HOME POWER

THE HANDS-ON JOURNAL OF HOME-MADE POWER

ISSUE #46

April / May 1995

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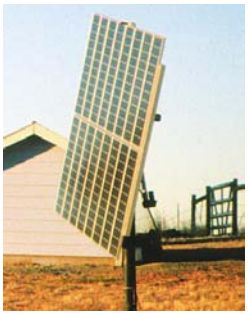

Features

GoPower

Fundamentals

Cover: Vladimir makes his own power from wind and sun. And he does it in downtown Chicago.! Story on page 6.
Photo by Vladimir Nekola

Construction

Columns

Regulars

Access and Info

Access Data

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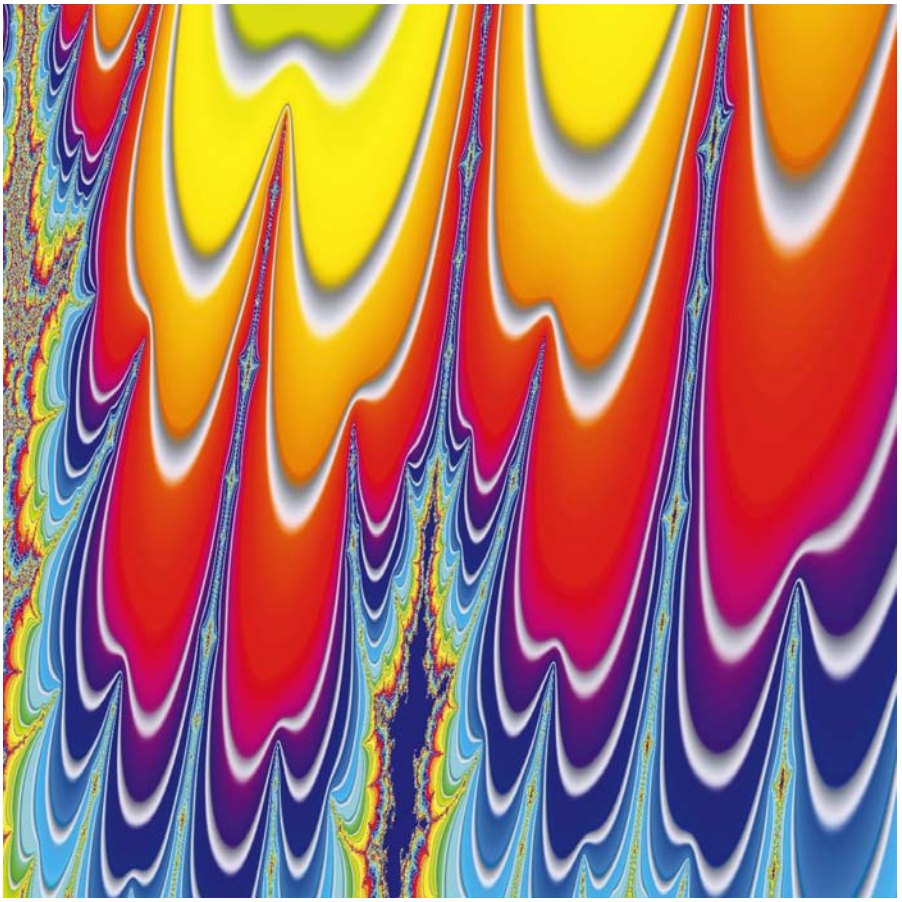


Energy Farming
Consider what would happen if homes came equipped with a 4000 Watt photovoltaic array. Most homes would instantly become net energy exporters. They would become energy farmers. Their "crop" would be sold to the local utility over the existing wires.

The technology to become an energy farmer exists today. The utilities wiring exists today. The sunshine exists today. What's stopping us from becoming energy farmers today? Only our inertia.

The barriers to energy farming are legal, financial and psychological. Energy has always been a commodity we bought from the power company. Our entire energy structure is based on centralized, utility-owned, power production. They make and we buy it.

Times are changing. New legislation is favoring net billing for home-sized RE systems (see page 72). Utilities are being challenged over their monopoly on power production (see pages 82 and 88). And just plain folks are discovering the concept of energy farming (see page 78).

It doesn't surprise me that technology is once again ahead of our ability to deal with it. We've got the hardware, but we're not sure what to do with it. Our energy establishment can't cope with the concept of energy farming. It challenges their hundred-year monopoly on electricity. Energy farming challenges our activism and dedication. Can we, as potential energy farmers, bring about this electrical transformation. You know we can.

Richard Perez for the Whole Home Power Crew

People

Clare Bell
David Booth
Paul Brasch
Sam Coleman
Windy Dankoff
Gary Flo
Michael Hackleman
Dan Hendrickson
Kathleen Jarschke-Schultze
Stu Kingman
Mark Klein
Stan Krute
Don Loweburg
Harry Martin
James McKnight
Vladimir Nekola
Karen Perez
Richard Perez
Shari Prange
Ray Reser
Mick Sagrillo
Bob-O Schultze
Dave Shantz
Thomas Starrs
Terry Torgerson
Michael Welch
John Wiles

" Think about it…"

"Time is an illusion perpetrated by the manufacturers of space"

—Graffiti

SOLAR DEPOT

camera ready
on film
four color

7.6 wide
9.8 high

this is page 5

Above: A night view of the 500 Watt wind generator and downtown Chicago.

Plugging into the Windy City

Vladimir D. Nekola

Here we are in downtown Chicago, the Windy City. The propeller in the back yard is whirling away, picking up speed. The wind is charging us up. Why do we use a wind generator in the middle of a large city? In Chicago, the Windy City, it makes sense to have the wind generating electricity. However, in the city electric power is readily available and cheap. We live two miles from the Sears Tower. Here the buildings are very close together. Even if you have a back yard, there is barely enough space for five or six tulips and a couple of hostas.

Well Why Not?

Thumbing my nose at urban conventions, lack of space, expense, and logic, I built myself a renewable energy system. We use a wind generator and a photovoltaic panel, and it works! I must admit that, since there was no element of necessity in this project, I consider my wind generator to be kinetic art. I painted the wind generator's tower purple and green to match the colors of the house. The tail of the generator has our favorite symbols painted on it. This reflects the philosophy that my wife and I have, and that of our friends. Functional objects can, and perhaps must,

have aesthetic value, especially if they are in public view. It is wonderful to see urban art in many places around the city, but this is even better: it is environmental art!

So, Why Do This?

Why did I put up a costly renewable energy system when I do not really need it? First, because I enjoyed it. I did it in true Home Power style, building it all myself rather than buying a ready-made unit. It was a challenge to find scraps, welding, and figuring out how to hoist a 47 foot tower in a 40 foot long back yard. I used to install wind generators in Argentina, my native country. It was not completely overwhelming to do the same thing in Chicago. The experiences I had in the past helped avoid some mistakes, but it was challenging. The experience of meeting Chicago's residential and electrical codes was new for me. We are surrounded by urbanites who are not familiar with renewable energy. We frequently give explanations to neighbors and passers-by about this weird contraption in the back yard. "Is this for cable?" "What kind of channels can you get with that revolving antenna?"

Here is How it Happened: From Theory to Practice

The first and best thing I did when I started the project was to go to the Midwest Renewable Energy Fair (we even have proof of being there: we appeared in HP #36, page 11, top photo; thanks for the picture HP)! After reading about wind generators, solar panels, inverters, and cables, it was helpful to see the products with our own eyes, to examine them, and to discuss their quality with experts. It was also important to see some of the systems in action and to get an accurate idea of their components.

Below: Daytime view of the wind generator and downtown Chicago.

Credit Card Meltdown

We started buying the various components of the system gradually. First, we bought the wind generator, a Windseeker 250. Right after our purchase, the company started selling the same wind machine in a 500 Watt model. We figured we could use a larger unit. For a minor charge, they were willing to make an exchange.

The second big purchase item (size-wise, but certainly not price-wise) was the wind generator's tower. I found an abandoned TV antenna tower at a renovation site where I was doing some electrical work, and bought it for $20!

Next we bought an inverter: a 12 Volt, 500 Watt Exeltech. We bought the model that was available at the time. Just as happened with the wind generator, as soon as we had bought the unit, a new and improved model appeared on the market. Alternative Energy Engineering was good enough to exchange our old unit for the newer model.

Next, we bought a used 100 Watt Quad Lam solar panel. We found the panel at the Midwest Renewable Energy Fair the following year, one of many great deals. The decision to include a solar panel in the system was yet another way of thumbing our noses at nature. Chicago has low solar insolation, but we loved the idea of harnessing sun power. We love the way it looks. Besides, it was such a good deal that it was hard to pass up!

The last major purchase was the set of batteries. I chose three 8G8D 225 amp Prevailer gel cell batteries. These batteries are clean and maintenance-free. Since the system lives in our kitchen, this was a necessary but expensive choice. We chose a 45 amp Todd Power Source battery charger, another expensive but unavoidable purchase.

We wanted the system to switch automatically from grid to batteries, and to divert surplus energy away from the batteries. We chose Photron Simple

Left: The wind generator at its "high" setting—maximum tower extension for maximum power production.

Switches and relays to control the power. We bought the remaining components of the control panel, such as meters, breakers, and fuses, along the way.

Stop Making Sense

Now that we had all components, we were ready to figure out what to do! It would have made much more sense to start the whole project by calculating our electric power needs, and then using the components that best satisfied those needs. Well, we did the reverse. We started with the system components. We had only a vague idea about how much energy the system would produce. Reflecting back on the whole process, I realize that we had to satisfy first our needs to live a philosophy and to create an aesthetic. Only then could we turn our attention to function.

I researched the average wind speed and solar insolation in Chicago. I calculated how much energy we could generate with the system I was building. We decided to power the energy-efficient lights of the second floor of our house and the stereo system. This satisfied the functional aspect of the system, and even though we realize that it is not much, we have the satisfaction of using wind to power our kitchen lights. We can listen to Cecilia Bartoli singing Rossini, courtesy of the Chicago wind and the sun. We do not miss a single note of her heavenly voice when the system switches back and forth between grid and batteries.

The Soaring Tower

There were two options for locating the tower: either on the roof or in the back yard. The roof would have been preferable were it not for the wind generator's vibrations. So, the only real option was the back yard. The only problem was the height clearance. The tower is 47 feet high, but the neighboring building is 53 feet. To clear the higher roof, I inserted a 21 foot extension of 2 inch pipe into the tower. I gained 18 feet in height, and was able to clear the surrounding rooftops. This low clearance is not ideal, but available urban space limits us. We decided to try out

Right: The wind generator at its "low" setting, the photovoltaic panel, and my wife, Else, on the deck.

Above left: Setting the wind generator on top of the tower. Vladimir is on the left, Enrique, a friend, is on the right.
Above center: Else and the 100 Watt photovoltaic panel.
Above right: Vladimir installs the photovoltaic panel on the house.
Below left: The 675 Ampere-hour, 12 Volt, battery bank is located in a closet off the kitchen.
Below center: A close look at the battery closet with controls and disconnects. Note the fire extinguisher.
Below right: Else and a view looking south into our kitchen.

Nekola's 120 vac Appliance Energy Consumption

No.	Inverter-Powered Appliance	Run Watts	Hrs./ Day	Days/ Week	W-hrs./ Day	%
5	ProLight Fluorescent Lamps	13	3	7	195	33.0%
1	MR-16 Halogen Lamp	50	3	7	150	25.4%
2	Philips SLS23 Fluor. Lamps	23	3	7	138	23.3%
1	Stereo System	35	3	7	105	17.8%
1	Incandescent Lamp	100	0.1	1	1.4	0.2%
1	Exhaust Fan	62	0.1	2	1.7	0.3%
	Total Appliance Power Consumption				591.1	

Above: Our favorite symbols painted on the wind generator's tail.

a low-clearing generator despite warnings by several HP writers. For security reasons, I decided to make the tower retractable, just like John Dailey's tower in HP#28. This allows me to raise and lower the pipe with a winch. When winds are extremely high, we can lower the wind generator to just below the level of the neighbors' roof. Lowering the tower also helps alleviate the noise of the propeller when the gusts exceed 45 mph. Noise is an issue in a neighborhood of adjacent buildings. So far, the only person who has complained about the noise is my wife!

I finished installing the wind generator on top of the tower just at the end of this fall. This gave me a chance to test the tower during the winter.

Doing the Right Thing

It was challenging to design the whole system and to do it right so that it met high technological criteria. I had to meet the National Electrical Code and the Chicago electric code criteria. The chances of lightning hitting the tower are very low. There are other slightly higher buildings around (such as the Sears Tower). I decided to make the system as secure as possible anyway. I manufactured a spark arrestor, following Mick Sagrillo's instructions in HP#24. I also installed a silicon oxide varistor for even more protection. Following John Wiles' advice in *Code Corner*, I decided to ground the negative side of the system. We haven't had any interference problems with the telephone, fax, TV cable, or computer.

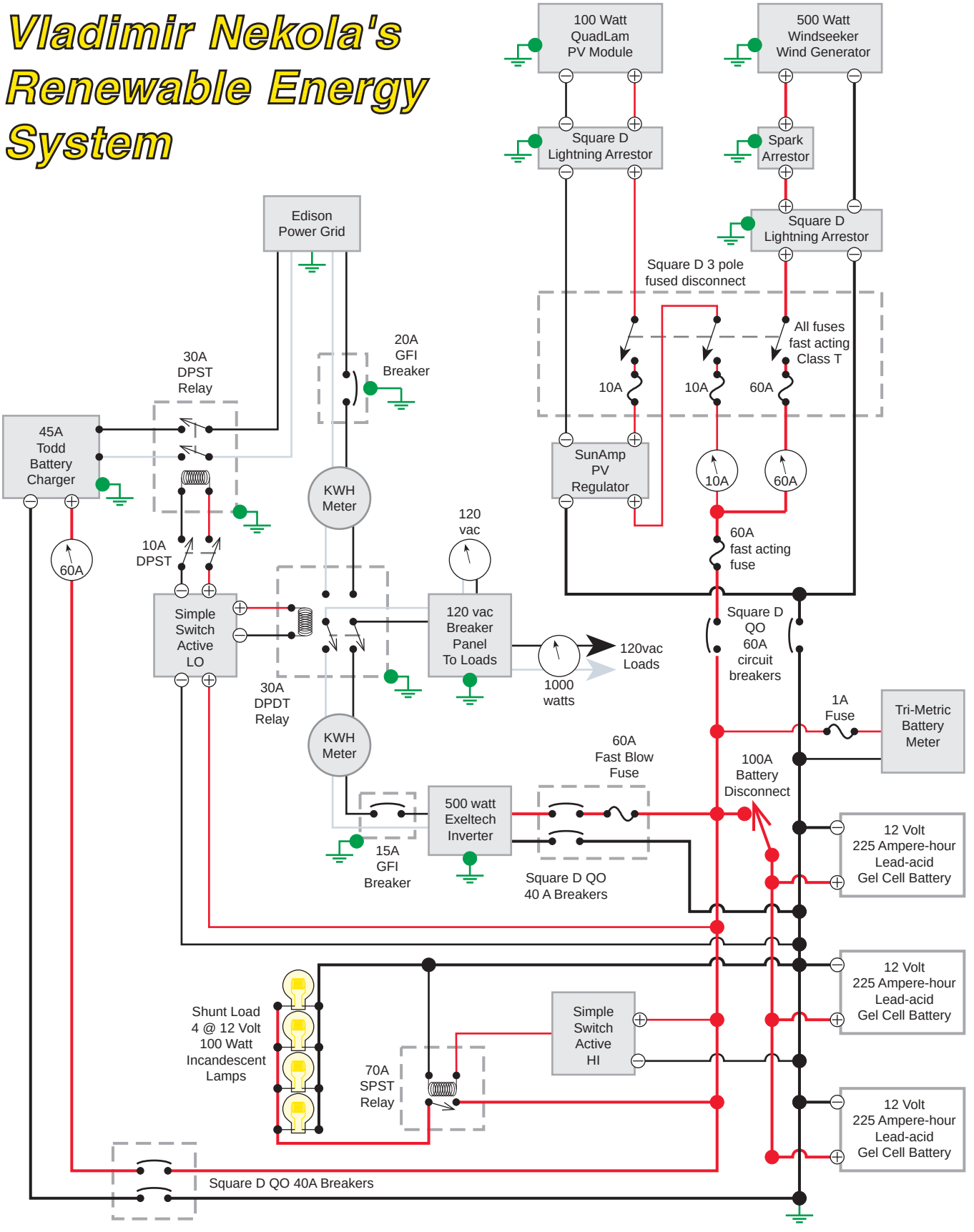
Since we travel frequently, the system had to switch automatically from inverter to grid when the batteries are at 75% capacity. I did this to extend the life of these batteries which have a low charge-discharge life cycle. The 25% battery discharge represents approximately three days of consumption without sun and wind. When the batteries are too high, the system diverts overflow power to four 12 Volt 100 Watt incandescent light bulbs. A 45 Ampere battery charger fills the system when the wind and the sun disappear for consecutive days. KiloWatt-hour meters, found at Maxwell Street, the oldest flea market in the country, measures the power consumed by the grid and the inverter. The system has been working for two months now, and seems to be operating smoothly.

But is it Art?

The aesthetics of renewable energy, not just as a philosophy but as the beauty of actual objects that make it work, was an important aspect of the project for us. This is why we chose to place the control panels right inside the house and not hidden in the basement. We can enjoy the aesthetics of the project, every time we are in the kitchen. The panel is painted in different colors and adds to the general feel of the kitchen. We also enjoy the purple and green tower and the decorated wind generator tail outside the kitchen window.

Below: This control panel is located on the other side of the battery closet's wall shown on page 10. This control panel contains two kiloWatt-hour meters, a voltmeter, a Watt meter, a Tri-Metric battery monitor, a battery charger, and the Exeltech inverter.

Vladimir Nekola's Renewable Energy System



Vladimir Nekola's Renewable Energy System Cost

Photovoltaic System

No.	*Item Description*	*Item Total*	*%*
1	QuadLam PV module - 100W	$290	5.9%
180	feet #3 wire THHN	$78	1.6%
40	feet of 1.25" aluminium pipe	$48	1.0%
1	SunAmp PV Control	$35	0.7%
1	Square D Lightning Arrestor	$27	0.6%
1	frame, bolts, etc.	$20	0.4%
1	Square D 30 A Disconnect	$18	0.4%
	subtotal	$516	

Wind Generator System

No.	*Item Description*	*Item Total*	*%*
1	Windseeker 500W Wind Generator	$1,000	20.5%
41	feet 2" Sch 40 steel pipe	$195	4.0%
360	feet 3/16" Aircraft cable	$135	2.8%
50	3/16" Cable Clamps	$100	2.1%
1	Winch with brake	$71	1.5%
120	feet #2 THHN wire	$62	1.3%
1	Sand and Gravel	$50	1.0%
1	Misc. wire, clamps, welding	$40	0.8%
40	feet #2 USE wire	$37	0.8%
12	5/16" Guy Wire Turnbuckles	$36	0.7%
1	Misc. Electric Connectors	$30	0.6%
1	Square D Lightning Arrestor	$27	0.6%
45	feet of Used Tower	$20	0.4%
1	Home-made Spark Arrestor	$15	0.3%
	subtotal	$1,818	

Batteries, Inverter, and Load Center

No.	*Item Description*	*Item Total*	*%*
3	Gel Cell Batteries 8G8D	$1,030	21.1%
1	Exeltech 500W Inverter	$480	9.8%
1	Todd Battery Charger	$210	4.3%
1	Tri-Metric Meter	$160	3.3%
1	Misc. relays, cables, fuses	$150	3.1%
2	SimpleSwitch Lo,Hi	$140	2.9%
1	Square D 3 Pole Fused Disconnect	$100	2.1%
2	Square D QO 60A w/box Breakers	$80	1.6%
2	Used KWH Meters	$60	1.2%
3	Ammeters	$48	1.0%
1	GFI Circuit Breakers 20A	$40	0.8%
1	Square D QO 40A Circuit Breaker	$25	0.5%
4	100W 12VDC Light Bulbs	$20	0.4%
	subtotal	$2,543	
	Grand Total	$4,877	

Above: Vladimir relaxes in his wind-powered kitchen.

Going with the Wind

Yes, it can be done, Renewable energy can be harnessed even in the big city, even when one does not actually need it. What's more, renewable energy can be beautiful in more ways than one!

Access

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Sources for materials:

Alternative Energy Engineering, PO Box 339, Redway, CA 95560 • 800-777-6609.

Real Goods, 966 Mazzoni St, Ukiah, CA 95482 • 800-762-7325.

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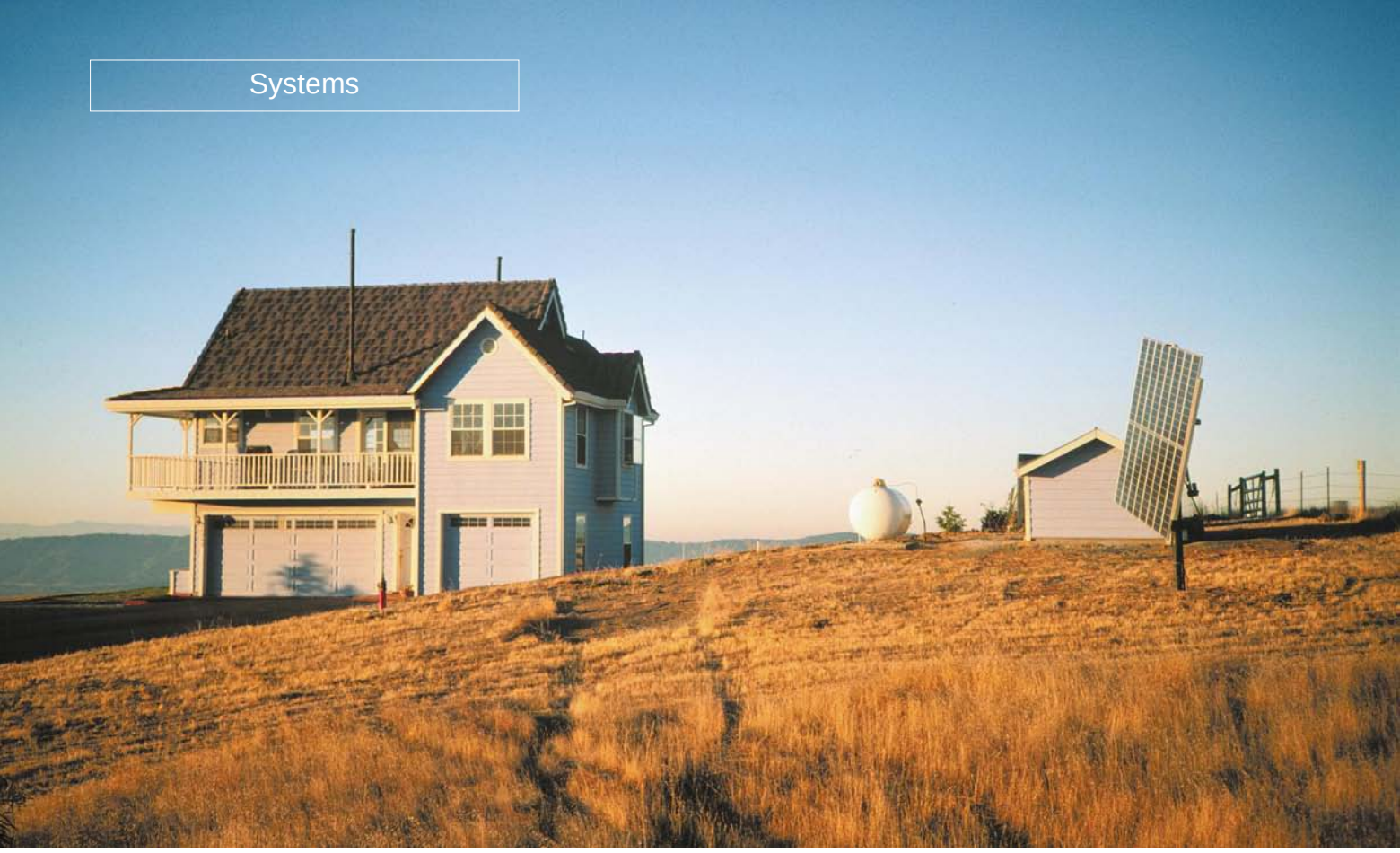


Above: This home is only a few minutes drive from San Jose, California. It is also two miles ($250,000) from the nearest utility power. A $15,000 solar power system provides the home with electricity that is clean, reliable, and best of all, completely paid for.

A Place in the Sun

Stu Kingman

Imagine building a new home close to the big city, and yet the nearest grid power is over two miles away. Furthermore, the local county government requires that all utilities be buried underground. We soon realized that line extension would cost $250,000 and was prohibitive. We would be on our own for power. I spoke with my brother, an architect. He handed me a stack of *Home Power Magazines*, and told me to start reading.

I read each issue, cover to cover, and took notes. I referenced each article by subject for easy retrieval. I was amazed at how far renewable energy technology had come in such a short time. I was also amazed at *Home Power Magazine* and the tons of valuable information in each issue. I initially knew nothing about renewable energy production. I soon learned enough to evaluate different components and assemble a system that works for us.

We are a family of five. My wife, Jennifer, is a best friend and full-time mom. She has a Business Administration degree from the University of Texas. She is also a flight instructor and teaches private, instrument, commercial and multi-engine pilots in her spare time. Hah! What spare time? I graduated with an Engineering degree in Aeronautics from San Jose

State University. I presently fly Boeing 767s for American Airlines out of San Francisco and San Jose, California. We have three children: Katie, age four; Garrett, age two; and Ryan, age eight months.

My brother, Architect Tony Kingman of Kingman's Creations, began work on drawings for our new home. Tony made best use of passive solar heating and cooling, materials and products to reduce energy consumption, and general site layout. He is very knowledgeable and specializes in this field. After several revisions to suit our needs and taste, we secured the permit application with no problems whatsoever. Construction began in October 1992, and was completed just four months later. The general contractor was only responsible for the work from the foundation up. I took care of installing all the utilities.

Well Test Hole

First, before and conditional to purchasing the property, we drilled a test hole to insure that water was available. No water — no purchase. It certainly paid off to do some homework before entering into such an agreement. You pay for a hole in the ground whether water is there or not. I spent several days at the Santa Clara County offices reviewing the public files of those parcels surrounding the twenty acres we were considering. Sure enough, I found records for several five and six year old wells. Each well hit water at 175 feet. With this in mind, I selected the well site, drilled, and found 30 GPM at 175 feet! This was very good news, and we purchased our property just southeast of San Jose, California.

Getting Set

To meet the fire protection requirements, I first installed a 5000 gallon water tank, a fire hydrant, a well pump, and a pressure pump with a pressure tank. Next, the 500 gallon propane tank was installed with the associated lines to the house and standby generator. Finally I arrived at the fun part: the electrical system.

Go!

Wire lengths dictated that anything other than 110 vac would be cumbersome, inconvenient and impractical. With this in mind, we elected to have the entire house

Below: This home uses a power shed. The power shed houses the batteries, power conversion equipment, and the propane-fueled back-up generator. All power is distributed through the system as 120 or 240 vac. This makes wiring and NEC approval simple and inexpensive.

Above: The Kingman family, Stu, Jennifer, Katie , Garrett, and Ryan. This location on Finley Ridge is ideal for both PV and wind power. This site receives dawn-to-dusk sun and ample winds.

wired to the NEC code. This way, if grid power was ever available (and IF we wanted it), then hooking up would be easy. Since there are no 220 vac appliances in the house, it was a simple to wire the two busses together to form a single 110 vac power line coming from the inverter. I sized this wire large enough to accommodate our current draw. Now we have all the conveniences of "normal" power. We also can hook up to grid power if we want, or if we sell the house in the future.

The entire system is extremely simple. When I leave on business for several days, I don't worry about anything going wrong. My wife and children have very reliable power for all of their needs, and absolutely no maintenance. All I do is periodically add water to the batteries — it only takes a few minutes.

Energy Production

Our location on the top of Finley Ridge is an optimum RE production site. The fog is thick in the valley much of the summer, but the sun shines every day up here. Unless a weather system rolls in, we get more sunshine than we know what to do with. We produce our power with sixteen Siemens M55s mounted on a Wattsun dual axis active tracker. I wired the panels in series/parallel to charge the 24 Volt nickel-iron battery. This tracked array produces from 8000 to over 10,000 Watt-hours of energy daily. Just a side note on the Wattsun tracker: I am very pleased with the unit. The instructions were clear and concise. The Wattsun is easy to assemble, and well engineered. The quality of the product is outstanding, and best of all, the bolt holes all lined up! I would highly recommend this product to anyone buying a tracker.

Power Regulation and Distribution

Power from the PV array arrives at the Heliotrope CC60 controller at 34 VDC (no load) and can be set to limit the output voltage to just about anything desired. I found that my batteries are happy with 29.4 VDC, which is below the high-voltage cutoff limit for the inverter. I mounted the controller on top of an Ananda Power Center IV (now superseded by the APT 5 series). I considered building up my own system, but Ananda did it right! Everything is neat, compact, enclosed, and easy to access. The Ananda was money well spent.

This particular Power Center contains a Cruising Equipment Amp-hr+2 Meter (a necessity), a 400 amp fused disconnect, and an automatic generator starter circuit that senses low battery voltage and/or high load. I have yet to use the last feature, but it seemed like a neat gizmo at the time.

Energy Storage

We store energy in nineteen nickel-iron cells located inside the power room. This battery consists of 19 series-connected 300 Ampere-hour cells. They arrived neatly crated with all the required hardware for assembly. These batteries were advertised as new, but appeared to be reconditioned and/or used. They were scratched and the interior plates were not shiny clean. The plastic caps were yellowed with age. A "seal" around the top of the battery cell looked as if it had been opened, then resealed. I called the dealer who sold me the cells, and was assured that the quality control in Hungary is not what we expect here in the U.S., and that the cells are, in fact, new and unused. Still looking further, I called the distributor and importer in New Jersey and they told me the same thing. Not really pleased or satisfied, I elected to go ahead and try them anyway. Although their appearance is not what I expected from a new battery, they seem to be performing fine so far.

Inverter

The Trace 2624-SB is an engineering marvel. It is well designed, easy to install, and set up. The voltage range for power usage is ample with the 19 series cell, nickel-iron battery. There has been no problem often associated with the voltage fluctuations of alkaline batteries. Before purchasing the inverter, I called and spoke to the engineers at Trace. They were very helpful with my questions concerning this, and convinced me that there would be no problems. They were right. I especially like the pass-thru circuitry.

Above: A view of the power shed before the roof was installed. The power shed allows all the system's components to live outside of the house. The compact design, especially the use of a power distribution center, makes the system efficient, simple to install, and electrically bullet-proof.

Whenever the generator is running, the inverter become a battery charger, and transfers generator power to the house. The transfer time from generator to inverter is not quick enough to keep my computer from rebooting itself. A slight flicker of the lights is all we notice when the generator shuts down.

The automatic sleep mode of the inverter is also a great feature. I can adjust it within a wide range to start the inverter on even the smallest loads. I have it set to start if any single light switch is turned on. All lights in the house are compact fluorescents for efficiency. After trying several different types, we like the Osrams best.

It still amazes me that I can run my power tools, computer, Whirlpool washer/dryer motor, microwave, lights, fans, water pressure pump, and so on from this sun-powered inverter! All phantom loads, such as the VCR's clock, are plugged into switched plug-strips.

Now that the Trace SW 4024 is available, we are considering an upgrade when we build the main house. After seeing our system, a neighbor ordered a

Above: This home uses standard 120 vac appliances. In keeping with solar cost-effectiveness, all units were selected for high efficiency. This home uses compact fluorescents and plug strips on its phantom loads.

complete PV system and new SW 4024. He will be moving up to the ridge with his family shortly. They've owned the property for over eight years, but never lived on it due to the lack of power. I told him that we are surrounded by power — it is just that most people are blinded by the lights from the utility company!

Generator

Kohler produces a fine product in their 7.5 kW unit. This particular model uses propane, which burns much cleaner. We don't have to haul gas or diesel in the back of the pickup. The propane man refills our 500 gallon tank for less cost than gasoline or diesel. Bulk delivery saves me time and expense. The generator turns at only 1800 RPM which saves significantly on wear and tear, and is very quiet. We can barely hear it from inside the house if we are listening for it. It in also enclosed inside the power house and produces 220 vac through two 30 Amp breakers. One leg of the 220 vac goes directly to one side of the main circuit panel in the Power House (110 vac) which powers half of the 220 vac well pump. The other leg goes directly to the inverter, then to the other half of the panel, which in turn feeds the house circuit box. This arrangement works beautifully with the automatic switching of the inverter. It always ensures power to the house itself, and automatic battery charging.

I also ran a wire into the house that is hooked up to an ordinary light switch labeled "Generator." This is a simple and convenient remote start. Also in this bundle, is 12 VDC power tapped off the battery bank directly into the cellular phone. We can now just leave it on all the time just like regular people!

Pumping using the Sun

We have not used the generator for quite some time since I installed a second 24 VDC pump in the well. The 220 vac Grundfos well pump required starting the generator to refill the storage tank. It took almost five hours of run time to refill it! Instead, I put a Shurflo submersible pump in the well below the Grundfos. The Shurflo is powered through a Solarjack LCB controller wired to the battery bank. This way, I have a reserve water pump (the Grundfos) and a full time solar-powered pump to maintain the water level in the storage tank. The Shurflo is controlled by a float switch in the tank. The Shurflo pump draws 4.0 Amperes at 24 VDC while running, and puts out 1.3 gallons per minute from a depth of 210 feet. We can water the lawn in the evening, and the pump will run silently at night until the tank is full.

