO Box 3048, Merrifield, VA 22116 800-363-3732 • TTY: 800-273-2957 energyinfo@delphi.com • www.eren.doe.gov

Energy Efficiency & Renewable Energy Network (EREN): links to gov. & private internet sites & offers "Ask an Energy Expert" online questions to specialists. 800-363-3732 • www.eren.doe.gov

Green Power Web site: deregulation, green electricity, technology, marketing, standards, environmental claims, & national & state policies. Global Environmental Options & CREST www.green-power.com

National Wind Technology Center. Assisting wind turbine designers & manufacturers with development & fine tuning. Golden, CO • 303-384-6900 Fax: 303-384-6901

Tesla Engine Builders Association: info & networking. Send SASE to TEBA, 5464 N Port Washington Rd. #293, Milwaukee, WI 53217 teba@execpc.com • www.execpc.com/~teba

Sandia's Stand-Alone Photovoltaic Systems Web site: recommended design practices, PV safety, balance-of-system technical briefs, battery & inverter testing • www.sandia.gov/pv

Solar Energy & Systems. Fundamentals of Small RE: Internet college course. Weekly assignments reviewing texts, videos, WWW pages, & email Q&A. Mojave Community College • 800-678-3992 lizcaw@et.mohave.cc.az.us www.solarnmc.mohave.cc.az.us

Federal Trade Commission (free pamphlets): Buying An Energy-Smart Appliance, Energy Guide to Major Home Appliances, & Energy Guide to Home Heating & Cooling. Energy Guide, FTC, Rm 130, 6th St. & Pennsylvania Ave. NW, Washington, DC 20580 202-326-2222 • TTY: 202-9326-2502 • www.ftc.gov

Solar Curriculum for upper elementary & intermediate grades. 6 week science curriculum or individual sessions—free! Over 30 classroom presentations & demos using free or low-cost materials. Susan Schleith, Florida Solar Energy Center • 321-638-1017 • www.fsec.ucf.edu

ALABAMA
Centre, AL. The Self-Reliance Institute of NE Alabama seeks people interested in RE, earth-sheltered construction, & other self-reliant topics. SINA, 6585 Co Rd. 22, Centre, AL 35960

ARIZONA
Mar. 5–10, '01; "PV for Park Services" workshop, Phoenix. Basic PV for off-grid applications. Focus on national park/public land applications: water pumping, gate entry systems, restrooms, etc. Lectures, labs, & hands-on components. US$550, camping available. Co-sponsored by AZ Dept. of Commerce Energy Office & Tonto National Forest District. Solar Energy International (SEI), PO Box 715, Carbondale, CO 81623 • 970-963-8855 Fax: 970-963-8866 • sei@solarenergy.org www.solarenergy.org

August 8–10, '01. Flagstaff, Arizona. Third annual Southwest Renewable Energy Fair. To be held at the NAU campus in conjunction with a national RE conference. Greater Flagstaff Economic Council, 1300 South Milton Rd., Suite 125, Flagstaff, Arizona 86001 • 800-595-7658 or 520-779-7658 Fax: 520-556-0940 • swref@gfec.org www.gfec.org

Glendale & Scottsdale, AZ. Living with the Sun: Lecture series by AZ Solar Energy Assoc. Save money & the environment. History & current overview of concepts, design, applications, & technologies on solar heating/cooling, architecture, landscaping, PV, & cooking. 7–9 PM, first Wed. of every month at Glendale Foothills Branch Library, & third Tuesday of every month at Scottsdale Redevelopment & Urban Design Studio. Jim Miller 480-592-5416

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

ARKANSAS
Sun Life Construction by Design: Seminars 3rd Sunday of each month on our passive solar earth-sheltered project. Hands-on seminars incl. ferro-cement, building dwellings for minimal materials expense. US$40 per day (includes construction manual). Loren Impson, 71 Holistic Hollow, Mt. Ida, AR 71957 • 870-867-4777 • loren@ipa.net www.Sun4Life.com

CALIFORNIA
Feb. 12–17, ‘01; “Line-Ties and More” workshop, Sacramento. Basic PV for off-grid applications & utility line-ties. Lectures, labs, tours, & hands-on installation. Co-sponsored by NCSEA & Sacramento Municipal Utility District. US$550. Solar Energy International (SEI), PO Box 715, Carbondale, CO 81623 • 970-963-8855 • Fax: 970-963-8866 sei@solarenergy.org • www.solarenergy.org

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

Energy Efficiency Building Standards for CA. CA Energy Commission • 800-772-3300 www.energy.ca.gov/title24

COLORADO
Feb. 23, ‘01. Denver. Colorado Solar Energy Industries Association (CoSEIA) New Product Exposition and Annual Meeting. 11 AM to 5 PM. CoSEIA, 2170 S. Parker Rd., #255, Denver, Colorado 80231 • 303-750-9764 • Fax: 750-0085

Carbondale, CO. SEI: hands-on workshops. 1 & 2 week sessions. PV design & installation, advanced PV, wind power, microhydro, solar cooking, environmental building technologies, solar home design, & straw bale construction. Experienced instructors & industry reps. US$550/week. Solar Energy International (SEI), PO Box 715, Carbondale, CO 81623 • 970-963-8855 • Fax: 970-963-8866 sei@solarenergy.org • www.solarenergy.org

GEORGIA
Mar. 14–16, ‘01; Greenprints 2001, Sustainable Communities by Design Conference & Green Trade Show. Building solutions, high performance building design, clean energy, & sustainable community development. Westin Peachtree Plaza & AmericasMart, downtown Atlanta.
Info: www.greenprints.org
Sponsorship: marci@southface.org
Exhibitor: mstar@greeprints.org • 404-325-1007

IOWA
July 1–Sept. 31, ‘01; Iowa Electrathon season. Registration US$44 incl. fees for all events, event insurance, rule book, manual, & newsletter subscription. Iowa Electrathon, attn. Nora Johnson, CEEE, Univ. of Northern Iowa, Cedar Falls, IA 50614 • 319-273-7575 • electrathon@uni.edu

Prariewoods & Cedar Rapids, IA. Iowa Renewable Energy Association meets 2nd Sat. every month at 9 AM. All welcome. Call for schedule changes. IRENEW, PO Box 355, Muscatine, IA 52761 319-288-2552 • irenew@irenew.org www.irenew.org

KENTUCKY
Livingston, KY. Appalachia—Science in the Public Interest. Projects & demos in gardening, solar, sustainable forestry, more. ASPI, Rt 5 Box 423, Livingston, KY 40445 • Phone/Fax: 606-453-2105 aspi@kih.net • www.kih.net/aspi

MASSACHUSETTS
March 22–24, ‘01; Building Energy 2001 Conference, Tufts University, Boston. Residential Green Building, Commercial Green Building, Products and Services, Policies & Outreach, Solar Technology & Solar Applications. Speakers, auction, slide show, & interactive trade show. US$295, workshops separate. NESEA, 50 Miles St., Greenfield, MA 01301 • 413-774-6051 • Fax: 413-774-6053 nhazard@nesea.com • www.nesea.com

Greenfield Energy Park needs help preserving the historic past, using today’s energy & ideas, creating a sustainable future. Greenfield Energy Park, NESEA, 50 Miles St., Greenfield, MA 01301 413-774-6051 • Fax: 413-774-6053 • nhazard@nesea.com • www.nesea.com

MICHIGAN
Tillers International, classes in draft animal power, small farming, blacksmithing, & woodworking. 5239 S 24th St., Kalamazoo, MI 49002 • 616-344-3233 Fax: 616-344-3238 • TillersOx@aol.com www.wmich.edu/tillers

MONTANA
Whitehall, MT. Sage Mountain Center: seminars & workshops, one day, inexpensive sustainable home building, straw bale const., log furniture, cordwood const., PV, more. SMC, 79 Sage Mountain Trail, Whitehall, MT 59759 • Phone/Fax: 406-494-9875 cborton@sagemountain.org

NEW MEXICO
Moriarty, NM. Workshops on RE, energy conservation, sustainable living, & energy independence. “Proffit” From The Sun, 505-281-1300 days • 505-832-1575 eves & weekends proffit@flash.net • www.proffitfromthesun.com

NORTH CAROLINA
Saxapahaw, NC. How to Get Your Solar-Powered Home: Seminars 1st Sat. of each month. Solar Village Institute, PO Box 14, Saxapahaw, NC 27340 336-376-9530 • Fax: 336-376-1809 solarvil@netpath.net

NEW YORK
Apr. 16–21, ‘01; PV Design & Installation, Ashokan Field Campus, Woodstock NY. Solar site analysis, system sizing, equipment, appliances, demonstrations, lab exercises, & hands-on installation. US$550. Solar Energy International (SEI), PO Box 715 Carbondale, CO 81623-0715 970-963- 8855 • Fax: 970-963-8866 sei@solarenergy.org • www.solarenergy.org Housing & logistical info: Larry Brown, Sun Mountain, PO Box 1364, Olivebridge, NY 12461 914-657-8096

Apr. 21, ‘01; 6th annual North Country Sustainable Energy Fair, Canton Middle School, Canton, NY, 10 AM. Tours of solar homes April 22. Keynote by Ed Smelloff of Pace Univ., formerly of Sacramento Municipal Utility District. Workshops and exhibits on RE production & conservation. Child care. Contact: Scott Shipley • 315-386-4928 shipleyscott@hotmail.com • www.ncenergy.org

July 24–25, ‘01; Increasing Productivity through Energy Efficiency; Tarrytown. ACEEE 2001 Summer Study on Energy Efficiency in Industry. rlunetta@erols.com • www.aceee.org

OHIO
Perrysville, OH. RE classes: 2nd Sat. each month, 10–2 PM. Tech info, system design, NEC compliance, efficient appliances, hands-on straw bale post & beam building. US$70, or US$90 w/spouse, in advance. Solar Creations, 2189 SR 511 S., Perrysville, OH 44864 • 419-368-4252 www.bright.net/~solarcre

OREGON
Feb. 15, ‘01, 7 PM, John Day, OR. Tom Wykes, OSU Extension Energy Agent from Bend, shows that saving on your energy bills is like having extra income. “Make” money by spending less on your home’s utilities and heat. EORenew, PO Box 485, Canyon City, OR 97820 • 541-575-3633 info@solwest.org • www.solwest.org

May 19, ‘01; John Day, OR. Annual tour of RE homes, EORenew, PO Box 485, Canyon City, OR 97820 • 541-575-3633 • info@solwest.org www.solwest.org

July 25–27, ‘01; John Day, OR. Pre-SolWest Workshop: Upgrade your office to solar! A three-day hands-on class will do an energy efficiency and solar upgrade to make an office cost-effective. EORenew, PO Box 485, Canyon City, OR 97820 541-575-3633 • info@solwest.org www.solwest.org

July 28–29, ‘01; John Day, OR. SolWest Renewable Energy Fair. Over 80 exhibits, demonstrations, workshops, & the “Tour de John Day” Electrathon race. EORenew, PO Box 485, Canyon City, OR 97820 • 541-575-3633 • info@solwest.org www.solwest.org

Date TBA, John Day, OR. Anthony and Victoria Stoppiello’s Simple Solar Water Heating, a hands-on installation workshop (have teachers, looking for site). EORenew, PO Box 485, Canyon City, OR 97820 • 541-575-3633 • info@solwest.org www.solwest.org

Cottage Grove, OR. Advanced Studies in Appropriate Technology, 8 wk internship at Aprovecho Research Center, 4 students per quarter. 80574 Haxelton Rd., Cottage Grove, OR 97424 541-942-0302 • dstill@epud.org www.efn.org/~apro

Feb–July; Energy Education Training. Locations in OR & WA. Classes: Addressing Residential Customer High Bill Complaints, Energy Auditor Training, Non-Intrusive HVAC Testing, Sizing Residential HVAC Equipment & Duct, Residential Water Conservation, Commercial Building Data Logging, Energy Management Certificate, Building Operator Certification, EZ Sim-Billing Analysis Software, Electricity from the Sun. Info, locations, times, & costs: Northwest Energy Efficiency Alliance, Lane Community College, 4000 E. 30th Ave., Eugene, OR 97405 • 800-769-9687 or 541-988-4729 • Fax: 541-988-4723 neei@lanecc.edu • www.nweei.org

RHODE ISLAND
An Energy Co-Operative is currently being organized which will provide electricity generated from renewable sources, energy efficiency and conservation services, and group purchases of “Energy Star” appliances and related products. For further info & the next meeting time, please contact Erich Stephens at erich@sventures.com or 401-487-3320.

TENNESSEE
Apr. 23–28, ‘01; “PV for Ecovillages” workshop. Basic PV for the off-grid home. Lectures, labs, & hands-on instruction. Eco Village Training Center at The Farm in Summertown. US$550. Camping & lodging available. Solar Energy International (SEI), PO Box 715, Carbondale, CO 81623 970-963-8855 • Fax: 970-963-8866 sei@solarenergy.org • www.solarenergy.org

Summertown, TN. Kids to the Country: a nature study program for at-risk urban Tennessee children. Sponsorships & volunteers welcome. The Farm, Summertown, TN 38483 • 931-964-4391 Fax: 931-964-4394 • ktcfarm@usit.net

TEXAS
Mar. 19–24, ‘01; “Women’s PV Design and Installation” workshop, Austin. For & by women! Lectures, labs, & hands-on installation. Held at the Hornsby Bend/Eco Resources Treatment Plant. US$550. Camping available. Solar Energy

International (SEI), PO Box 715, Carbondale, CO 81623 • 970-963-8855 • Fax: 970-963-8866 sei@solarenergy.org • www.solarenergy.org or Meridian Energy Systems, Austin, TX 512-477-3050 • www.meridiansolar.com

Mar. 26–31; "PV for Home Systems" workshop, Austin. Basics of PV for off-grid living & line-tie applications. Lectures, labs & hands-on instruction. Held at the Hornsby Bend/Eco Resources Treatment Plant. US$550. Camping available. Solar Energy International (SEI), PO Box 715, Carbondale, CO 81623 • 970-963-8855 Fax: 970-963-8866 • sei@solarenergy.org www.solarenergy.org or Meridian Energy Systems, Austin, TX • 512-477-3050 • www.meridiansolar.com

Sept. 28–30, '01; Texas Renewable Energy Roundup, Fredericksburg. RE exhibits, demonstrations, workshops, tours. Texas RE Industries Assoc. & Texas Solar Energy Society, PO Box 9507, Austin, TX 78766 • 512-345-5446 Fax: 512-345-6831 • R1346@aol.com www.renewableenergyroundup.com

El Paso Solar Energy Association bilingual Web site. Info in Spanish on energy & energy saving. www.epsea.org

El Paso Solar Energy Association: meetings normally held 1st Thurs. of each month. EPSEA, PO Box 26384, El Paso, TX 79926 • 915-772-7657 epsea@txses.org • www.epsea.org

Houston Renewable Energy Group: meetings last Sunday of odd-numbered months at TSU Engineering Building, 2 PM. HREG, PO Box 580469, Houston, TX 77258 • jferrill@ev1.net www.txses.org/hreg/HREGhome.htm

WASHINGTON, DC
March 6–8, '01; Hydrogen: The Common Thread: 12th Annual U.S. Hydrogen Meeting & Exposition, Washington Hilton & Towers in Washington, DC 202-223-5547

June 3–7, '01; Windpower 2001; Grand Hyatt. Annual meeting of the American Wind Energy Association. Windpower 2001, 122 C St. NW Suite 380, Washington, DC 20001 • 202-383-2500 laura_keelan@awea.org • www.awea.org

WASHINGTON STATE
Energy Education Training, locations in WA & OR. See OR entry for more info.

WISCONSIN
Amherst, WI. Midwest Renewable Energy Association (MREA) workshops. See ad. Call for cost, locations, instructors, & further workshop descriptions. MREA membership & participation: all welcome. Significant others half price. MREA, 7558 Deer Rd., Custer, WI 54423 • 715-592-6595 Fax: 715-592-6596 • mreainfo@wi-net.com

the Wizard speaks...

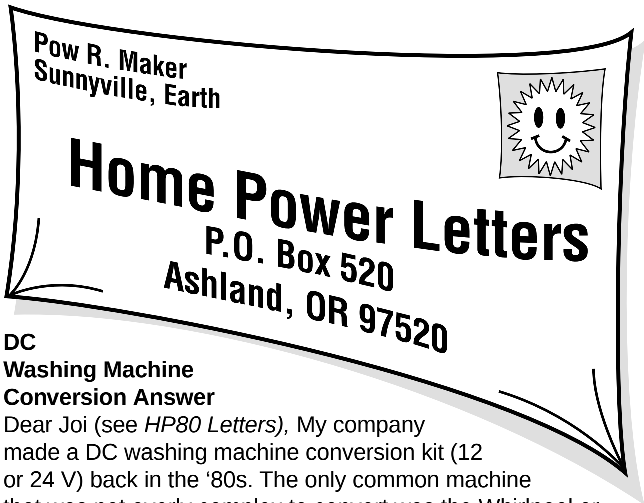
Random Subjects

Cold Fusion
The phenomenon known as cold fusion may not be fusion at all. Fusion and transmutation may be secondary processes engendered by a different primary process. This primary process could be a transformation of the ground state of the hydrogen atom to a lower energy level. Such a transformation would produce some of the excess energy seen in cold fusion experiments, and create more suitable conditions for secondary fusion and transmutation.