PV Electric System Cost

We spent about $15,000 on the solar electric system including the propane generator. I calculate a payback, including interest on the money invested, at nine years. I expect that all the system's components will last that long, probably even longer.

Propane Appliances

Other than the generator, the only other LP gas consumers are the cookstove, the 12 cubic foot Dometic refrigerator, Aquastar 125 instantaneous hot water heater, and the two backup wall heaters. Our primary winter heat comes from a very efficient wood stove, which still consumes the lumber scraps from construction.

Our propane cookstove is an off-the-shelf Sears model and works fine. Unfortunately, I didn't do enough homework on this particular model. I didn't realize that it uses an electrically-sourced glow-bar in the oven. While this 600 watt glow-bar works fine on the Trace inverter, it is still a power-hog. The stove-top has piezoelectric ignitors and works fine with the modified sine-wave Trace inverter. The stove and microwave oven (750 watts) are both plugged into a dedicated switched outlet next to the stove. This switch lets us shut off both their "phantom load" clocks and allows the inverter to "sleep" at night.

I plan to install solar hot water and solar hydronic heating in the main house, but couldn't justify the expense in this building that will be a guest house in the future.

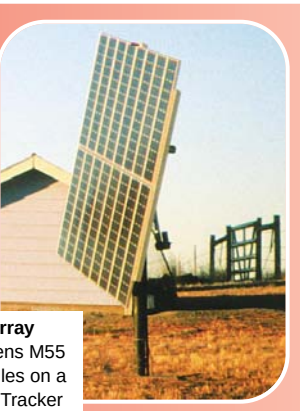
Down the Road

We plan to continue with Phase II of our building plan, and begin construction of the main house in about three years. Again, the beauty of RE comes into play since it is so easy to add on. A Bergey BWC 850 wind

Energy Production

Engine Generator
7.5 kW. Kohler
120/240 vac
Propane fueled

Wind Generator
not yet installed
Bergey BWC850



PV Array
16 Siemens M55
PV Modules on a
Wattsun Tracker

Energy Processing

Trace Inverter/Battery Charger
24 VDC to 120 vac 2.6 kW. inverter
120 vac to 24VDC battery charger

Heliotrope CC60 PV Controller
Prevents overcharging the battery.

Ananda Power Center IV
System power distribution with over current protection and disconnects.

Cruising Equip. Amp-hr+2 Meter
System and Battery State of Charge Instrumentation.

Energy Storage

Nickel-Iron Battery
Nineteen series-connected 300 Ampere-hour nickel-iron cells.
Battery capacity:
300 Ampere-hours at 24 VDC
or 7.2 kiloWatt-hours.

Energy Usage

System Loads — Appliances
Water pumping, washer/dryer, lighting, microwave, toaster, gas oven ignition, phone, color TV, stereo, VCR, computer….

turbine is definitely in the immediate future here on the ridge. It will become a major contributor to our energy production. Finally, another project is the elimination of the Propane Guy. To use our excess power, I am designing a small hydrogen production and storage plant.

If I Did it Again...

We are very satisfied with our system. There is nothing I would do differently if I did it again. I cannot stress enough how helpful *Home Power Magazine* was during this project. Had it not been for this terrific publication, I doubt that we would have ever begun. There is a great feeling of independence and satisfaction being off-the-grid and making your own power. No more ever-escalating electrical bills. The energy is clean, and available to everyone!

Access

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Architect: Tony Kingman, Kingman's Creations, 1427 Avocado Rd., Oceanside, CA 92054 • 619-967-8293. Lic#: C23670. "Specializing in Alternative-Powered Residences"

WIND BARON
four color
7.4 wide
4.75 high

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2 to 50 Gallons Per Minute

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They operate on 100 to 1000 watts of DC power at 30 to 120 volts. The power may be supplied from solar modules, wind generator, batteries or any combination of the three.

The motors are state of the art, brushless DC, permanent magnet type constructed from marine grade bronze and 304 stainless steel. Designed with a NEMA standard connection, they bolt directly to standard 4" diameter submersible pump ends. Internal pressure equalization allows motor submergence to any depth without damage to seals.

The pump ends are multi-stage centrifugals constructed from marine grade bronze and 304 stainless steel. The impellers and diffusers are constructed from a very rugged thermoplastic extremely resistant to mineral and algae deposits. Field servicing is easily accomplished without the use of specialized tools.

SOLARJACK'S SCS series pumps can be installed below the water level in a well, lake, river, or cistern. They can be used to fill open tanks or used to pressurize water systems. Their small size and light weight allow easy installation into a shallow well by hand.

SOLARJACK'S SCS series pumps are designed for use in *stand alone* water delivery systems. They are pollution-free, corrosion-free, self-lubricating and quiet. There is no better way to provide water for remote homes, campsites, livestock, small farms as well as many other needs beyond the commercial power grid.

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A Graphic Guide to Solar Water Pumping

Windy Dankoff

I live in New Mexico, where water is life, especially when the sun shines. I have been building solar-electric pumps for fifteen years, and I've seen lots of ways to get things wet without sucking from the power line. In previous *Home Power* articles I explained many of the details of water supply and solar pumping. In this article, I present a graphic overview of the entire design and decision process. My scope is the full range of possibilities from remote stand-alone pumps (the windmill of the 90's) to pumps integrated with home power systems, health clinics, etc.

The full chart looks complicated, but so does a big road map. The process is simple. Each branch asks you to choose a path, based on your situation or your needs. Let's start by using Figure 1 to select system configuration. For example, say you need both water and power at your site and your water source is 300 feet from your house.

Starting from the left, choose water and power required. Since you have a house to power too, the next stop is a combined power and pump system. But is the water source too far from the house to power it from the home system? It is farther than 200 feet (>200 Ft), so follow that path up to the next branch. You can go either way now, to stand-alone pump system, or high voltage DC or AC pump. A stand-alone pump system means that the water system is not connected to the home's power, because of the distance of wiring. The other option is high voltage , which reduces the wire size requirement.

Figures 2 and 3 guide you in choosing the type of pump, defined by pump placement and pump mechanism. Figure 4 gives you the full overview. A glossary is included to help you with terminology and more info, and even brand names for the various devices available to date.

If the map leads you to two alternate routes, estimate the cost of each one as a complete, installed system. Then, carefully read the specifications for each pump. One may not fit into your well, for example. Also, technology that's routine in California may not be serviceable in Cameroon. Consult with a knowledgeable system supplier to be sure you get the best advice based on the latest developments. This chart is a tool to help you narrow your choices, not to finalize a decision.

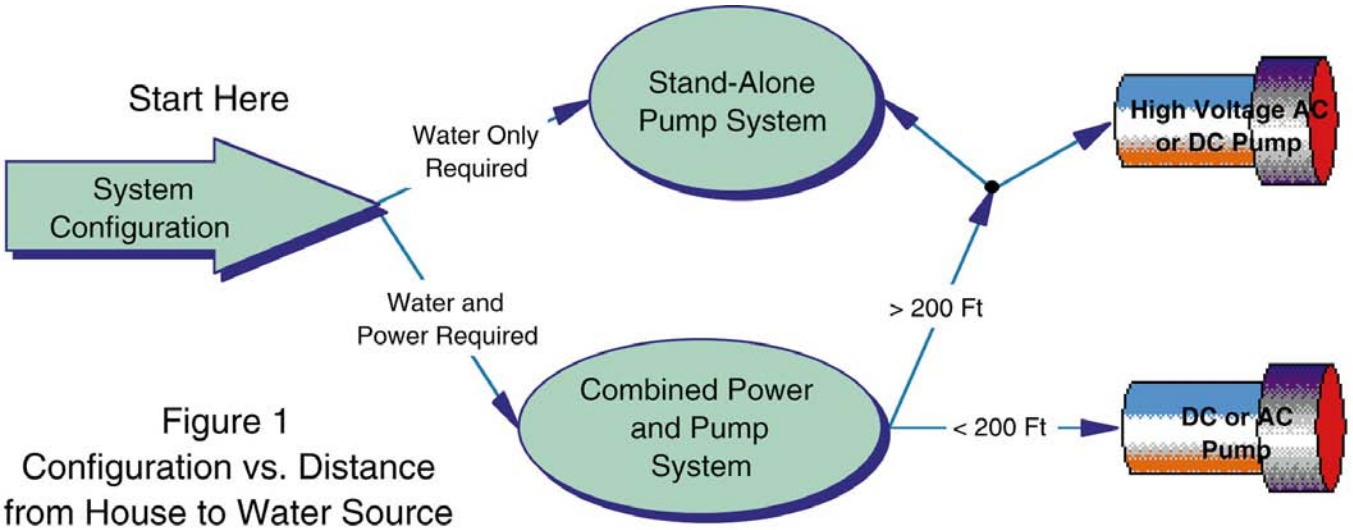


Figure 1
Configuration vs. Distance from House to Water Source

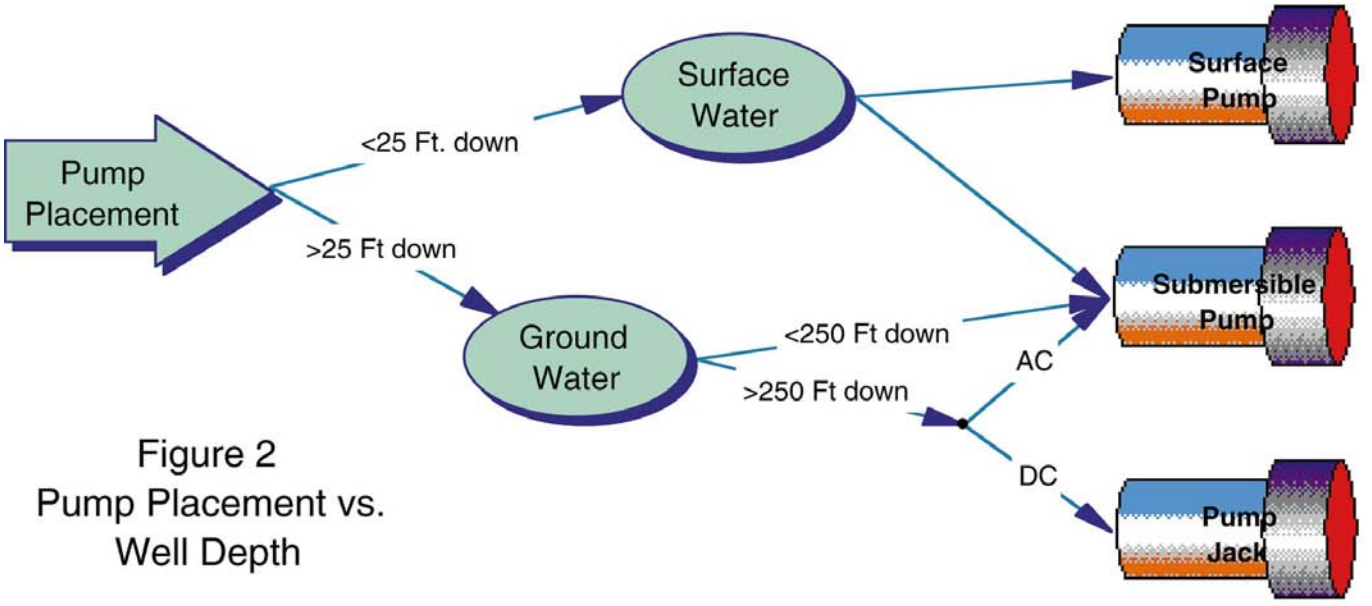


Figure 2
Pump Placement vs. Well Depth

Water pumping terms to help you understand these decision trees.

AC — Alternating Current, the type of power supplied by the utility grid and by most fuel-powered generators. The polarity (and direction of current) alternates back and forth. See Inverter.

Booster Pump — A surface pump used to increase pressure in a water line, or to pull from a storage tank and pressurize a water system.

Centrifugal Pump — A pumping mechanism that spins water by means of an "impeller". Water is pushed out by centrifugal force. See also Multi-Stage.

Check Valve — A valve that allows water to flow one way but not the other, like a door in the wind.

DC — Direct Current, the type of power produced by photovoltaic panels and storage batteries.

DC Motor, Brush-Type — The traditional DC motor, in which small carbon blocks called "brushes" conduct current into the spinning portion of the motor. They are used in DC surface pumps and also in DC submersible diaphragm pumps. Brushes naturally wear down after years of use, and may be easily replaced.

DC Motor, Brushless — High-technology motor used in centrifugal-type DC submersibles. The motor is filled with oil, to keep water out. A complex electronic system is used to precisely alternate the current causing the rotor inside to spin.

DC Motor, Permanent Magnet — Permanent magnets produce a magnetic field inside the motor shell. These motors start without a great current surge, and will run slowly but not overheat with reduced voltage. Contrast: induction motor. May be run from AC by using a rectifier (see rectifier).

Diaphragm Pump — A mechanism that forces water by squeezing a chamber made with a rubber-like material. Flapper valves let water into and out of the chamber. It may have 2 or more chambers that alternate pumping action. The principle is similar to that of the living heart.

Drop Pipe — The pipe that carries water from a pump up to the surface.

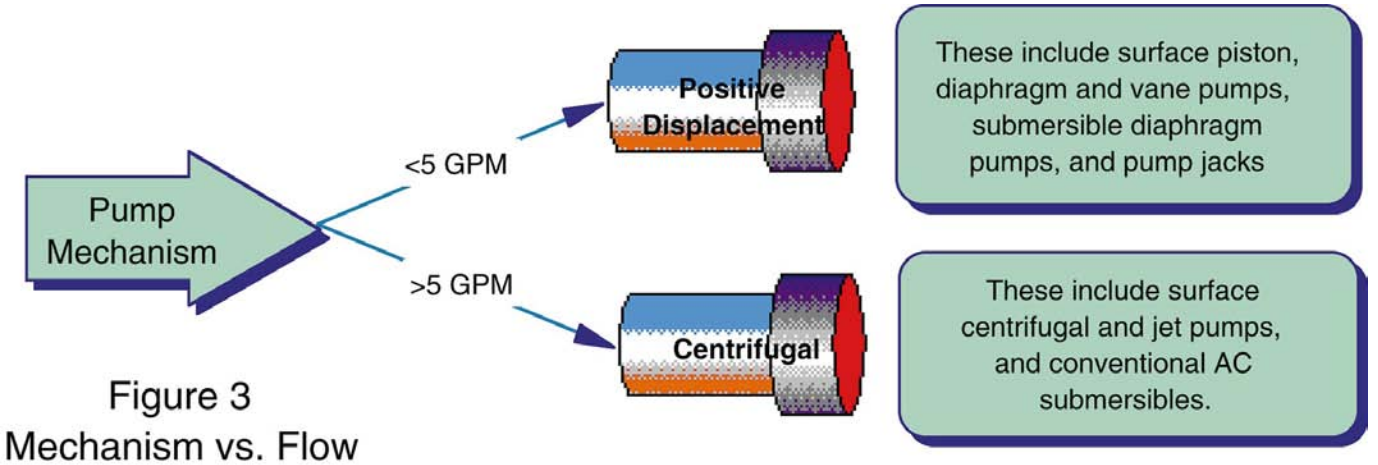
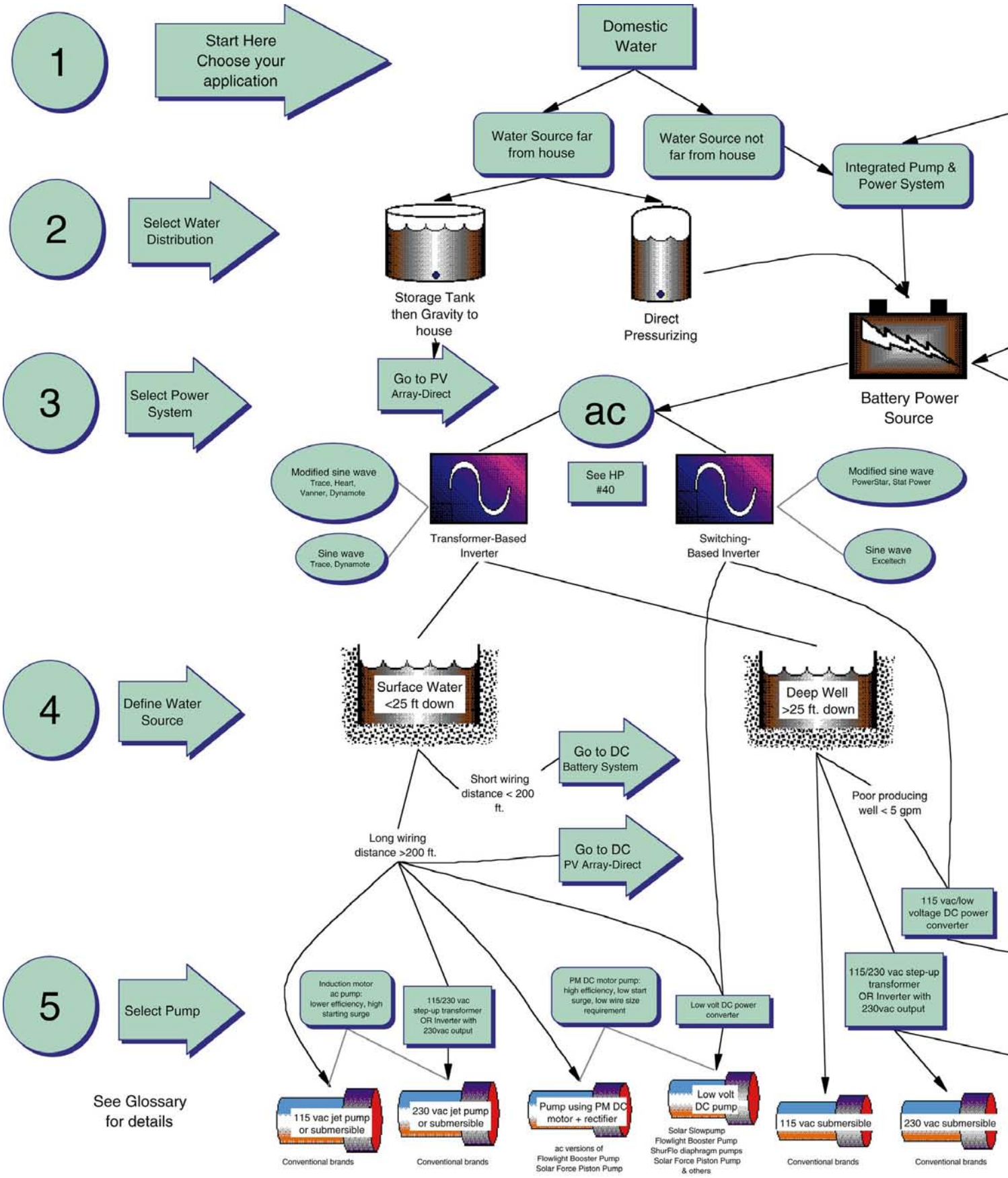
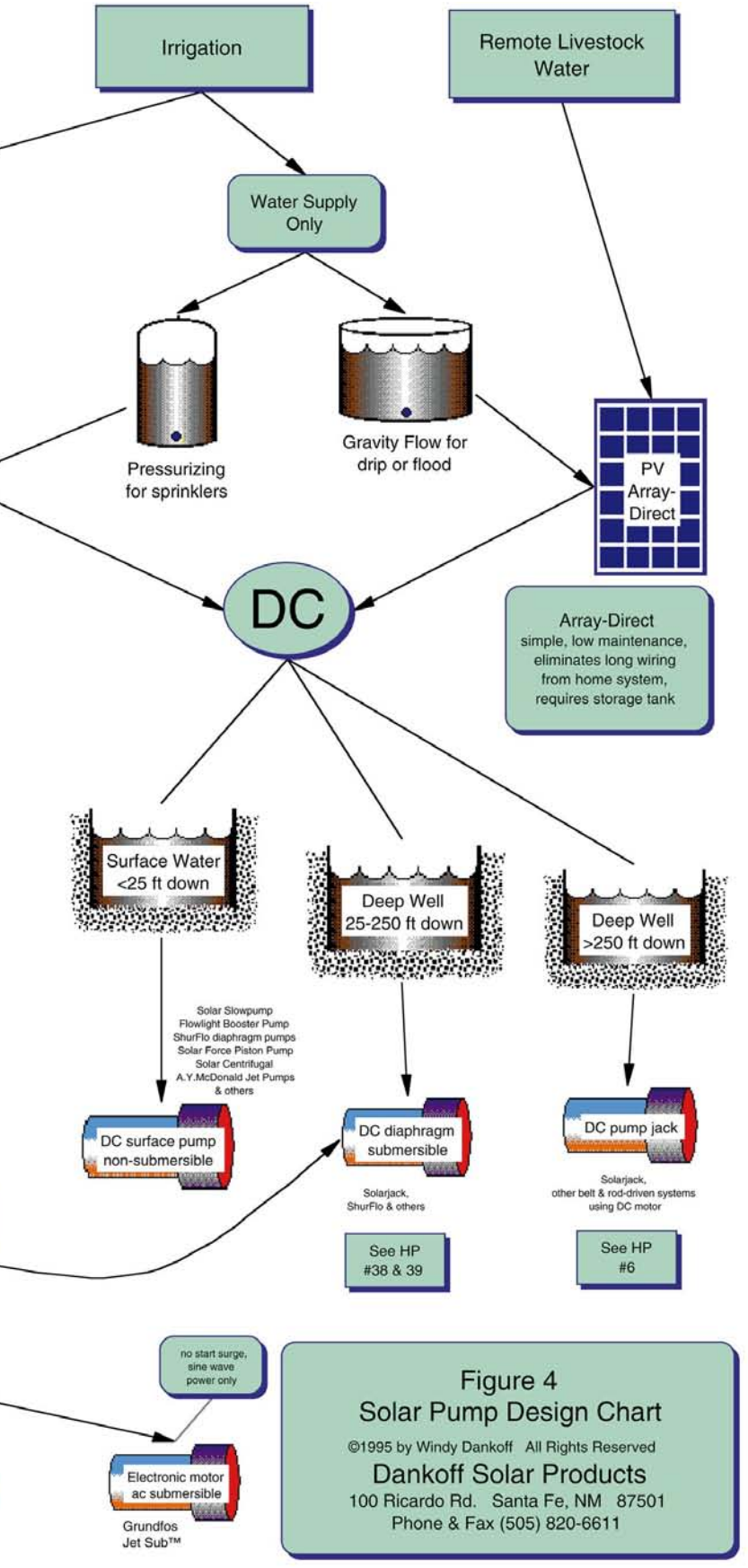


Figure 3
Mechanism vs. Flow Requirement


1
Start Here
Choose your application
Domestic Water
Water Source far from house
Water Source not far from house
Integrated Pump & Power System
2
Select Water Distribution
Storage Tank then Gravity to house
Direct Pressurizing
Battery Power Source
3
Select Power System
Go to PV Array-Direct
ac
Modified sine wave
Trace, Heart, Vanner, Dynamote
Sine wave
Trace, Dynamote
Transformer-Based Inverter
See HP #40
Switching-Based Inverter
Modified sine wave
PowerStar, Stat Power
Sine wave
Exceltech
4
Define Water Source
Surface Water <25 ft down
Deep Well >25 ft. down
Short wiring distance < 200 ft.
Go to DC Battery System
Long wiring distance >200 ft.
Go to DC PV Array-Direct
Poor producing well < 5 gpm
115 vac/low voltage DC power converter
5
Select Pump
Induction motor ac pump: lower efficiency, high starting surge
115/230 vac step-up transformer OR Inverter with 230vac output
PM DC motor pump: high efficiency, low start surge, low wire size requirement
Low volt DC power converter
115/230 vac step-up transformer OR Inverter with 230vac output
See Glossary for details
115 vac jet pump or submersible
Conventional brands
230 vac jet pump or submersible
Conventional brands
Pump using PM DC motor + rectifier
ac versions of Flowlight Booster Pump
Solar Force Piston Pump
Low volt DC pump
Solar Slowpump
Flowlight Booster Pump
ShurFlo diaphragm pumps
Solar Force Piston Pump
& others
115 vac submersible
Conventional brands
230 vac submersible
Conventional brands



Foot Valve — A check valve placed in the water source below a surface pump. It prevents water from flowing back down the pipe and "losing prime". See check valve and priming.

Gravity Flow — The use of gravity to produce pressure and water flow. A storage tank may be elevated above the point of use, so that water will flow with no further pumping required. A booster pump may be used to increase pressure. See pressure.

Head — See Vertical Lift

Impeller — See "Centrifugal Pump"

Induction Motor — The type of AC electric motor most commonly used in water pumps. It requires a high surge of current to start, which is a challenge in running it from an inverter, and also increases the wire size required. Prone to overheating if current is not sufficient to start the motor, or if voltage is too low.

Integrated System — A single energy system in which various energy sources and loads (including pump) are pooled together, with seasonal balance in mind. In summer, when less lighting is required, solar power is available for increased water use. In winter, when the pump runs less, the system's energy is more available for lighting. Energy from the home's backup generator may supply pumping power, and so may the home system batteries.

Inverter — An electronic device that converts DC to AC power and steps low voltage up to high voltage, equivalent to utility grid power.

Jet Pump — A surface-mounted centrifugal pump that uses an "ejector" (venturi) device to augment its suction and pressure capacity. In a "shallow well jet pump", the ejector is within the pump. In a "deep well jet", the ejector is down in the well, and assists the pump in overcoming the limitations of suction (a portion of the water is diverted back down the well). Jet pumps are not energy-efficient when drawing from a depth beyond 25 feet.

Linear Current Booster — See pump controller ("LCB" is a trademark of Bobier Electronics)

Multi-Stage Centrifugal — A centrifugal pump with more than one impeller and chamber, stacked in a sequence to produce higher pressure. Conventional AC deep well submersible pumps and higher power solar submersibles work this way.

Open Discharge — The filling of a water vessel that is not sealed to hold pressure. Examples: storage (holding) tank, pond, flood irrigation. Contrast: pressure tank.

Photovoltaic — The phenomenon of converting light to electric power. Abbreviation: PV.

Positive Displacement — A pumping mechanism that seals water in a chamber, then forces it out by reducing the volume of the chamber. Examples: piston (including jack), diaphragm, rotary vane and

gear pump. Generally used for low volume, high lift applications. Contrast with "centrifugal". Synonyms: volumetric force pump

Pressure — The amount of force applied by water that is either forced by a pump, or by gravity. Measured in pounds per square inch (PSI). PSI = vertical lift (or drop) in Feet / 2.31.

Pressure Switch — An electrical switch actuated by the pressure in a pressure tank. When the pressure drops to a low set-point (cut-in) it turns a pump on. At a high point (cut-out) it turns the pump off.

Pressure Tank — A fully enclosed tank with an air space inside. As water is forced in, the air compresses. The stored water may be released after the pump has stopped. Most pressure tanks contain a rubber bladder to capture the air.

Priming — The process of hand-filling the suction pipe and chamber in a surface pump with water. Surface pumps can draw water better than air, so priming is generally necessary when a pump must be located above the water source. See foot valve.

Pump Controller — A specialized voltage converter for PV array-direct pumps. It allows the pump to start and run under varying sun conditions. Mechanical analogy: automatic transmission.

Pump Jack — A deep well piston pump. The piston and cylinder is submersed in the well water and actuated by a rod inside the drop pipe.

PV Array — A group of PV (photovoltaic) panels (also called modules) connected together to produce the voltage and power desired.

PV Array-Direct — Use of electric power directly from a photovoltaic array, without storage batteries to store or stabilize it. This is used for most solar pumps that are not powered by a home power system. Water is stored in a tank for use when the sun is not shining.

Rectifier — A simple electronic device that converts AC to pulsating DC power.

Sine Wave — The ideal way that AC power alternates (see AC), like the smooth swing of a pendulum. Contrast with so-called "modified sine wave" produced by some inverters.

Suction Lift — Vertical distance from the surface of water in the source, to a pump pump located above (surface pump). This distance is limited by physics to around 20 feet at sea level (subtract 1 ft. per 1000 ft. altitude) and should be minimized for best results.

Total Dynamic Head — Total Head (Vertical Lift) including losses due to pipe friction.

Transformer — An electrical device that steps up voltage and steps down current proportionally (or vice-versa). Transformers only work with AC power. An electronic "voltage converter" is required to alter DC voltage.

Utility Grid — Commercial electric power distribution system. Synonym: Mains

Vane Pump — (Rotary Vane) A positive displacement mechanism used in low volume high lift surface pumps and booster pumps. Durable and efficient, but requires cleanly filtered water due to its mechanical precision.

Vertical Lift — Total Vertical Lift = vertical lift from surface of water source up to the discharge in the tank + (in a pressure system) discharge pressure. Synonym: Head.

Voltage Drop — Loss of voltage (electrical pressure) caused by undersized wire, especially in long wire runs. AC motors are easily damaged by excessive drop (see induction motor).

Access

Author: Windy Dankoff, Dankoff Solar Products, 100 Ricardo Rd. Santa Fe, NM 87501. Phone & Fax (505) 820-6611

For a poster-sized, black and white copy of the Solar Pump Design Chart and more information, please send $8 ($12 outside of USA) to the author.

Home Power Articles Reference

HP#5 An Introduction to Solar Water Pumping (Dankoff)

HP#6 Using PVs to Pump Deep Wells (pump jack) (Perez)

HP#11 Solar Powered Water Pumping (Dankoff & McCarney)

HP#17 Running Submersible Well Pumps on Inverter Power (Dankoff)

HP#26 Water and Electricity Do Mix (Code Corner) (Wiles)

HP#31 Installing a PV-Powered Submersible Pump (Schultze)

HP#33 Drilling a Water Well (Perez)

HP#38 Using a DC Submersible Pump in a Domestic Water System (Dankoff)

HP#39 Storage Tanks, Gravity Flow, and Booster Pumps (Dankoff)

HP#40 Water Pumping for the Independent Home: ac or DC? (Dankoff)

HP#42 Solar Slowpump (Things that Work!) (Schultze)

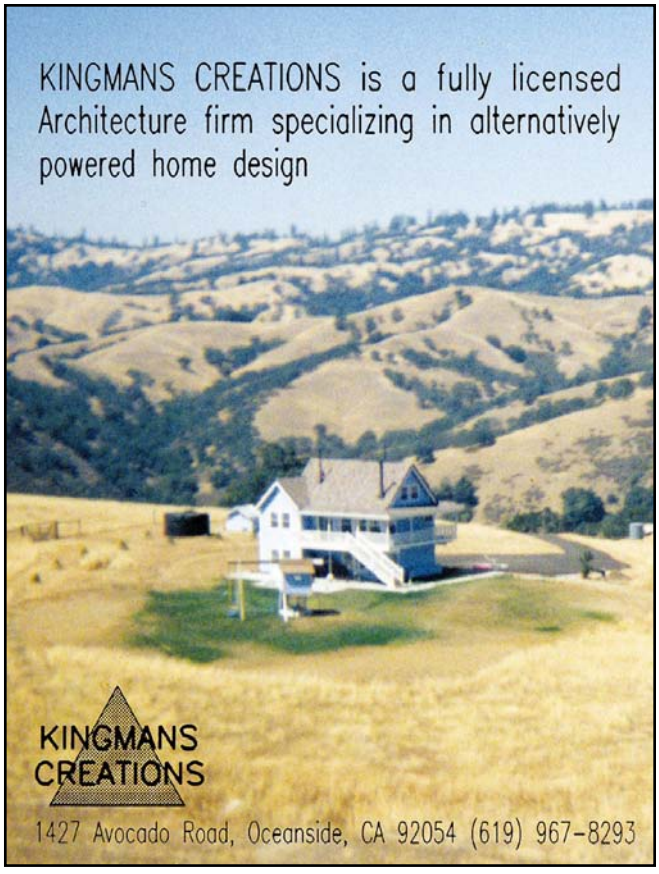


Photo courtesy of Zond Systems

Wind Generators and Birds: Power Politics?

Mick Sagrillo

Lately, a number of articles have been published in various periodicals bringing attention to a problem that is occurring on wind farms. It seems that dead birds have been found at a few locations. Some writers have even gone so far as to dub the wind generators “raptor-matics” and cuisinarts of the sky!”

Many *Home Power* readers considering a wind generator have asked about the seriousness of this problem. They are concerned that if they install a wind generator they will be responsible for batting birds all over the neighborhood. It’s time to address this potentially serious issue.

All of the studies done to date on bird mortalities associated with wind power have been done on wind farm-sized equipment. We’ll take a look at this problem, what conclusions have been drawn, and speculate on why. From there, we’ll apply this information to home sized systems.

Early Indications

The problem of bird deaths associated with wind farms stems from reports filed with the California Energy Commission (CEC) in the early 1980’s. At the time, the California wind farms were growing in number and size. Because some of the casualties were protected species, the CEC felt that the matter should be investigated further.

What the CEC discovered was that the reports were true. Dead birds were indeed found on the ground at the wind farms. Many of the birds were at one location, the Altamont Pass east of San Francisco. To make matters worse, they were raptors: red tailed hawks, kestrels, & golden eagles. More studies were ordered.