Scale
The theories defining the structure of mass, energy, space, and time seem to be determined by scale. Presently, we have quantum mechanics at the smallest scale, classical physics at the intermediate scale, and general relativity at the largest scale. Below the limit of quantum uncertainty, there is no theory to describe what is happening. At very large scales, there are anomalies whose explanation may require theories beyond relativity.

Earth Engine
What we need is a device that can produce electricity from the temperature difference between the earth and the ambient air. This device would need to operate on very small temperature differences, and work whether the temperature difference was positive or negative. The temperature of the earth, at a sufficient distance below the frost line, remains relatively constant.

Space-Time
It may be that our perception of reality is an illusion. There may not be any matter or energy or force at all. Matter and energy could just be dynamic patterns of the space-time continuum. The apparent forces would then be just the dynamic patterns of space-time curvature, which connect those patterns that we perceive as matter and energy. The whole of space-time continuum would then be a single, self-organized, dynamic pattern.



DC Washing Machine Conversion Answer

Dear Joi (see *HP80 Letters),* My company made a DC washing machine conversion kit (12 or 24 V) back in the '80s. The only common machine that was not overly complex to convert was the Whirlpool or Kenmore (same thing) that was made for over ten years, until 1988. The mechanism was belt-driven and did not require a multispeed or reversing motor. Our conversion used less than 100 watts of AC from an inverter to run the timer, the water valve, and a relay that was part of our kit. The relay would switch the DC motor on and off. We still get occasional calls for motor brushes from people who have been using our conversion since the '80s.

We discontinued the kits in '95 because parts and repairs for the older machines were expensive, inverters had gotten much cheaper, plus AC washing machines had gotten much more efficient than the oldies. I encourage you to go with the flow and use the modern stuff. However, if you insist on being a DC purist (you and Wilma Flintstone), find an old Maytag wringer washer (other brands have vertical motors and are hard to work with). Test it on AC to be sure it works. Purchase a DC motor of equivalent power and speed (our Flowlight Booster Pump motor does the job). It is nearly impossible to get a foreign motor to fit into the machine, so mount it on a board under the machinery. Purchase a longer belt as needed, and make a belt guard to prevent injuries to fingers. Use a Square-D QO series circuit breaker as a power switch and for overload protection. Be clean. Be free. Windy Dankoff, Dankoff Solar Products, Inc. windy@dankoffsolar.com

It Ain't Gonna Happen

Mr. Perez, I have recently discovered *Home Power,* and I think it is an excellent forum for sharing, discussion, and information. I would like to comment on your net metering article in *HP79* (Oct/Nov 2000).

First, some background. I am a computer systems specialist who has spent more than half my career of 35 years consulting for public and private power companies. My projects have been mostly in the area of cost accounting and utility billing systems. The insiders and departments I worked with and for were primarily in accounting, business planning, and stockholder services. My tenure in these organizations has included Washington state (before, during, and after WPPSS) and Arizona.

Point number 1: Off the point of your column, but something I feel strongly about, is a movement I follow that has been gathering strength the last five years or so. Private utilities are joining with some environmental organizations to force removal of key hydro dams in the Pacific NW. Internally, the real goal of these efforts is to reduce the amount of cheap, publicly-financed hydro power, so the profit-motivated power companies can provide power at 4 to 6 times the generating cost of hydro. If your only objective is to make more money, spending a few million courting the dam-blowers to improve profit margins by 400 to 600 percent *forever* is a very good deal.

Oddly, public power is following private power's lead. I have surprising news—even if it's a publicly owned, not-for-profit organization, they still are concerned about profit margins. I have worked inside a large city-owned utility, a large county-owned utility, and a regional co-op. They are all exactly the same as any privately-owned utility when it comes to the bottom line.

Point number 2: Your and others' efforts to make net metering work is completely doomed. Both public and private power will never allow this to become cost effective for home generators of power. I have seen the cost accounting and company strategy statements and in a word—itain'tgonnahappen. They will continue to make it difficult and cost ineffective because it just isn't something that will add to their bottom line.

And if you happen to be successful in connecting, their cost accountants have (fraudulently) shifted so much of the cost from generation to distribution that the most you can get by selling electricity to them is a small fraction of what additional KWHs cost. In Arizona, the largest private provider has calculated the generation side of the equation to be 40 percent of a total of US$0.10 per KWH. This means that they don't have to reimburse you for the 60 percent they call distribution. Unfortunately, it means they are saying that the cost of generating is 4 cents per KWH, a cost that is outrageously understated. Specifically, they are being very creative in costing out those power lines, transformers, and poles.

Point number 3: One factor most outsiders miss when they are talking about the cost of electricity in this country is the vast, hidden costs of coal, gas, and nuclear energy. These hidden costs take two forms: reliance on outside (other countries') energy, and nuclear/gas/coal cleanup. The first, reliance on outside energy, hurts the balance of trade with key trading partners Canada and Mexico, as well as a large part of the Middle East. Except for Canada, we also subsidize these countries, which is sort of like rubbing salt in a wound that was self-inflicted.

Not to mention nuclear/gas/coal cleanup, which we, our children, and our children's children will be paying for. Just in the state of Washington, the cost of nuclear cleanup and disposal will reach US$5 billion a year, and that goes on for the foreseeable future. If the sum total of all hidden costs are added to the actual cost of centralized power production and distribution, the average cost of generating and distributing a KWH in America is more like 30–40 cents, instead of 12–15 cents. Kind of makes solar and wind energy look more attractive, doesn't it? [Editor's note: For comparison, here are some ranges of energy costs for renewables. Per KWH, hydro is 2–5 cents, wind is 12–25 cents, and solar is 25–35 cents.]

In conclusion, I feel that the only way to make a difference is to generate your own power for yourself. Don't even try to add your excess to the grid. It won't do any good, it will cost you time and money in the short term, and it will make you even more cynical in the long term. My cynicism comes from years of knowing firsthand what goes on and how decisions are made inside the companies that provide our power. I am actively working on plans for my next house. It will be energy efficient, comfortable, and completely off the grid.

I want to add that I no longer take utilities (private or public) as clients. I can provide details about when and by whom I was employed. I cannot provide any specifics about where and from whom I learned what I know about their business and accounting practices. Tom Lederle, Sedona, AZ • tomlederle@hotmail.com

Hello Tom. Wow, you bring up some heavy-hitting points. It is neat to have an insider's viewpoint on these things. Sometimes we get wrapped up in what we are doing, and kind of take an isolated look at things, which can end up with something of an ivory tower viewpoint. But every now and then, someone like you throws a bucket of cold water on us with a serious reality check. I have been dealing with utilities—well, mostly one infamous one—for many years. It is important to know that active folks can and do make headway when working with them. Of course, when you can join sides with a utility on a project, they certainly happen a lot faster and easier.

Point 1: Everyone knows that profit is what motivates private utilities and keeping users' costs down is what motivates the public ones. Both of these strategies end up looking similar. Yes, the utilities can make more money by increasing the cost of generation, especially in the old days. But restructuring (improperly also known as deregulation) is changing all that.

Under pre-restructuring, utilities made their money based on public utility commissions giving them a return on investment (ROI), for both construction and maintenance. It pays for these utilities to increase their costs. But the main point of restructuring is to get rid of their monopoly status and the ROI type of profit making. As more and more states deregulate, cheap power looks best to the generators, which are no longer necessarily the utilities. In fact, the utilities are becoming simply pipeline providers, maintaining and charging us for the use of their grid.

It's still a monopoly, though. It will probably be a long time before we have a choice in transmission providers. After all, what community wants two or more sets of powerlines uglifying their streets? That means the utilities, now specializing in transmission, are still monopolies needing regulation by public utility commissions. PUCs are government organizations which in theory are supposed to watch out for the consumer, but in practice are usually in the pockets of the utilities for political reasons. This is an area that really needs a lot of activist help, and that is what it is going to take to keep our utility bills reasonable.

Point 2: I don't believe it. We are all aware of the internal strategies of the utilities and how they are coupled with the political power they wield. But I am a firm believer in what we in the public can do if we set our minds to it. We can turn this around if enough of us try hard.

Point 3: Right on. I agree with your conclusion in that making your own power is the best *way, but it is definitely not the only way. Activists are making a difference. And so many of us will never be able to be off-grid that we have to continue working to make the grid cleaner as well as making it easier and cheaper for our surplus energy to be made available to our neighbors.* Itisgonnahappen; *it is just going to take hard work and perseverance. Michael Welch*

Noisy Wind Genny

Dear *Home Power,* In July I installed an Air 403 atop a 60 foot fir tree next to my house. Although the northwest coast of Vancouver Island is notoriously windy, there is no truly prevailing wind, leaving us with thermal westerlies in summer and cyclonic southeasters in winter. The wind genny tree sits right at the edge of our small landlocked bay, but the wind must pass over the tall timber on nearby islands to reach us, and is usually turbulent if at all strong.

On October 19, we had a real southeaster and I learned something about the Air 403 that I believe is quite important, but is not discussed openly. They can be very noisy. In a breeze, there is a hissing, sometimes sudden, that seems to bounce back off the trees and bushes. Then as it starts to work, a rising moan comes out of the tree. I can live with that, though it takes some getting used to in a place where the silence is usually only broken by wolves, eagles, or me. During the October 19 storm, we were getting as much as 40 amps in a gust, but a whole new sound was heard. It's an indescribable hoarse shriek, sudden and very loud. My cousin could hear it 1/4 mile away through the woods, over the roar of the storm. This is not going to make wind power popular with the neighbors.

Overall, the Air is a marvel of efficient design, and I hate to find fault. On the other hand, we need to keep moving ahead, and feedback from users is an important part of progress. I have tried to figure out what is happening during these short, but hair-raising episodes, and here are my observations, for what they're worth.

After passing through the hissing, freewheeling first stage and into the low moan associated with steady work, the machine is pretty well behaved. Then when a hard gust hits, the Air does its blade-bending trick and lets out its ungodly howl. By watching the E-Meter, I could see that this would happen while generating as little as 10 amps. I gather this means the rotor is stalling before it gets up to speed. If the gust continues long enough, the machine gets up to 30–40 amps and the sound dies down.

There is a tone in this sound that reminds me of the "ring" of the propeller assembly. This assembly is remarkably light and rigid, like a drum head or violin string. Since being a good acoustic resonator is not a requirement for a wind genny, I wonder if vibration-absorbing bushings at the blade roots might damp out a lot of this sound. Considering the forces involved, this may not be easy, but I think it's worth discussing.

With tens of thousands of these units operating, there could be a serious backlash developing. Openly discussing the disadvantages of RE systems is a vital part of both solving problems collectively and maintaining credibility, and I think *HP* does this pretty well. Yours Truly, Robert DeVault, Tahsis, BC, Canada

Hello Robert, Except for the noise concern, you sound like another happy Air customer. Noise is no secret—we have openly admitted for years that the Air can be noisy in high winds. While the 403 is quieter than the original 303, we still are not satisfied with the noise it produces in 40+ mph winds, and have continued to develop new technology that is even quieter, yet does not affect reliability, performance, or cost.

It is important to note that there are more than 37,000 Air wind turbines around the world with the same design. An estimated 8,500 are installed on sailboats, often mounted just a few feet from people. If noise was a serious issue, I doubt we would have sold as many as we have. Andy Kruse, Southwest Windpower

Hello Robert, Home Power's *Air 403 (upgraded from an Air 303) is installed on my farm, which is a moderate wind site. We haven't formally tested the machine, but I'd like to share my* *experiences with you. The Air is mounted on a 29 foot tower. At this height, the turbine is 15 feet above all trees and buildings within 200 feet (60 m). Beyond 200 feet, with the exception of one tree, the site is all hayfield and totally free of obstructions for a good 1,500 feet (460 m). I consider this to be pretty standard siting and installation (maybe better than average) for these machines. Wind turbines should be installed at a height of 30 feet above any surrounding obstacles within at least 300 feet. If people go to the expense of putting up a full-on tower, it usually makes economic sense to install a larger machine.*

I've been watching the 403, the ammeter, and system battery voltage for several months now. As pathetic as this sounds, intuitively I know about how much the machine is producing by how loud it is. If I can't *hear it from inside the house, seventy-five feet away, it isn't producing more than an amp or so at 12 VDC.*

Yesterday we had good wind in the valley and the Air was wailing (acoustically speaking). It wasn't in full-on governing—or as my partner calls it, "Harley Davidson" mode—but it was loud. *The ammeter ranged between 5 and 9 amps at 12 VDC, which is typical for this "volume". My conclusion is that if these machines aren't making a substantial amount of noise, then they aren't producing meaningful power.*

Unfortunately, the Air 403's small rotor diameter limits the turbine's output at my moderate wind site. The machine rarely pushes the battery bank (440 AH at 12 VDC) up to regulation, set at 14.9 VDC. This system's only load is the occasional use of the stereo in the shop. In moderate winds, it produces no meaningful power. And at high winds, when it does start producing some power, it's loud.

We're planning on leaving the Air up and running. But both Renee and I know where the shutdown switch is when we want some peace and quiet. For my money, and my site conditions, I'd rather have another PV. Joe Schwartz

Hello Robert, Thanks for your good and thoughtful letter. I encourage anyone contemplating the purchase of a wind turbine (and you can apply this advice to other technologies) to do these things:

- *Talk with several experienced dealers who have actually installed the equipment.*
- *Talk with as many users of the equipment as possible.*
- *Talk with knowledgeable people (preferably technicians) at the manufacturing plant.*
- *Talk with competitors in the industry.*
- *Seek out independent wind energy "experts," journalists, and instructors for opinions.*
- *See and hear the machine in operation on a good site.*

What we want to avoid is having people disappointed with RE, and with specific products. So it's worth asking why people are disappointed. I think the main reason is that they don't have enough information before they purchase. They talk with one or two enthusiastic dealers or salespeople, look at a few ads, and then plunk down their money, with high expectations. They've taken little time to find out the drawbacks and disadvantages of the machine—and there are always drawbacks and disadvantages.

By talking with as many people as possible who have had direct experience with the equipment you intend to buy, you can get the most realistic picture of what you are going to get. I suspect that this approach would have avoided the disappointment with your wind turbine. Ian Woofenden

Energy Needs

Dear Mr. Perez, Over the last few years that I have been studying residential renewable energy projects, I have noticed an interesting trend: people always seem to crave more energy. Once a system is installed, people seem to fantasize about more solar panels or more battery capacity. I assume that since the energy is green, people feel justified in running as much stuff as they can.

It seems to me that this "more energy, more stuff" attitude is the same consumer mentality that has brought about the demand for fossil fuels that exists today. So my question is how much electrical energy do we really need? The pure answer, I suppose, is none. After all, mankind has survived without electricity for its entire existence except for the last one hundred years or so.

So why do we need electricity today—why does everyone act as if electricity is a basic requirement essential for existence? I suppose the answer is because this is partially true. In today's developed societies, it is next to impossible to function in collaboration with others without electricity. Work schedules exceed daylight hours, communication is mostly electronic, and we're balancing domestic chores with work schedules. This all results in a very real dependence on electricity to exist socially in today's society.

But the question still remains, how much do we really need? What basic tangible requirements are necessary to provide us with a high quality of life? I think the common answer is food, shelter, warmth, and a comfortable social atmosphere. I can't say much about food or shelter with respect to electricity, but I can say something about warmth and social atmosphere. Most of the energy we use in our homes goes into heating, hot water for the most part. I have only one thing to say about this—*go solar!*

In the interest of keeping this letter short, I am only going to say it once again: Vacuum tube based *solar water heaters.* I have personally witnessed tens and maybe hundreds of thousands of families living in Asia with no electric hot water. It works, it's simple, it's cheap (less than "a buck-a-watt"), and if you have enough collection area, you can keep warm too.

Now that hot water and heat have been taken care of, all that remains are the basic electrical requirements for a healthy social existence. In my opinion, these are lighting, communications, and some domestic machinery (for example, a basic washing machine). So how much energy do we really need? Skipping all the analysis, I think 3 KWH per day per person is a real goal, or incrementally less with additional people.

You don't think so? Well lets see what it can do: Lights at night, 50 W x 6 for six hours a day; outside safety lights, 200 W for one hour per day; communications (laptop computer), 100 W for three hours per day (includes recharge); electronic entertainment (music, radio), 50 W for six hours per day; washing clothes, 1,000 W for 0.25 hours per day (average). No real hardships here. Sure, there are many things you now can't do, but maybe that's the beauty of it. The things you *can* do still outweigh the things you can't.

Costs for a 3 KWH per Day System

Item	*Cost (US$)*
500 W of modules & electronics	$2,500
2 deep-cycle 12 V batteries	$20/month
1500 W inverter & % SOC meter	$1,000
Total	$3500 + $20/month

My point is… Everyone always seems to say that renewable energy is too expensive. But could it be possible that their demands are too expensive? Lets look at what is required for the virtually maintenance-free 3 KWH per day model.