Stakeholders

I need to digress and say that I had little idea of the extent of the bird/wind turbine problem before delving into it. I had read many of the same news reports that some concerned readers had, but not much more. After quite a bit of research, I unearthed more about dead birds than I ever thought existed. I found that some exhaustive studies have been funded to the tune of millions of dollars to determine both the extent of the problem and what can be done to soften the environmental impact of wind power. One company, Kenetech, has spent more than $2 million on one study for one location. This is obviously serious business, as big money is on the table!

The stakeholders spending time and money on the issue are not restricted to wind farm companies. Key players from government and regulatory agencies, besides the aforementioned CEC, include the US Department of Energy (DOE), the National Renewable Energy Laboratory (NREL), and the US Fish and Wildlife Service. Involved energy interest groups range from the Electric Power Research Institute (EPRI), the research association for the utilities, to the American Wind Association (AWEA) and the National Wind Coordinating Committee (NWCC) under the auspices of President Clinton's Global Climate Change Action Plan. Environmental players run form the National Audubon Society to the Union of Concerned Scientists, and virtually everyone in between.

The research is being conducted on various levels. AWEA has compiled a list of well over 110 studies and reports known to have been done worldwide on bird deaths associated with wind farms. Some studies focus on retrieving carcasses from wind farms and determining the cause of death. Others describe the videotaping of birds interacting with wind turbines. And some studies involved the selected release of birds in wind farms. Let's look at some of the findings to date.

Death By....

The CEC found 108 bird deaths from 1984 through 1988. Seventy-two of the deaths were collision related and 36 were electrocutions. A two year study (1989 to 1991) conducted in California's Altamont Pass found 183 bird mortalities. Of these, 55% were determined to be collisions with wind turbines or their structures, 11% were collisions with wires, 8% were electrocutions, and 26% were unknown. The startling discovery was that 66% of these accidents involved raptors.

The situation with electrocutions has been known for decades. Birds light on wires and power poles. When their wings span the distance between two hot wires or a hot and ground wire, the bird completes a circuit and draws tremendous amounts of current. The result is instantaneous death.

Mechanical solutions to bird electrocutions are under continuous development by the electric power industry. For example, spacing wires further apart works well with smaller birds, but is impractical for larger birds with greater wing spans, such as raptors. They tend to perch, as well as nest, on the power poles themselves. Over the years, the electric power industry has developed a variety of anti-perch mechanisms. These devices, which deter birds from landing on power poles, are usually quite effective.

The good news is that spread wires and anti-perching devices have reduced bird electrocutions by 90%. Most electrocutions can be avoided. Also good news is that many of these techniques are considered state of the art for new power generating facilities, including wind farms.

Motion

All studies conducted indicate that birds avoid moving objects, such as the blades of an operating wind turbine. All birds, that is, with the possible exception of raptors. Our understanding of what raptors perceive and comprehend gets a little fuzzy here.

Most of smaller bird carcasses found at the wind farms were determined to have died in collisions with wires, apparently while trying to land. Like tree branches, wires are prime perching material for birds. Collisions with intended perches is a relatively common cause of death in the bird world.

Most of the dead raptors appear to have died in collisions with the wind turbines or their towers. They just seem, to fly into the towers, or the generating mechanisms on the tower, or even the blades themselves. Non-rotating blades! There is no evidence that large numbers of raptors are being batted out of the sky by rotating blades. Why, then, all the dead raptors?

It is well known that raptors are not the most graceful of landers in the bird world. It has long been established that the mortality rate for raptors in their first year of life is a startling 30%, due mainly to collisions. It appears that they don't have as keen an eyesight, in terms of contrast and differentiation, as popular culture attributes to them.

There are two other factors at play in raptor collisions under normal conditions. First, raptors apparently

concentrate on finding prey and not paying attention to their surroundings. As someone who habitually drives off the road and into ditches for lack of attention to the task at hand, I can certainly empathize with this problem. (So far I've been lucky!) Second, all birds, with the exception of raptors, change course to avoid objects in their path of flight. It's not understood why, but raptors do not necessarily practice this same avoidance behavior. We do know that when they spot prey, their concentration increases and they speed up in flight. However, they do not always take evasive action when approaching obstacles.

If this sounds ridiculous to you, and you believe that we know all there is to know about our world, consider the following. We all know that owls , another raptor, have very large eyes. Owls are nocturnal, that is they are active at night. We have always attributed their success as night hunters to their apparently keen eyesight. Recent studies indicate that owls have exceptionally acute auditory skills. They are able to detect time lapses in sound of three ten-thousandths of one second. Studies showed that owls can determine the location of moving prey in total darkness with absolute accuracy by sound. So much for what we think we know about keen-sighted owls!

An explanation for the high mortality of raptors in wind farms is taking shape. Sort of!

Discrepancies

Concern about migratory birds is always near the top of the list when the wind farm question comes up. Many people have speculated that large numbers of birds would be killed by flying through a wind farm while migrating. However, studies indicate that migrating birds fly between 1000 and 10,000 feet far above the 80' to 160' towers that most wind turbines are mounted on. The situation in San Gongorno Pass near Palm Springs exemplifies what I mean. The pass intersects a major migratory flyway in the western US. In 1986, 69 million birds flew through the pass during the Spring and Fall migrations. Only 38 dead birds were found, none of them raptors. Statistically, while it is true that birds are dying, these numbers are insignificant. Bird mortality in this case was only .00006% of the total migrating population.

Part of the apparently high bird mortality in Altamont Pass may be that it is the largest of our three major wind farms in California. More than 6500 turbines are in the Altamont. The Tehachapi Pass has 5200 turbines and the San Gongorno Pass has 3000. In addition, the turbines in the Altamont represent many different designs and configurations and are on a great variety of tower structures.

However, studies on bird mortality in wind farms are not all consistent. The numbers of bird deaths in other wind farms do not mirror, percentage-wise, those found in the Altamont Pass. For example, only nine dead raptors were found in Tehachapi Pass between 1984 and 1988, and another four from 1988 through 1991. While Tehachapi contains 80% of the total number of turbines that exist in the Altamont, raptor mortality in Tehachapi was less than 13% of that in the Altamont Pass between 1984 and 1988, and only 4% between 1988 and 1991. So, what exactly is going on in the Altamont Pass?

The Altamont Dilemma

There appear to be other factors at play in the bird mortalities at the Altamont Pass than just large arrays of wind turbines. Research originally intended to shed light on what some thought was a simple problem, wind turbines killing birds, has only complicated matters by unearthing a part of Nature in turmoil.

Geographically, the Altamont Pass is east of San Francisco. This part of California, including the adjacent Central Valley and Livermore Valley, have seen intensive land development pressures in recent years. Many animals, especially reclusive species such as raptors, migrate out of developing regions to avoid human harassment. They also follow the migration of their prey.

We now have a situation where wildlife, feeling the pressure of urban development and human harassment of their territories, have migrated in to the Altamont Pass area. From all the evidence, this reaction by wildlife to urban sprawl only to encounter wind turbines appears to be unique to the Altamont area. None of California's other wind farms are experiencing similar pressures. The same is true of wind farm developments in other parts of the United States, including Minnesota, Iowa, Texas, and New York.

The influx of certain wildlife species in the Altamont area has not gone unnoticed by farmers and ranchers. Concerned with an explosive rodent population, some of these farmers and ranchers have turned to various means of chemical control. For example, reports indicate that one area farmer admitted to using eleven tons of chemical poisons to control ground squirrels. Shades of Silent Spring and the '60's! We might be on to something here.

Haven't we learned in the last three and a half decades that these poisons travel up the food chain from prey to predator? Must we go through these battles again? To date, most bird mortality studies have focused on the wind turbines themselves as the bad guys whacking

birds out of the sky, and what can be done to alter their structures. I could find only one reference in one study dealing with possible heavy metal poisoning of these raptors. Hasn't it occurred to anyone that maybe these birds are being drugged stupid and this is the reason that are smashing into the wind turbines in the Altamont Pass? Only Paul Gipe, in his soon-to-be released book *Wind Energy Comes of Age*, has postulated that "residential poisons...may predispose birds to collision."

Perspective

As indicated in some of the previous examples, scientists consider the low numbers of bird deaths in wind farms biologically insignificant, especially when compared to other human causes of bird mortality. For example, automobiles are responsible for some 57 million bird deaths every year! More than 97 million birds die by flying into plate glass every year! And about 1.5 million birds die from collisions with structures (such as towers, stacks, bridges, buildings) every year.

Examples of bird's problems with structures is highlighted in a DOE report. The report cites a tally of 2700 annual bird collisions with a TV tower in Florida over an eleven year period. In another instances, 800 to 1400 birds were killed every season for five years in collisions with a radio tower in North Dakota. I don't mean to make light of a grave situation, but viewed in this context, the 183 bird deaths in the Altamont Pass over a two year period of time is a small number indeed.

Paul Gipe puts the statistics somewhat in context for us. In Altamont Pass, the world's largest and most complex wind farm (with over 6500 turbines), bird mortalities range from .024 to .059 birds/turbine/year. Why, then, have some parties made such a big deal of this issue?

Power Politics?

By now, you may have the impression that I think this problem has been blown out of proportion? You're right. But that doesn't exonerate one from doing some major soul-searching. This is a guilt issue for the wind industry.

Is bird mortality a serious problem? Very much so. It is a moral consideration — at least for some of us — as well as having legal ramifications. It is a federal offense to knowingly injure or kill a protected bird, such as a red tail hawk, kestrel, or golden eagle. Some zealots have actually threatened wind farm operators with prosecution for the incidental death of birds due to the routine operation of wind turbines. Has the same threat been made to the utilities whose highlines have wiped out birds? I hardly think so. How about anyone who has ever hit a bird with their car or had a bird careen into their picture window? Highly unlikely. Why then, have the wind farms been singled out?

One can only speculate, especially when one takes a long look at who is framing the issues in terms of pro-birds/anti-wind. According to Gipe in *Wind Energy Comes of Age*, "Sweden's nuclear lobby has begun using the bird issue to discredit wind energy...Groups as diverse as...the West Virginia Coal Association have publicly aligned themselves with opponents of local wind projects on the grounds that wind turbines kill birds."

What's going on here? One wonders if this is really an issue, or just power politics as usual? Whatever the motive, the tactic has been successful. Right or wrong, the popular press has picked up another hot-button issue. The headlines read: Wind Generators Kill Birds! Unfortunately, the public has begun to doubt the value of wind power in our energy mix. To quote Gipe again, "...the American public perceives the problem is more widespread then it really is, and perception is reality in politics."

Environmental Ramifications

Renewables, including wind power, are meant to be a sane and gentle alternative to conventional energy sources : nuclear, coal, and petroleum. Renewables, including wind power, avoid the environmental impacts associated with these conventional fuels. These impacts include land disruption due to fuel extraction, material transportation, waste disposal, air and water pollution, destruction of habitat, and who knows what else in the case of nuclear power.

I hate to say this because I'm really making myself vulnerable, but maybe we need to accept these bird deaths as part of doing business as human beings. After all, we are the ones using the electricity. Donald Aiken of the Union of Concerned Scientists has made the case that we accept bird deaths in other human activities. Driving cars and having picture windows in our homes claim an order of magnitude more birds than do the wind farms. No one has suggested that we eliminate cars or windows.

Again, I am not making light of this issue, but only trying to put it in context. To quote Paul Gipe one last time, "California's wind plants offset fourteen times the oil spilled by the Exxon Valdez...It will take wind turbines in the Altamont Pass 500 to 1000 years to kill as many birds as the Exxon Valdez oil spill." I think I'll stick with my wind generators.

Around The World

Again, the situation in the Altamont Pass appears to be a unique one. There is only one other place in the world that is experiencing comparable bird deaths. This is just north of the Straights of Gibraltar in Spain. This is the area where Spain is closest to Morocco between the Atlantic Ocean and the Mediterranean Sea. Migratory birds flying from Africa to Europe catch a ride on the thermals as they approach the high ridges of Gibraltar after crossing the Straights.

In the last few years, these same ridges have seen an influx of commercial wind turbines. The idea was to put these thermals to use generating electricity. Higher than normal bird deaths have been reported in the wind farm during spring migration for the last two years. Speculation is that the birds riding the thermals cannot get enough lift to clear the ridges and the turbines, especially during marginal wind conditions. The unfortunate result is that some birds have met their demise in some of the turbines.

Unlike the situation in Altamont Pass, the problem here is clear cut. As a result, the wind farm will not be operating this spring during migration time. This will allow scientists time to observe the migration, evaluate the problem, and postulate on some solutions. A wise decision, indeed.

Lessons For Us

Let me preface my conclusion by saying that Lake Michigan Wind & Sun has hundreds of wind generators located all across the country and in 29 foreign countries. These are all residential-sized units ranging from a few hundred watts to 20Kw. I have no experience with commercial or wind farm-sized equipment.

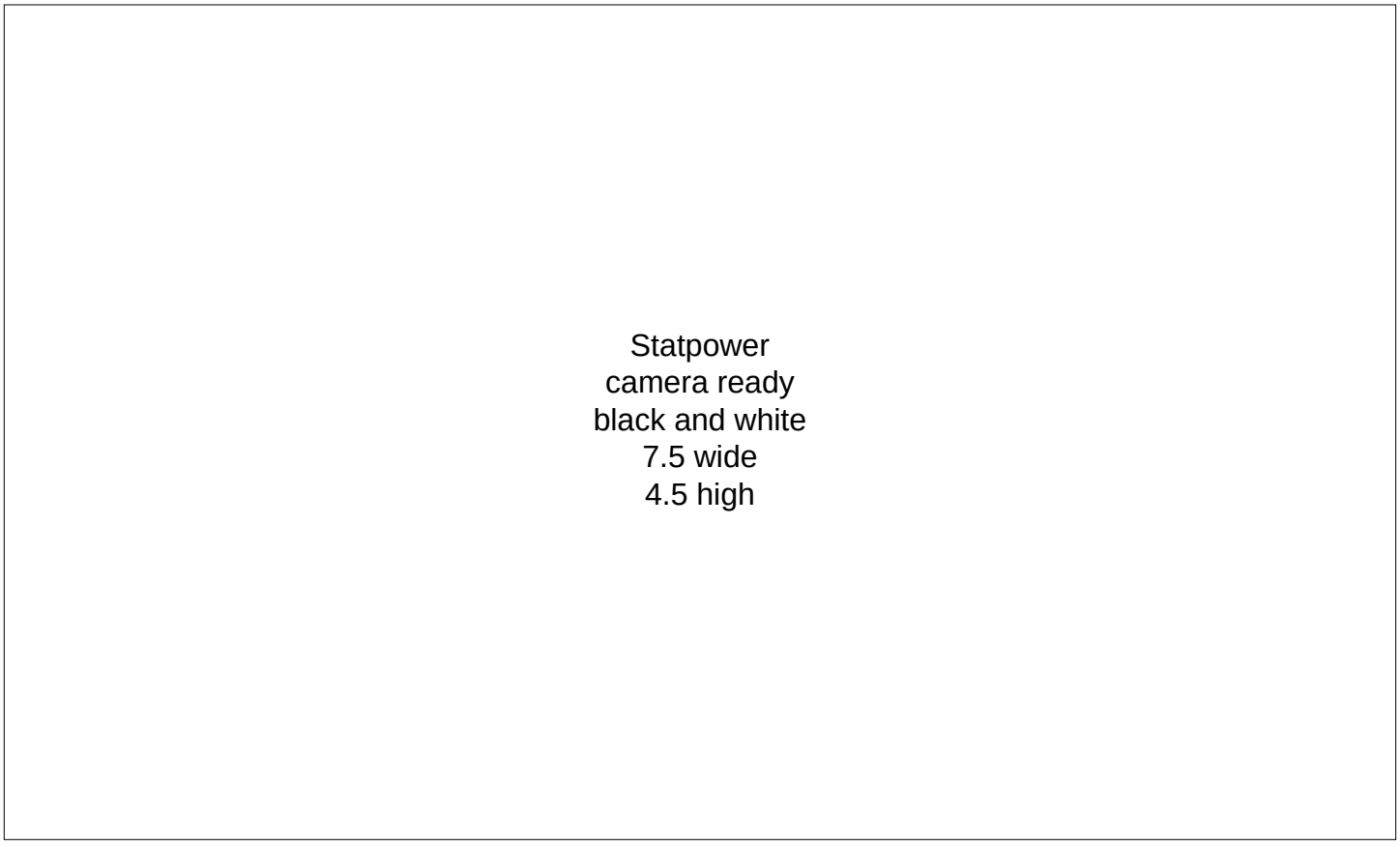
We have never gotten a report of a bird kill from any of our customers. Reports that we get from the field combined with our experience indicates that all birds shy away from the rotating blades of a wind generator. This isn't to say that they won't go near the tower while the blades spin. My three wind generators and towers are favorite perching spots for our local feathered friends. But as soon as the wind begins blowing, and the jennys cranks up, they're gone.

Some of you may recall that I reported back in HP#30 that one of our wind generators took out a goose one night. Extensive review of that incident revealed that this was pure speculation on the part of our insurance agent. Even though a dead bird was never found, it seemed to the agent like a logical thing to put down on a form. So much for filling out every blank space on forms.

I can honestly say to anyone interested in installing a wind system and concerned with bird deaths that wind power is perfectly compatible with all wildlife, including our feathered friends. I feel good about the fact that, as an individual, birds can breathe a little easier because of the fossil pollution my wind generators displace.

Access

Mick Sagrillo ponders the Zen of wind power at Lake MIchigan Wind & Sun, Ltd., E 3971 Bluebird Rd., Forestville, WI 54213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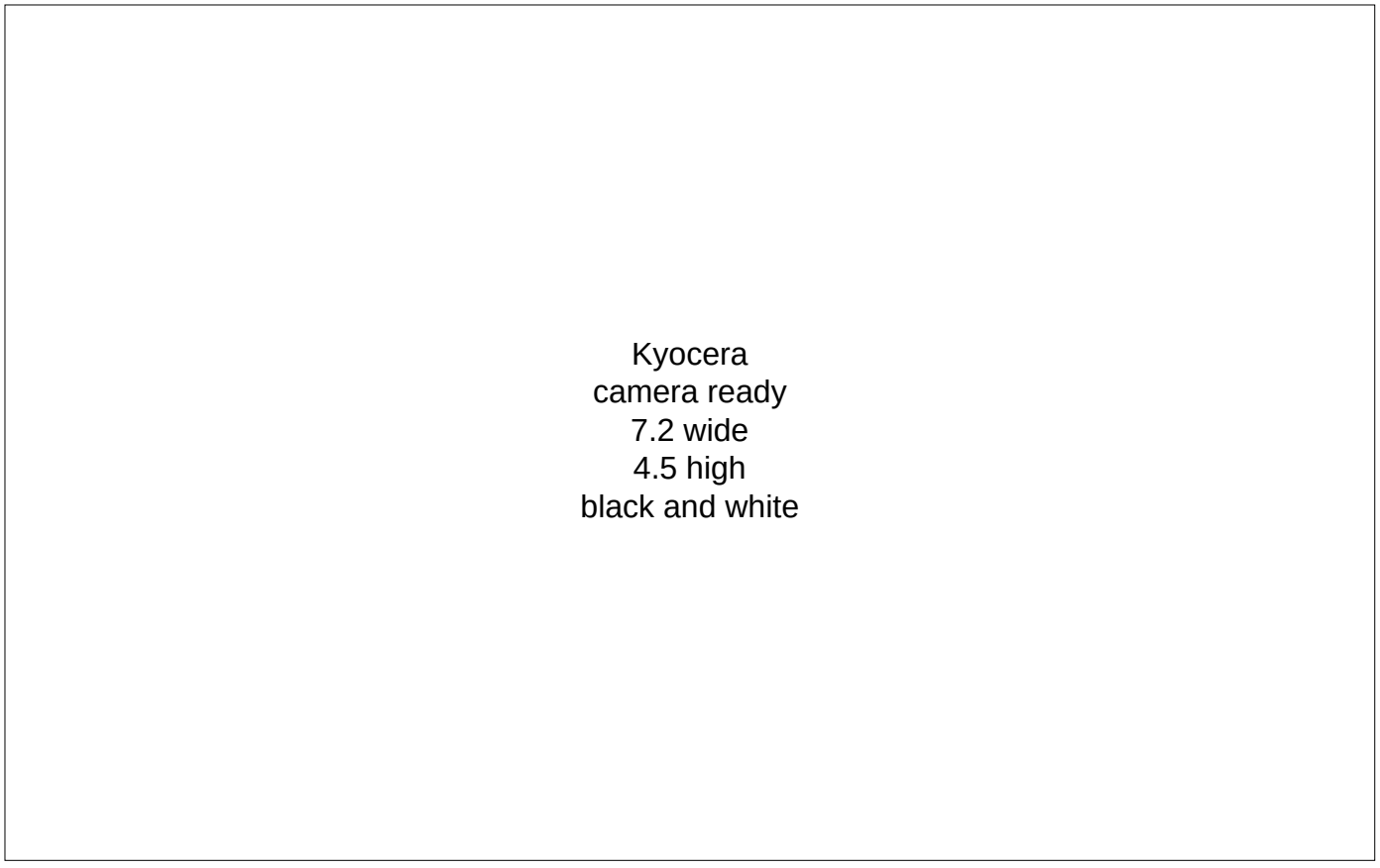
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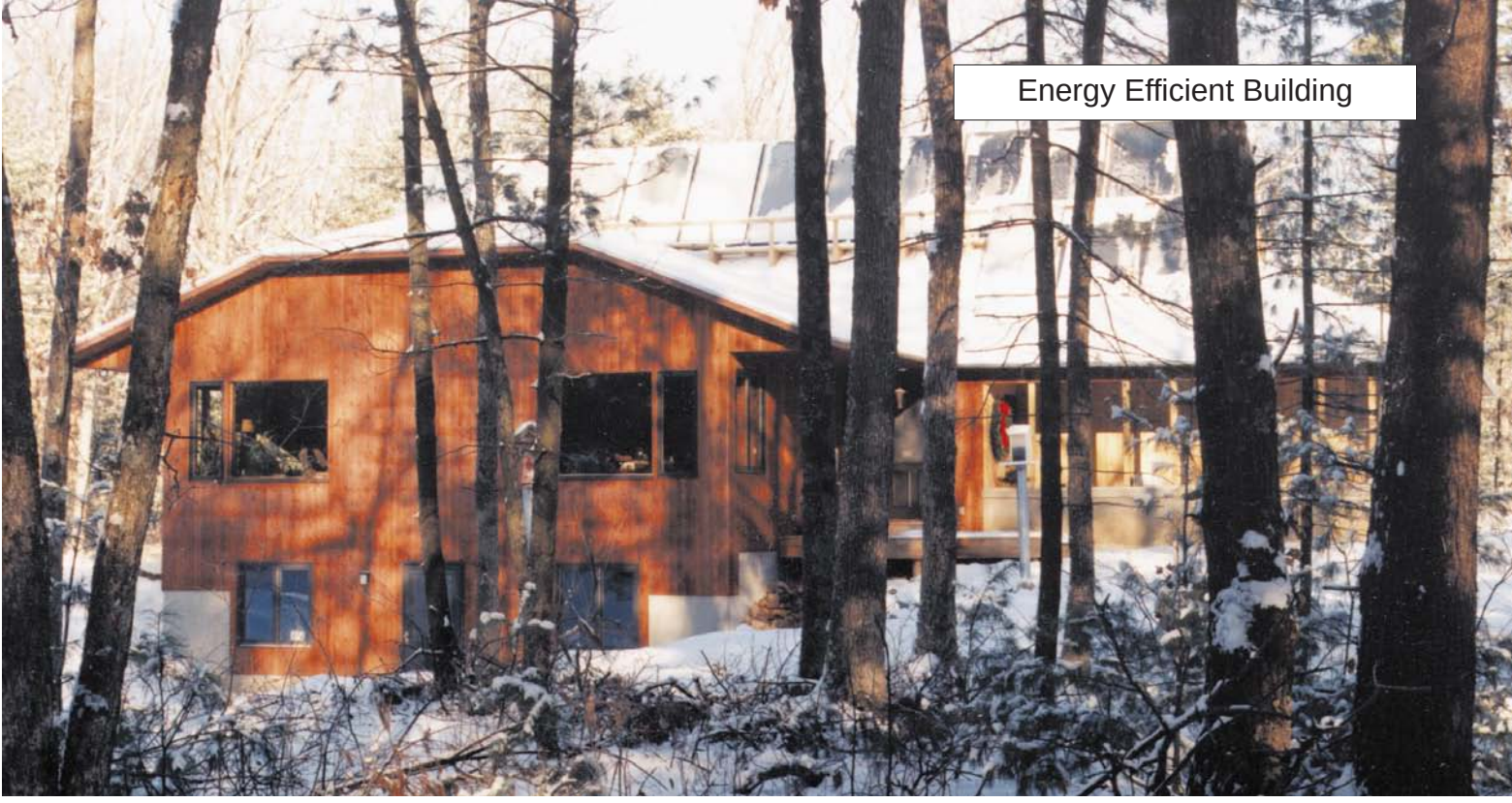


Above: John and Susan Davenport's Wisconsin home stays snug and warm during the coldest winter. This home uses active-solar hydronic heating and a wood-fired masonry heater. Energy efficient building design keeps the heat inside the building. Photo by John Davenport

Gimme Shelter

Mark Klein, James McKnight, Ray Reser, and Dave Shantz

We design and build long lasting buildings which are easy to heat and cool. In central Wisconsin, we have an annual 8000 degree day climate. We'll sometimes see -40°F, but 10–20°F are typical lows. In this climate it's challenging to capture and store heat. Our buildings reduce interior temperature changes, and use daylight to create a comfortable, energy-efficient home.

Most of our projects have involved reworking existing building plans to improve thermal performance. We use many techniques for winter heating and summer cooling. The techniques are:

- Strapped-wall frame construction
- Continuous integrated vapor barriers
- Blown-in blanket fiberglass side-wall insulation
- Blown-in cellulose attic insulation
- Radon mitigation
- Air-to-air heat exchangers
- High performance windows
- Window quilts
- Whole house cooling fans
- Passive design strategies

In the fall of 1993, we were approached by John and Susan Davenport. They wanted an active solar space heating system for their new home. We'd been considering active systems based on the performance of several homes owned by our crew members.

Two members of our construction crew had been coming to work that fall reporting the success of their active solar hydronic systems. This caused some envy and admiration among the rest of the crew.

Every morning it would be, "Had a fire yet, Dave?"

"Noooooooooooooo!"

This went on for a month or so before Dave had his first fire. The end result of his test year showed a 50%

reduction in firewood consumption and a reduction of 75% in the energy use for hot water.

Dave Shantz and Denise Brennecke built their home ten years before. Based on an article from *New Shelter Magazine*, they placed 800 feet of 3/4 inch plastic pipe in a 12 inch sand bed under their basement slab. They heat their 1120 square foot, well-insulated, contemporary style home (21,000 cubic feet) with wood heat and passive solar gain. They don't use a back-up heat source. In a typical heating season, they burned four cords of oak firewood. With the addition of ten 4' x 6' solar hydronic panels, they reduced this to two cords or less. In addition, the base temperature of the house was increased by 5° to 10°F, and temperature swings were reduced from 25 to 10 degrees.

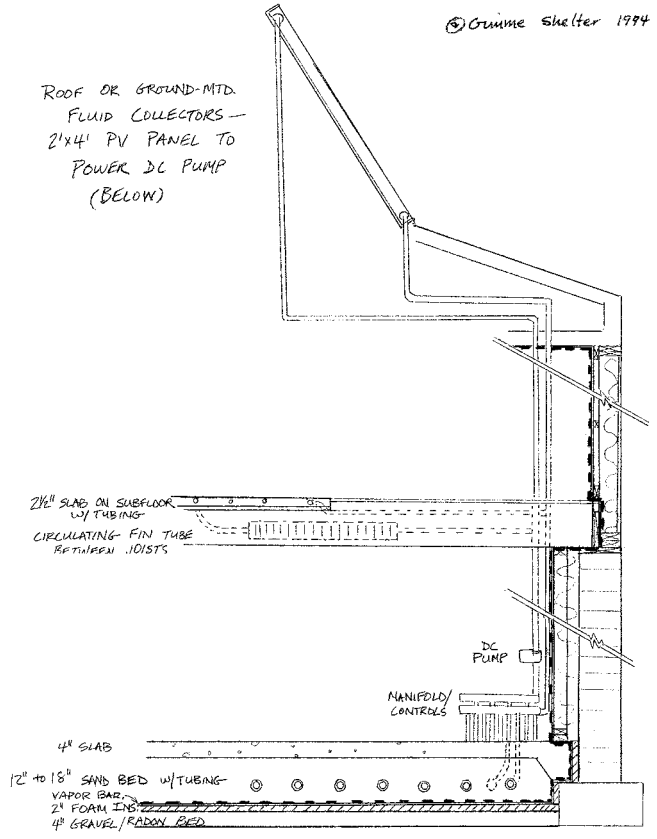
The success of Dave and Denise's system inspired us to offer it to the Davenports as a basis for an active/passive solar space heating system. The design process was fairly typical. John and Susan supplied an initial floor plan and some general style and design interests. We exchanged sketches to resolve floor plans, and developed an elevation concept. A key element in the Davenport design is the solar ridge which allowed us to create mounting space for ten 4' x 8' liquid collectors and a future PV system. This ridge provides a high quality solar window without sacrificing lawn or garden space. It also provides generous ventilation for active (whole house fan) and passive ventilation. The solar ridge offers convenient access to the solar array and a fair amount of attic space. At that point, we decided to deter two projects. We postponed an attached greenhouse on the walk-out basement. We also postponed a master bedroom wing to the west. This wing will complete the footprint of the house and provide additional roof space for a PV system.

Once we resolved the design, we moved on to the specifics of the heating system. The issues are conservation, storage, and production, as in every RE installation.

To conserve heat, we used 2 x 6 walls strapped with 2 x 2 and 2 x 4 lumber to create a cavity. We fill the cavity with fiberglass insulation using the blown-in blanket (B-I-B-S) system at R-4 per inch. This blown fill insulation offers consistent, uniform density, and reduces air infiltration and convective heat exchange. We feel it offers a significant improvement over a batt-insulated sidewall. Another value of strapped sidewalls is a reduction of thermal bridging in the framing. With interior and exterior skins, this wall is considered to be an R32 wall. We insulate ceilings to R60 with blown-in cellulose insulation. In some cathedral ceilings we use B-I-B-S, but if we can we use cellulose.

Below: The Davenport home under construction. Note the "solar ridge" holding the solar thermal panels.
Photo by Jim McKnight

Above: The hydronic tubes laid on the wood subfloor prior to pouring a 2.25 inch concrete slab in the kitchen. Below: Sidewall detail. Photo by Jim McKnight



To limit cold air infiltration, we use a virgin, cross-laminated, polyethelene vapor barrier. This barrier is specifically designed for home construction. We integrate the vapor barrier's installation into the house's framing (see sidewall detail). All joints and penetrations are taped or caulked. Electric receptacles in exterior walls are sealed using air/vapor barrier electrical outlet boxes.

It is very important in any home to address ventilation issues. Typical solutions are controlled ventilation using

Above: The crew plumbs the tubing manifold.
Photo by Jim McKnight

air-to-air heat exchangers, or exhaust-only ventilation systems with make-up air tempered through closets or basements. Either system works well. In an air-to-air system you conserve heat and use electricity. In an exhaust only system you use less electricity, but waste more heat. A third choice in ventilation is a passive style or active/passive system. The passive system uses rising hot air to exhaust stale household air. Incoming air can be tempered through heating systems or by using an air-to-air heat exchanger in the exhaust stack.

We started the heat storage system before the floor was poured. We placed 1200 linear feet of 1/2 inch polybutylene tubing in sand beds on top of 2 inch rigid foam insulation. In the basement, there is a nominal 10 inch sand bed. In the studio area, there is a 24 inch sand bed with two lifts of tubing. On top of the frame floor in the living room and kitchen, we placed another 600 linear feet of tubing and poured another 2 1/4 inches of concrete over this to provide a base for ceramic tile.

The glycol solution is delivered to the sand beds at temperatures up to 170°F. It is tempered through 50 feet of 3/4 inch fin tubing to reduce thermal stress in the thin-slab concrete. After the roof was framed, sheathed, and roofed with standing seam, galvanized

Above: The EnviroTech masonry heater provides back-up heat for the home. This modular heater kit contains 6000 pounds of thermal mass.

Left: The EnviroTech masonry heater before application of its brick veneer.

Photos by John Davenport

steel, we installed the ten 4' x 8' panels directly on the solar ridge. Installation went smoothly with the assistance of Snowbelt's crew and the safety of the permanent catwalk. Supply and return lines to the six-zone manifold in the basement were 1 inch copper tubing with insulation. This is a closed loop system utilizing a 60% glycol, 40% distilled water solution. The fluid is circulated by two DC Hartell pumps powered by a single 36 watt photovoltaic panel. The fluid circulates only when the sun is shining.

There is about 115 tons of thermal mass in the sand beds and concrete. There is an additional three tons in the masonry heater and five tons in the thincoat plaster. This sounds like a lot of material and it is, as any of our crew would testify. Without heat input during the coldest weather, this mass only provides a week or so of protection from freezing.