And since North America is the land of financing: Based on no money down, 8 percent interest, and a ten year payback, it amounts to about US$65 per month. I would venture to say that this is pretty much affordable for most everyone. So for everyone who says that solar is too expensive, I say maybe your demands are too expensive.

I am in the process of building my own 3 KWH per day system to try it out. I'm not saying for sure that I'll stick with it, but somehow I think it will be fun to be more in touch with my consumption. And who knows where that will lead. If anyone wants to try out this 3 KWH per day model, I will volunteer my assistance with any type of technical support required. Andy Swingler, BEng., Electric Power Conversion Engineer, Vancouver, BC, Canada andys@ece.ubc.ca

Hello Andy, You are correct—most folks could easily live with 3 KWH per day and not even suffer a decrease in their standard of living. You are also correct that efficiency is job one, and this is what we continually preach in Home Power.

In fact, the folks who live here at Funky Mountain Institute average 1.25 KWH per day. Most of the electricity we make here is used to publish Home Power. *We have a washing machine, a microwave (which sees lots of lunchtime use), a TV/VCR, a refrigerator/freezer, various kitchen appliances, two stereos (active most of the time), a deep well pump, and more. Our house/office is heated by passive and active solar energy systems, as is our water.*

I think you are overestimating on the lights. Our rule here is that each person gets one light burning for them at any given time. We use 15–20 watt compact fluorescents (CFs). And 50 watts is pretty high for the average CF too. The common ones we see are in the 15–25 watt range. I certainly agree that solar energy is inexpensive. Richard Perez

Easy Battery Watering
Richard, I just tried a battery watering technique today that you might have heard of, but I thought I'd pass it along just in case. I learned it on the electric vehicles mailing list.

Buy one of those cheap garden and pest sprayers, preferably one with a plastic wand. If the wand isn't of the plastic variety, make sure that you cover the usual brass wand with electrical tape for safety. Remove the tip adjustment and clip off the end of the wand so you have a clean opening for the tube. Put the water in the sprayer, pump it up, and use it to fill all those little battery holes.

I just went through two gallons of watering with ease. It was so much easier that my old style pour-in method. Makes quick work of that occasional battery maintenance chore. Dan Metcalf, KF6PYT • dan@metcalfs.com • www.metcalfs.com

Hello Dan, Way cool! And easy, to boot! Richard Perez

Electric Co-op Intertie
Dear *Home Power,* I am an avid reader of your magazine and have read with interest your readers' complaints about being intertied with utility companies. We were having problems with too much voltage. We had it tested and we were receiving about 287 volts. It destroyed a lot of appliances before it was fixed. So we decided to go solar. We have twenty-four Siemens 100 watt solar panels, a Trace Power Panel with two SW5548 inverters, thirty-two Trojan L-16s, and an 8.5 KW propane generator. We are intertied with an electric co-op.

When the system was installed, I had the co-op inspect it for safety, and corresponded with the company from which they purchase their power. Everything checked out fine, and we have been online for about sixteen months. At the time of the inspection, they wanted to purchase any excess power. Without knowing the capabilities of the system, I told them that the system was designed to meet our needs except for the air conditioning, so in the summer, we would use their power.

They called me yesterday and stated that they are not making any money on me. They said that their break-even rate is US$1,400 per year and I am only buying US$700 per year. They also stated that if everyone did what we did, they would go out of business. They charge US$0.11 per KWH. They further stated that the only way that they will buy any excess is if I install a 300 KW system to help their peak shaving. And since they are not making any money, they want to bump my US$8 per month service charge to US$60 per month to make up the difference. I know that all things in life are not fair, but does this sound legal? I am not asking for legal advice, just about your experiences with utilities. I live in Kansas, and am the only one like this on their system. Ken Steelman • moedot@ourtownusa.net

Hello Ken, Since Kansas doesn't have a net metering law, what your utility is doing may be legal. In most states, rural electric co-ops are not under the jurisdiction of a public utilities commission, so you probably can't complain to them. I suggest going public with this locally. Apply pressure through your local newspaper. Get started organizing for a state net metering law.

You are not alone. We recently passed a net metering law in Oregon. We having exactly the same problems with rural electric co-ops, even though we have a net metering law. Richard Perez

Hi Ken, Richard is right on, but I would add one more avenue of approach. Most co-ops have a board of directors made up of community members. Start meeting with the board members and turn them on to small-scale, decentralized RE. You might find some mighty sympathetic folks there. Michael Welch

Laptop Power Consumption Email Conversation
I designed and will soon be installing a stand-alone PV system to power my in-home office. I've whittled my loads way down in the last few years, replacing high-watt printers, copiers, and computers with low-watt models. My most consistently used device nowadays is a Pentium notebook computer.

Recently my very efficient 1997 Compaq Armada 4131T broke down, requiring more expense (or so I thought initially) to repair than to replace. It used an average of 15–16 watts when operating. So I went out to look for used notebooks, and found that the majority seem to use substantially more power than the old Compaq. Finally I bought a 1998 Dell Latitude CP (which uses at least double this wattage), because I needed to get back to work (make some money) and the price was very good.

If I stay with this Dell Latitude, I'll need to expand my PV array by one more panel, which will cost about US$300 plus some for the DIY installation and connection. Then the rest of the system can probably stay as is, since I designed it for some minor expansion like this. Or, as I just found out, I can purchase another old Compaq Armada 4131T for only a little more than this price, and make no changes in the power system.

Before doing anything, I've also been trying to find out about the energy consumption ratings of notebook computers. This is not easy. Do you know of anybody who's faced this situation or published such info on notebooks? If I end up testing a slew of notebooks and nobody's published this kind of info, would *HP* be interested? I'm using a WattsUp power meter in my 30 minute tests to record average and peak power consumption. The local used computer store is being tolerant, since I've bought from them before! So far, I've tested only a handful of notebooks. John Robbins, Morningview, Kentucky • jrobbins@queencity.com

Hello John, We've never done a through survey of how much energy laptops use. We'd love to have this information. But I do know one thing—if you can get the 12 VDC "car cord" for any laptop, it's going to be way more efficient than using 120 VAC through the inverter and laptop power supply. Richard Perez

Later That Day…

Dear Richard, I've been metering my Dell Latitude since emailing you earlier today and it seems to use much less power since I removed the CD from its bay (as it was when I got it) and put in the diskette drive (which I use more anyway). I've also adjusted all the power saving settings to the max, so maybe I should also give that some credit. Anyway, it looks like I've used only 46 watt-hours in 4.0 hours, which is an excellent 11.5 watts average! So I am happier now anyway, with regard to my PV system capacity.

I've also noted that the notebook uses 19–21 watts when the hard drive is actively running, but power consumption reduces to 14–15 watts when the hard drive is not active but also not powered down. So I'm sure power consumption depends a lot on the kind of computer work somebody does. (I'm running CAD, email software, word processing, spreadsheet, and hour-by-hour building energy modeling software in Windows 98 most of the time.)

Are you certain that all the off-the-shelf DC-DC converters are more efficient? Since I have more than one notebook and each uses different DC voltages, I bought a Nesco DC converter. It accepts DC from 10–30 V and allows multiple voltages in this range for output. I've got 12 volt lead-acid batteries in my office and car, plus a 15 volt 8 AH NiCd pack I assembled for portability. The Nesco typically gets hotter than the AC-DC converter that comes with either the Dell or the Sharp, so I've been suspicious about its efficiency. I've not yet tested the Nesco. I'll let you know when I do.

Thanks for your thoughts. I'll keep track of my findings and report back when my data is more comprehensive and complete. I've been trying to get volunteers in my area to meter and send me data on their notebooks. Sure would be nice to assemble data on at least a dozen notebooks, don't you think? What do yours use? John Robbins, Morningview, Kentucky
jrobbins@queencity.com

Hello John, Items such as the CD drive and hard drive are big consumers of power in a laptop, since they use electric motors.

The effectiveness (both energy efficiency and expense) of the "car cord" depends on the particular laptop. Our old PowerBook 160 is far more efficient on the car cord than on the factory 120 VAC supply. However, newer laptops are using higher voltages (usually well over 12 VDC) and sometimes, as you discovered, several voltages. This means that the car cord must essentially become an inverter, so expense goes up and efficiency goes down.

We have two laptops here. One is the old PowerBook 160 that does databases and data logging. The other is a G3 PowerBook that is Karen's primary computer and most always plugged into the main PV system here via the the stock 120 VAC supply. If we're operating these laptops in the field, I usually grab a small 12 VDC battery and the Exeltech XP125 inverter. The PB160 draws 23 watts. The G3 draws 26 to 45 watts depending on drive use, CD use, and battery state of charge.