Fortunately , we seldom experience a week of no solar gain, and we installed a masonry heater as a backup. The charm of a masonry heater is that it combines a great fireplace-style burn with extremely high-performance combustion efficiency. Burning wood for heat is using a renewable resource in an efficient manner. The low emissions (1 g. per hour) and the ability to capture and store the heat released by high temperature combustion (1800 to 2000°F) make masonry heaters a good choice for a backup heater. Masonry heaters have the added environmental value of burning very well on small-sized, less valuable, "trash" wood. A typical mid-winter fire is forty pounds of wood, burned wide open for about three hours. When the fire is out, the chimney damper is closed. The three tons or more of masonry releases its stored heat over a twelve to twenty-four hour period.

We installed an EnviroTech masonry heater with a bake oven. It is a 4000 lb. modular kit of cast refractory components, veneered with a locally provided masonry exterior. John and Susan were interested in investing their labor in this part of the project. We targeted some of their vacation time and spent a week or so assembling the module and laying the veneer. It is said that the hearth is the heart of the home. The process of stove building and subsequent use strikes some basic chords in home builders and owners. It was a pleasure to build and a pleasure to burn.

Many of the components which interact to affect thermal performance are integral to the building. The cost of the integrated solar space heating system was around $14,000. This includes ten 4' x 8' used Solar King panels, the solar ridge, 1800 linear feet of tubing, installed in sand beds and thin slabs, manifolds, DC pumps, PV panel, propylene glycol and distilled water. The cost of the masonry stove was about $8,500.

The Davenport home is 2400 square feet of heated space, including basement, with a volume of 22,000

cubic feet. This winter John and Susan tracked temperature and wood use. Wood burning season began for them in late November. Typically they make four to five, thirty to forty pound fires per week. Interior house temperatures range from 65 to 76°F. Extremely cold periods often coincide with sunshine, a big help in moderating temperature swings. It is not at all unusual to see thirty to forty hours of subzero temperatures with no backup heat. As in Dave's experience, the only need for fires before mid-November and after mid-February is for pleasure.

Construction Specs for John & Susan's Home

Foundation

Exterior 4" drain tile in gravel bed at footing level. Interior radon barrier consisting of 4" flexible pipe in gravel bed below slab, run to a sealed sump pit for venting outside. One inch minimum rigid insulation under slab, vapor barrier run continuously to connect with wall vapor barrier, caulked and taped at seams and sump penetrations. Interior basement walls are 2 x 4 walls set 1.5" to 2.5" away from exterior walls. Then the entire cavity is blown with fiberglass/adhesive system (BIBS) at R-20. Vapor barrier is continuously tied to under slab vapor barrier and joist vapor. All mechanical penetrations through exterior are caulked, airtight electrical boxes on all exterior walls are taped and caulked to vapor barrier.

Framing

Floor joists are set back 5.5" on 2 x 10 treated plates, a 2' flange of vapor barrier is laid on the plates before the joists are set, assuring a continuous vapor barrier connection to the basement and sidewall vapor barrier. Then the deck is sheathed with 1 x 10 pine, vapor barrier is temporarily stapled to the deck and 2 x 6 exterior sidewalls are dropped onto treated plates. This "band cavity" can then be blown full of BIBS fiberglass and sealed as part of the wall insulation and vapor barrier package, assuring a higher R value and a tighter perimeter than in conventional framing. All penetrations through the band joist are caulked and taped.

Exterior Walls

2 x 6 walls with the horizontal strapping create a 7" wall cavity blown with BIBS system for R-29. Vapor barrier is tied to band flange and ceiling vapor barrier by tape or caulk assuring a continuous seal. Airtight electrical boxes are caulked and taped to vapor barrier. The exterior is sheathed with 1 x 10 pine sheathing and as a base for conventional exterior treatments. An alternative exterior is to place the strapping on the outside of the wall and use vertical pine or cedar in a single layer as both sheathing and siding (either in a board and batten or vertical T & G application). Double masonry walls, straw bale construction, and clay straw (cobb) construction are other structural choices.

Interior Walls

A 5/8" drywall base with a thincoat plaster finish surface (one or two step) for higher durability, and greater thermal mass, wood paneling, or masonry.

Roof System

Truss or rafter framing should incorporate a 12" energy heel which allows for full amount of insulation at the perimeter. Blown cellulose at a minimum of 16" or R-60. Continuous vapor barrier tied to wall vapor barrier, all penetrations sealed with caulk and tape. Ceiling cans (light fixtures) housed in a vapor barrier when set prior to insulation (observe code clearances). Galvanized, standing seam metal roof recommended for long term performance.

Recommended Systems

Air-to-air heat exchanger, exhaust only fans with makeup air (controlled ventilation) or breathable wall systems; whole house fan (cooling); fresh air intake for combustible appliances and heaters; in-floor radiant heating, masonry heaters; efficient lighting and appliances.

Degree Days

"Temperature levels over time are expressed in degree days. A degree day occurs for every degree the average temperatures falls below 65°F for a 24 hour period. If the average outside temperature was 55° for 24 hours, ten degree days would have accrued." from *Solar Houses for a Cold Climate*, Carrier & Day, C. Scribners & Sons, 1980

Examples would be:

Location	*Degree Days*
Portland, OR	5000
New York, NY	5000
Boston, MA	6000
Sault St Marie, Canada	9000
International Falls, MN	10000
Eureka, CA	4000
San Francisco, CA	3000
Little Rock, AR	3000
Miami, FL	100
Denver, CO	6000

For information on a specific area contact: Passive Solar Design Strategies, 1090 Vermont Ave NW Ste 1200, Washington, DC 20005 • 202-371-0357.

Access

Authors and Designer/Builders: Mark Klein, James McKnight, Ray Reser, Dave Shantz, Gimme Shelter Construction, PO Box 176, Amherst, WI 54406.

Vapor Barrier Materials: Shelter Supply, 1325 E 79th St, MInneapolis, MN 55420 • 1-800-762-8399.

Resource Conservation Technology, 2633 N Calvert St, Baltimore, MD 21218 • 301-366-1146.

Masonry Stoves: EnviroTech-Dietmeyer, Ward & Stroud, PO Box 323, Vashan Island, WA 98070 • 1-800-325-3629.

TNT Masonry Stoves, 12380 Tinker's Creek Rd, Cleveland, OH 44125.

"The Book of Masonry Stoves" by David Lyle, Brick House Press, 1984.

"Finnish Fireplaces: Heart of the Home" by Barden Hyytiainen, Building Book Ltd, 1988.

Solar Domestic Hot Water Systems, Panels, Technical Assistance: Real Goods/Snowbelt Solar, 286 Wilson St, Amherst, WI 54406.

In-floor Hydronics: In-floor (polybutylene tubing), 920 Hamel Rd, Hamel, MN 55340 • 1-800-356-7887.

Wirsbo (polyethelene tubing), 5925 148th St, Apple Valley, MN 55124 • 1-800-321-4739.

General Construction/Design: *"A Pattern Language"* by Christopher Alexander, et. al., Oxford University Press, 1977.

"Canadian Homebuilders' R-2000 Manual", 150 Laurier Ave W, Ottawa, Ontario, Canada.

Fine HomeBuilding, Taunton Press, Newton, CT 06470-5506 • 1-800-888-8286.

Above: One wing of the “L” shaped Nebraska style cottage at Shenoa Retreat Center in Philo, California.

One Man’s Personal Straw Bale Odyssey

David Booth

Many folks assume modern building methods and materials represent the epitome of quality and durability. I feel there remains a great deal to be learned from builders of vernacular architecture. Early builders have used indigenous materials and passive solar design principles for generations.

Many of these builder/designers found it necessary to choose the native materials found in their locale. They combined time-tested construction strategies with innovative individual variations. Builders of any time period tend to be somewhat conservative. They think traditional construction methods have been thoroughly tested. But in any era, there are innovators. My hat is off to the pioneer architect/builders who first recognized the hidden potential of straw as a building material. Straw-bale construction is one building tradition which has a little known history. Despite this lack of recognition, the revival of straw-bale building methods is undergoing explosive growth. This unique alternative construction approach requires materials with far less embodied energy than conventional building practices.

So what makes it so special?

Straw is primarily an agricultural waste product which is often available locally. Straw, is the dry stalks left after cereal grains are harvested. It is an annual crop, largely under-utilized today. Too often it’s simply burned in the field because its a nuisance for the farmer to till it back into the soil. When burned, straw releases pollutants like carbon monoxide, particulate hydrocarbons, and nitrogen oxides. Burning straw also contributes carbon dioxide, the most prevalent greenhouse gas, to our atmosphere. Baling the straw

produces a modular unit that lends itself to masonry building techniques. Straw-bale wall systems can be used, along with other sustainable construction practices, to produce durable and extremely energy efficient buildings. Isn't it apparent that we have the makings of a "win-win" proposition? Building energy efficient homes of straw can answer some of our concerns about resource depletion and atmospheric pollution. Straw-bale construction uses an abundant, renewable material well suited for inexpensive shelter. We could also reduce global warming and possibly save old-growth forests as well. Fossil fuel costs will escalate in the future. The embodied energy used in the mining, manufacture, transport, and on-site fabrication of modern synthetic building materials will inevitably increase. This increase will be translated into higher building costs for the consumer.

How does straw-bale stack up against the competition?

"Embodied energy" is a term which applies to the combined net energy incorporated into a material on an overall life cycle basis. The decisions we make every day as consumers of manufactured products have real long-term environmental consequences. These impacts are complicated by multiple factors. All factors must be considered if we are to accurately measure whether our choices are environmentally sound. The following table excerpted from a presentation given by Richard Hofmeister at the 12th annual Association of Collegiate Schools of Architecture last March gives one a sense of the magnitude of energy costs embodied in several familiar building materials and straw-bales.

*Building Material Energy Cost**	*BTUs*
Rough softwood, board foot	7,700
Finished softwood, board foot	7,900
8" X 8" softwood beam (20')	84,200
8" equiv. viga (peeled pole)	50,000
Roll roofing, sf.	11,000
Aluminum sheet, sf.	32,000
Concrete, cu. ft.	96,000
Fiberglass insulation, sf. (3.5 in.)	6,900
Cellulose insulation, sf. (3.5 in.)	1,000
Fiberglass insulation, sf. (R-50)	100,000
Straw-bale, sf. (R-50)	3,400

*In all cases energy costs are for materials delivered to the job site. BTU analysis for straw-bale, sf. R-50 (2 equip-hrs per acre / 1.5 gal fuel per hr = 3 gal for 2 tons or 44 bales). Long Taylor and Berry, 1978. Hay harvesting costs in TX, B1171, TAES, College Station, TX. Assumes a high figure of 150,000 BTUs / gal of fuel.

So why should we care anyway?

Native Americans were taught by their elders to consider that the consequences of their choices would remain as a legacy for their descendants. A passage from the Great Law of the Iroquois Confederacy reads, "In our every deliberation, we must consider the impact of our decisions on the next seven generations." Our dominant mainstream culture has clearly rejected this sense of long term responsibility. Today, the choices made between prospective building materials is driven by short-term economic considerations. In this light, current practices are not sustainable. If we wish to leave an enduring legacy for our children and future generations, we must realize that embodied energy costs are more consequential than our momentary financial situation.

Never cry wolf

Ever since the day when the big bad wolf huffed and puffed and blew the little piggy's house down, straw has had an undeserved reputation as a flimsy building material. But the time has come to set the record straight and separate facts from fairy tales. Anyone who participates in a hands-on straw-bale construction workshop or a wall-raising with tightly bound bales can set their fears to rest.

The tightly pressed rice straw-bales I worked with last summer proved to be particularly dense and durable. These *construction grade* bales were substantially more robust than those I had used to build my solar greenhouse. I couldn't believe how tough it was to drive four foot rebar pins through the bales with a twelve pound sledge hammer. I staggered back in amazement with a sense of futility. No matter how tenaciously I pounded, the bales resisted the penetration of the rebar. Fortunately, the blood responsible for my flushed expression trickled back to my brain and a light flashed on upstairs. The solution: simply slip the end of each rebar pin into the chuck of a powerful 1/2 inch drill, tighten the chuck and let it twist away through the bale while you lean into it with all you're worth. These bales were composed of the interlaced stems of rice straw. They are substantially more tenacious when "imbaling" rebar than most other types of straw bales.

I'm convinced that a good *construction grade* bale is anything but flimsy. Bale builders will tell you that it pays to shop around and demand tightly bound bales. Don't accept short, rotary cut straw which falls out readily; this is mulch material. Your inspection of prime bale building stock should reveal longer, sickle harvested straw. Bales should not deform noticeably when lifted by one string or wire.

Above: Early summer brings a bounty to this greenhouse.

Left Top: The north wall of David Booth's greenhouse.

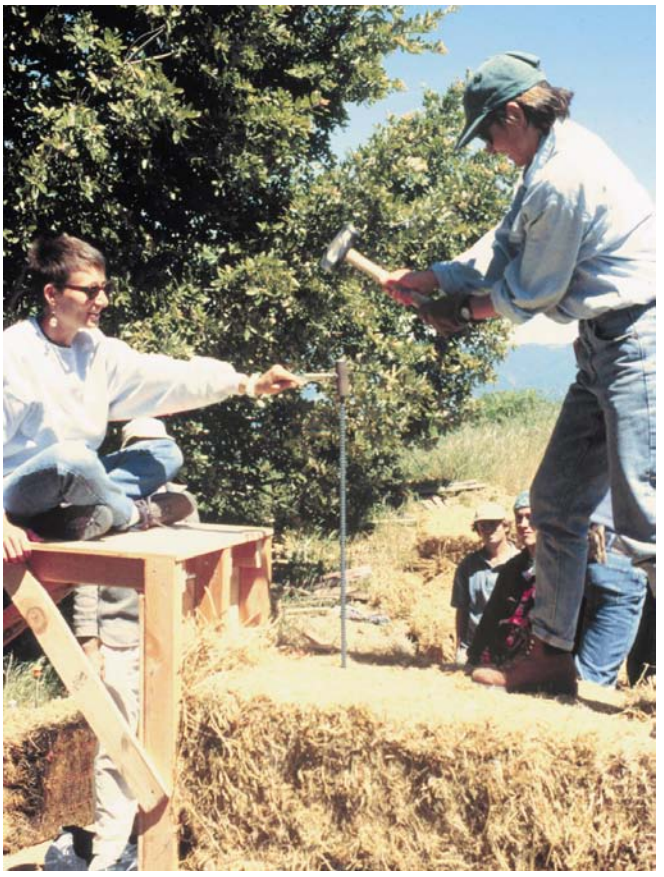
Left Center: The west wall of the greenhouse after stucco and before roofing.

Left Bottom: Winter comes to the greenhouse, but the plants are snug and protected.

The second coming

Mark Hawes's article, *Straw and Solar: A Perfect Renewable Match* (HP#35), documented the growing interest in straw-bale construction. Straw bale construction began in the Sandhill country of Nebraska where timber was scarce and precious. The native soil would not compact well enough to slice out sod chunks. History buffs can review the precursors of current practices in back issues of The Last Straw from the new pioneers of Out on Bale Unlimited.

The straw-bale revival has really taken root in Arizona and New Mexico. Here, straw-bale structures seem to fit harmoniously with adobe and other earth construction techniques. In this region more new homes are being constructed with straw than can be tracked and documented. Many are unpermitted homes and outbuildings, but a growing number are code approved. Initially, New Mexico allowed construction of several homes on an experimental basis. Now they have incorporated a draft code for

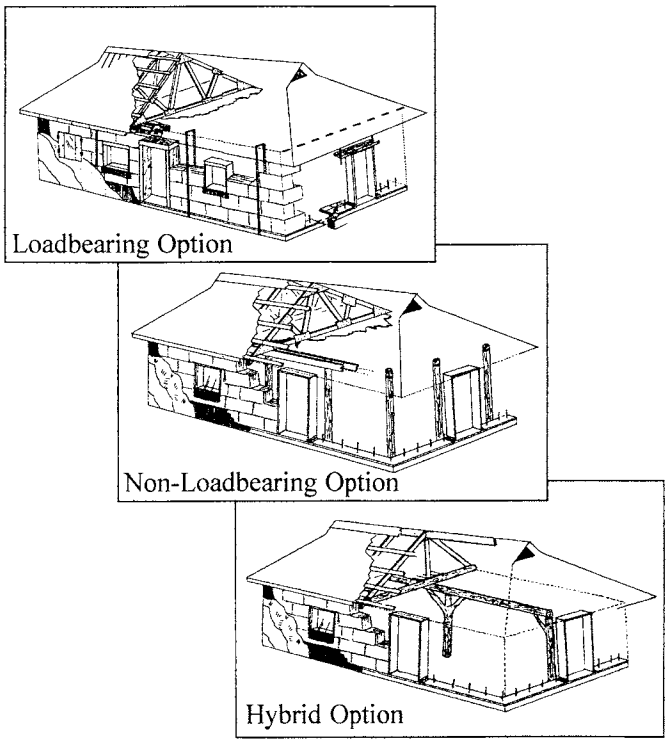


Above: Driving rebar the old-fashioned way — with a hammer.
Right Top: Driving rebar the easy way with a 1/2 inch electric drill.
Right Bottom: Ross Burkhardt demonstrates a straw saw of his own design to workshop participants.

nonload-bearing, straw-bale structures as an appendage to their interpretation of the Universal Building Code. Pima County and Tucson in Arizona have approved and accepted the structural integrity of a load-bearing, “Nebraska style” home. This seems to be the first of a growing trend. On the west coast this approach is still a fringe activity, though interest is growing rapidly. Straw-bale construction is adaptable to regions which have temperate, mediterranean (with pronounced dry and wet seasons), and even arctic climates.

Mother Nature’s miracle synthetic fiber

Millions of years of evolution has brought us a polymer material called cellulose. The repeating chains of simple sugars (glucose) have marvelous structural and insulative properties. Straw is primarily composed of cellulose, hemi-cellulose, and lignins. Wood and paper products are also primarily cellulose. So, despite the apparent differences in structure, straw and wood are more similar than they are different in their chemical composition. The insulative ability of materials to resist the transfer of heat is commonly expressed today with R values. The cellulose in straw will typically have an R value of about 2.3 per inch (bales laid flat). This depends on the particular type of straw and how tightly it is compressed. This can multiply to an astounding R 50-57 for walls constructed of three-strand bales. This is the type of bale most readily available on the west coast. The possibility for creating super-insulated walls from an abundant, inexpensive, renewable indigenous material sets straw- bale construction apart. It could require as much as four times the cost in materials and labor to produce a wall system with comparable insulation using wood framing and synthetic insulations.



A closer look at the most common synthetic insulations reveals negative environmental effects and high embodied energy. Foam boards such as polyurethane are extremely flammable despite disproven claims that they are self-extinguishing. This drawback is shared by other common foams like expanded polystyrene, extruded polystyrene, and polyisocyanuride. While the cellulose of straw is flammable, when it is compressed into a dense bale, too little oxygen is available to support rapid combustion. Have you ever tried to burn a phone book? Bales are similar, they only tend to smolder when ignited. Besides, I'm only advocating their use in a wall encased under a continuous coating of stucco and/or plaster. In 1993, tests were performed at a materials testing lab in New Mexico on plastered bale walls subjected to almost 2000 °F for two hours and 15 minutes. The plaster on the heated side did finally crack exposing the bales underneath. But then, the underlying bales only charred to a depth of a couple inches into the test walls. Earlier tests in Canada also demonstrated the exceptional fire resistance of plastered straw bales.

Jump down, turn around, pick a bale of hay (straw)

I was bitten by the bale bug two summers ago. I obtained my first hands-on experience with one version of straw-bale construction. I built a solar greenhouse on my land in the coast range of Northern California. My friend, Amanda Potter, and I erected a 14 foot X 28 foot free-standing greenhouse using a novel combination of minimal wood framing, bales, glass and stucco. The finished structure has worked wonderfully for extending the growing season year round. The structure seems a success although there always seems to be something you would chose to do differently. I made some minor, correctable mistakes with the glazing details. Yet, we discovered that straw is an amazingly forgiving building material. Straw-bale wall system just don't demand the precise tolerances required of conventional wood framing methods. The materials allow for more architectural freedom and creative expression than I thought possible.

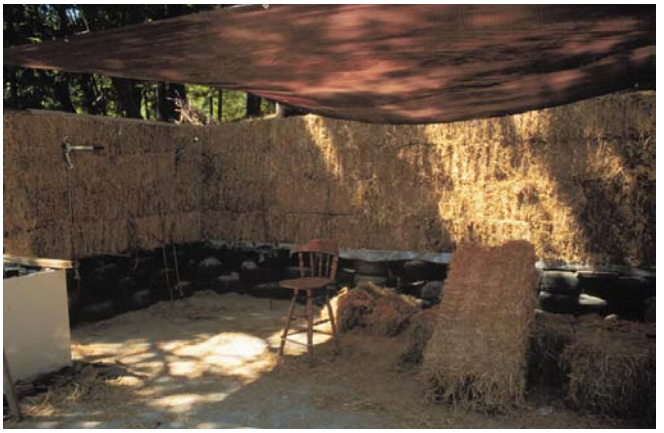
Good ventilation is critical to the performance of most greenhouses. Natural cross flow circulation in my building is aided by two solar-powered, 16 inch fans from Alternative Energy Engineering. The nearly fifteen year old ARCO 33 watt photovoltaic modules still crank out those electrons. The quiet, smooth-running fans with their permanent magnet motors push a good deal of air even on overcast days. I'm sure I could have used smaller panels, but the old ARCO units were at hand and already paid for. A direct wired PV vent fan is yet another example of a marriage of components with elegant simplicity. It has only one moving part to wear out and no sophisticated controls or batteries.

My greenhouse is free standing and not used to help heat an attached dwelling. This allowed me to take some liberties with passive solar sunspace design principles. Usually the upper roof plane is composed of an opaque material with underlying insulation leaving the lower roof slope to be the primary gatherer of direct solar gain. However, in my climate the temperatures are rarely severe, and the coldest weather is often accompanied by overcast conditions. I opted for more glazing and interior walls whitewashed with a mixture of lime and white portland cement over the stucco. A few water-filled black 55 gallon drums help create a thermal flywheel. This keeps the winter low temperatures tolerable. I was pleasantly surprised to discover that high temperatures during the 100 degree plus dog days of summer were only slightly higher within than outside. The PV driven fans and adequate vent sizing spared me from having to use shade cloth over the glazing.

The Mo' Straw the Mo' Better

By the following summer, it was apparent that many owner-builders and a few professional contractors had also succumbed to straw-bale fever. I knew there was a wealth of experiences to share and a deeper appreciation of this simple, sane, and environmentally prudent approach to acquire. So I went to various wall raising workshops and observed the handiwork of other west coast bale builders. I collaborated with a friend, Ross Burkhardt, in teaching the fundamentals to

Above: Sue Moon's straw-bale studio.



Above: This straw-bale building uses old tires filled with rammed earth for a foundation.

Above: The Nebraska style, load-bearing cottage at the Shenoa Retreat Center. This structure was the first of its kind to receive a full building permit in California. Notice the continuous box beam capping the walls.

Above: Metal crossbanding and inset 2x4 uprights were added to satisfy the concerns of building code officials doubtful about earthquake safety.

Above: Setting up to do the interior plastering in a straw-bale cottage.

aspiring bale builders during two and a half day workshops in Ukiah, CA. It became clear to even novice builders that the methods of straw-bale construction are simple. This isn't rocket science. The skills required to build superior dwellings is within the capabilities of most folks. Ross worked with a metal worker to refine essential straw-bale building hand tools. These include straw needles to make half or special length bales, rebar drivers, and straw saws. These tools are now available from Real Goods Trading Company. In this era of homlessness and the insidious 30 year mortgages, it is a relief to find an affordable, comfortable housing technology.

Almost all the straw-bale structures I worked on or visited last summer were built with load-bearing straw-bale walls. Each of these five structures exhibited different interpretations of the "Nebraska style" method. Mark Hawes's HP # 35 article focused on using bales as in-fill insulation in a post and beam framework. Pole

barn and metal buildings can incorporate bales as nonstructural additions to the exterior walls. However, the designer/builders I worked with out west assumed that the "Nebraska style" approach would prove to be less expensive and require less lumber. New information has just recently come to my attention which puts these conclusions in doubt. A contributing chapter from Paul Weiner in a new book, *The Straw Bale House* by Steen(s), Bainbridge, and Eisenberg evaluates the options and trade-offs of load-bearing versus modified post-and-beam construction. Weiner discovered that after completing two nearly identical 900 sq. ft. straw-bale structures that the modified post-and-beam system used less lumber and imposed fewer architectural restraints.

New twists on the old theme

On several occasions I helped with what I believe is the first load bearing, "Nebraska style" house to obtain building code approval in California. This cottage, part of the Shenoa Retreat in Philo, CA, nears completion as I write. The architect, Bob Theis, chose to use a continuous plywood box beam situated directly on top of the eight foot walls. The box beam will distribute the compressive roof loads and possibly absorb the racking forces generated by earthquakes. By the time I witnessed the structure in progress, some of the walls had been erected in a workshop taught by David Eisenberg from Out on Bale. Communications with Bob and the contractor, John Swearingen, informed me of the procedures which had been followed to that stage. The first course of bales were impaled over rebar stakes protruding from the raised curb around a poured slab. Successive courses were pinned with additional lengths of rebar, two per bale. Bales were lifted over lengths of threaded rod and pushed down with some difficulty. More lengths of threaded rod were added until they extended through each course and the top box beam. Eventually, these continuous rods secured the box beam to the footings at six foot intervals around the structure's perimeter. The rods were tensioned by torquing nuts down on the beam which precompressed the entire bale wall. This use of threaded rods and plywood bond beams is not typical of most of the load-bearing structures recently built in the Southwest. There, folks have commonly used a ladder shaped top plate and cables with turnbuckles to tie the roof assembly to the foundation and wall system.

Engineering test data clearly substantiates the compressive strength of load-bearing, straw-bale walls. But additional measures proved to be necessary to satisfy the building inspectors regarding the Shenoa structure's ability to withstand the racking forces imposed in earthquakes. Vertical lengths of 2 X 4 were notched into the bales and accompanied with steel bands in a crossing pattern. This was specified by the structural engineer on the project, Richard Hartwell, to create segments of shear wall to resist the over-turning moment that might catapult a wall over itself. This cottage is surely setting precedents. It has weathered the rigorous scrutiny of the code officials of Mendocino County. One of the owners, Carolyn North, told me that securing the full permit had incurred additional costs for engineering and a test wall. But she realized that their efforts should open the door for others to build with load-bearing "Nebraska style" wall system elsewhere in the state. Securing a permit for a post-and beam structure with straw-bale in-fill is likely to be significantly simpler. Most code officials are a conservative lot. They understand the structural behavior of wood and metal elements in the familiar post-and-beam system.

Strands of the web that bind...

Closer to home, I discovered an underground network of straw builders. I collaborated with Sue Moon who shared her enthusiasm for bale building with local KMUD public radio station listeners. Later in the summer, her studio's walls were erected in a two day workshop for women only led by Jill Lorenzini from Out on Bale. You can imagine my surprise when I strayed down the wrong driveway, and stumbled upon another straw-bale structure under construction by her neighbor, David Witherspoon. This sort of coincidence makes me wonder if this is still just a fringe activity.

Sue's weaving studio is noteworthy for its gracefully curving walls. David's garage is unique because it was the first bale structure I'd seen built upon a tires and rammed earth foundation (Earthship style ala Reynolds). David used come-alongs draped up and over the walls and top plate to compress the bales before roofing the building.

I traveled to California's vast Sacramento Valley to secure high quality bales for my next project. During this trip I was bowled over by both the enthusiasm and building acumen of Rick Green. Rick has been a high-powered contractor of conventional housing and commercial structures for years. Yet he is farsighted enough to recognize that sustainable solutions to building must evolve. Rick and his father also grow rice. They are aware that the rice straw which is such a bane to the growers may soon be a boon instead as demand for straw as a building material grows. Rick is exploring possibilities for storing bales over the winter and transporting them to the locale where they'll be readily available for builders. In an outbuilding near his house he showed me an experimental, interior partition wall built of metal studs, chicken wire, straw, and mud

plaster mixed on-site. Bales of straw may not be the answer to every building problem. Rick is betting that the compressed straw/wood fiber-board he is helping develop will find a market niche.

Most recently my trail of discovery lead me to An Alternative Builder's Colloquium in Cottage Grove, Oregon. This series of talks, slide shows, and hands-on workshops introduced me to even more like-minded individuals with a passion for sustainable architecture. Straw-bale construction was just one technique which shared the forum that week. Earthship structures from recycled tires, adobe, rammed earth dwellings, and two significantly different approaches utilizing both clay and straw blends, cob and light clay processes were also highlighted. There were too many experts among the participants to mention. However, the straw-bale contingent was strongly represented. It included Ted Butchart from Washington and Bob Merrill from Oregon. These gentlemen are working in the virgin territory of the Pacific Northwest. Ted and Bob are extending straw buildings into a region with a very different climate than the dry, desert southwest were the revival first took root. Keeping the moisture level of straw-bales incased in a stuccoed/plastered wall below 20% is essential to its long term durability. With proper architectural detailing bale structures will survive the interplay of climactic elements even on the edge of the temperate rainforest. Details such as large roof overhangs, gutters, proper grading around the structure, adequate ground clearance, and maintenance of the bales' protective overcoat are essential.

I feel quite optimistic that straw-bale construction has a bright future. After overcoming the initial skepticism, "Live in a house of straw; you've got to be kidding?" I've watched the dawn of acceptance among lay people and builders alike. The standing evidence of straw-bale structures built around the turn of the century is a testament to its durability. However, to adapt this approach to other regions, new methods and alternative materials can and will be created. It's all a dynamic, creative process of co-evolution. Each development unveils simpler and more natural ways to build our shelters. And we can do it without ripping off coming generations.

This review of my personal straw bale odyssey is not necessarily unique or exceptional. And *Home Power* may not be the appropriate forum to get down to the nuts and bolts details of straw-bale construction. The *Last Straw* newsletter from Out on Bale (un) LTD is the most recognized periodical for that purpose. Many *Home Power* readers will surely be bitten by bale bug fever in due time. It's an insidious and highly contagious disease. Other alternative building materials and techniques certainly have their place and are part of the solution. Yet straw-bales are nearly ideal for passive solar construction, and you'll find yourself making fewer environmentally compromising choices.

In an upcoming issue I'll review three state-of-the-art publications which have just gone to press. The new pioneers of the straw-bale revival have been steadily at work collecting new and more detailed information. I'm in the process of greedily devouring two new manuals, a great video, and a 300 page book complete with, ooh-so many, pictures. I'll get back to you, but hunger calls. If your appetite is tweeked, start networking and check into these resources.

Access

Author: David Booth, Synergistic Solutions, POB 391, Miranda, CA 95553 • 707-943-3061 • Straw-bale and solar-hydrogen education, presentations, workshops, consultation

Out on Bale-BY MAIL, 1037 E. Linden St., Tucson, AZ 85719 • 602-624-1673 *The Last Straw* newsletter, journals, testing data, videos, etc.

Real Goods Trading Corp., 966 Mazzoni Ave., Ukiah, CA 95482 • 800-762-7325 Straw tools and manuals

Alternative Energy Engineering, POB 339, Redway, CA 955560 • 800-777-6609

Ross Burkhardt, Bale Builders, POB 1436, Ukiah, CA 95482 • 707-462-2368 • Workshops

Rick Green, Benchmark Development, POB 110, Willows, CA 95988 • 916 934-7225 • Grows, bales, stores, arranges hauling of rice straw

Ted Butchardt, GreenFire Institute, 5630 Cooper Pt. Rd. NW, Olympia, WA 98502 • 206-866-8999 Workshops, consulting

Bob Merril, Lost Valley Education Ctr., Dexter, OR 97431 • 503-937-3351 Workshops, consulting

Bob Theis, Architect for Daniel Smith and Assoc., 1107 Virginia St. Berkeley, CA 94702 • 510-526-1935 Designer of straw-bale structures, consultation for building code approval.

The Straw Bale House by Athena Swentzell Steen, Bill Steen, David Bainbridge with David Eisenberg. The most exhaustive text on the subject anywhere, new and hot of the press. Available from the Canelo Project, HCR Box 324 Canelo, AZ 85611 • 602-455-5548

Build it with Bales-A Step-by-Step Guide to Straw-bale Construction by S.O. MacDonald and Matts Myhrman. Available from Out-on-Bale BY MAIL (see above)

another “must have” manual from two of the new pioneers.

How to Build Your Elegant Home with Straw Bales by Steve Kemble and Carol Escott. Manual and video available from Sustainable Systems Support, POB 318, Bisbee, AZ 85603. Best how-to video for the owner-builder.