It would indeed be interesting to measure the energy consumption of a wide variety of laptops. Home Power *readers often use laptops to save energy. Most laptops are just about as powerful, in terms of computing power, as desk models these days. Richard Perez*

***HP* Battery Box Heat Buildup**

Dear *Home Power,* I am puzzled by your battery box. You cycle 10 to 13 KWH per day energy. That means 2 or 3 more KWH become heat, yet your article describes adding even more heat to this well-insulated box.

6 by 2 by 3 feet equals 72 square feet of box surface. If 2.4 KWH per day are generated as heat, that's 1.3 watts per square foot, which equals 4.74 BTU per square foot heat loss. If the walls are R10, the delta T is 4.74 times 10, which equals 47.4°F. The batteries would tend to get really hot. Do they? Steve Baer, Zomeworks, Albuquerque, New Mexico

Hello Steve, Most of the energy we use isn't stored in the battery, but used directly from the arrays. The primary loads here (about 75 percent of our electrical energy consumption) are computers, operating during daylight hours. The average wintertime temperature in the power room is around 45°F (7°C). When the batteries are gassing and the exhaust fans are operating, this is the temperature of the incoming air for the battery box. Without additional heat, the battery would average about 45°F during the winter. With the thermostatically controlled hydronic heating system, the battery temperature stays at about 75°F (24°C), ±3°.

During the summer, ambient temperature in the power room can get as high as 95°F (35°C). We run the two Zephyr battery fans 24 hours a day to keep the heat down in the battery box, and also an exhaust fan in the power room itself during daylight hours. Overall, we're super pleased with the hydronically heated battery box. It keeps the batteries at optimum temperature with very little energy input from the solar hot water systems. Richard Perez

CIS—The Future of PV?

Hi Richard, Enclosed is a copy of an article that appeared in our locally produced *Cottage Magazine* Sept/Oct 2000 issue. [Enclosure was a short blurb on R&D for copper indium diselenide (CIS) thin-film solar cells at the University of Florida.]

I well recall all the predictions of $1 per watt for solar cells by the year 2000. Yeah, right! I've just ordered two more Uni-Solar 64s, which are costing me $534 Canadian each. So much for the $1 per watt. Could it be that this copper indium diselenide will be the required element to help meet that goal? Could we perhaps hope for an even lower price?

The reason I am sending this to you is twofold. First, you seem to be able to contact those in the know and it would be absolutely terrific to see one of your typically excellent articles on CIS and how it is progressing. Second, I wonder if you could provide a name of anyone at the University of Florida and their address. Of course, I do have some questions for them. However, believe it or not, I also have an idea to do with manufacturing that I would like to pass on to them.

I sincerely hope that this CIS works as well as claimed in the article I enclosed. I just hope we don't have to wait ten years for panels. By the way, I trust you have read the article inside the back page of *Solar Today* (current issue). Wouldn't it be perfect if solar displaced oil in our lifetimes. Could happen—you never know. All the best, Keith Elliott, Box 2015, Ladysmith, BC Canada V9G 1B5

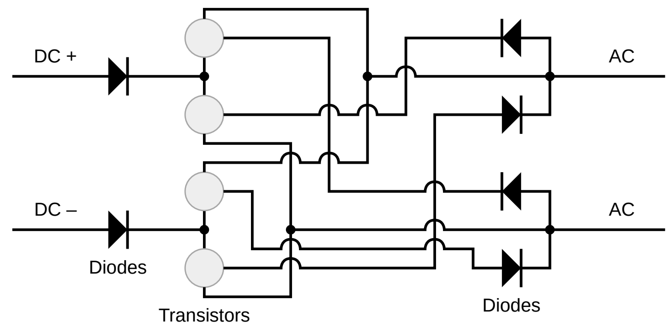
Hello Keith, Keep your eyes out for future articles on CIS modules. At least one manufacturer, Siemens Solar, is gearing up for production this winter. We are hoping to tour their factory sometime soon and do a piece on the process and promise.

We don't have the University of Florida contacts, but we are publishing your address in case anyone else can help you. Who knows, maybe some of the CIS folks around the nation will see it and respond. Michael Welch

10 KW Grid Inverter For $30
I have been a guerrilla for the last four years, but I didn't know it. This is what happens when you work in a vacuum with no outside influences. When I stumbled upon *Home Power's* Web site, I knew I'd found home! I am writing this letter because I need input and help from anyone interested in cheap or cheaper power generation. I have a homemade 10 KW wind generator and grid converter I built myself for around US$2,000 total cost! At this price, it paid for itself real fast! Forget the five year return on your investment sales pitch I got from some companies. How about six months and it's paid for?!? Not even California matching funds could have been as economical as setting up my own pirate wind generator and converter.

I started surfing the World Wide Web the other day and a new world opened up for me! I realized that I was *not* alone anymore (got to get one of those guerrilla masks). I also noticed that things were very pricey, especially the grid inverters. I solved the problem of power matching and DC to AC conversion myself with this gizmo I built in my garage for about US$30 in surplus army electronic parts. I thought it was a no-brainier, but it seems that most people are doing it differently. The "Graefe inverter" consists of four 100 amp power transistors and four 100 amp diodes (brand name unknown and probably unimportant). It has no safety features—I never gave it much thought until I started asking and talking to other people in the industry. That's why I need more input from you people who seem to think it's Halloween whenever you get on your roof (grin).

How it works: In the first phase of a 60 cycle wave, the line is for 1/60th of a second in a DC phase. One line is negative and the other has positive voltage. In that instant, two of the diodes pass



current to the matching transistors and biases them so current is fed into the line in the correct phase. In the next phase, the line voltage reverses and negative becomes positive. In that instant, only the other two diodes can pass current to the other pair of transistors and the output again matches the grid wave form. The process repeats itself faultlessly 60 times a second. The waveform is clean and it even matches every little hiccup in the grid exactly. Ron Graefe • oicu2@oicu2.com

RE Advice
Hey, folks, nice magazine, keep up the good work! Five years ago my wife and I retired early (we were 53 & 54 years old) and built our own beach house off the grid in Sonora, Mexico. It was fun then and it still is. We learned many lessons the hard way, but that's life. If I could offer a little advice to anyone thinking about doing the same thing, here it is. Read the books and do the math. When you think you know how many PV panels you will need, add one or two more. Then buy the biggest (within reason) and highest quality battery bank you can afford, and treat it like one of your children.

Initially, our primary lighting was 110 VAC compact florescent. I now have changed over to 12 VDC halogen lamps originally intended for track lighting systems. On paper, they are not quite as efficient as fluorescent lamps, but in the real world of off-grid living, they work better. Here's why. The light quality is better, nice and warm, not "office light." The built in reflectors direct the light where you need it. They work when (not if) your inverter fails. The inverter can be turned off most of the time, extending its life and conserving power. (Inverters are not the efficient, trouble-free units they are made out to be…) Light output can be adjusted with a simple rheostat if needed. In the event of a real nightmare situation, you still have usable light right down to six or seven volts of battery power.

Bottled gas is available here, so we use a gas range and refrigerator. Try to keep things simple. Trackers are not worth the effort. Put your panels up on the roof, out of harm's way, and, you don't have to look at them. Forget all the gizmos and gadgets. That's money down the drain. Robert Seeber, Guaymas, Sonora, Mexico

Adopt a Library!

When Karen and I were living with kerosene lamps, we went to our local public library to find out if there was a better way to light up our nights. We found nothing about small scale renewable energy.

One of the first things we did when we started publishing this magazine twelve years ago was to give a subscription to our local public library.

You may want to do the same for your local public library. We'll split the cost (50/50) of the sub with you if you do. You pay $11.25 and Home Power will pay the rest. If your public library is outside of the USA, then we'll split the sub to your location so call for rates.

Please check with your public library before sending them a sub. Some rural libraries may not have space, so check with your librarian before adopting your local public library. Sorry, but libraries which restrict access are not eligible for this Adopt a Library deal—the library must give free public access. — Richard Perez

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Richard Perez

A Sunny Future

After living on solar electricity for almost twenty years now, I'm still regularly amazed by it. The energy just streams in with the sunshine. I'm sure that almost every user of solar electricity has thought, "If I can do this, maybe we can all do it."

I wonder about our energy future. What will the next decades bring us? Can we—and will we—adopt solar energy as our primary source? Here's what I think may happen within the next fifty years.

A Blast from the Past

When speculating about the future, it's always good to look at the past. How have things progressed to date? Such speculation leads to a more realistic prediction of the future.