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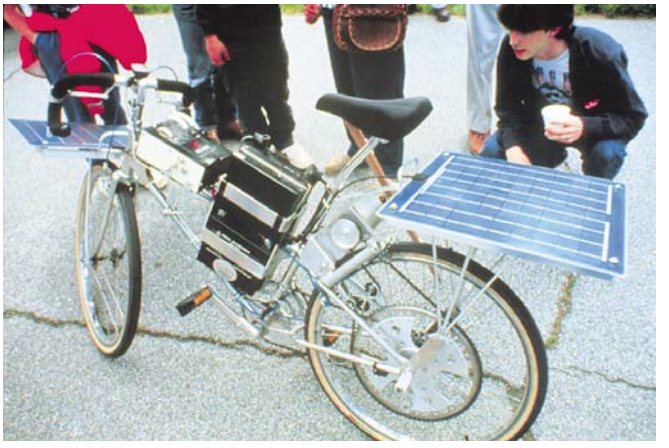
Above: Clare Bell in her electric Porsche.
Photo by Michael Hackleman

Odds n' Ends

Michael Hackleman

This edition is a hodgepodge of subjects for which I've been awaiting more info, names, places, photos, time, and space. A letter from Gary Flo about the safety and performance issues of transformerless chargers for EVs was made into an article. I've included Paul Brasch's last article debunking the myths about EVs. Finally, this Go Power includes the "favorite photo" (a solar-electric-human powered vehicle) referred to in the last issue.

Lately I've been bicycling, walking a lot, and using the bus. My electric car has sat forlornly at the curb for many weeks. The opening remark in my EV book is: "One half of the problems associated with transportation today is the internal combustion engine ..." As I finished writing the book, I found myself ending it with this remark. " ... and the other half of the problem is the automobile." Truthfully, my EV has a worn-out battery pack. No matter. My legs and lungs are getting stronger and I'm enjoying the beauty around me more.



A solar-electric-human-powered bicycle.
Photo by C. Michael Lewis

Thank you, HP readers, for your inquiries about the availability date of my new EV book. Unfortunately, the publisher felt that it could not publish the book "as is". I'm reluctant to gut the existing technical info they want deleted. Stalemate! So, I am looking at other options.

The Shopping Cart Race photos I spoke of last issue aren't available yet. However, I did put together the video footage I shot, and the result is a 42-minute piece called Hand Made Vehicles #3. #2 in the HMV series is the Panther Electric Video which my son and I edited. A half-dozen students narrate the piece. It was only 18 minutes long, so I added footage from three different Electrathon races to bring it up to 45-minutes.

I've been feeling disillusioned about opportunities here in the USA to create real change in areas like solar, wind, and rail. I find officialdom notably ignorant about the viability of AE and even opinionated to the contrary. I often forget about exporting alternative technology! Developing nations could use a good alternative to buying old fossil fuel technologies in order to modernize. With the high price of fuel outside the USA, sustainable energy sources are an easier "sell".

"Developing" doesn't mean "stupid". These are people without the benefit of subsidies for energy sources like nuclear. The vicious cycle of more fuel, parts, maintenance, and technical training is quickly revealed to the third world'er. The real costs can't hide like they do in the bureaucracy of the USA.

While I am encouraged that someone I voted for finally made it into office (Bill Clinton), everybody is trying to do him in. Still, I'm glad this country has a real human being as a President, and a real man in office instead

of a puppet. Good Lord, it's like someone finally represents US. Puts the US back in USA. Meanwhile, Congress does a polar shift, and Newt and crew have put out a *Contract ON America*.

Following the good projects at Phoenix in 1992 and 1993, I had high hopes for launching into some new areas. However, the proposals I put together in 93-94 still sit in a file, including a lightweight four wheel drive all-terrain EV, a two wheel drive street EV, and the ULR (Ultra Light Rail) system.

Everything seems politically gridlocked or economically challenged. Still, I'm drawn to rail systems. My current tack is to work at educating through videotape about the merits of rail, recent advancements in electric propulsion systems, and the real cost of roads. "Infotainment" is an interesting medium.

I offer a tidbit for those dabbling in electronics. It's universally known that the reliability of electronic hardware is inversely proportional to the number of electronic devices it uses (transistors, diodes, MOSFETs, thyristors, etc.). The REAL reason electronic devices work is due to the magic of compressed smoke. Through a very technical process, compressed smoke is put into all electronic devices. Nobody knows exactly how the compressed smoke makes the device work. However, irrespective of function, once you mess up and smoke is released from an electronic device, it never works again. It's a fact! And this is a wrap.

Access
Michael Hackleman, PO Box 63, Ben Lomond, CA 95005 • Internet email: michael.hackleman@homepower.org

Above: The first electric car to break 100 mph lap speed at PIR was this '85 Indy Lola conversion sponsored by EXIDE batteries and piloted by Billy Roe. Photo: Paul Brasch

Electric Cars:
Toys or Reality?

Paul H. Brasch

Street legal electric cars are a joke: *How long is the cord? They are no more than golf-carts or handicapped vehicles. Electricity could never power a car for freeway use or for more than a very few miles. If they were "practical", why don't I see them on the road? They don't go far enough and they cost too much. It takes too long to recharge. You can't use electricity for a motorcycle.*

The statements above are the perceptions in the minds of the public. The REALITY is very different. Let's look at the facts.

Myth: Electric Vehicles (EVs) can't go very fast.
The reality is that the present land speed record for an EV was set way back in 1974 at 175 miles per hour at Bonneville by Silicon Valley engineer, Roger Hedlund. (editor's note: The new record of 183 mph was set by a streamlined GM Impact on March 11, 1994. MH) There is a newly built vehicle soon to break 200 mph that has been built by Ed Rannberg of Eye Ball Engineering in the Los Angeles area.

What about motorcycles? Ed Rannberg also built an electric drag bike. It was written up in the Feb. '92 Cycleworld. It does 0 to 110 mph in 11 seconds flat.

There also has been full-scale auto racing at the Phoenix International Raceway (PIR) for the past 4 years. Put on by the Solar & Electric Racing Association and sponsored by Arizona Public Service (a utility), the top speeds at the March '93 event broke 100 mph. (The track record at PIR is about 175 mph set by Michael Andretti in a methanol Lola Indy style car.) The batteries in some racing vehicles have been exchanged in as little as 13.5 seconds, faster than most Indy pit stops. Eighty to one hundred vehicles have been competing in these races.

Myth: EVs don't go far enough.
A typical gasoline to electric conversion will give you a 50 - 70 mile per charge range. A poor conversion job

may only give you a 40 mile range, while a good job on a good car will yield 80 - 100+ mile range. A Porsche 914 conversion I have driven has a 100-mile range at 60 miles per hour on the freeway and a top speed of 90 mph.

I gave a talk about EVs at a Rotary luncheon. An auto dealer who was in attendance took the position that a car must be able to travel more than 100 miles at a time. Several editions of the Nationwide Personal Transportation Survey conducted by the U.S. Department of Transportation (DOT) and the Federal Highway Administration from 1969 to 1990 show that the national average travel per vehicle is less than 25 miles a day.

The auto dealer simply refused to accept this and claimed that California's average was 15,000 miles/year. I dispute that but even so this is only about 42 miles a day. So what is wrong with a 50 - 70 mile per charge car? Such a car is only using today's golf-cart, deep cycle lead-acid batteries.

A major improvement to the lead-acid battery goes into production by an Austin, Texas company — Electrosource. Their battery promises about a 90% improvement in energy capacity and more than 900 deep discharge cycles. New charging technology allows this and other batteries to be recharged in 8 minutes to 50% and 30 min. to 100% of charge. If you can recharge in little more time than it takes to fill up with gas, where is the problem?

It is true that to recharge in 8 minutes, special equipment is needed. This could be available at "service stations" just as gasoline is. Try filling your gas tank at home! It is not practical. With an EV, you can do most or all of your recharging at your convenience at home. Recharging at home off a 230 volt dryer outlet would take 4 - 5 hours for a complete "fill" from "empty". In practice, much less is needed in normal daily use. This could usually be done at night which actually helps the electrical utilities. They even offer reduced rates for this nighttime use.

Myth: EVs cost more to buy.
The auto industry, backed by the oil industry, is less prone to say that a practical EV cannot be built since GM demonstrated their "Impact" EV in January '90. This is something that private individuals had been doing for 20+ years, even if they could not match the Impact's 0 - 60 in 8 seconds acceleration. Now, the auto industry says that they can do it but an EV will cost from 2-5 times as much to build and sell.

This is all jive. With less than 1/10 the precision machined parts in the drive train, there is a big savings here in production, which is partly offset by the battery cost. Newly manufactured EVs should cost LESS to produce in full production than today's gas buggies. Evidence to support this statement is that conversion kits to change a gas drive to electric drive sell for $4,000 — $7,000 in single quantities. With Federal and some states' tax credits for doing this, it can be done for about $5,000 — $6,000. So why should a new EV sell for $50,000 — $100,000? It's preposterous.

Below: Veteran Indianapolis 500 winner Tom Sneva (in driver's seat) talks to his crew during a pit stop.

Director of Ford's EV program, Dennis Wilkie, admitted that "any college student with a voltmeter and a battery pack can make a working electric car." With some technical help, such a car can go 80 - 100+ miles on a charge for 1-2 dollars of electricity.

Myth: EVs will put people out of work.
Back to the auto dealer. He was terrified when I said that an EV could last 20 years as it needs only tire and brake maintenance, chassis lubes and battery replacement (this but once every 3 - 5 years with golf-cart batteries and potentially twice as long for the new Electrosource battery). He asked what do we do with all the unemployed maintenance people?

This is what they said about buggy whips 100 years ago. Ten to 20 years ago, with the advent of the microprocessor, people thought that everyone was going to lose their job. But look at the size of the electronics and computer industries today. Many more jobs were created. The electronics industry, just in the past 2 years, has started to realize that there is an enormous worldwide market for "electronic cars".

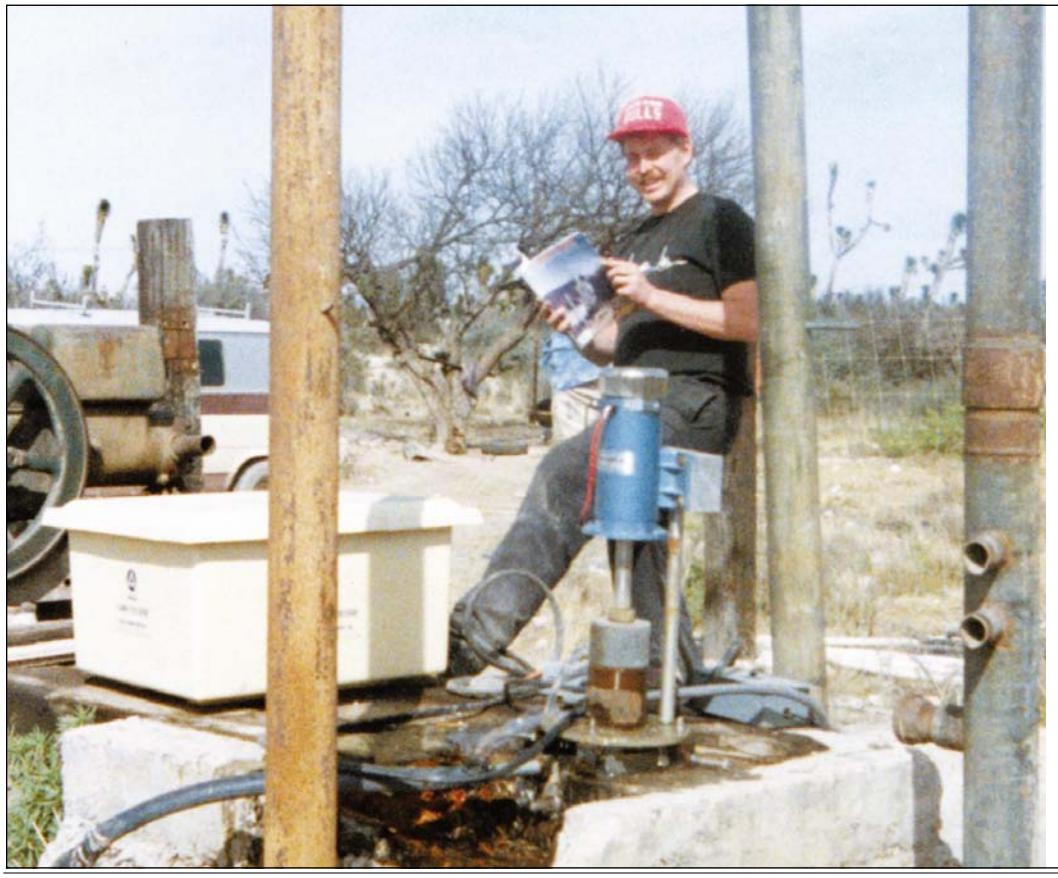
Myth: EVs cost more to operate.
A member of the Electric Auto Association determined that his total ownership cost for his electric Karman Ghia was only 8-10 cents per mile. Compare that with 20-25 cents per mile for his 40 mpg gas car!

Myth: If they are so "practical" why don't I see them on the road?
The simple fact is that unless a gas to electric conversion has some sort of identifying markings like "electric car", you cannot identify it from the outside. There is an estimated 10,000 to 15,000 EVs on the nation's streets that private individuals have converted.

What still needs to be done to improve today's EVs? Better battery chargers. Motor speed controllers with improved power capacity, reduced cost, and a regenerative braking feature. Better instrumentation and information for the driver. I have developed the first Hall-effect instrument to quantify the energy removed or returned to a battery pack.

So the next time someone asks "how long is the cord?" you can reply that there is no cord — batteries are included, and smile on your way to the bank. The joke is on them because of the expensive smog-belcher that they are driving.

Access
Paul H. Brasch, the creator of the Electric Auto Association's publication *Current EVents* and a 22-year member of the 26 year old organization, died August 13, 1994. This is the last article he wrote.



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Above: A Porsche Spider converted to electric by MendoMotive.

EV Battery Charger Issues

Gary Flo and Michael Hackleman

As an EV conversion shop, we have to evaluate all the potential products available. The K&W charger, as mentioned in Shari Prange's article on EV chargers (HP #40, Electric Vehicle Chargers, pg 66-68) is sold by all the main EV parts retailers. It is transformerless, lightweight, automatic, and somewhat reasonably priced. However, there are other options and a number of important issues to address, too.

Despite the attractiveness of their light weight, transformerless chargers have invoked a great deal of controversy in the engineering community. Some people think they will be outlawed when EV regulations are written. Why? During charging, any battery post becomes "live" with respect to ground. A person touching one battery terminal could get a 110-volt (AC) shock if the circuit is completed to ground through the body because of bare feet or a wet floor. Also, the body or chassis of the car could become live if there was any leakage between the battery terminals and metal battery racks, etc.

To protect against these hazards, transformerless chargers (including the K & W unit) are equipped with a Ground Fault Interrupt (GFI) switch which disables the charger when the conditions exist.

Unfortunately, EVs with metal battery racks experience "nuisance tripping" of the GFI. During charging, acid mist vents from the batteries and is deposited on the battery tops. This provides a handy conducive path from the battery terminals to the metal battery racks, tripping the GFI. This can also occur when the battery fluid is too high and electrolyte overflows during charging, wetting the battery tops. As well, colleagues who have worked on EVs with transformerless chargers report getting "zapped" before the GFI trips.

Regularly washing the battery tops with an alkaline solution (such as baking soda) will minimize GFI trips. It may be a required procedure if the GFI won't permit the continuation of a charge without tripping.

To circumvent this situation, some EV builders that use transformerless chargers, such as Electro-Automotive, have wisely gone to plywood or polypropylene boxes for the battery pack. Others, such as Solar Car Corporation (Florida) and U.S. Electricar (California) refuse to use transformerless chargers altogether due to liability and safety questions. Our company (MendoMotive) is considering using transformerless chargers, but only in a fiberglass-bodied kit car. We already take other safety precautions such as rubber-coating metal battery racks, rubber caps for all battery terminals, and lexan covers for all exposed high-voltage areas.

One merit of transformers in chargers is that they provide isolation from the 110 vac line so that nothing

Below: From left to right, Stephen Heckeroth, Dick Hamilton, Norm Fluhrer, and Gary Flo.

in the car is “live” to ground (except the incoming wires). Another merit is that by selecting the number of primary and secondary windings,you can get any voltage. Finally, an “extra” secondary winding can supply the needed recharge current for a battery in the EV’s 12-volt system for lights and other accessories.

The primary disadvantage of chargers with transformers is their weight. At 50-100 lbs, these are real “boat anchors”. Bycan and Lester make some very reliable chargers of this type, and they are suitable and reasonably priced. They are fully regulated, and come in 110 v or 220 v AC versions, or both (Lester makes a great dual). They are often used “offboard”, but may be found onboard in EV pickup trucks and the old Electra-vans.

The emerging EV industry is providing new options. American Monarch has entered the EV charger market with a 43-lb, 1500-watt transformer charger using their patented “gas point detection” system for greater battery life. Here at MendoMotive, we have been using a crude transformer charger with an Elveco toroidal transformer that weights only 30 pounds. It puts out 15 A (1800 watts) on low, and 24 A (2880 watts) on high. If the secondary voltage is chosen properly, even an unregulated transformer charger can charge the batteries correctly. The 150-volt tap on our transformer, through a rectifier, charges twenty T-125 batteries (120 volts) perfectly to 150 volts in about 8-10 hours. It tapers down to 2 Amps at the end simply due to greater battery resistance. For the DIY’er (Do It Yourself’er), transformers are readily available through surplus catalogs for building your own charger. All it takes is a transformer, rectifier, and some fuses.

Future EV chargers will use high-frequency transformers working up to 20 kHz (20,000 cycles) to achieve high power at low weight while retaining isolation. Chargers from Hughes Aircraft use this method. A Santa Rosa company is developing a 5,000-watt charger using a 2-pound transformer. Other companies offering chargers are New Concepts, Norvik, Solectria, and Enerpro. Solar Car Company is working with Todd Engineering on both chargers and converters.

Two new products will soon be available in the USA: the Zivan K2 and the K & W BC-250. Both use high-frequency (20-100 kHz), isolated transformers. The Zivan K2 charger will weigh eight (8) pounds with a 2,500 watt output. It is available in 110 v or 220 v AC versions for battery packs of 12–180 VDC, and retails at $685. The K&W BC-250 weighs sixteen (16) pounds and will yield 4,000 watts. It will operate on an input range of 110–250 vac, charge a 96–160 VDC pack, and retail at $1,095.

Access

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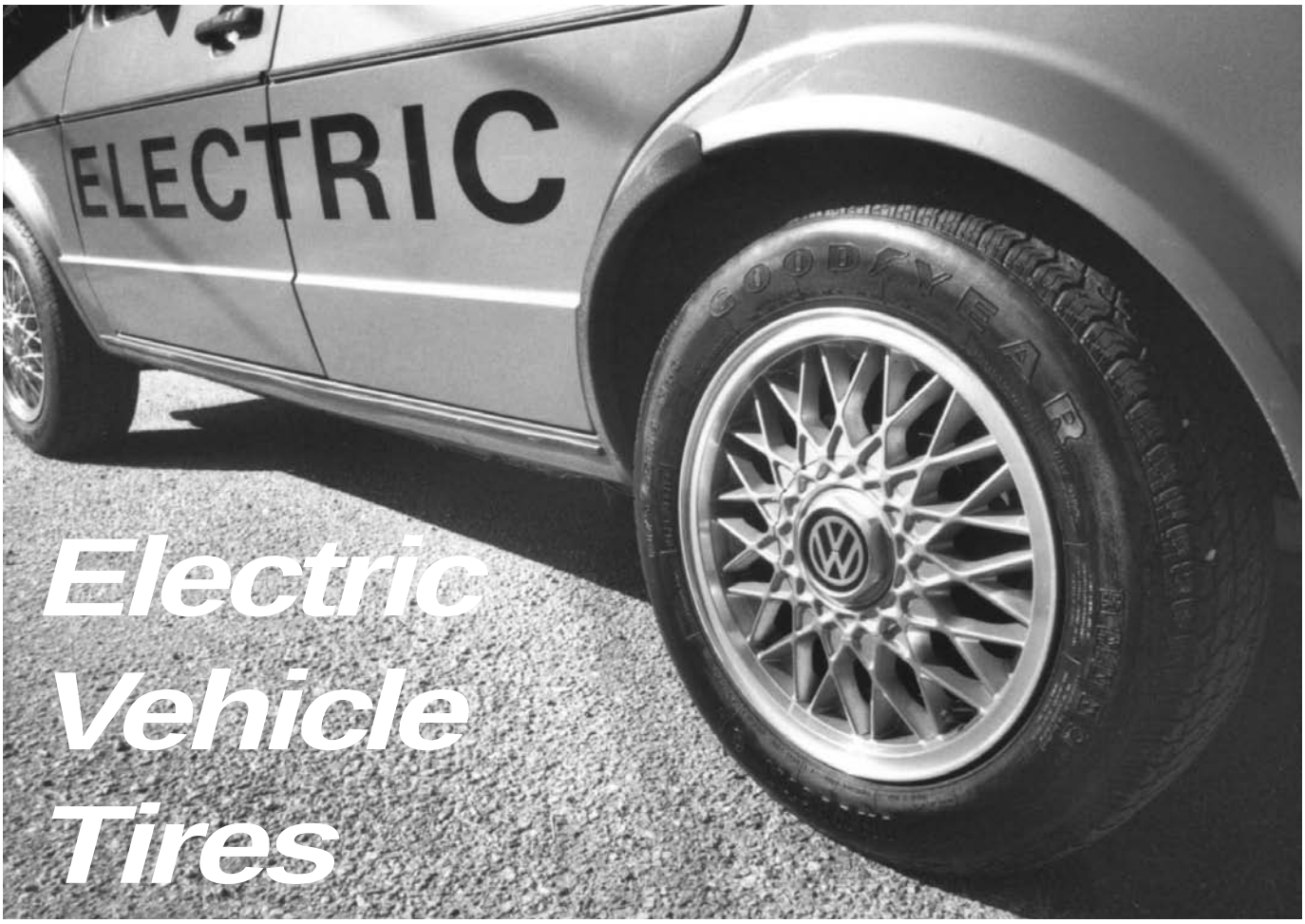


Electric Vehicle Tires

Above: Goodyear Invicta low rolling resistance tires make a significant improvement in electric car performance.

Shari Prange

Friction is both hero and villain to any car, but especially to the electric car. You need friction for the tires to grab the road so you can accelerate, steer, and brake. You learn this immediately the first time you try to drive across ice. Some parts of the car, like the brake pads and clutch, are intended to operate by friction.

On the other hand, the friction of parts rubbing against each other causes heat. Heat represents lost energy that is not being used to move the car. It also stresses the components and defines the limits of their operating ranges. Friction of the tires, and even of the air against the body of the car, acts like millions of tiny hands holding the car back and wasting its energy.

The trick is to eliminate as much unnecessary friction as possible without losing the essential friction that makes the car work.

Rolling Resistance

One part of an electric car where you can control the friction is the tires. The first absolute requirement is that the tires are radials. The old bias ply tires simply will not stand up to the demands of a heavy electric vehicle, nor will they give you good efficiency.

With that as a given, we need to look at rolling resistance. “Rolling resistance” means exactly what you think it means: how much does the vehicle resist rolling? This is affected by many things, such as wheel bearings and transmission fluid, but right now we’ll just look at tires.

At first blush, it would seem that the key to low rolling resistance is a smaller contact patch with the ground. Big, fat, racing “slicks” make a lot of contact with the pavement. They have lots of grab for acceleration, but lousy rolling resistance. Racing bicycle tires are skinny things meant to put the least possible strain on the human “engine” of the bicycle.

With this in mind, some people choose the skinniest tires possible, and then pump them up as hard as they can, to minimize the contact patch.

Air Pressure

This theory has flaws. Minimizing the contact patch also reduces the car’s handling and braking, which could become a safety issue in emergencies.

Second, it won’t necessarily get you the optimum rolling resistance. The relationship between tire pressure and rolling resistance is not a straight line. At some point, it reaches a plateau. Beyond that, added tire pressure will only decrease handling without improving rolling resistance.

If you’ve ever had a tire with a slow leak, you know how a soggy tire can drag at the car. On an electric car, a low tire will become apparent in reduced range before it is visible to the eye, so it’s important to check tire pressures regularly with a gauge. This should be done when the car has been parked for a couple of hours. When the car is driven, the tires become warm and the air pressure goes up.

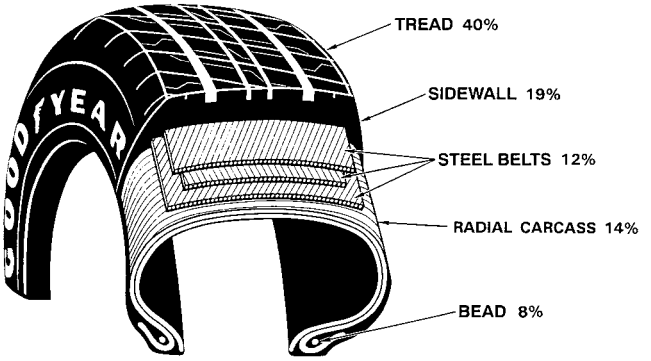
It’s easy to see the relationship of air pressure to rolling resistance in an electric car. You can do some experiments yourself to determine the optimum pressure. Choose a straight, flat, empty stretch of road and drive down it at a constant speed. Note your ammeter reading. Now alter the tire pressure and repeat the process. You can see the current draw vary at the same speed, depending on tire pressure, and you can feel the difference in handling, too.

Tire Construction

There is another aspect to tire rolling resistance, which is the internal construction of the tire. As the tire flexes going down the road, the internal cords move and pull against the tire. By altering the internal design of the tire, its shape, materials, and tread, rolling resistance can be reduced dramatically without decreasing the handling characteristics.

One way to improve rolling resistance without deteriorating handling is to use different compounds in the rubber. The flexing of the tire as it goes down the road causes heat, which represents lost energy and high rolling resistance. Altering the materials in the tire and make it run cooler, with lower rolling resistance.

TIRE COMPONENTS CONTRIBUTING TO ROLLING RESISTANCE



Courtesy of Goodyear Tire & Rubber

In recent years, tire companies have begun to concentrate on reducing rolling resistance for improved fuel economy. Rolling resistance in passenger car tires has been improved 42% since 1980. This represents a 6% -8% improvement in fuel economy. Tires that are designed to increase your miles per gallon will also increase your miles per kilowatt/hour.

Goodyear pioneered tires designed specifically for electric cars by working with General Motors on the Impact. Their research also produced the low rolling resistance Invicta GAL and Invicta GLR tires. Firestone, Bridgestone, Goodrich, and Michelin have also produced low rolling resistance tires.

For a detailed comparison of different tire models, consult Consumer Reports magazine. They test tires about once a year, and include several characteristics, including rolling resistance.

Tire Size

In general, a larger diameter tire will give you lower rolling resistance, but sizing is a little more complicated than that. The important factor is the “aspect ratio” of the tire. This represents the ratio of the sidewall height (from bead to tread) to the width of the tire in cross section. A tire with an aspect ratio of 70 would have a sidewall height equal to 70% of the tire’s width.

A tire with a low aspect ratio will be a high performance tire, and will also have high rolling resistance. The height of the sidewall looks small compared to the width of the tire. A tire with a high aspect ratio will have a taller sidewall in comparison to its width, and lower rolling resistance.

The aspect ratio can be found in the code printed on the side of the tire. A typical code might read “P185/70R14”. “P” stands for “passenger car tire”. The “185” is the cross section width in millimeters. The “70”

is the aspect ratio. “R” stands for radial construction. Finally, the “14” indicates the size in inches of the wheel for which the tire was designed.

You may still need to use a tape measure. If the low rolling resistance tires you want have a different width or aspect ratio from the tires currently on your car, you will need to do some measuring to be sure they will fit. Check fit at full right and left turns, not just straight ahead. Also, remember that the springs will compress when the car hits a bump. A tire that fits just barely sitting still may bang against the fender on top when you hit a pothole or lean into a tight turn.

The tires you want may not be available for the size wheels on your car. If you still want the tires, you will need to find a different size wheel with the right bolt pattern to mount on your car. This can be a bit of a search, but worth it, as the low rolling resistance does make a very noticeable difference in performance.

Balance & Alignment

Have your new tires spin balanced when they are mounted. Balanced tires will give you a smoother ride and more efficient performance.

This is also a good time to have your wheels aligned. Get a recommendation for an alignment shop from someone you trust. People often think of alignment as a front end operation, but many cars need rear alignment as well. If it applies to your car, do both.

Poor alignment will wear out your tires unevenly and prematurely. More important, a poor alignment will use up energy and reduce the range of your car.

It’s a good idea to do a minor maintenance inspection on your car once a month. This would include checking the pressure and condition on all four tires. Be sure to take a good look across the whole tread of the tire, not just the part you can easily see from the outside. Poor alignment could cause the inner edges of the tire to wear down to the cord while the outer edges still look fine.

Get The Whole Picture

The electric car is an entire system including many different parts. No portion of the system should be ignored. Even though tires have nothing to do with the drive system of the car, they can have a significant effect on its performance.

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Author: Shari Prange, POB 1113, Felton, CA 95018

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Magazine Mechanics

Negatives Can Be Positive

Karen Perez

You've probably noticed we've raised our subscription rate. We planned to absorb the 10% 1st class and 14% 2nd, 3rd & 4th class postage increases. Paper prices have made this impossible. It's either raise our rates or quit publishing. In the short term this is a real negative for us all. In the long run this could be great for the environment and all of us.

Are you scratching your head, wondering why paper has gone up so much, so fast? I'll try to explain the reasons.

Negatives

Everyone will be paying substantially more for all grades of paper products, from newsprint to toilet paper. Industry analysts expect worldwide paper shortages to last at least a year, maybe more.

In the early 80s the economy was good, and paper mills over-expanded. By the mid-80s and 90s there was a worldwide recession. Paper prices went down dramatically. Supply and demand — more paper was manufactured than the market required. The price of paper went down.

Now, in the mid-nineties the economy is improving. Businesses worldwide, especially in Europe and Asia, are on an up-swing and using more paper. Supply and demand — prices are way up.

The recycled high post-consumer, non-chlorine paper we use for the interior of Home Power has gone up 31% since November 1994. In November we were paying $53.25 per hundred pounds of paper, in January $63.75, by March $70. We use approximately eight tons of paper, per issue, for the interior pages. Then there's the cover paper, sub card, envelopes, etc., etc. The non-chlorine, high post-consumer paper that we use was $10–14 more expensive than low post-consumer, chlorine bleached paper. Now, there is only a $1 difference between the two.

Positives

I think that most of the reasons that paper has gone up (and is going up) are good.

In Indonesia there is a moratorium on cutting of trees. In the western US the number of board feet harvested is down. Worldwide paper pulp inventories have decreased almost 50% between mid-'93 to September '94. There have been sharp increases in the price of virgin, paper pulp, very sharp increases in waste paper (old newspaper, old magazines, office paper, etc.) prices. Paper has become so valuable that it is being stolen from recycling bins and streets in New York and San Francisco.

Mills are being forced to adopt new EPA guidelines. Some mills will close rather than comply. This is temporarily bad for jobs, but great for the environment. Go non-chlorine!

We do not need to use trees to make paper. Egyptians, Greeks, and Romans made paper from papyrus, a type of reed, in the fourth century BC. The Chinese have been making paper from rice straw for centuries. I'm hoping that price increases will make alternatives to tree-pulp, like Cereal straw, hemp, and kenaf more attractive.

Farmers consider cereal straw a waste product. Farmers burn straw in the fields where it grows. Burning cereal straw produces more carbon dioxide than power plants. California's farmers burned 1,097,000 tons of wheat and rice straw between July and August 1991. These burns produced 60,000 tons of carbon monoxide (CO) and particulates. This pollution went into the atmosphere. California power plants produced 25,000 tons of CO during this period.

These alternatives to tree pulp are infinitely renewable — annually. Agricultural jobs could help replace jobs lost in the timber industry. Tree pulp alternatives would help save our dwindling forests. Trees make oxygen, retain moisture, happy habitat, and at least for me, lower blood pressure.

A Summary

In the short term we pay more for all paper products. In the long term these higher prices could lead to helping correct some of our environmental messes. Paper

production has contributed to water pollution, dwindling forests, and major land fill problems. If we change the way we make paper we can help save our few remaining ancient forests. We can improve air and water quality, and reduce garbage. It's up to us!

Access

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California "Net Metering" Legislation Introduced

Thomas J. Starrs

Senate bill (S.B. 656) requiring California utilities to provide "net metering" for residential customer-owned, utility-interconnected renewable generation was introduced in the California legislature by Senator Alquist (D – San Jose) on February 22. This is one of the most exciting legal developments in years for solar, wind, and small hydro advocates. But the bill requires your active support!

What is Net Metering?

Net metering is an easily-administered, low-cost, equitable method for encouraging utility customers to own and operate small renewable generating systems. It uses a single meter to measure both electricity purchased from and sold to the utility over a given billing period, using a "reverse the meter" approach. The meter runs forward to measure electricity consumed, and backward to electricity produced. The customer pays the bill for net energy consumed, and receives either a payment or a carry-over credit for net energy produced. Payment for net energy produced during the billing period is at the lower "avoided cost" rate, rather than the retail rate.

Why is Net Metering Important?

Net metering substantially improves the economics of renewable self-generation by utility customers in two ways. First, it avoids the expense of installing separate meters to measure electricity consumed and produced by the customer-generator. These costs can be substantial; one California utility wanted to charge a customer $1,300 for the purchase and installation of dual "non-ratcheting" meters. Second, it increases the effective price paid for electricity generated by the customer.