When we started *Home Power* thirteen years ago, we knew who was installing solar electricity and why. The early adopters were folks who were off-grid. These folks were located so far from the end of the power lines that it was unaffordable to extend them to their homes.

The mainstay for folks off-grid was the engine generator. Over a decade ago, the battle between solar electricity and the generator was fought and won by the PV modules. It's really very simple—solar electricity is cheaper than generator-produced power. In addition to being cheaper, PVs offered higher reliability, virtually no maintenance, no noise, and no pollution. The engine generator simply could not compete.

Few people think of moving to the country and relying on a generator anymore. Solar electricity has demonstrated its off-grid superiority in the marketplace. There are now over 180,000 off-grid solar-electric systems operating in the U.S.

On-Grid

If solar electricity is to be as successful on-grid as it has been off-grid, it must be cost competitive with utility-produced energy. The average price of utility energy in the U.S. today hovers between eight and nine cents per kilowatt-hour at the meter. The real price of utility energy is actually about double that, with the additional costs concealed in our taxes. But for the sake of argument, let's just consider the price at the meter—nine cents per KWH.

If a solar-electric system is going to compete with grid power in the marketplace, it must be at least as cheap as grid power. This means that over the PV system's lifetime, it must produce electricity at nine cents per KWH or less. Let's ignore that utility power prices are continually getting higher. Let's ignore the pollution generated by utility power and the costs of that pollution.

The Magic Number

The magic number is US$2 per peak PV watt. This means that a 100 watt PV module will need to cost US$200 in order to compete with grid energy at its current price. This magic number assumes a 20 year lifetime for the PV module (they already have *warranties* of 20 to 25 years depending on the brand). At US$2 per peak watt, the PV system will produce electricity at a cost of nine cents per KWH over twenty years. This includes the cost of of the PVs, mounting structures for the PVs, wiring, and a utility-intertie inverter.

At this magic number of US$2 per peak watt, the average home could be powered by a PV system for less than US$14,000, or about half the cost of a new car. In terms of new construction, a solar-electric system would add less than 10 percent to the cost of a new home. Most new homes in the U.S. spend much more money than this on the bathroom or the kitchen.

Is It Possible to Make a US$2 per Watt PV?

PVs are now retailing for between US$5 and US$6 per peak watt. The PV industry is really very new, only a little over thirty years old. PV prices have continually declined, albeit slowly, and PV warranties and performance have continually increased. We are headed for the two-bucks-a-watt PV, and I expect we'll get there sometime in the next twenty years. The key features in reducing PV cost are using less precision-engineered material and reducing manufacturing costs.

These inexpensive PVs will probably not be of the conventional cell type we are used to. They will probably be a type of thin-film. Three major PV manufacturers are bringing thin-film PVs to market. Siemens is working with a copper indium diselenide technology. BP Solar is working with a cadmium telluride thin-film technology. Uni-Solar is already marketing silicon-based thin-film modules.

All of these thin-film PVs use far less precision engineered material. A conventional solar cell is about 500 microns thick, while these thin-films are less than two microns thick. All of these thin-films are far easier to manufacture than conventional solar cells.

Thin-films are vapor deposited on a backing plate, usually glass or stainless steel. This process is far easier than casting ingots of hyperpure silicon, sawing up the ingots into cells, turning the cells into photodiodes, and finally assembling the cells into modules. For an analysis of the manufacturing differences between conventional cells and thin-film, see the excellent article by Knapp and Jester in *HP80.*

The Infrastructure

Just having a cheap PV will not automatically turn us into a solar energy based society. As with everything, energy needs an infrastructure. There are now thirty states in the U.S. with net metering laws requiring utilities to buy our solar energy at retail prices. These laws will continue to expand until it's possible to actually farm energy and make a profit selling power to the grid.

Why? Because it's good for our economy and good for our environment. As supplies of fossil fuels diminish, their costs will rise. See Randy Udall's article on page 43 of this issue. As utilities deregulate, the opportunities for small energy producers increase. As more of us become concerned with pollution and its effects on our environment, we will demand cleaner power. And solar energy is the logical answer.

No More Utilities?

Will the utilities dry up and go away? Most certainly not. We will need the utility infrastructure to distribute the solar energy around the country. The sun doesn't shine everywhere, every day. We will need the utilities, and their network of powerlines, to send solar electricity from sunny areas to those places that are blessed with less sunshine. And there is always the question of what we will do at night.

While batteries are effective in small off-grid systems, it's impossible to imagine storing enough energy in batteries to power this country for even a single night. We will need another energy storage medium, and it will be the utilities' job to administer it. I suspect that this medium will be hydrogen.

Solar Hydrogen

We can make hydrogen gas from the surplus power of all the PV arrays nationwide. This hydrogen gas can be fed into the nationwide network of natural gas pipelines, making natural gas hydride. Once we have enough solar-electric arrays up, we can eliminate the natural gas from the pipelines altogether. At night, this hydrogen can be burned in existing natural gas turbines, or consumed by huge fuel cells, which will deliver our nighttime power. The utilities will become a transmission and storage medium for solar electricity produced nationwide on rooftops.

Our transition from carbon burning to solar hydrogen could be gradual—we don't have to change our entire energy infrastructure overnight. First we could displace the worst polluters, such as coal-fired plants. Then we could gradually work our way through decommissioning the nukes. Hydrogen is compatible with conventional gas fired turbines—we can use what is already installed and operating.

Fuel cell technology is promising, and we should be able to tackle this huge conversion job within the next twenty years. As metal hydride storage of hydrogen matures, it will make hydrogen-fueled vehicles a reality. All the technology we need to make this happen is already in place or under commercial development. All that's missing is the energy source—that two-bucks-a-watt PV.

You Can Help!

If this energy musing seems like a future you would like your children to live in, then it's time to act. Just as the off-grid PV users helped give birth to today's solar-electric industry, on-grid users can now speed our transition to a solar hydrogen-powered society. Just do it. The only way we are going to get that US$2 per watt PV is by buying and installing US$6 per watt PVs right now.

Access

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richard.perez@homepower.com • www.homepower.com

Q&A

Desulfator Noise

Dear *Home Power,* I am going to build the lead-acid battery desulfator as shown in *HP77.* I also have been looking at the two desulfators advertised in *HP.* I have two technical questions.

Will the pulse affect my digital cell phone, and if so, can it be shielded? We are about nine miles off the grid and it is our only means of communication. We have it tied into our 12 V battery.

Second, the *TtW!* article indicated that the Solar Boost MPPT charge controller works on the maximum output voltage of the panels, which in my case can reach almost 19 V open circuit. The desulfator article indicated a maximum voltage of 16. I don't know what the maximum connected voltage might be, but it might exceed 16 V if it can freewheel. Will Greenslate, Mosier, Oregon

Hi Will. You will not notice noise from the desulfator in your cell phone because the power level of the pulse is very low and the battery acts as a filter. We have run two different brands of electronic desulfators here for years and have noticed no RFI on our cell phone, radiotelephones, HF ham radios, and 2 meter ham radios.

The open circuit voltage of the PV array will not be a factor because the voltage of anything connected to the batteries is battery voltage, not PV open circuit voltage. Under normal charging, your batteries will probably not get above 15 VDC. But during equalization, your batteries could be significantly higher; 16.5 VDC would not be unusual. Simply add a forward biased silicon diode to the positive input lead of the desulfator. This will drop the incoming voltage by 0.75 VDC. Richard Perez

The Right Voltage

After reading *Home Power* for a few years off the newsstand, we finally purchased a subscription and love your magazine.

We've been off the grid for almost a year now and have a few questions regarding our solar-electric setup. First, it's tiny—three 60 watt Kyocera panels, a Solar Boost 50, and six Exide GC4A batteries. We're learning that November is extremely overcast here in northeastern Vermont and we get very little charging capacity. The only system monitor we have is battery voltage. My first question is what is true battery voltage? Last night when I shut off the inverter, the batteries measured 11.8 volts. This morning, after sitting idle all night, the were at 12.0. Which is correct? When I turned on the system last night, the batteries were at 12.2, but they were down to 12.0 within 30 minutes, and 11.8 after three hours when I shut everything off.

My second question is about alternative charging. The batteries are just inside the back door. Could we drive the car up next to the door and run jumper cables in to the batteries? We would have the charge controller disconnected during charging. We have no backup generator.

And finally, we recently replaced our Trace C30A+ charge controller with the Solar Boost 50. Is this unit too big for our existing system? We plan to add a few more panels and possibly an Air 403 wind generator next year.