To understand this second factor, you need to understand how utilities typically compensate customers for electricity purchases in the absence of net metering. Most utilities use a scheme called "simultaneous purchase and sale", in which customers are charged the retail electricity rate for electricity they purchase from the utility, and paid the much lower avoided cost rate for electricity they sell to the utility. In California, for example, the retail rate among large investor-owned utilities averages about $0.12/kWh and the avoided cost rate averages about $0.03/kWh.

This scheme, which was set-up by the Public Utility Regulatory Policies Act (PURPA) in 1978, was designed for relatively large renewable energy producers, such as the owners and operators of wind farms, solar thermal power plants, and geothermal power plants. It is not well suited for small renewable energy generators whose systems are intended primarily to offset their own electricity demand.

Under simultaneously purchase and sale, a customer is only allowed to offset electricity consumed with simultaneous energy produced. Anytime electricity consumption exceeds production, the customer is charged the retail rate, and anytime production exceeds consumption the customer is paid the avoided cost rate.

The following example illustrates the difference. Let's say Sally Solar installs a 2 kW PV system on the roof of her new house. The system produces 360 kWh/month, and Sally consumes 400 kWh/month. Sally's utility charges a retail price of $.012/kWh, and pays an avoided cost price of $0.03/kWh. Before she installed the PV system her bill was:

= 400 x $0.012
= $48.00/month.

Now that her PV system has been installed, how does Sally fare under each of these schemes?

Simultaneous Purchase and Sale: With simultaneous purchase and sale, Sally can still offset some of her retail consumption, but only by producing electricity at the same time. Sally works during the day when her PV system is producing most of its power, but with clever use of timers on some of her major appliances she manages to offset 20% of her monthly demand, or 80 kWh. That means she buys 320 kWh/month at retail, and sells 280 kWh/month at avoided cost. Her bill is:

= (320 x 0.12) - (280 x 0.03)
-= 38.40 - 8.40
= $ 30.00/month

Net Metering: With net metering, Sally can use all of the electricity generated by her PV system to offset her retail consumption (since she is not a net producer over the month). Now her bill is:

= (400 - 360) x 0.12
= 40 x 0.12
- $4.80/month

Although these numbers are just illustrative, and will vary from customer to customer and from month to month, they show the importance of net metering from the customer's perspective. Adopting net metering will save Sally over $300 a year, making it much easier to justify her investment in PV.

Who Qualifies for Net Metering?
Under the proposed bill, all California utilities — including investor-owned, municipal, and rural cooperative utilities — are required to provide net metering to eligible customers.

Eligible customers are residential customers who own and operate solar, wind, or hydropower electrical generating facilities with a capacity of not more than 50 kW. The facilities must be located on the customer's premises, must operate in parallel with the utility's transmission and distribution facilities, and must be "intended primarily to offset part or all of the customer's own electrical requirements."

In order to address the utilities' concerns about too many customers choosing to self-generate, the proposed bill limits the availability of net billing to a total capacity equal to 0.05% of each utility's peak electricity demand. This provision makes the bill a "win-win" proposition, because this capacity limit is low enough that the potential rate impacts are insignificant, but high enough that it allows substantial growth of customer-owned, utility-interconnected renewable generation. In PG&E's service territory alone, for example, the capacity limit would be 87 MW. This is equal to 20,000 2 kW PV systems, 4,000 10 kW wind generators, and 700 10 kW small hydro systems combined!

Where Does the Bill Currently Stand?
The effort to get the bill enacted is being coordinated by the California Solar Energy Industries Association in Sacramento. Now that it is in print and has a bill number, the next step is to get our representatives (both in the Assembly and the Senate) to support the legislation. The bill soon will be going to the energy committees for a vote, where it may be amended and possibly weakened. The sooner you express your support, the better the chance of the legislation being enacted.

What Can I Do?
If you are a Californian, the most important thing you can do is write your state Assembly members expressing support for S.B. 656. You also should write Senator Alfred Alquist, who is the author of the bill. In addition, you should send a copy of any letters you write to Kathyrn Lynch, who is managing the legislative campaign for CalSEIA and will distribute your letter to other important legislators and committee members. Addresses for Senator Alquist and Ms. Lynch are provided below.

Finally, you can write your local utility and ask it to support the legislation. Utility support will be very important. If you write to Southern California Edison, be sure to give it credit for already having a net metering program in place — it is one of the few utilities in the country to have adopted net metering on its own volition, without pressure from regulators or legislators. Writing your utility is particularly important if you are served by a municipal utility or a rural cooperative — these utilities usually are more responsive to their customers.

In your letter say who you are, why you have a personal interest in net metering, and why you think net metering is important to California (e.g. it promotes renewables, stimulates job growth, enhances the diversity of the energy resource mix). Ask your representatives to support the bill, and ask to be informed of the outcome of the bill.

If you are not a Californian, don't despair! Utilities in at least a dozen states have net metering programs in place. Find out if your utility offers net metering, and if not ask them why not. Net metering programs have been developed by individual utilities, by state utility regulators, and by state legislatures. Any of these avenues may be successful!

Good luck, and write soon. Every letter counts!

Access
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California Sate Senate: The Honorable Fred Alquist, California State Senate, P.O. Box 942848, Sacramento, CA 94248-0001 •916-445-9740 voice • 916-323-8386 fax

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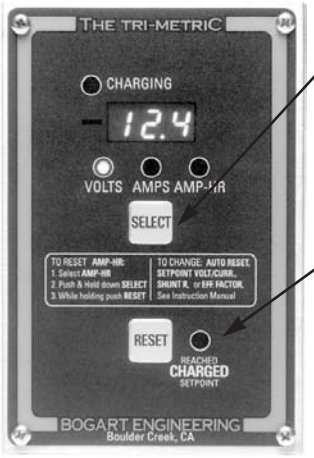

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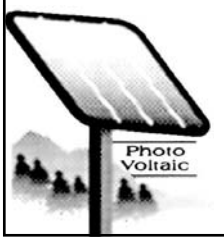

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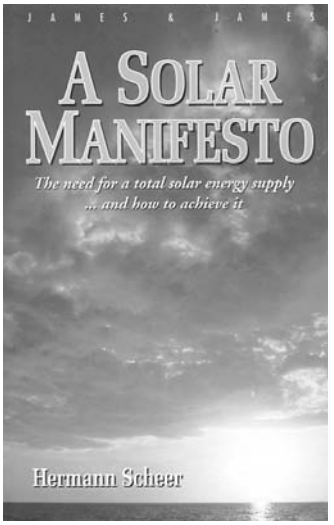

"Manifesto: a public declaration of intentions, motives, or views.", according to Webster's New Collegiate Dictionary. I was a little surprised when I looked it up. I always thought a manifesto went quite a bit further - more like "a public declaration of what we had to do, or else suffer the consequences".

Certainly, Mr. Scheer's work falls within both definitions. He offers proof, examples, and guided thinking about his premise, which states; "It is not too late to save our environment from the path to destruction that it appears to be taking. To save it will require a major shift in the way our political, industrial, and economic leaders think."

He makes the case that most of our environmental and social problems (including overpopulation) are really energy supply problems. He further states that a radical change to a global solar strategy is the only viable answer to the question "what can we t o do to save the earth?".

He criticizes dependence on energy conservation, efficiency and a gradual phase-out of nuclear power. He views them as being ineffective and counterproductive ... "an ineffective fallback position when pressure from 'business-as-usual' advocates won't let our leaders give us the solar future we absolutely need".

"A Solar Manifesto" contains specific answers to arguments which for years were offered against a change to a solar future. It responds to arguments in favor of the status quo, then offers a blueprint for implementing the necessary changes.

Mr. Scheer's information incorporates the work of many others. It's well documented and includes more than 200 references. The book was originally written in German and translated into English.

Scheer's credentials are excellent. They include membership in the German Bundestag (Parliament) since 1980; he has been President of the European Solar Energy Association since 1988; he also has several other relevant books to his credit.

I recommend "A Solar Manifesto" to anyone interested in thinking deeply about the environmental and energy future of the world. It isn't fast-and-easy reading. It is very valuable in the message and solutions it brings.

Wouldn't it be great if we could get Newt Gingrich, Bob Dole, and Bill Clinton to read this book with open minds?

Access:
A Solar Manifesto is available in the US for $35 from Books International PO Box 605 Herndon, VA 22070 (703)435-7064; or in England for L22.50 from James & James Ltd 5 Castle Road London, England NW1 8PR 071-284-3833

Solar Electricity Engineering of Photovoltaic Systems

By Eduardo Lorenzo

Reviewed by Sam Coleman

Solar Electricity is a well written, college level textbook. It was written for a solar energy course at the Polytechnic University of Madrid, Spain. It is available in both Spanish and English. The book is very technical and contains numerous equations, charts, graphs, and illustrations.

The text begins with a look at past, present, and future energy scenarios with a view towards the photovoltaic solution. The book covers all aspects of PV energy from the cell and module to the engineering of complete systems. There are sections on batteries, power conditioning, solar radiation, solar concentrators, and more.

If you are interested in the technical, mathematical, scientific and engineering aspects of solar electricity you will find this book interesting. As I said, this is a

college text and readers will require a fair amount of technical background.

Access
Publisher: Progensa (Promotora General de Estudios, SA), Avda. Republica de Argentina, 1, 41011, Sevilla, Spain. Phone (+345) 427 81 58, Fax (+345) 428 00 14.

First English edition November 1994. First published in Spanish as Electrcidad Solar, April 1994. The books ISBN number is:ISBN 84–86505–55–5

We don't know the cost of the book. I tried to locate "Solar Electricity" at bookstores in Oregon and California, but the book's ISBN is not listed in current books in print. Unfortunately, the book will have to ordered from Spain.

Incredible Secret Money Machine ll
A How-To Cookbook for Setting Up Your Very Own Computer, Craft, or Tech Venture

By Don Lancaster

Reviewed by Kathleen Jarschke-Schultze

Entrepreneur Don Lancaster has revised and updated this latest edition of his Incredible Secret Money Machine book. With the more current information and guidelines this book would be invaluable to anyone planning on buying cheap land beyond the grid and making a living from a remote location. It will be very useful to anyone who wants to be financially independent and work for themselves.

The book itself is 5 inches by 11 1/2 inches, paperback, with 164 pages of good ideas, plans and ways to implement them. The cost is $18.95 and they do accept VISA and Master Card. After all, we do live in a free enterprise system here in America. Don shows you how to take advantage of that fact and build a diverse, interesting and productive life style and gain financial savvy. Don's ideas are realistic and have been proven by himself and readers of his first edition.

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HP Survey Results

Sam Coleman

The final results are in from *Home Power's* Renewable Energy Survey. Four hundred and seventy-nine readers have responded. Of these, 65% are renewable energy (RE) users, while 55% are connected to the grid, and 20% use both RE and grid power. Household size varies from 1 to 10 people, with an average size of 2.6 persons per household. Most homes (73%) have three people or less. The geographical distribution of respondents is shown in table one.

General Results

Of the RE users, 96% use solar, 21% use wind, and 7% use hydro. The cost of a renewable energy system ranges from $200 to $300,000 dollars. The latter is for a grid intertie system in England. System cost averages $8240. Most RE users (95%) installed their own systems, while 11% have used a professional installer at some point.

Table 1

Region	*Respondents*
Northeast	9.6%
NY/PA	5.0%
Mid-Atlantic	3.3%
Southeast	3.8%
North Central-East	4.6%
North Central-West	9.2%
Central	4.6%
South Central	5.8%
Mountain	15.0%
West	34.7%
International	4.4%

The age of RE systems averaged eight years, with the oldest being ninety-three years and the newest being less than one year old.

There are 3.9% of RE users who sell power back to the grid. The average rate they received is 8.1¢ per kilowatt-hour. The lowest rate is 2¢ per kilowatt-hour, while the highest is 15¢ per kilowatt-hour.

Table 2

	RE Use KwHrs/Day	*RE Cost ¢/KwHr*	*Grid Use KwHrs/Day*	*Grid Cost ¢/KwHr*
Minimum	0.1	1.8	0.1	2.1
Maximum	95.0	351.0	120.0	38.0
Average	3.4	67.6	18.6	9.5

Table 2 summarizes the cost and usage figures for both RE and the grid. RE cost is prorated over fifteen years.

RE and Grid Ratings

Our respondents rated both the grid and renewable energy systems for satisfaction, reliability, and environmental effects. The results are shown in Table 3 and Figure 1. For all these categories, five was the highest possible rating, while one was the lowest.

Future Renewable Energy Scenarios

We asked our readers to rate four future RE scenarios from one to five, with one being the lowest rating and five the highest. The four scenarios were:

- utility scale renewables on grid
- the utility owns the off-grid RE systems and sells the energy to us
- we own the RE systems and sell to the utility
- we own the RE systems and are disconnected from the grid.

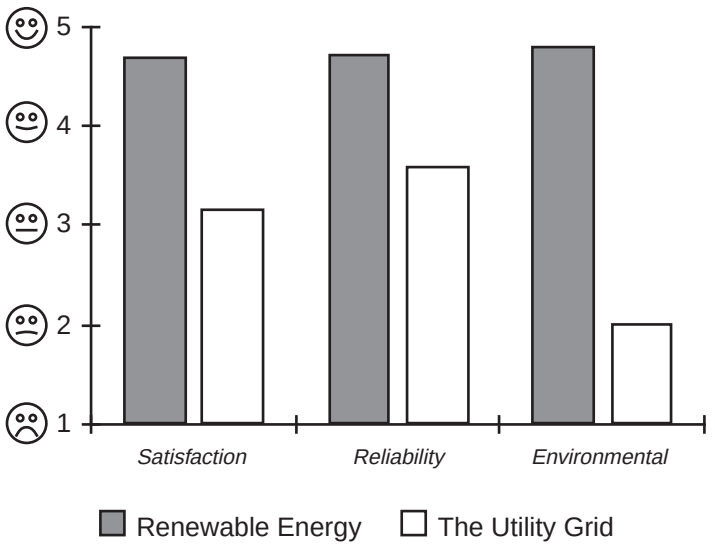
Figure 2 shows the ratings distribution for the four scenarios as a percentage of respondents. Table 4 shows the average rating for the four scenarios.

Conclusions

Today, renewable energy systems can supply as much power as you can use. They are, however, still more expensive, on the average than the grid. Some of this apparent expense is due to high cost, low-use systems such as cabins and vacation homes. Although solar is the renewable energy of choice, hydro and wind make a substantial contribution.

The comparison between the grid and renewable energy systems (Table 3 and Figure 1) shows that renewable energy is preferred over the grid in all three categories. This is especially true in the area of environmental effects. Even when we compensate for the ten percent difference in grid and RE usage, this conclusion remains valid. *Home Power* readers still prefer renewable energy systems to the grid.

Figure1-Average RE and Grid Ratings



In the future scenarios comparison (Figure 2 and Table 4), *Home Power* readers prefer private ownership of renewable energy systems to utility ownership by a two to one margin. The highest preference was given to private off-grid RE systems. The lowest was where the utility owns the off-grid system and sells energy to the consumer.

This survey indicates that our energy future lies with privately owned renewable energy systems.

Thanks

Many thanks to the 479 readers who have responded to this survey. See *Home Power* #42, page 16 for the RE survey article and form. The raw data from this survey will be available on the Home Power BBS.

Access

Sam Coleman, c/o Home Power, PO Box 520, Ashland, OR 97520 • 916-475-3179.

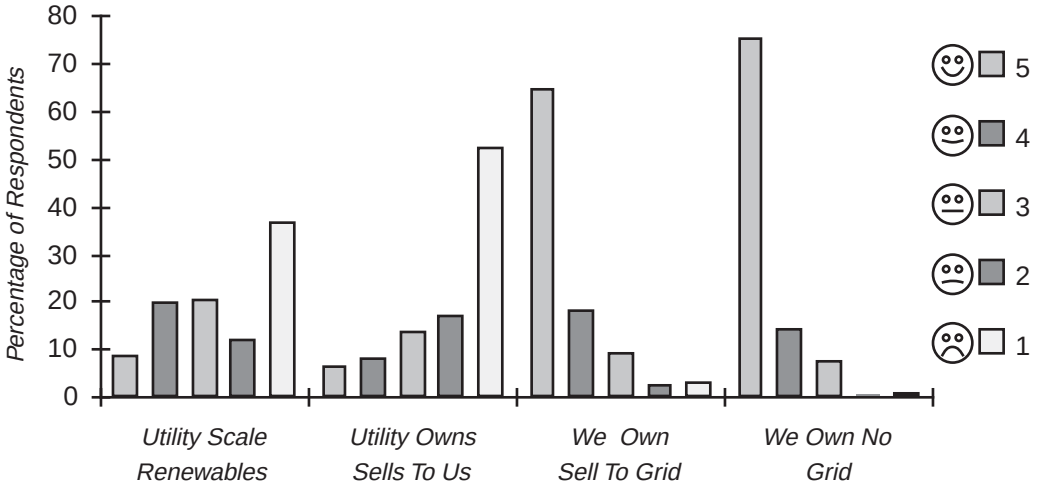
Table 3

	Renewable Energy			*Utility Grid*		
Rating	*Satisfaction*	*Reliability*	*Environmental*	*Satisfaction*	*Reliability*	*Environmental*
5	74.2%	78.5%	84.8%	13.0%	28.2%	2.7%
4	22.5%	18.2%	11.6%	30.5%	32.1%	8.5%
3	2.6%	1.0%	3.6%	28.6%	19.1%	21.2%
2	0.7%	1.7%	0.0%	14.9%	13.7%	22.4%
1	0.0%	0.7%	0.0%	13.0%	6.9%	45.2%

Table 4

	Utility Scale Renewables	*Utility Owns Sells To Us*	*We Own Sell To Grid*	*We Own No Grid*
Average Rating	2.52	1.99	4.38	4.62

Figure 2 — Home Power readers rate future energy scenarios



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Independent Power Providers

Don Loweburg and Bob-O Schultze

The California Offgrid Scene

Although Southern California Edison states otherwise, the offgrid PV program is off to a slow start. With hundreds of interested prospects on its list, only six systems have gone to bid and none of those have generated revenue for the winning contractors. What is the snag? We think Edison is the snag. They represent an extra layer in the process. An independent can usually get an entire system up and going in less than a month. As we have said before, the utilities will add cost to the consumer, reduce profits for installers and introduce bureaucratic delays to the entire work process. The utilities are entering this market for profit, not for the benefit of their customers and the existing PV industry as they like to proclaim. Manufacturers should pay more attention and recognize who their traditional customers are. Surveys show strongly that customers prefer independence over utility ownership when it comes to renewables.

California Ongrid

The California PV4U collaborative could not come to consensus around the rooftop PV issue. Although several transitional options to full ownership were offered by the advocates,(IPP, TURN, UCAN and the CPUC DRA), Edison held out for full ownership of customer sited PV. Since several utilities are proceeding with projects involving customer sited PV, this issue will be resolved at the Commission level. IPP and those who support the advocates position are preparing for the next step.

The National Scene

Utility PV projects (off and on grid) are proceeding in many states. Large DOE and EPRI funded utility-tied wind turbine projects are currently underway in New York, Vermont, and West Texas. IPP members are monitoring these activities. We are developing alliances with consumer groups in many states. This issue will ultimately become a consumer issue when more people understand the big picture that utilities have in mind. It is very clear that PV is one element in a larger strategy summarized by the term Distributed Utility (DU). Under this umbrella fall renewables, battery storage, DSM, fuel cell and even flywheel storage. These technologies have one fact in common, they are all deployed at the point of load. They inherently minimize the need for distribution and central generation. In the face of pending deregulation, the utilities feel they must control the use of these technologies or face significant loss of market.

For the best source of information DU this contact EPRI and get the DR (Distributed Resource) Connection dated November 1994. In this issue Amory Lovins states, “Any utility would be wise to include the distributed utility concept as a major element, if not the centerpiece, of its strategic direction.” He states further concerning PV, “We will usually find that distributed photovoltaics are worth half to one order of magnitude (5 to 10 times) more than standard utility economics say they are worth.”

There is no inherent reason that utilities should provide these services. They can and should be offered competitively by others. PV, for example, is capital intensive and passive, meaning it has a high cost per watt purchase price but little or no operating expense. Conventional generation is expense intensive and active, meaning that it has high operating costs, ie fuel, maintenance, and replacement parts. It also requires high overhead in personnel costs, mechanics, fuel and parts purchasing agents, fuel storage costs, etc. The utilities already have the infrastructure in place to deal with conventional generation, but don’t yet understand—and therefor shun—renewable generation techniques. Business as usual.

IPPs on the other hand, have the capital and flexibility to invest in new, relatively small and dispersed, power generation. All they need is a level playing field with the utilities and fair payment for their product based on the real cost/benefit ratio of RE produced power. Traditional utility discounted cash-flow (DCF) accounting methods don’t apply well to PV generation, yet those are the models used to determine IPP purchasing contracts.

Corporate Welfare

It’s no secret that the utilities effort to implement PV is being funded by the DOE through grants to the UPVG. DOE proposes to give the utilities $166 million during the 6 year TEAM-UP program. While the TEAM-UP money is theoretically available to groups other than utilities, the criteria of the Request For Proposals (RFP) makes it clear that only utilities need apply.

To accelerate the commercialization of PV we propose that the DOE use this money to set up a fund to provide low interest loans to qualified end users to purchase their own systems. It’s very simple. The government already offers federal loan guarantees thru the Freddie Mac and Fannie May programs. Expanding those programs to include off and on grid renewable energy systems would cost the taxpayers next to nothing and stimulate RE sales where they will do the most good, on the individual level. The current proposals will serve to extend the utilities near

monopoly of electricity production and greatly limit new and diversified independent power providers. Sounds like more business as usual to us.

It's ironic that our government is funding projects that will help individual families purchase PV systems in other countries. In South Africa our DOE is financing rural residential PV systems. According to a press release from the Renewable Energy for African Development (READ) group, "The multi-million dollar first phase in South Africa will include the establishment of a credit facility to allow consumers to purchase up to 4,000 photovoltaic home power systems in rural areas." If you think we should be offering loan guarantees on home power systems in THIS country, let the DOE know. Contact Bud Annon or James G Rannels at DOE PV Applications. The fax number is 202 586 5127.

IPP Members Show Support

Last month we sent a survey to members asking for support of the IPP -Advocates position on rooftop-sited utility owned PV. A very significant number of signatures supporting this position were returned. Thank you very much. We also welcome comments from the readership on this issue. Home Power's poll and IPP's both indicate a strong preference for customer owned PV. The ownership position paper is available online at the HP BBS as IPPINFO or sent as E- Mail by contacting i2p@aol.com.

More Good News and Support Needed

The California net metering bill is going to committee. SB 656 (Alquist) makes net metering available to utility customers using any renewable generation source. Up to 271 MW of cumulative capacity is allowed under this bill. Individual generators are limited to 50kw. We support this bill. It is very important to have a strong show of support for this bill right now.

Send letters to: Senator Alfred Alquist, California State Senate, PO Box 942848 Sacramento, CA 94248-0001

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To Join IPP: By E-mail: i2p@aol.com. By phone: (209) 841-7001 or (916)-475-3402

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Authors: Don Loweburg, PO Box 231, North Fork, CA 93643. ofln@aol.com and Bob-O Schultze, POB 203, Hornbrook, CA 96044. econnect@snowcrest.net

Example Systems

Small Stand-Alone Systems

John Wiles

This Code Corner will continue the series of examples on the selection of the wiring, overcurrent devices, and disconnects for various types of PV systems. These designs will meet the requirements of the National Electrical Code (NEC).

These are examples only and should not be used to define the requirements for any particular system. No information will be presented on sizing the PV array. The array sizes and the loads are used only for illustration. Calculations for a specific system should be accomplished using the methods presented in previous issues of Home Power. The examples in this Code Corner will cover small DC-only systems. The last example in the series will cover a complex residential hybrid PV system with a backup generator.

The systems described below and the calculations shown are presented as examples only. The calculations for conductor sizes and the ratings of overcurrent devices are based on the requirements of the 1993 National Electrical Code (NEC) and on UL Standard 1703 which governs the installation of UL-Listed PV modules. Local codes and site-specific variations in irradiance, temperature, and module mounting as well as other installation particularities dictate that these examples should not be used without further refinement. Tables 310-16 and 310-17 from the NEC provide the ampacity data and temperature derating factors.

EXAMPLE 1 Stand-Alone Lighting System

Array Size: 4, 12-volt, 64-watt modules, Isc = 4.0 amps, Voc = 21.3 volts

Batteries: 200-amp-hours at 24 volts

Load: 60 watts at 24 volts

Description

The modules are mounted at the top of a 20-foot pole with the metal-halide lamp. The modules are connected in series and parallel to achieve the 24-volt system rating. The lamp with an electronic ballast and timer/controller draws 60 watts at 24 volts. The batteries, disconnect switches, charge controller, and overcurrent devices are mounted in a box at the bottom of the pole. The system is grounded as shown in Figure 1.

Calculations:

The array short-circuit current is 8 amps (2 x 4).

NEC 125%: 1.25 x 8 = 10 amps

UL 125%: 1.25 x 10 = 12.5 amps

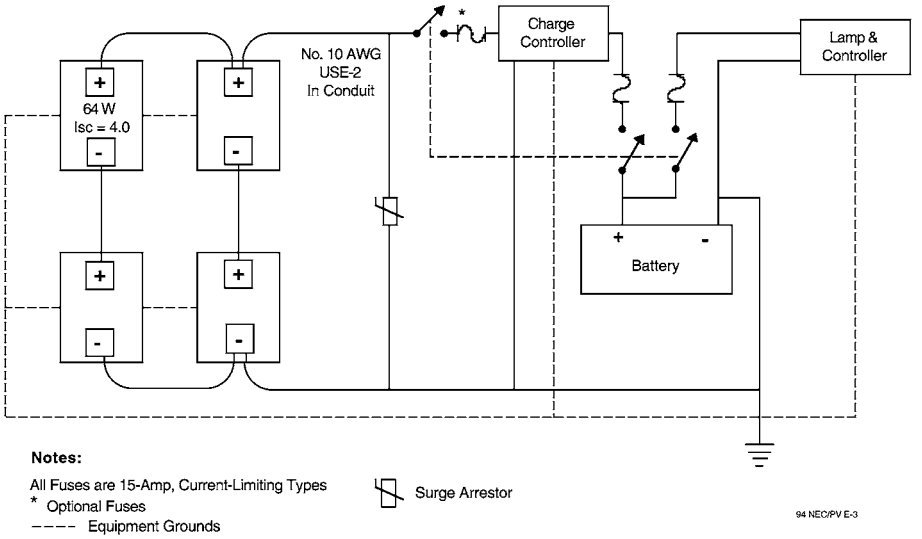
Load Current: 60/24 = 2.5 amps

NEC 125%: 1.25 x 2.5 = 3.1 amps

Number 10 AWG USE-2 is selected for module interconnections and is placed in conduit at the modules and then run down the inside of the pole.

The modules operate at 61-70°C which requires that the module cables be temperature derated. Number 10 AWG USE-2 (90°C insulation) cable has an ampacity of 40 amps at 30°C in conduit. The derating factor is 0.58. The temperature derated ampacity is 23.2 amps (40 x 0.58) which exceeds the 12.5 amp requirement. Checking the same #10 AWG cable with a 75°C insulation, the ampacity at the fuse end at 40°C ambient temperature is 30.8 amps (35 x 0.88) which

FIGURE 1 Stand-Alone Lighting System



exceeds the 10-amp requirement. This cable can be protected by a 15-amp fuse or circuit breaker.

The same USE-2, number 10 AWG cable is selected for all other system wiring as it has the necessary ampacity for each circuit.

A three-pole fused disconnect is selected to provide the PV and load disconnect functions and the necessary overcurrent protection. The fuse selected is an RK-5 type providing current-limiting from the high battery currents. A pull-out fuse holder with either Class RK-5 or Class T fuses could also be used for a more compact installation. The 15-amp fuse at the input to the charge controller is not absolutely necessary since this circuit is protected from overcurrents by the 15-amp fuse between the charge controller and the battery. The disconnect at the input of the charge controller is necessary.

The equipment grounding conductors and the system grounding conductor to the ground rod should be number 10 AWG conductors.

The DC voltage ratings for all components used in this system should be at least 53 volts (2 x 21.3 x 1.25).

EXAMPLE 2 Remote Cabin DC-Only System

Array Size: 6, 12-volt, 75-watt modules, Isc = 4.8 amps, Voc = 22 volts

Batteries: 700 amp-hours at 12 volts

Load: 75 watts peak at 12-volts DC

Description

The modules are mounted on a rack on a hill behind the house. Non-metallic conduit is used to run the cables from the module rack to the control panel. A disconnect and control panel are mounted on the back porch and the batteries are in an insulated box under the porch. All the loads are DC with a peak combined power of 75 watts at 12 volts due primarily to a pressure pump on the gravity-fed water supply. The battery bank consists of 4 350-amp-hr, 6-volt deep-cycle batteries wired in series and parallel. Figure 2 shows the system schematic.

Calculations

The array short-circuit current is 28.8 amps (6 x 4.8).

UL 125%: 1.25 x 28.8 = 36 amps

NEC 125%: 1.25 x 36 = 45 amps

The module interconnect wiring and the wiring to a rack-mounted junction box will operate at 65°C. If USE-2 cable with 90°C insulation is chosen, then the temperature derating factor will be 0.58. The required ampacity of the cable at 30°C is 77.6 amps (45/0.58) which can be handled by number 8 AWG cable with an ampacity of 80 amps in free air at 30°C. Conversely, the ampacity of the number 8 AWG cable is 46.4 amps (80 x 0.58) at 65°C which exceeds the 45 amp requirement. Checking a number 8 AWG cable with 75°C insulation operating at 45°C (assumed junction box temperature) yields an ampacity of 57.4 amps (70 x 0.82) which is in excess of the 36 amp requirement.

From the rack-mounted junction box to the control panel, the conductors will be in conduit and exposed to 40°C temperatures. If XHHW-2 cable with a 90°C insulation is selected, the temperature derating factor is 0.91. The required ampacity of the cable at 30°C would be 45/0.91 = 49.5 amps in conduit. Number 8 AWG cable has an ampacity of 55 amps at 30°C in conduit which exceeds the 49.5 amp requirement. Conversely, the number 8 AWG conductor has an ampacity of 50 amps (55 x 0.91) at 40°C in conduit which exceeds the 45 amp requirement.

The number 8 AWG cable, evaluated with a 75°C insulation, has an ampacity at 40°C of 44 amps (50 x 0.88) which is greater than the 36 amps that might flow through it under noon-time irradiance conditions.

The array is mounted 200 feet from the house and the round trip cable length is 400 feet. A calculation of the voltage drop in 400 feet of Number 8 AWG cable

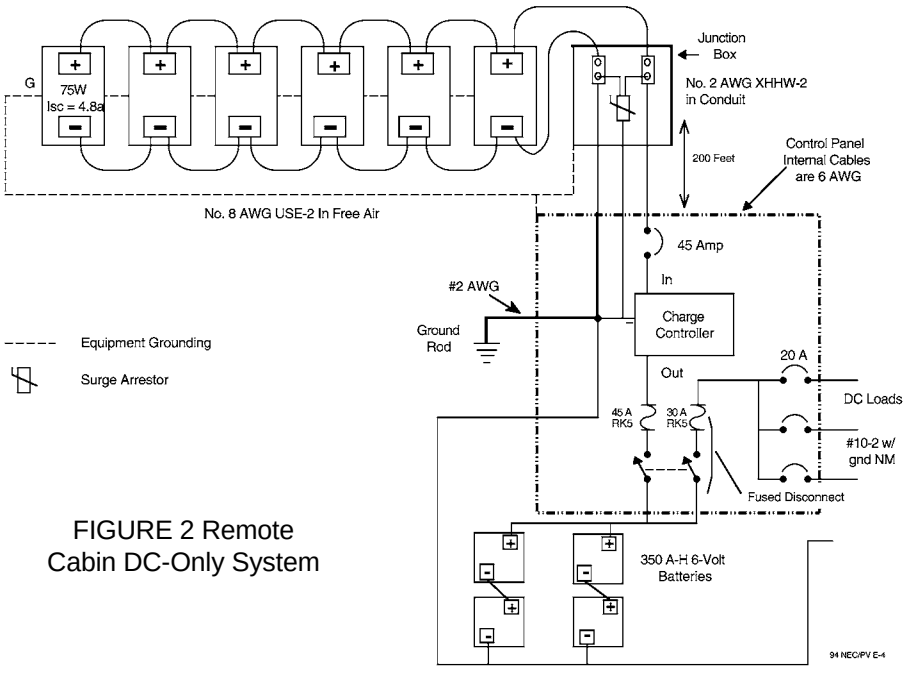


FIGURE 2 Remote Cabin DC-Only System

operating at 36 amps (125% Isc) is 0.778 ohms per 1000 feet x 400 / 1000 x 36 = 11.2 volts. This represents an excessive voltage drop on a 12-volt system and the batteries cannot be effectively charged. Number 2 AWG cable was substituted which has a voltage drop of 2.8 volts which is acceptable for this installation.

The PV conductors are protected with a 45-amp single-pole circuit breaker on this grounded system.

Number 6 AWG THHN cable is used in the control center and has an ampacity of 95 amps at 30°C when evaluated with 75°C insulation. Number 2 AWG cable is used from the negative DC input to the point where the grounding electrode conductor is attached instead of the number 6 AWG conductor used elsewhere to comply with grounding requirements.

The 75-watt peak load draws about 6.25 amps and number 10-2 with ground (w/gnd) nonmetallic sheathed cable was used to wire the cabin for the pump and a few lights. DC-rated circuit breakers rated at 20 amps were used to protect the load wiring which is in excess of the peak load current of 7.8 amps (1.25 x 6.25) and less than the cable ampacity of 30 amps.

Current-limiting fuses in a fused disconnect are used to protect the DC-rated circuit breakers which do not have an interrupt rating sufficient to withstand the short-circuit currents from the battery under fault conditions. RK-5 fuses were chosen with a 45-amp rating in the charge circuit and a 30-amp rating in the load circuit. The fused disconnect also provides a disconnect for the battery from the charge controller and the DC load center.

The equipment grounding conductors should be number 10 AWG and the grounding electrode conductor should be number 2 AWG.

All components should have a voltage rating of at least 1.25 x 22 = 27.5 volts.

Summary

The calculations used in these examples are based on UL and NEC requirements. While there is some leeway in the selection of cable types, overcurrent devices, and disconnects, all DC-rated devices should be used. Oversizing the cables will lower voltage drop and increase performance, particularly where long cable runs are involved.

Access

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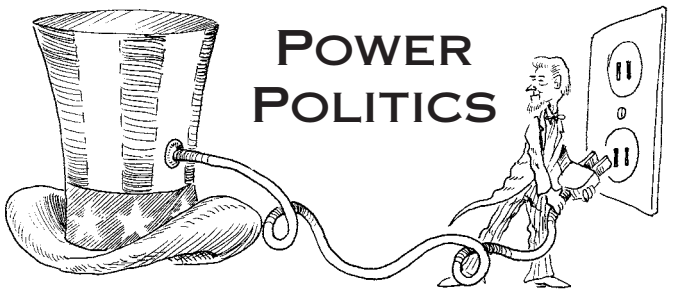

Net Billing, Solar Incentives & Nuclear Waste

Michael Welch

I need to start this issue's column with a request. We've been working on finding out which states and which utilities within each state allow net billing for excess renewable energy generated by home power systems that are also on the grid. We'd like to hear from those of you that have that knowledge in your locale.

Net billing means that the amount of energy you supply to the grid is subtracted from the amount that you use from the grid before you are billed by the utility. The bill (or check) only includes the difference. This can be done several ways, but the easiest is probably letting the meter automatically run backwards when the household is producing more than it is consuming.

In my territory, with the dreaded Pacific Gas & Electric Company, home power producers are paid "avoided cost" for excess power. That translates to under 4 cents per kilowatt hour (kWh), while the utility is charging about 11 cents per kWh. Of course, there are a lot of factors involved in the pricing, including time of use, etc., but on the average, it means that I would have to give the utility about four times as much electricity as I get from them, just to break even.

This bites the big one. Other utilities in CA have used net billing, but are not required to. At this time, there is legislation pending that would require it on a statewide basis, but it is unclear what kind of chance it has in the legislature or if California's right-wing governor would allow it to become law or veto it.

Please send me the specifics of what is happening or about to happen in your neck of the woods. It would be great to get info on specific legislation and contacts in your state. Separately, any suggestions for Power Politics Columns are welcome, and I just love to get inside info that I can pass on to readers.

Rate-Based Incentives

Net billing ties strongly into the success of the rate-based incentives models discussed in the last two issues of Home Power Magazine. Obviously, the better deal the utilities give producers, the more likely people are to put these systems on their roofs. If the utilities give us good deals on sell-back, then that amount can stay in an incentives fund to further increase the number of roof-top systems funded by local programs.

By the way, it was pointed out to me that I had been using the term "rate-base" in a way which was somewhat confusing and inconsistent to those familiar with utility industry terminology. The technical term means the accumulated capital cost of facilities purchased or installed to serve the company's customers. It is the "base" upon which utilities are allowed a return on their investment.

Being a more people-oriented person, I had fudged the term to mean the base of population that is paying for the utility's power. Colloquially, the term has been used that way for quite awhile. It is important to note that the technical definition is different, yet related. To confuse the matter even further, rate-based incentives are called that because the amount available to the incentive programs are founded upon a percent of local utility bills, or rates that the consumer pays.

Personally, I believe that calling the incentives "rate-based" is appropriate, even if not technically correct to industry watchers. What we are advocating is relatively populist in nature, and deserves a populist definition which itself may even fly in the face of the utilities.

We at Home Power are still hoping to hear from you folks that have an interest in researching and implementing rate-based incentives in your own communities. Hello, is anyone out there? If you missed the articles in the last two HP issues and want to know what the heck I'm talking about, just drop me a line and I'll send you copies.

Contract On America

Well, the new Republican Congress is through the first half of its 100 day action program, and as you might imagine, both the poor and the environment are on shaky ground.

Things are not all bad, however. Bennett Johnston, a Democrat from Louisiana who is the number one nuclear advocate in the nation, recently announced his retirement. Johnston held one of the most powerful seats in the nation as chairperson of the Senate Energy Committee. Over the years, he has crusaded for the nuclear industry's agenda in spite of public opinion and his own party's platforms. Maybe he doesn't like taking the back seat to someone else after being so powerful. Good riddance, I say.

So, now the Republicans are claiming a mandate to either eliminate or gut regulations that have an impact on corporate bottom lines. And let's call a shovel a shovel, the point of the conservative agenda is not to save taxes for the common person, but to give every break possible to corporate America, and big business in general.

As you might imagine, that segment of America includes the fossil fuel and nuclear industries, and for the most part excludes the home power industry. Don't look for any more breaks for national renewable energy policy in the near future. In fact, the new chairperson of the Energy Committee is Senator Murkowski of Alaska, and you can bet he's deep in the pockets of Alaska oil interests. Rumor has it he'll be reopening oil industry efforts to drill in the Alaska National Wildlife Refuge (ANWR, remember that?).

S-167, The Nuclear Waste Policy Act of 1995

But, Senator Johnston is not done with us yet. He has introduced the latest form of the Nuclear Waste Policy Act, long known as the "Screw Nevada Bill". He apparently has Murkowski's blessing.

The bill has been scheduled for Energy Committee hearings starting March 2, which is after this is being written. For many years, Nevada state government has been fighting the proposed siting of a high level nuclear waste repository at Yucca Mountain. The new bill will eliminate safeguards that have allowed Nevadans to continue challenging the siting. First, it guts the radioactivity release limits that are in the original bill. This makes it easier for many concerns that Nevada has to be downplayed within the siting procedures.

Second, it does away with safeguards to prevent temporary nuclear waste facilities from becoming permanent and encourages the building of such a facility, which might end up at the Nevada site. Under the new law granting a 100 year license, it would likely become the de-facto permanent repository for high level nuclear waste.

But, the bill could have another insidious effect. It sets aside prohibitions that keep utilities from siting their own dumps. This leaves it wide open for the utilities to negotiate non-government storage options. A storage site could be built at any one of a number of Native American tribal lands, which maintain their own sovereignty and are therefore not subject to many state or federal regulations. The nuclear industry is very interested in using this as a way of getting around the issue of state's rights in the siting of a nuclear waste storage facility.

In fact, the previous version of the Nuclear Waste Policy Act set up a program throwing lots of money in the direction of tribes and other entities that wanted to examine and pursue the possibility of siting a "temporary" storage facility on their lands. One such tribe was the Mescalero Apaches of Minnesota. The feds sent hundreds of thousands of dollars their way as legal bribery to encourage the siting process. For quite awhile, it looked like the Mescaleros would go for it. Tribal leaders were proceeding with the process in spite of not having the support of the majority of tribal members. The tribe finally got a chance to vote for or against the project late in January, and the native pro-nukers' plans were soundly defeated.

But since then, another small tribe has popped up that wants to get in on the cash cow. The Skull Valley Band of the Goschutes tribe in Utah has indicated they would love to have a nuclear waste facility on their lands. Their reasoning is that their lands are already despoiled by other polluting projects located there, including a hazardous waste incinerator, so they have nothing to lose.

You might think that the Clinton Administration would veto these changes to the Act, but think again. Remember awhile back when we expressed concern that Energy Secretary Hazel O'Leary came from a utility background which included nuclear power? Well, a coalition of utilities that has been working very hard to site a non-government dump is lead by Northern States Power, the very utility that O'Leary worked for before becoming Secretary of Energy!

O'Leary scheduled an industry meeting for March 1, the day before Energy Committee meetings are scheduled to start on Johnston's new Nuclear Waste Policy Act of 1995. As of this writing, the word in Washington, DC is that O'Leary will use that meeting to claim a consensus of support for the Act, which would make it very difficult to defeat.

The only hope is that safe-energy advocates will show up in force at that open meeting to prove that she does not have such a consensus. It was fortunate and not intentional that the existence of that meeting was disclosed to activists in time to get the word out. Most

safe-energy activists admit that they don't have much chance of defeating the Act in the Senate, and are putting the effort into stopping it in the House.

So, you know the drill, write the President, your Senators and your Congressperson to stop this latest pro-nuclear farce.

Access

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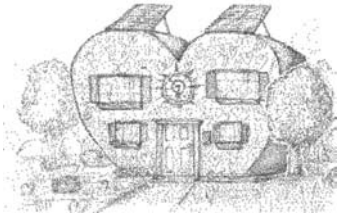
Nuclear Information and Resource Service, 1424 16th St. NW, Washington, DC 20036, (202)328-0002, Internet: nirsnet@aol.com

Home & Heart



Kathleen Jarschke-Schultze

The great efficient washing machine search continues — more information and questions. I am testing a Staber H-Axis top loader, model HXW2300. I have not used and tested it thoroughly enough to write a review in this issue.

Speed Queen

Lowell G. Wilson wrote about his Speed Queen washer-extractor, model BX218. He's pleased with its performance. It does have stainless steel where the water and clothes are. It is a laundromat model with a start switch and cycle selector where the coin slot would be.

While looking for the machine's manufacturer at the laundromat the woman there told him, "These machines never breakdown." Lowell did have to replace the water level switch in his model. Lowell says the part was easy to change and he feels the main parts are fairly simple and straightforward.

The BX218s load capacity is 18 lbs. Its electrical rating is 120V, 60 hz, single phase.The drive motor has an internal overload protection; wound for two speed operation: lifetime lubricated. Spin — 3500 RPM and tumble — 350 RPM. The door lock is an electrically operated solenoid that energizes to lock. Water flow rate is 5 gpm. The estimated water usage is 31.5 to 43 gallons. This is based on cycles, with and without prewash, under loaded conditions.

The circuit breaker is a 20 amp, 1 phase 60 hz model. Full load amps for the same model are 13 amps. The wash speed is 55 rpm and the spin speed is 560.

White Westinghouse

One reader says his White Westinghouse front loader Model LT350RXW runs the drum with a DC motor. The motor's speed and direction (which reverses constantly during the wash) is controlled by a solid state controller. The controller senses the drum's speed by a tachometer attached to the drum or motor. It is Tom's opinion that it would be difficult to adapt this machine to run off of battery power, as he thinks the speed controller employs a triac to regulate motor speed.

More W-W

One family has used White Westinghouse front loaders for the last 35 years. They are planning to buy #4 soon. There have been service problems, but all repairs were done by the owner. More important than the water saving feature is the use of one-half the amount of detergent and bleach. This is an important environmental consideration and money saver. The owner figures he's saved enough money to pay for the occasional repair part.

European DHW

This reader continues on to explain that in Europe point-of-use HW (hot water) heaters are the norm and electrically powered. They have undersink units, shower heads, dishwashers, clothes washers, and booster units of all kinds.

He uses a dishwasher with a booster for sterilizing and drying. He detached the wires to the resistance-heater cal-rod and allows the dishes to air dry. He thinks this might work on a clothes washer with a booster HW unit. Several people have suggested using a blending valve before the single input valve on the machine. A blending valve would allow you to choose the water temperature entering the machine. There are even automatic temperature blending valves which give you a stable blend with changing input temperatures from hot and cold sources.

Washing with only cold water has not worked for this family. Apparently unable to deal with grease, oil, fats, until a temperature of 120°F is reached. Cold water detergents need a like temperature to clean well. A last hint is to use the lowest sudsing detergent you can find in your H-axis washer. This eliminates all of the liquid and many cold water laundry soaps.

Wascomat

A full-time RVer for the last 10 years, who considers himself well versed in the laundromat dance, says his favorite front loader is the Wascomat. "It has two wash cycles and cleans much better than top loaders. They come in several sizes and are expensive." Because the Wascomat uses less water it also uses less detergent. For information he suggests asking the owners of laundromats and/or dealers in larger cities that sell commercial.

Home Wascomat

A South Dakota reader has a Wascomat P-10 which uses 90 watts on wash and 390 watts on spin. It's rated at 10 lbs. per wash, more or less and uses 22 gallons of water per cycle. The machine has a gravity drain so needs a floor drain, low drain, or placed on a stand. The P-10 has a very high spin speed so there is less drying time. These machines are occasionally available

from industrial washing machine service centers or dealers for $100 to $400.

Conclusion

A woman called to tell me about a new kind of H-axis washing machine that's in her local laundromat . It's called a Primus and is made in the U.S. She couldn't see the address, but the woman who worked there is trying to find it. I've tried to find the address, but came up blank.

I continue to use and monitor the Staber HXW2300 H-axis washer. I will be reviewing it. I am saving up my opinions and results for that time. It is a really unique appliance and so far I like it.

The government has mandated that appliances become more efficient. H-axis washers are, by their very design more efficient. I have heard that several large manufacturers are planning on releasing H-axis in the next year or two. Competition is good, choice is good. Several people have called me to ask which washer I recommend — None so far. I am still looking and devouring all the information and recommendations people send to me.

Access

Kathleen Jarschke-Schultze is testing the washer at her home in northern-most California, c/o Home Power Magazine, PO Box 520, Ashland, OR 97520 • 916-475-0830 • Internet E-mail: kathleen.jarschke-schultze@homepower.org or • kjs@snowcrest.net

Staber Industries, Inc., 4411 Marketing Place, Groveport, OH 43125 • 614-836-5995 or 800•848-6200 • FAX 614•836-9524

Asko, inc., 903 N. Bowser #200, Richardson, TX 75081

AEG OKO-Lavamat, The Andi Co, 65 Campus Plaza, Edison, NJ 08837 • 908•225-8837

White-Westinghouse, 6000 Perimeter Dr. Dublin, OH 43017 • 800-245-0600

Wascomat, 800-645-2204 or 800-645-2205

HAPPENINGS

AFRICA
The 1995 ISES "In Search of the Sun" Conference, "The World Solar Energy Exhibition and the finish of a solar car race is scheduled for September, 11–15, 1995 in Harare, Zimbabwe. For exhibitor and attendance information contact Peter Armstrong, exhibitor director, In Search of the Sun, PO Box 2851, Harare, Zimbabwe, Phone: (263-4) 730707, Telex: 0907 (26623 ZW), Fax: (263-4) 730700, e-mail: xcarelse@zimbix.uz.zw

CANADA
The 7th Canadian Hydrogen Workshop will be held June 4–6, 1995 in Quebec, Canada. Workshop topics are Hydrogen production, usage, storage, safety, environment, fuel cells, and metal hydride rechargable batteries. For more information contact: Canadian Hydrogen Association, 5 King's College Rd, Toronto, Ontario M5S 1A4, fax 416-978-0787.

Are you operating a diesel or gas generator with their high fuel and maintenance costs, or just doing without electricity? Have you ever wondered about the energy available in falling water? This course will tell you how to determine the feasibility if a low maintenance water power option — not necessarily nearby. The two day, fourteen hour micro-hydro courses are suitable for everyone, regardless of technical background. The course includes an overview of electricity & energy and terms & concepts. Upon completion, you will be able to assess the potential of your stream or creek to meet your electrical needs. Learn how to size system components, estimate costs, and have some basic installation guidelines. The cost of the two day course is approx. $90 Cnd (approx. $65 US). May 13 & 14, 1995 — Univ College of the Cariboo, Williams Lk, BC V2G 3P7, (604) 392-8043. For more information contact, Bob Mathews, course instructor, at 604-679-8589. Field trips and other course dates will be scheduled as demand requires.

FRANCE
13th European Photovoltaic Solar Energy Conference and Exhibition, Nice, France, 23–27 October 1995. Call for papers on fundamentals, new materials, crystalline silicon, thin film, concentrators, PV systems, strategies and policies; deadline April 28, 1995. For more information contact Dr. H Ossenbrink, EC-Joint research Centre, European Solar Test Installations/ESTI, 1-21020 Ispra (VA), Italy, phone +39-332-789 172, fax +39-332-785 561 or +39-332-789 268

NATIONAL
Model Home Electrical System Workshop: Help install the PV and wind generator systems that will power this year's Midwest Renewable Energy Fair in Amherst, WI. Instructors for the PV installations will be Jim Kerbel of Photovoltaic Systems and Chris LaForge of Great Northern Solar. Instructor for the wind generator installation will be Mick Sagrillo of Lake Michigan Wind & Sun. The workshop runs from June 15th to the 22nd, and is limited to 12. Cost is $125, payable to the Midwest Renewable Energy Association, POB 249, Amherst, WI 54406. For more information, call Jim Kerbel at 715-824-2069.

American Hydrogen Association Bulletin Board System: Solar Hydrogen BBS, 415-494-3116, 1200–14,400 baud V.32bis. V.42bis 8N1, Prosperity without Pollution: also AHA Tempe BBS (602) 894-8403.

Free Energy-Saving Information for homeowners who are preparing for the arrival of winter and would like information on cutting their residential energy bills. The Energy Efficiency and Renewable Energy Clearinghouse (EREC), is offering a free booklet entitled "Heating The Home".To obtain a copy contact EREC by calling 1-800-DOE-EREC (363-3732) or by writing EREC, PO Box 3048, Merrifield, VA 22116

EAST COAST
American Tour de Sol — National Road Rally Championship for Electric and Solar Electric Vehicles, May 20–27, 1995, Waterbury, CT—Portland, ME, traveling through five states: CT, MA, VT, NH & ME, with pit stops in Northampton and Greenfield, MA, Brattleboro, VT, Mount Monadnock State Park, Lexington, MA, and Dover, NH. The public is invited to view over 50 electric and solar powered cars on secondary highways and free public displays in Connecticut, Massachusetts, Vermont, New Hampshire and Maine the week of May 20–27. These non-polluting vehicles will be competing in the American Tour de Sol for the national electric and solar vehicle championship title, and clean air for the region. Production electric vehicles built by the big three and other electric vehicle manufacturers, students and individuals from around the country and abroad. For more information about the event, volunteering, participating, sponsoring, or exhibiting please contact Northeast Sustainable Energy Association (NESEA), 50 Miles St, Greenfield, MA 01301, (413) 774-6051, Fax (413) 774-6053.

ARKANSAS
Sun Life is now conducting "Third Saturday Seminars" on inexpensive building techniques. The focus of these seminars is to teach others how to build their own homes from materials that can last a thousand years and cost less than conventional wood-framed homes. These are hands-on, all day workshops. Contact Loren at PO Box 453, Hot Springs,AR 71902

ARIZONA
Beginning January 1995 the State of Arizona is offering a state tax credit for installation of all types of solar energy systems. A solar technician, certified by the Arizona Department of Commerce must be on each installation job site. For more info contact ARI SEIA, (602) 258-3422

CALIFORNIA
Arcata, California will host the Humboldt County's Fourth Annual Renewable Energy Fair at the Arcata High School on Saturday April 22, 1995. Displays, workshops, music, food, and Earth Games & kids activities. For more information contact REF, PO Box 4179, Arcata, CA 95521, (707) 822-3481

SMUDs 1995 Brown Bag Solar Series VII. Where: SMUD Energy Services, Plaza 50–2, Conference A (upstairs), 6701 4th Ave, Sacramento, CA When: Every other Tuesday, Noon to 1:00 pm, Bring your lunch, and enjoy the FREE presentation! April 4, Energy As The Definition Of The Esthetic; May 2 Community Involvement In Using Renewables/Recycling; May 16 What's New At Solar Box Cookers International; May 30 Truckee Ground Source Pilot Project; June 13 Building With Rice Hulls/Solar Water Heated Floors;

June 27 Solano Wind Project Update. For more information or to borrow a video of past presentation call (916) 732–6835.

Siemens Photovoltaic Training Workshop, intensive five day seminars, will be held May 15–19, July 10–14, and October 16–20. For more information contact Cindy Vernon, Siemens Training Department, 4650 Adohr Lane, Camarillo, CA 93010; (805) 388-6585,FAX (805) 388-6395.

REDI (Renewable Energy Development Institute) Conference '95, August 11–13. Contact REDI, 733 S Main St, Willits, CA 95490, (707) 459-1256, Fax (707) 459-0366.

COLORADO
The 6th Crestone Energy Fair, Labor Day Weekend, September 2nd and 3rd, 1995, Crestone Town Park, Free to the public. A gathering of solar advocates, experts, and novices for a weekend of solar technology, fun, music, food, council and a tour of solar homes. This is a self organizing solar potluck and camp. Come and enjoy. Booth fee — 1 item donation to the Green Goods

Raffle. Turtle Island, PO Box 222, Crestone, CO 81131

'95 Jade Mountain/Denver Electric Vehicle Council Electrathon Challenge Schedule: Electrathon Challenge '95 events will be held the third Sunday of the month. Vehicle inspection will begin at noon with competition starting at 1:00 pm. The future is electric! Join the fun at the next Electrathon. April 23rd, 12:00–3:00, 33rd and Arapahoe, Boulder, CO. May 21st, 12:00–3:00 6th Ave and RD93, Golden, CO. June 25th, 12:00–3:00, 33rd and Arapahoe, Boulder, CO. July 23rd, 12:00–3:00 6th Ave and RD93, Golden, CO. All event locations are tentative. August 27th and September 24th locations to be announced. For more information call Bill Williams (303) 449-6601 or write DEVC, 2940 13th St, Boulder, CO 80304

Solar Energy International (SEI) is offering workshops on the practical use of solar, wind, and water power. The 1995 Renewable Energy Education Program (REEP) features one and two week workshops: Solar Home Design , Environmental Building Technology, PV Design & Installation, Advanced PV, Solar Cooking & Biofuels, Micro-Hydroelectric Systems, and Wind Power. Guest speakers and professional instructors will teach the design of state-of-the-art solar homes that are self-reliant, energy efficient, healthy to live in, and earth-friendly. Participants will learn the knowledge and skills to build energy-independent homes with solar, wind, and water power. The series is for owner-builders, industry technicians, business owners, career seekers, and those working in developing countries. The workshops may be taken individually or as part of a program. The cost is $400 per week. Scholarships and work/study programs are available on a limited basis. Contact: Solar Energy International, PO Box 715, Carbondale, CO 81623-0715 or call 303-963-8855.

1995 Sun Sprint of the Rockies is an electric, hybrid and solar/electric vehicle race. For its inaugural year, the race will be run from Aspen CO to Moab, UT crossing some of the world's most beautiful scenery during the days of July 11–21, 1995. All contestants must be present on July 10, for the pre-event technical testing in Aspen. On the morning of the 11th we will begin the 550 mile road trek to Moab, UT, with at least 14 educational shows open to the public. The course will include steep mountain passes, low flat lands, and twisting canyon roads to challenge the vehicles. We will average about 50 miles per day, each with mid-day recharging. This will be a fun filled time for both the public and the racers. It will also be very educational for the racers as well as the public. For more information please contact Zach Keele at 303–872–3882, fax 303–872–2390, or write to hi at 81438 Hwy 92, Maher, CO 81415.

IOWA
The Iowa Renewable Energy Association is sponsoring an Earth Day Tour in April 30, 1995. Systems that are up and running of thermal, solar, photovoltaics and wind, and energy efficient and non-toxic housing will have open house at many locations throughout Iowa. For details contact Prairie Technologies Ph (319) 338-0836, Fax (319) 351-2338

MASSACHUSETTS
The Seventh Annual Sustainable Transportation and S/EV95 (Solar & Electric Vehicle) Symposium, Boston, MA, October 1995 (exact location and dates to be announced) will bring together a broad coalition of transportation planners, electric and hybrid electric industry representatives, business people, policy makers, ands engineers to foster the growth of a viable electric vehicle industry, and the development of a sustainable transportation vision for the nation. In-depth workshops, concurrently held sessions and an extensive trade show have made the event the major electric vehicle conference in the United States. For more information contact: NESEA, 50 Miles St, Greenfield, MA 01301, 413-774-6051, fax 413-774-6053.

MICHIGAN
Cedar Valley Workshops and Seminars. Traverse City. MI will be holding week-long workshops in renewable energy technology during the summer of 1995. Workshops in superinsulated construction (June 18–25), solar heating (July 9–15), wind power (July 23-August 5), and photovoltaics (August 13–19) will be offered, For more information contact Dr, Conrad Heins, 215 E. Muskegon St., Cedar Springs, MI Phone (616) 696–0603.

MINNESOTA
SOLAR '95 Conference, 10,000 Solutions: Paths to a Renewable Future will feature the 24th American Solar Energy Society Annual Conference and the 20th National Passive Solar Conference. Billed as the largest and most comprehensive solar energy conference. Solar '95 will emphasize practical cost-effective applications of solar energy that can improve the nations economy. Speakers are leaders in solar research and commercialization efforts. Tours and workshops are planned. July 15–20, 1995 in Minneapolis, MN. For more information contact: American Solar Energy Society, 2400 Central Ave G–1, Boulder, CO 80301, 303-443-3130, fax 303-443-3212

MISSOURI
The US Department of Energy, NREL, and Crowder College Missouri Alternative and Renewable Energy Technology (MARET) Center are sponsoring the nation's first solar powered bicycle race, June 19, 1995 on the Grand Prix race course at the Indianapolis Raceway. Solar BikeRayce USA is open to high schools, vocational schools and other secondary educational institutions. A solar powered bicycle is a pedal-powered bicycle that uses an electric motor, batteries and solar panels for added power. Riders use a combination of muscle power, solar energy and stored energy. To win, the team's best athlete must ride the solar bike to achieve the highest speed by optimizing their use of human and the bike's electrical energy. The first 60 schools submitting proposals will participate in the race. Entries will be split into two divisions: teams with a male rider and teams with a female rider. The winning team from each division will receive a trophy and a $1,000 cash award. Second & third place finishers from each division will receive trophies and $600 and $400 respectively. Applications an regulations are available from: Solar BikeRayce USA, Crowder College MARET Center, 601 Laclede Ave, Neosho, MO 64850, 816-899-5512.

NEW YORK
The New York State Electric Auto Association (NYSEAA) is dedicated to sharing current electric vehicle technology. Monthly meetings, for date and location call Joan at 716-889-9516

Earth Day Festival and Energy Fair will be held April 22–23, 1995 at the Institute of Technology in Rochester, New York: Featuring alternative transportation, workshops on solar architecture, solar electric systems, energy efficient and environmentally conscious building, batteries, rail transit, sustainable agriculture, natural gardening and landscaping, vendors of RE products, and government agency energy programs and grants For more information on exhibiting, attending or participating, contact CEI, 50 Main Street West, Rochester, NY 14614-1218, 716-262-2870, Fax 716-262-4156, EMail, ctrenvinfo@igc.apc.org

NORTH CAROLINA
Solar Energy International (SEI) will be presenting a workshop in Photovoltaic Design & Installation in Raleigh from April 17–22. The workshop will cover design and sizing of photovoltaic systems Participants will learn the basics of PV through labs and a hands-on installation, and will tour residential and utility-tied PV systems. Contact Solar Energy International, PO Box 715, Carbondale, CO 81623-0715, or call 303-963-8855.

OHIO
Solar electric classes taught at rural alternative powered home with utility backup. Maximum of 12 students. Must advance register. $30 fee per person, $35 per couple, lunch provided. Class will be full of technical info, system sizing, NEC

compliance, etc. Students will see equipment in use. Dates: May 3, June 10, July 8, Aug. 12, Sept. 9, Oct. 14, Nov. 11, & Dec. 9. All classes held from 10 AM to 2 PM on Saturday.. Call 419-368-4252 or write Solar Creations, 2189 SR 511 S, Perrysville, OH 44864-9537.

The Great Lakes Electric Auto Association's mission is to contribute to the freeing of the US automobile market from dependency on petroleum through advancements in electric and hybrid/electric technology. For more information contact, Larry Dussault, GLEAA, 568 Braxton Pl E, Westerville, OH 43081-3019, 800-GLEAA-44 or (614) 899-6263, Fax (614) 899-1717. Internet address DUSSAULT@delphi.com.

OREGON

The Lost Valley Educational Center is an intentional community and learning center devoted to developing the skills and awareness that will create a sustainable lifestyle. They are offering various low-cost workshops covering everything from low-cost underground housing to building solar ovens. For more information call or write Lost Valley Educational Center, 81868 Lost Valley Ln, Dexter, OR 97341, 503-937-3351

WISCONSIN

May 6 and 7, The Midwest Renewable Energy Association presents a two day workshop, Designing and Detailing for Energy Efficiency in Home Construction. Workshop presents Mark Klein, Ray Resar and Jim McKnight of Gimme Shelter Construction, Amherst, WI. Gimme Shelter is a construction firm long dedicated to energy efficient and renewable energy design and construction methods. Their hand-built homes dot the countryside throughout Central Wisconsin. This course covers residential siting, passive solar design, active solar, in-floor hydronic heating systems, energy efficient and environmentally friendly building materials, super insulation, daylighting, and more. A portion of the class will take place at a Gimme Shelter construction site, The workshop topics discussed may be developed by individual interests of participants, to further draw on the wealth of knowledge Gimme Shelter brings to the course. The two day workshop is located in Amherst, WI, cost $200. For more information: MREA, PO Box 249, Amherst, WI 54406. Ph. 715-824-5166.

Model Home Electrical System Workshop: Help install the PV and wind generator systems that will power this year's Midwest Renewable Energy Fair in Amherst, WI. Instructors for the PV installations will be Jim Kerbel of Photovoltaic Systems and Chris LaForge of Great Northern Solar. Instructor for the wind generator installation will be Mick Sagrillo of Lake Michigan Wind & Sun. The workshop runs from June 15th to the 22nd, and is limited to 12. Cost is $125, payable to the Midwest Renewable Energy Association, POB 249, Amherst, WI 54406. For more information, call Jim Kerbel at 715-824-2069.

The Sixth Annual Midwest Renewable Energy Fair will be held June 23–25, 1995 at the Portage County Fairgrounds, in Amherst, Wisconsin. Contact Midwest Renewable Energy Assn., POB 249, Amherst, WI 54406 • 715-824-5166

John (JT) Smith, J.T.'s Power Production in Palermo, CA recently passed away.
"J.T. was a friend to alternative energy in general," says Gene Hitney of Hitney Solar. "We will miss him very much."

the Wizard speaks…

New Science

One of the major problems in science is the overcoming of theoretical limitations created by previous experiences. Prior experiences often do not apply to present or future situations. Periodically, new theories need to be developed to explain anomalous results which don't fit into present ideas. Now is such a time. Much data exists which calls into question many of the assumptions of modern scientific theory.

A great deal of experimental and theoretical work is being done in an attempt to develop a new scientific paradigm for the future. A great deal of this effort is based in the theory of the zero-point field. (see The Wizard Speaks HP#42). This deals mainly with energy from the vacuum field of space and its interactions with matter. Not only does this work promise new technologies and energy sources, but also a greater and more coherent view of the way things work.

As with any major paradigm shift, there is great resistance to these new theories from the scientific establishment. This is especially true of quantum mechanics and relativity theory. Many of the theoretical breakthroughs have been to the detriment of these two disciplines. Changing viewpoints are inevitable and now is the time for the emergence of a new theoretical synthesis which will produce the new future paradigm.

Letters to Home Power

An Answer — Grid Intertie Letter HP#43
I am an owner (along with other business partners) of a 1200 kW (1.2 MW) hydroelectric plant in southeast British Columbia, the output of which is sold to the local utility, West Kootenay Power. As part of our contact, the metering is set-up such that we buy all power required at the plant (lighting, tools, heat, etc.) at the retail rate, and sell all our output at the contract rate.

The rationale behind this seemingly unfair arrangement versus that of net billing can be understood by examining the scale of the projects. With varying water flows, our private hydro plant generates over five million kWh per year, and requires only .02% of that itself (#1 typical home consumption, i.e. it is a drop in the bucket and not worth arguing about).

Canadian electric utilities are large, government-owned monopolies regulated by Commissions (WKP above is private — a small exception). There are no laws requiring them to purchase any private power. During 1991 & 1992 I attempted to negotiate a net billing arrangement (or, barring that, a two meter system as described by Carl Berger) between BC Hydro — the Provincial utility — and my customer who wished to install a 10 kW wind generator. (Where utility lines are available, grid tie is the method of choice, not only for eliminating the battery and reducing inverter costs, but because it provides unlimited storage capacity.) Amongst other arguments (clean, renewable energy; private $ — no public debit or risk; decentralized — more jobs/kWh; etc.), I used the same demand-side management (DSM) argument described by Mick Sagrillo. BC Hydro has an aggressive DSM program, "Power Smart", which subsidizes conservation. Ie., they pay customers to reduce their bills by saving energy. If they would just imagine that the wind generator was a bunch of energy efficient appliances & lites, they could pocket the subsidy $$ normally paid-out. Unlike Mick, I had no success at all and have given up dealing with this utility until they experience a modicum of enlightenment.