Looking forward to your reply and the next issue. Dan Bisbee, St. Johnsbury, Vermont • Dbisbee@lydall.com

Hello Dan. Battery voltage is not an accurate indicator of battery state of charge. You need a battery ampere-hour meter such as the Tri-Metric or E-Meter. Battery voltage fluctuates with current transfer. When the battery is being discharged, the voltage goes down—the heaver the discharge, the lower the voltage. When the battery is being charged, the voltage goes up—the heavier the charge, the more the voltage rises.

It is possible to hook up your car to the battery and recharge it. But this is terribly inefficient—you'd be running a 100+ hp engine for a load that is really less than 5 hp. Also, unless you bypass or adjust it, the car's voltage regulator will keep the battery from being charged very much, since it is normally set to keep your starting battery at about 13 volts. In the download section of our Web site, there is an article on how to build a DC generator using a lawn mower engine. It's cheap, efficient, and very effective.

The Solar Boost is a great regulator. Having a regulator that is oversized is an excellent idea. It allows you to expand the system without replacing the regulator. Richard Perez

Need A Diversion, & Controller Set Points

Dear Richard and the crew, If the following topic has arisen in the past in *Home Power,* we missed it, so we hope that we are not going over old ground.

We are trying to figure out how charge controllers and diversion load controllers interact. We have a Trace PC-500 power centre, with a 60 amp PWM charge controller onboard, handling our 1,350 watts of PV power. A 1,500 watt Bergey wind turbine is also hooked up to the battery bank through the PC-500, but the turbine has its own charge controller. So both charge controllers are sensing the same battery bank.

Our challenge comes when we try to incorporate a diversion load controller to pick up any excess power and dump it into our 115 gallon domestic hot water tank. The two charge controllers work on battery voltage and taper off their input depending upon that reading. So how do we incorporate a diversion load controller that also only operates when a battery voltage reading above a set level is detected? It would seem that the charge controllers never permit the battery to rise above a set voltage (except when equalizing)—that's their job. So how does a diversion load controller get a piece of the action?!? We are beginning to wonder whether it is an either/or situation; charge controller or diversion load controller, but not both. Can you shed any expert light on this for us, please?

Second question; I recently purchased a TC60 charge controller to act as a diversion load controller. The main charge controller is located in a PC500 power centre. The whole system is still being set up and tweaked. The batteries are HUP Solar-1s, 1,900 AH, configured for 24 VDC. Manufacturer's voltage settings for these batteries are: Bulk = 29.6 V; Float = 27.0 V; Equalise = 30–31 V.

I have adjusted the PC500 charge controller set points to give Bulk: 29.610 V; Float: 27.013 V; Equalise: 31.04 V. At present, the TC60 (diversion load controller) settings are Bulk: 29.615 V; Float: 27.016 V.

My query is whether these latter settings are satisfactory to permit a smooth diversion of incoming power from the batteries to the water heating element dump loads when the batteries are fully charged. Or do the TC60 voltage settings need to be further apart from those of the main charge controller and, if so, in what direction?

As you can tell, my knowledge of things electrical is pretty basic (read "Nil"!), so any help or advice you can provide will be mucho appreciated! George & Lynn Mycroft • pharos@usit.net

Hello George and Lynn. The answer to the first question is really very simple. Set both of the existing charge controllers up by 0.1 VDC, then set the new diversion controller 0.1 VDC lower than the other two controllers. This way the diversion regulator will operate first. If the hot water heater is fully heated, then either of the two other controls will operate.

Those controller set points sound just fine to me for a room temperature battery. The only question I have is: How long does the battery remain in bulk charge mode before reverting to float mode? I'd recommend at least five hours. Richard Perez

Desulfators & Equalization

Thank you for your recent advice on checking my batteries. I charged them and checked specific gravity, and found the bad ones. My battery bank has never been better (still have eight good ones)!

Additionally, I installed a desulfator. My question is, do I still need to equalize them? If I do, how high should the equalizing voltage be, and for how long? The batteries are Interstate Workaholics (around 200 AH @ 6 V), about 5 to 7 years old. Roy D Surovec, Edwards AFB, California • roy.surovec@edwards.af.mil

Hello Roy. The desulfator will work many wonders, but eliminating the need for equalizing charges is not one of them. You still need to run periodic equalizing charges. An equalizing charge is a controlled overcharge of an already fully recharged battery. Raise all voltage limits on controls, and overcharge the battery, at no faster than the C/20 rate, for five to seven hours. Voltage may get as high as 16.5 VDC (especially if the battery is cold).

Perform the equalizing charge every three to four months, or every five to seven deep cycles, whichever comes first. Have plenty of distilled water on hand. Equalizing charges will use up lots of water, and since the electrolyte is doing the rolling boil, this is the absolute best time to water the cells. Richard Perez


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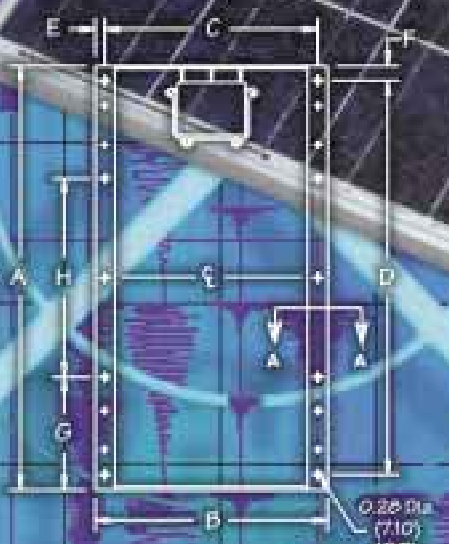
Carton Gross Weight	63.0 lbs. (28.6 kg)
Number of Cartons per Pallet	10
Number of Modules per Pallet	20
Max. Pallet Dimensions (LxWxD)	60.0 x 28.0 x 39.0
Max. Pallet Dimensions	38.0 cu.ft. (1.1 cu.m)
Gross Weight of Max. Pallets	685.0 lbs. (311.0 kg)
No. of Modules per 20' Container	440
No. of Modules per 40' Container	960

MOUNTING HOLE LOCATIONS

Dimension A	56.1 in. (1424.0 mm)
Dimension B	25.67 in. (651.0 mm)
Dimension C	23.94 in. (608.0 mm)
Dimension D	53.82 in. (1366.0 mm)
Dimension E	0.87 in. (22.1 mm)
Dimension F	1.14 in. (28.9 mm)
Dimension G	9.48 in. (240.0 mm)
Dimension H	37.12 in. (942.0 mm)



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Short-Circuit Voltage	7.45 Amps
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NOW: I use renewable energy for (check ones that best describe your situation)

- ☐ All electricity
- ☐ Most electricity
- ☐ Some electricity
- ☐ Backup electricity
- ☐ Recreational electricity (RVs, boats, camping)
- ☐ Vacation or second home electricity
- ☐ Transportation power (electric vehicles)
- ☐ Water heating
- ☐ Space heating
- ☐ Business electricity

In The FUTURE: I plan to use renewable energy for (check ones that best describe your situation)

- ☐ All electricity
- ☐ Most electricity
- ☐ Some electricity
- ☐ Backup electricity
- ☐ Recreational electricity (RVs, boats, camping)
- ☐ Vacation or second home electricity
- ☐ Transportation power (electric vehicles)
- ☐ Water heating
- ☐ Space heating
- ☐ Business electricity

RESOURCES: My site(s) have the following renewable energy resources (check all that apply)

- ☐ Solar power
- ☐ Wind power
- ☐ Hydro power
- ☐ Biomass
- ☐ Geothermal power
- ☐ Tidal power
- ☐ Other renewable energy resource (explain)

The GRID: (check all that apply)

☐ I have the utility grid at my location.

I pay ______¢ for grid electricity (cents per kilowatt-hour).

____% of my total electricity is purchased from the grid.

☐ I sell my excess electricity to the grid.

The grid pays me _____¢ for electricity (cents per kilowatt-hour).

(continued on reverse)

I now use, or plan to use in the future, the following renewable energy equipment (check all that apply):

NOW	FUTURE		NOW	FUTURE	
❑	❑	Photovoltaic modules	❑	❑	Methane digester
❑	❑	Wind generator	❑	❑	Thermoelectric generator
❑	❑	Hydroelectric generator	❑	❑	Solar oven or cooker
❑	❑	Battery charger	❑	❑	Solar water heater
❑	❑	Instrumentation	❑	❑	Wood-fired water heater
❑	❑	Batteries	❑	❑	Solar space heating system
❑	❑	Inverter	❑	❑	Hydrogen cells (electrolyzers)
❑	❑	Controls	❑	❑	Fuel cells
❑	❑	PV tracker	❑	❑	RE-powered water pump
❑	❑	Engine/generator	❑	❑	Electric vehicle

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