Clearly the encouragement of this type of private investment (well explained in "Rate Based PV", see HP#44) is in the global public interest Without economic structures/mechanisms in place to facilitate private investment, such available $$ (discretionary spending) will be squandered (my opinion) on more/fancier skidoos, seadoos, pools, 2nd/3rd cars, ski boats, etc.

The only valid argument the utility can make is that DSM tends to reduce peak loads, whereas a random/intermittent RE generating residence could have the same peak load as before, just less energy use. Utilities call this "shaping" of the load graph. But is this a significant argument to offset the societal benefits? Bob Mathews, Appropriate Energy Systems, PO Box 1270, Chase, BC V0E 1M0, Canada

Insatiable
Your magazine is great! I've been involved with electronics all my life and thought I'd seen it all. However, every issue brings up something new. I never thought about phantom loads or "Cruising" watt-hour meters before.

I can sense the changing of my technical philosophies every time I read and RE article. As a member of the National Association of Radio and Telecommunications Engineers (NARTE) I receive their newsletter (NARTE News). One of the biggest issues there is dependable power for data processing or communications centers. The current state of the art is to bring in utility mains from at least two sub-stations and perhaps have a battery bank with inverters as a last resort backup. When I started reading Home Power, realizing the advances in PV technology over the last couple of decades, I thought of perhaps using PV panels to charge that big backup battery bank Now, my ultimate dependable , redundantly backed up power system would be to use solar power and batteries as the primary source and the utility mains as a backup. The sun fails much less than the power company and there are no power line glitches, spikes, or brownouts in a properly designed inverter system.

My appetite for this stuff is insatiable. Robert Ciappa, Farmingville, NY

Hi, Robert. You are right about RE being more reliable than utility power. There are several grid-connected computer slaves hereabouts who maintain RE systems just for the computers. At HP Central, our computers have never eaten a watt-hour of utility electricity. We don't ever, never, crash from bad or no power! I figger that tain't nothing as reliable as sunrise! Richard Perez

OTG
I (we) first got off-the-grid (OTG) in 1986 with two 50 watt panels and two rope handle batteries in a 25' trailer. Now we're at 600 watts with a tracker and eight L-16's in a 1449 square foot passive solar home (85% completed). We're less than 1/4 mile from the grid in the new home, but the local power co-op wanted $2761 to hook-up. Which was enough incentive to us to stay OTG. I've learned more from your magazine in the last six months than all of my OJT (on job training) in the last eight years. Thanks for a great magazine!! Steve & Pat, Big Water, UT

Aw, shucks, thanks for the flowers. Richard Perez

Why Anti-Grid?
Your magazine is great! As an aspiring RE user, I'm inspired by all you folks who are living off-the-grid, but I expect to be living among grid wires for a long time. The anti-utility sentiment seems a bit short sighted since most folks are in the my boat. If RE is going to save the world, it will be grid intertied. I'd be buying one panel per month if I didn't need to deal with batteries — c'mon, most people can't keep their car batteries charged through the winter! The article on European

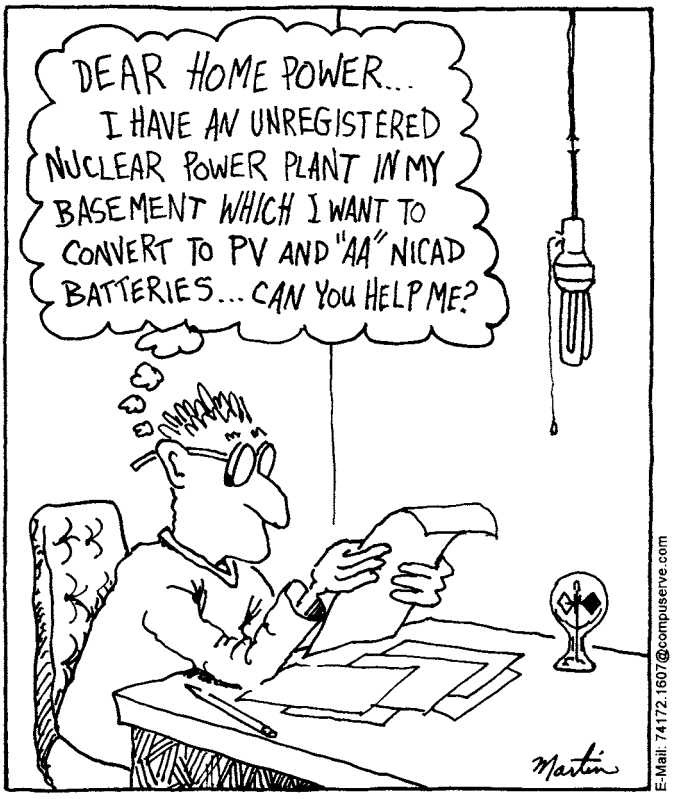
local RE incentives was great and I'd also like to have more on how to get the utility to let me intertie, intertie system demands & designs, etc. Also keep the electric and RE powered transportation info coming! If the "hill people" who carry this publication (an assumption) want to keep the hills nice, we need liveable cities and suburbs with electric cars and a panel on every roof (not trackers) connected to the ugly power lines (not batteries). Unfortunately, we have so many people that sticking one's head in the sand means you're going to get your neck stepped on. Keep up the good work. Tom Kacandes, Albany, NY

We are definitely in favor of grid-intertie systems. We have done many articles on them. In the past, utility-scale systems have been so poorly handled that some utilities have deemed them not cost effective. Fair buy back rates can be a problem because utilities are only required to pay avoided generating cost. If you want a better deal, ya' gotta' negotiate. You should be buying that panel every month. There's no reason why you, too, couldn't have an intertie system — batteries are not required (see HP#45, page 18)! What we are against is utilities using private property for their equipment (and in a lot of cases charging these folks a premium for the electricity that is produced — on their own property) and the utilities putting such a strangle-hold on the market that folks like you and me won't be able to buy the equipment (especially PVs). A lot of the problems we have today are because some marketing genius decided to sell oil, (early cars were electric), paper (all those huge forests were going to waste and the owners needed a market — thanks William Randolph Hurst), nuclear power (to cheap to meter, let's not worry about the waste, nukes aren't dangerous). If the subsidies for the electric and petroleum industries evaporated renewable energy would be cost effective —right now! Karen Perez

I Dare You!

Lighten up on the utilities! Most RE folks live where the utilities are small co-ops, trying to do what the locals want, and they want PV programs. Maybe all the political articles and updates belong in a different forum. Great technical articles; but your politics sound so self-serving to your advertisers, not subscribers. Pat Quinlan, Madison, WI

Hi Pat, thanks for your feedback on our technical articles. We disagree with your assumption that most RE'ers are living with utility small co-ops. The largest number of RE'ers live in Northern California in the territory of Pacific Gas & Electric Co., the largest investor-owned utility in the world. It looks to us like the monopolistic utilities want to take over a large portion of the market that small RE businesses pioneered! We've long been proponents of decentralized power production as a way to empower folks to maintain more control over their lives. As long as big utilities control our power sources, customers will not have the opportunity to fully determine their own energy futures. Your point about our politics seeming self-serving is not quite correct. We do feel an allegiance to those that have built this industry from the ground up, but it is circumstantial that many of them happen to be our advertisers. It is also true that some of our advertisers are on record as supporters of utilities' bids to jump into the home power industry. Michael Welch



3 Wheelers

I'm basically a lazy letter writer, but I must correct Michael Hackleman on his statement in HP #44, page 43.

"A common fear held by the general public is that a 3-wheeler is more susceptible to rollover then a 4-wheeler. Nonsense! A properly designed 3-wheeler can have an overturn resistance as good or better than most modern sedans. In tight turns, the tires will lose adhesion long before enough side force can be developed to flip the vehicle."

I'm afraid the general public is right in this case. Bucky Fuller with his 3-wheeled Dymaxion car in 1933 and, in recent years, the Japanese with their 3-wheeled all terrain farm vehicles had to learn the hard way that if one wheel goes in a hole in the road or has a tire blow-out the vehicle must tip. Think of a cow with four legs or a four legged stool. If one leg collapses you don't need necessarily lose your balance on the other three — but you certainly would have more problems if you only had two left.

More than 500 people had to get killed while riding 3-wheeled farm vehicles (counting the USA only) before manufacturers finally got the message and added another wheel.

I feel very strongly about this as I was a lucky survivor from a 3-wheeler accident where one wheel dropped into a hole, instantly flipping the vehicle over. Before this accident I, like Michael Hackleman was a strong believer in the safety of 3-wheeled vehicles. I compared them in my mind with the stability of a 3 legged stool or a camera tripod which doesn't rock on an uneven surface like four legs would.

All the best for the coming year. Alfred T. Forbes, Todd-Forbes Publishing, PO Box 3919, Auckland New Zealand

I was so happy to see this letter from Alfred Forbes on the hazard of 3-wheelers. The spectacle of the high death and injury toll of ATVs (all terrain vehicles) with 3 wheels brought to light this hazard. Or, more often, a person will recount the apparent instability they experienced when they rode their first trike as a youngster.

Unfortunately, all 3-wheeler vehicles are judged from these examples. True, the ATVs and the toy tricycles are 3-wheelers. However, they are also "trikes", a configuration that puts a single-steered wheel up front. This configuration is EXTREMELY DANGEROUS, in hard braking, cornering, or in potholed terrain. The hazardous condition is amplified by the relatively high center of gravity of these vehicles. Unfortunately, the manufacturers of these vehicles had no idea how badly the vehicles would be abused by their riders.

My statement was "a properly designed 3-wheeler can have an overturn resistance as good or better than most modern sedans" and I will stick by it. The three-wheeler I refer to is the "motorbike" configuration, where there are two-steered wheels up front. To work well, the track of the front wheels (distance between them) should be about 60% of the wheelbase (distance from front wheels to rear wheel) and 70-85% of the vehicle weight should be on the front wheels.n And, of course, keep this weigh LOW.

To conclude, while it true that one of three Dymaxion vehicles (Bucky Fuller's design) that rolled and killed an occupant mid-century was configured as a motorbike, my understanding is that it happened at extreme speed. Today, basic aerodynamics would label the Dymaxion's design as a "lifting body" which is great for space shuttles and pure folly for use with automobiles. Wheels, whether there are three, four, or ten, are useless when something goes airborne. Michael Hackleman

Dear Home Power, Home Power is a great hands-on resource quite different from the hype and hustle magazines from the days of subsidies and tax credits. Your articles deal with stuff that works from people that have done it, not just bought the T-shirt. RE may currently have a fairly small user-base, but there are many proponents that only need a little encouragement to try some applications. You guys provide that encouragement. M. Williamson

Thanks for the strokes. You've hit our mission right on the head. Oh, we'd also like to make our shirts available to our readers again in the future. The Crew

To the editors of Home Power:
Yippeeee! I got my first edition of HP and am enjoying it.

And then, Eureka! In the back pages I found a feature for electric dummies like me - Dr. Demento.

Thank you, HP, for thinking of "electrical negatives" like this reader who enjoys the alternate energy concepts but finds it a bit going as you are somewhat a technical manual at times.

Now I know what an ampere and a volt is. My wife and I have the definitions pinned on our energy-gobbling fridge/freezer, and now we've got it engraved into our skulls.

Now, we're awaiting the next edition of HP and our next lesson. Keep it coming. John Wright, Wiarton, Ontario, Canada

Glad you found the basic electric articles useful. We haven't had space to run another for two issues now, but we promise to keep on publishing ground-zero basic info. Richard Perez

What I like the most are the reproducible product tests - without all the hype and puffed-up claims being passed along. Just a "here's what we got it to do" approach; I love it. Your "TtW!" icon is truly appreciated. Your "shade-tree mechanic" technical explanations about why the difference in products is important makes HP a wonderful buying guide. Time-Life pubs. could take lessons from you.

I'm a physics researcher for NASA-Ames labs, so I really do appreciate things that really work. It isn't easy! Al Spivak, Berkeley, CA

Giving products the ole' fry and die test is one of my favorite activities. If we give a device the Thumbs UP, then you can be sure it is what its maker says it is. Richard Perez

We feel that your publication is excellent and we enjoy the obvious enthusiasm exhibited by all of those involved.

There is a great deal of firewood on the 45 acres where we live and we would appreciate an article or a referenced source concerned with steam power. Some introductory information on the feasibility, etc. of this technology would be great.

Your magazine already covers a lot of ground, but we do not recall anything about thermoelectric generators. Gold Ranch, Auburn, CA

Steam generation is something we are interested in covering. How about it, readers, is anyone out there doing it with steam? One reason you don't hear very much about steam power is that it's potentially very dangerous. A small mistake could create an explosion and serious burns. One resource we know of is Reliable Steam Engine Co., PO Box 671, Waldport, OR 97394, (503)563-2535. They have been working on a prototype steam-to-electricity turbine.

The only article on thermoelectric generation we've published was in issue #36, page 47 called "The Need for a Winter Energy Supplement." I have read in "In Review", an NREL publication, about advanced research being done on thermal-photovoltaic generators. They use infrared energy from a heat source to produce electricity. As this technology develops into something useful, we'll keep readers informed. Michael Welch

Things That Don't Work versus Things That Do
It would be really nice to see a consumer section in your magazine for actuality comments on products that don't get rave reviews. We've had some really BAD experiences with some of the new "wonder" equipment that has cost us lots of money and time - our friends have had similar experiences. We understand that your advertisers wouldn't appreciate you down-rating their goods, but could they really complain about a "Bummers & Bombers" section by your readers? Home power isn't all rainbows. Jerry Owens, Auke Bay, AK

Thanks for your feedback. We would like to hear about your bad experiences with equipment and manufacturers, because maybe there is something we could do to help you out. But, we do thank you for this opportunity to explain TtW! and why we don't publish the bummers:

Home Power tests renewable energy products and reports on equipment that works in the magazine. There is no charge for, or advertising requirements attached to, a "Things that Work!" test report. We conduct these tests as a service to our readers and to the renewable energy industry.

The criteria for passing the "Things that Work!" test are simple:

• The product must meet its maker's specifications.

• The product must last in actual service.

• The product must give good value for its cost.

If a product meets these three criteria, then it is a "Things that Work!" and will be written up in Home Power.

Any product passing "Things that Work!" testing is entitled to use the Thumbs Up logo in their advertising in Home Power or any other publication.

We do not publish negative reports. Our motto is: "If we can't say something nice, we don't say anything at all." We realize that our industry is growing and many products in the industry also have "growing pains." If a product doesn't meet the criteria, then we will tell only its maker. Many products have flunked their first "Things that Work!" test and come back again as winners.

"Things that Work!" testing is conducted in real life situations. The product is installed to the maker's specifications in a non-technical user's system. It is evaluated over a six week period. Next, the product is placed on the heavily instrumented system at Home Power Central. It is performance tested by technically aware people for at least two weeks. Our testing is rigorous, and when a product passes, our praise is generous. Richard Perez for the HP Crew.

Ocean Power

Dear friends, Thank you! Your response to our request for a donation to our inmate library was wonderful. You have sent us several back issues and the current issue of Home Power. I, and several other of the men incarcerated here, read, no, devour the information in your magazine. It is not only a breath of fresh air for us, but the simple yet innovative information you provide will help everyone breathe fresher air.

Prior to (and also after my incarceration) I built and lived on sail boats, sometimes thousands of miles from the nearest grid. Creating our own propulsion, and electrical power from the wind and sun is an everyday and a life long occurrence for my family and me.

While most of your information is aimed at people living ashore, there is a tremendous area for crossover of information and equipment. I read one article by a man who built a ferro cement house with beautiful curves and flowing shapes. Wire mesh reinforced concrete is a boat building technique. He also built a chest type freezer and refrigerator with 4" to 8" of insulation and an Adler-Barbour Marine Cold Machine as the compressor, evaporator, and condenser unit. This is all typical marine equipment and applications.

I am very interested in information on how to convert a mini-hydroelectric unit to marine use. It would seem to me that a boat moving at 5 to 10 knots (5 1/2 to 11 mph) and with a pickup about three feet underwater would be generating enough force to create a significant amount of low voltage power. I would appreciate communicating with anyone who has ideas or information on this subject.

Again, thank you for opening my eyes to Home Power. Jon Rosenthal, Garner Correctional Institution, Box 5500 Newton, CT 05470-5500

Get in touch with Jack Rabbit Energy Systems (see ad index this issue). They market tow behind hydros for sailboats and zero-head, high flow creeks. Richard Perez

This & That

Dear Home Power Crew, Greetings to all from the far North! (Yukon Territory) We've had a very nice winter so far, very warm, like today it is -18˚ C (0˚ F) and it had been warm like this all January. The sun is shining on our house again after a month's absence but some of our neighbors are still in the shade of a low hill to the south of us. RE is a little different for us up here, we burn a lot of sunshine that has been stored in solid form!

I have yet not received #43. Also, yesterday I picked up a nice empty HP envelope at the post office. It appears that the flap was not sealed and the mag. just slipped out.

We have gone with a Trace 4024 and the resulting 24 volt battery system. But we also had some 12 volt needs. I had seen the Vanner Voltmaster in catalogs, but when converted to Canadian dollars, the prices were outrageous.

I went shopping around and found a supplier with 24 V to 12 V power converters. There are a range of sizes, 2.5 A to 40 A in an "Industrial Power Series" as well as a "Communications Series" that has additional filtering, etc. for sensitive radio equipment. I purchased an Industrial Series 15 A model and it has worked perfectly for us. They are very will made with a neat, tidy aluminum case, 9" long by 4" high by 1 3/4" deep. Output voltage is constant with varying input, unlike the Vanner that gives you a varied output as the battery input changes.

The specs for model 1CT2412-15AS are (other models similar):

input voltage range	20 - 30 VDC
output voltage	13.8 VDC ± 300 mV
output current (continuous)	13.5 A
output current (maximum)	15 A
line regulation (20 - 30 V)	.06 VDC
load regulation (.5 A continuous)	.04 VDC
output ripple (maximum)	40 mV rms
over voltage protection	16 VDC
efficiency (minimum)	88%
temperature range	-50 - 150˚ F

(note, at 150˚ F continuous current must be derated by 30%)

I've not tried to measure the efficiency yet, but 88% minimum sounded good to me. How efficient is the Vanner? The bottom line is $134 Canadian, and at current exchange rates that's about $100 US. They are made in Canada by Innovative Circuit Technology Ltd., 9775 188th St. #402, Surrey, BC, Canada, V3T 4W2, (604)888-6304. It could be a candidate for TtW!

Now for a question: Why haven't you tested an Omnimeter? I've looked at amp hour meters for years. They all get pricey with the exchange rate, but for the cost and especially the features, the Omnimeter looks good. I kept waiting to see if you would test one but I had the opportunity to get a bit of a deal so I bought one. I'd still like to see what you think of it.

Thanks for all the good info and interesting stuff that HP is. Dan Reams, Watson Lake, YT Canada

Thanks for the great info, Dan. It sounds like you've found a winner in that DC to DC converter. Your missing mags are on the way. We apologize, but we all know that Stuff Happens (or in this case, un-stuff). Murphy's Law can be blamed when about 1% of our mailed magazines disappear.

About your question on the Vanner Voltmaster, our experience shows the efficiency to be 90%+, and that the RF noise in their circuits is very quiet.

There are some great choices out there these days for Amp-hour meters. One new one that is very reasonably priced is Cruising's new E-Meter. At less than $200 US it provides some neat new features.

There is a simple reason why we haven't yet reviewed the Omnimeter in TtW! Joe Bobier keeps adding great features, and essentially that makes it a moving target. So far, we can report that the meter works as advertised, and our test sites have been pleased. Michael Welch

Nickel-Iron Troubles

Dear Home Power Magazine, I would like to relate my experience with nickel iron cells imported from Hungary. I purchased 25 of these cells through Abraham Solar and I had them shipped to my homestead on the Yukon River in interior Alaska. I received the cells dry to save on freighting costs which were high because of my remoteness. I received the dry chemicals from Alternative Energy Engineering (AEE) and I mixed the chemicals following instructions to a T. I operated the cells for eight months, during which time I could never attain their 300 amp Amp Hr. rating. At about 200 A-hr (measured with a Cruising Equipment Amp Hour +2 meter), the voltage would drop on some of the cells to about 0.5 V and on others the polarity would reverse. Eleven out of twenty-five cells exhibited such behavior at a discharge of C/5. Thinking that the amp hour meter might be inaccurate, I load tested individual cells with a length of wire and a clock with the same results. Having been told that these cells require several cycles of high voltage and current, I used a gasoline driven welder to charge them. Results were the same: failure of the cells to maintain voltage under discharge. Mick Abraham set up a teleconference call with him, me, and the importer. The importer said if I returned the cells, they would refund my money. Mick refunded his portion of the money soon after I sent the cells back to the importer.

However, after many months and numerous calls from both Mick and myself, the importer still had not refunded my money. Mick and I finally said enough was enough and we both contacted the New Jersey Division of Consumer Affairs who finally forced them to pay up. I had to wait nine months and lost $1,200 on shipping and phone calls. Let the buyer beware!

So what am I using now for a battery? I'm using an 18 year old Exide lead acid engine starting battery which was given to me. Who says lead acids don't last and are messy? Not me. The efficiency of this old battery is much better than the new nickel irons. It is actually cleaner and uses less distilled water. Also, the voltage characteristics are in tune with my Trace. Nickel alkalines? Forget it. Give me an old lead acid any day.

In closing, I would like to report that Mick Abraham of Abraham Solar was very helpful and spent a lot of time and energy on my behalf. Also, Dave Katz of AEE gave me credit for the cost of the chemicals which were used. John Stam, Galena, AK

Wow, what a nightmare. It is valuable information for our readers who are considering using these batteries. Please see the system article on page 16 of this issue for another experience with these batteries. It is heartening to report on the excellent service you received from the two RE retailers you dealt with. Michael Welch

The Sun Shines on England

Dear All, Thank you for your dedication to producing a great magazine. It is good to hear all the news. How about more, lots more, homebrew projects.

Several points from Issue 45

Firstly, it would appear that you too are being forced into nuke power. Here in the UK, billions of pounds has been spent by the government subsidizing this madness even though back in '76 a Parliamentary White Paper by Sir Brian (now loved) Flowers concluded that "we should not rely for energy supply on a process that produces such a hazardous waste as plutonium unless thee is no reasonable alternative." If the vast amount of money had been spent on RE research we might well have had a breakthrough instead of what I term New Killer Fools.

Secondly, about EV Q&A on the Internet (HP #45 page 54 by Michael Hackleman). The Isle of Man readers and other UK readers might like to know that there is an EV society in Britain — The Battery Vehicle Society. The secretary is Mr. R.A. Pryor, Ringrose Pottery, 3 Blandford St. Mary, Blandford Forum, Dorset DT11 9LH, England. They publish several small books on conversion for those who wish to do away with the IC (infernal contraption) engine.

Keep up the good work and please, more do-it-yourself projects. G.P. Chayney, Bournemouth, England

Tax Credits for RE Sellback

Dear Home Power, After reading twenty-three issues of your magazine, I have come to appreciate your expertise, both technical and political. Robert Siebert's contribution to HP 45 gave me an idea I'd like to offer for debate.

Many urbanites, like Mr. Siebert and myself, have the economic resources for building small RE power systems that could cleanly and simply feed the grid, thus avoiding the problems and dangers inherent in batteries, et cetera. Just a few thousand of these systems would offset the need for the utilities to build yet another new plant complete with its toxic spewings or salmon grinders.

Unfortunately, altruism remains the only motivation available to folks wishing to do their part, not really enough to motivate serious investment dollars. What if a bit of practical legislation provided a more tangible reward to sweeten the deal? I suggest legislation that would let folks sell RE generated electricity to a utility grid and keep the proceeds, or a percentage thereof, tax free.

As I understood it the big 1970's push toward RE was prompted by the OPEC crunch and driven by installation tax credits. A big chunk of the purchase and installation cost of most any RE system could be written off, regardless of the system's efficiency or reliability. The result: overpriced clunkers flooded the market and made RE a profanity.

I see no such problem with my proposal. Letting folks reap the harvest of RE tax-free would motivate would-be investors to seek the most productive and reliable systems available. In essence, RE electrical producers on the grid would become "micro-municipalities", enjoying the same small but long-term return on their investments as those that put their cash in municipal bonds with tax-free dividends.

Mid-scale facilities could also be funded through such bonds. These installations might capture photons over space previously not cost-effective enough to be used, like over parking lots or big building roofs. Such urban installations would place the power source closest to the power consumers like major shopping malls and factories, reducing transmission losses.

The biggest factor in the scheme, of course, would be the utilities themselves, not known to wholeheartedly embrace altruistic action when it costs them dough. Why should they be forced to buy this power and provide the interlopers with potentially lucrative tax receipts?

To encourage their participation and cooperation, the scale of individual RE sites should not be limited. This way the utilities themselves can get in on the action, writing off future revenues from the wind farms and PV farms that paid for themselves years ago. This would give them ample reason to keep existing facilities humming right along and to consider future projects.

About the rates paid for the new power: to be fair, utilities should pay themselves the same rate as they pay out to the smaller contributors. Whether that rate is wholesale or retail makes a huge difference to all enjoying the tax benefit, of course; but even a tiny wholesale rate would start the program rolling. Also, the more smaller producers in the game, the more political torque available for the arm-twisting necessary to raise future wholesale rates.

I don't foresee much government resistance to such a plan, at least before factoring in utility lobbying. As far as I can tell, this is a fiscally conservative option, one that favors private investment rather than newly created bureaucracy and well suited to the tightwads sitting in DC today.

Given today's tiny number of small scale producers in the grid-intertie community, tax revenue losses would be inconsequential. Combine the amount of power sold by this community with making that money tax exempt and I doubt the feds would lose more than a couple hundred thousand bucks nationwide. (I admit ignorance when it comes to how much power money the big utility farms generate and could write off.) Even if the plan actually passes and takes off, the gross revenue Uncle Sam would pocket from the stimulated economic activity would dwarf any "loss" from power sale write-offs.

It sounds so simple to me, I feel it must have been tried and has failed, or has some huge flaw a novice like myself misses. You folks at HP have a far better sense of history and energy economics, so I ask: Could it work? Jim Dempsey, Seattle, WA

Well, Jim I think that the first step is a fair buy-back rate from the utilities. See the article on page 72 of this issue. California is proposing net billing. Utilities are facing nation-wide deregulation. Nothing seems for sure except sunrise. Richard Perez

Q&A

To Block, or Not To Block

Electricity at our remote vacation cabin is supplied by six Arco model M55 solar panels and for charge control we use a Trace model C-30. Because of trees, we get only a little over 2 hours of shade-free solar each day for a gain of about 30 Amp-hours. Increased charge efficiency would be welcome.

Our panels have blocking diodes and we have read that diodes are no longer used since they reduce panel output. Instead, panels are matched with charge controllers that have automatic night-time shut-off to control reverse current flow.

Can we expect increased charging if we remove the blocking diodes and replace our charge controller with a unit that has the night-time shut-off feature? We are considering changing to the Trace C-30A, in any case, because it can be switched to accept an equalizing charge. I realize that two hours is too short a time for adequate equalizing, but since the batteries are full when we visit our cabin, the charge would come on top of full batteries. Ned Vilas, Davis, CA

Hello, Ned. Chances are that the diodes built into your ARCO modules are bypass diodes, not blocking diodes. ARCO (now owned by Siemens) and several other major PV manufacturers place a small bypass diode in ever module's junction box. This bypass diode is connected reverse bias between the module's positive and negative output terminals. A blocking diode is wired forward bias in the module's positive output lead. A quick look inside your J-boxes will determine if your diodes are by wired for bypass or blocking. If you see the diodes connected between the + and -– terminals of the module, then they are bypass diodes. FYI, almost all diodes have a band printed on their negative (cathode) side.

Removing bypass diodes will not give you any efficiency increase. Bypass diodes protect a shaded module from illuminated modules when the array is partially shaded. Blocking diodes are "one-way" electrical valves that keep the battery's stored power from flowing back into the PV modules at night. Removal of blocking diodes will potentially increase the voltage delivered to the battery by about 0.5 to 0.8 VDC. Since PVs are essentially constant current devices, this voltage increase will manifest only when system's voltage is high. This means when the battery is just about fully recharged.

Since you didn't mention the capacity or type of battery you are using, I can't determine if your present charge control is what you need. With a limited solar window such as yours, I'd go for the C-30A and set the disconnect voltage at around 2.5 VDC per cell. This setting assumes a lead acid battery (6 series cells times 2.5 VDC per cell equals 15 VDC battery voltage). How much water does your battery consume? Water consumption is a very reliable indicator of under and overcharging. If you are having to add water to a cell every two weeks or so, then you are overcharging the cell. If you only add water to the cell every six-eight months or so, then you are undercharging the cell. Richard Perez

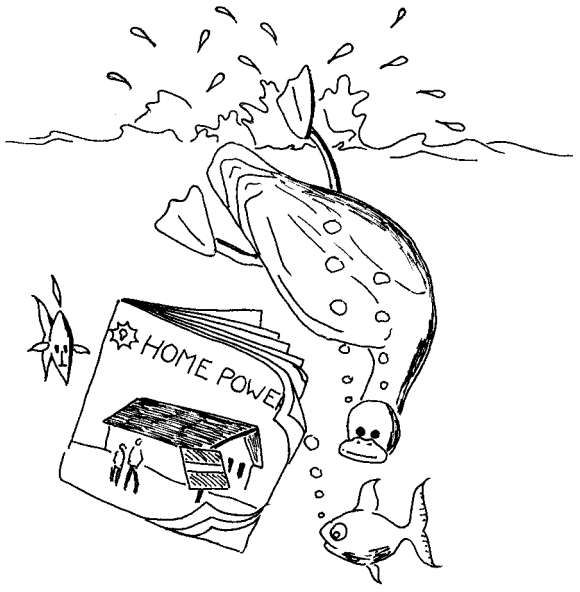
Switching To and From the Grid for Charging

I have a solar system with eight 51 W panels, a 2500 W Trace Inverter and an SCI 30 A controller. Our grid is available for 8 hours during the day. I find that if I have grid power during the day and the batteries are floating at 9 am, there is no solar charging as the charging light on the SCI goes off. This is a waste of solar charging potential.

Is there an automatic control switch available (or can it be built?) to switch the inverter from the grid when solar power is available and the inverter is on float mode and then back again when usage is above the solar panels' output? Phillip Wilson, Pétion-Ville, HaÏti

Hello, Philip. There are some problems lurking in your request. Consider what would happen if your system's load were just about equal to PV production. Here the electronic control could rapidly switch the inverter in and out of charger mode. This could damage the inverter and will certainly raise hell with any appliances on line at the time. Your problem is a little more difficult than just switching the inverter on and off of the grid because you are using the Trace's built-in battery charger. This charger transfers all the inverter's loads to the grid (or generator) when in charge mode.

I suggest that you use a separate charger and not use the one built into the Trace. The separate charger (I recommend the Todd or Statpower units) could be wired into the grid. The inverter would always be inverting and always be powering all the system's loads. Use a voltage sensing switch (like the Simple Switch from Photron) to connect the separate charger to the utility only when the battery voltage is low. This system would be user transparent. It requires no attention from the system's users. It will also make maximum use of your solar electricity. See the schematic on page 12 of this issue for a wiring diagram. Here Vladimir Nekola uses a Simple Switch to activate a Todd battery charger. Richard Perez



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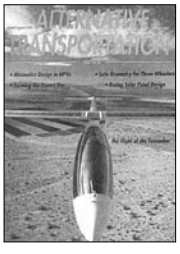

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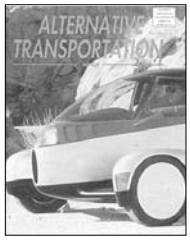

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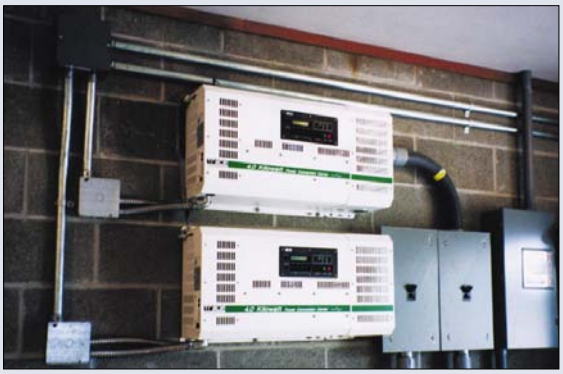

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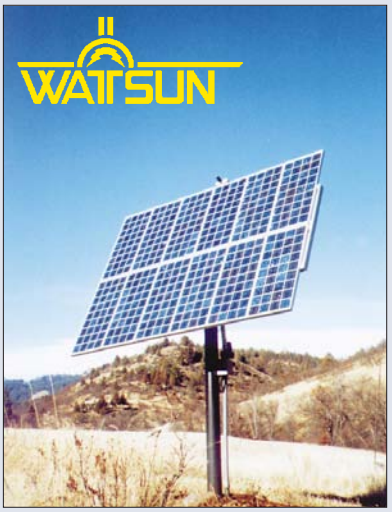

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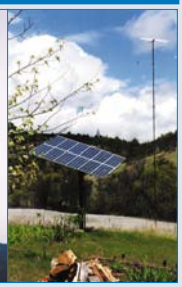

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